Fluidyne Archives

Articles

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- Magnetically Attracted Carbon Particles
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- Mega Class Project August 2005 Update
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- Mega Class Mk2 update December 2004
- The 'German Reports'

Fluidyne Gasification

Archive - Since 1976

These files are often referred to by Doug Williams in exchanges in the Gasification mailing list and the Biomas mailing list to which he belongs. Doug is the Managing Director of Fluidyne Gasification.

All the files can be downloaded by right-clicking them and selecting "Save target as". The diagram files are in standard jpg and gif format, and the specifications are Adobe PDF files produced using OpenOffice.org

Doug can be contacted by email at this address. He usually checks the mail at least once per day.

Diagrams

Specifications

Archives

Key Links:

Carbon Black

World War II Gasifiers

Forestry

Sweetwaters

Engines

Pacific Class

Wood to Char

Another day in paradise

Coppice Willow

Other Stuff

Letter from Vesa

Contact Doug

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Fuel preparation for commercial gasification projects, especially those of large size, has been a major problem for those seeking to change over to renewable biomass available from forestry activity. With only smaller fine chips from conventional plate or drum chipping technology, it is difficult to obtain a fuel chip specification to meet the needs of charcoal size in the packed bed of gasifiers.

I first saw the screw auger chipper sold as the Sasmo brand back in 1985, and have always believed this method could replace the traditional wood block fuel, and eventually in 2000, tested chips cut with a Sasmo in Northern Ireland. The chips were clean cut, critical to unrestricted flow movement, but very uneven in size due to the wood coming from storm damaged trees, mainly decaying. This created a lot of fines and dirt like material, causing unusual gasification problems. This was resolved by screening.

With fuel preparation the critical fuel supply issue, a recommendation was made to purchase the latest version of the Sasmo chipper, now redesigned and marketed as Laimet HP-25, www.laimet.com for our Californian project with CalForests. This development project will be reported separately. Tractor driven for these tests, the chipper is now being set up with it's own engine.

Given the rare opportunity to actually test out some of the lesser know facts of gasification fuel chip behaviour in a gasifier of know performance, provided positive experience for those attending, that I am sure will percolate down into other uses and needs for specification sized chip.

Chips are not easy to photograph in a way that truthfully convey size, but you can see the changes as explained in the text.

These tests were conducted in August 2008.

This is the HP 25 Laimet screw auger chipper located in California that was purchased to evaluate this method of fuel preparation specifically for gasification application.

Because we were testing four different species of conifer available from the collection region, The chips were blown into recycled fertilizer bags for separate gasification trials.

Having waited since 1985 to get to use one of these machines, the first log had to be signed off by all involved.

We tested three sizes of screw auger blades, and this is from the smallest blade.

Having the first log stick and stall due to our over cautious low RPM speed level, provided this photo of how the chip cuts develop using a screw motion.

Instead of lifting full length logs, we cut them into 5ft (1.5m) lengths for easier handling by hand. The finish site will incorporate equipment for full log handling. Each 5ft length took three seconds to chip.

These are the medium chip, and take note of

the average size, compared to the following differing species.

Medium chip, but smaller size range.

	Medium chip, again with differing size range.
	This is the business end of the Laimet Chipper, showing the small screw auger being changed. This took 1.5 hrs with quite a struggle

until we learnt the tricks not covered in the instruction manual. We changed the blades four times in ten days, but this is not normally done once in use.

The screw augers are shipped like this, in a cage that is used to return the augers back to the factory for total rebuilding. The blade edges are like razors, and very hard. The big screw is on the right, and medium on the left.

	This is the biggest chip size, and as you can see, it has a good chunky structure.
	The same big chip/chunk side on, showing

none of the linear fracturing commonly seen in small chips.

Changing species, the big chip/chunk changes it's size ratios, and shattering produces more fines. Wood moisture also play a big part in how the chip cuts.

From previous experience of fines in chip, we screened out the fine bark and whatever else fell through the screen. These fines always gravitate to the bottom of piles, and get picked up as a slug, causing a complete change to the staged char evolution in a packed carbon bed common to many gasifiers.

Note the oversized end chunks from the log. These too need separating

out as their char evolves at a differing rate to the average small chip

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Magnetically Attracted Carbon Particles

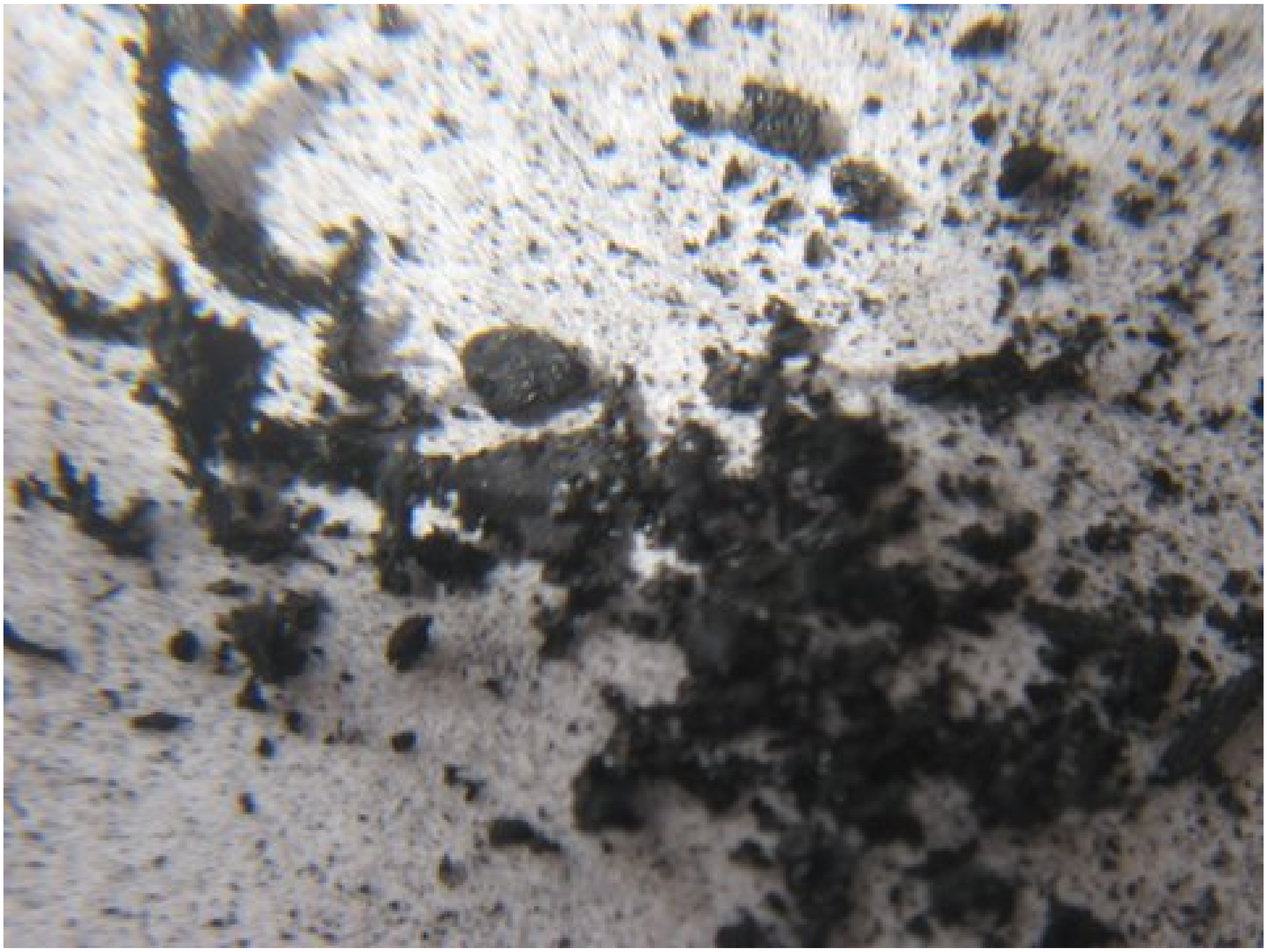
Discovered while conducting packed charcoal bed analysis of an Andes Class gasifier, some of the fine carbon dust located in the oxidation zone of the gas making process, were found to be attracted to a magnet. While unusual to see carbon sticking to a magnet, a number of explanations have been offered, with the most likely one, that trace elements such as iron migrate with the pyrolysis gases, and carbonize in the oxidation zone.

This is only a simple explanation, the truth is probably a little more complex. The photos tell their own story, and I can only apologise for my poor photography.

September 2008.

With the back ground dust

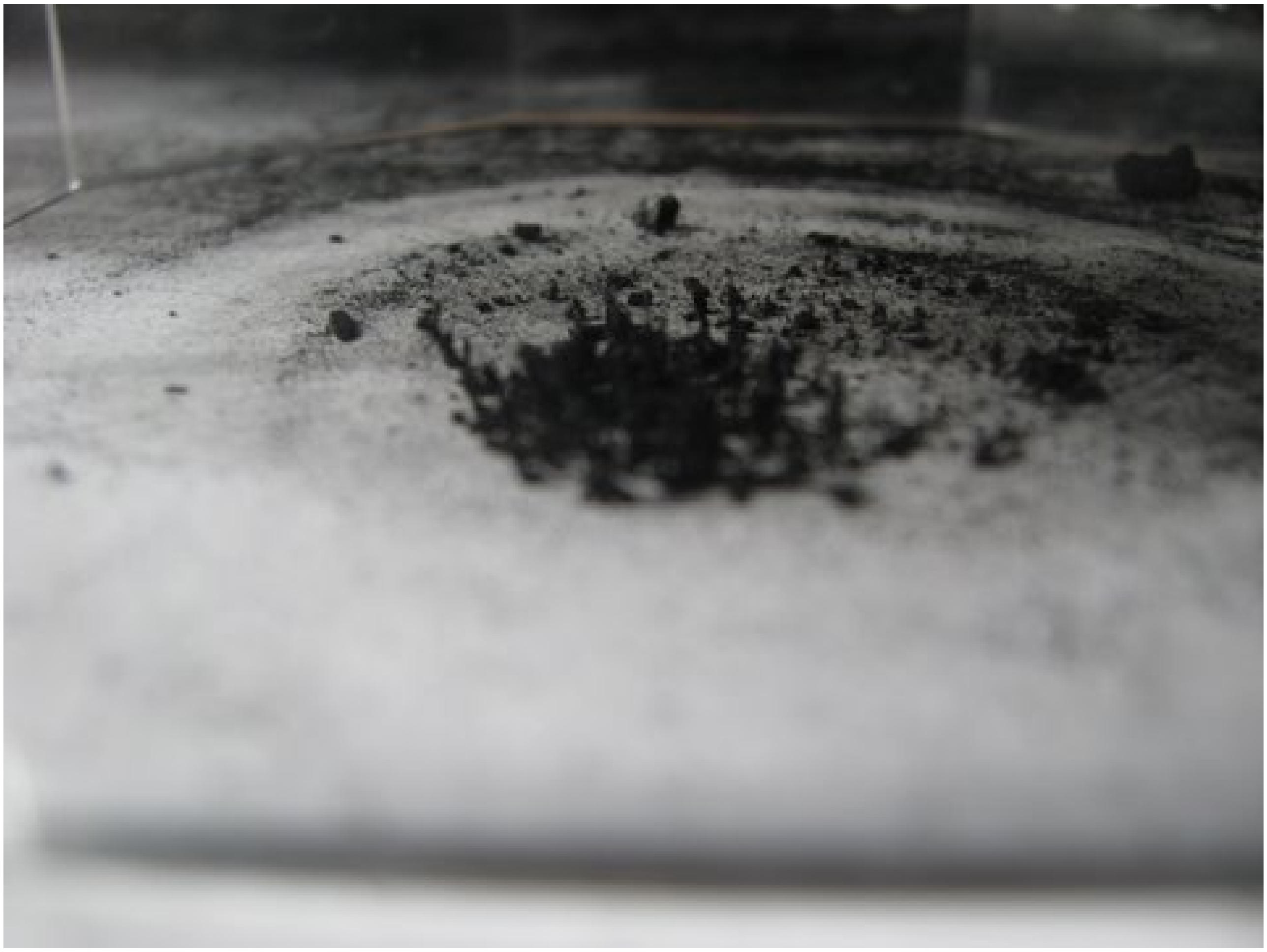
separated, the remaining particles join to form a miniature vertical carbon forest.



This shows the tiny blister like reflective nodules, which suggests this carbon is carbonized tar from the pyrolisis gases.

With the naked eye, these carbon trees looked like Pine, or Fir trees.

Very difficult to
get the 3D effect.

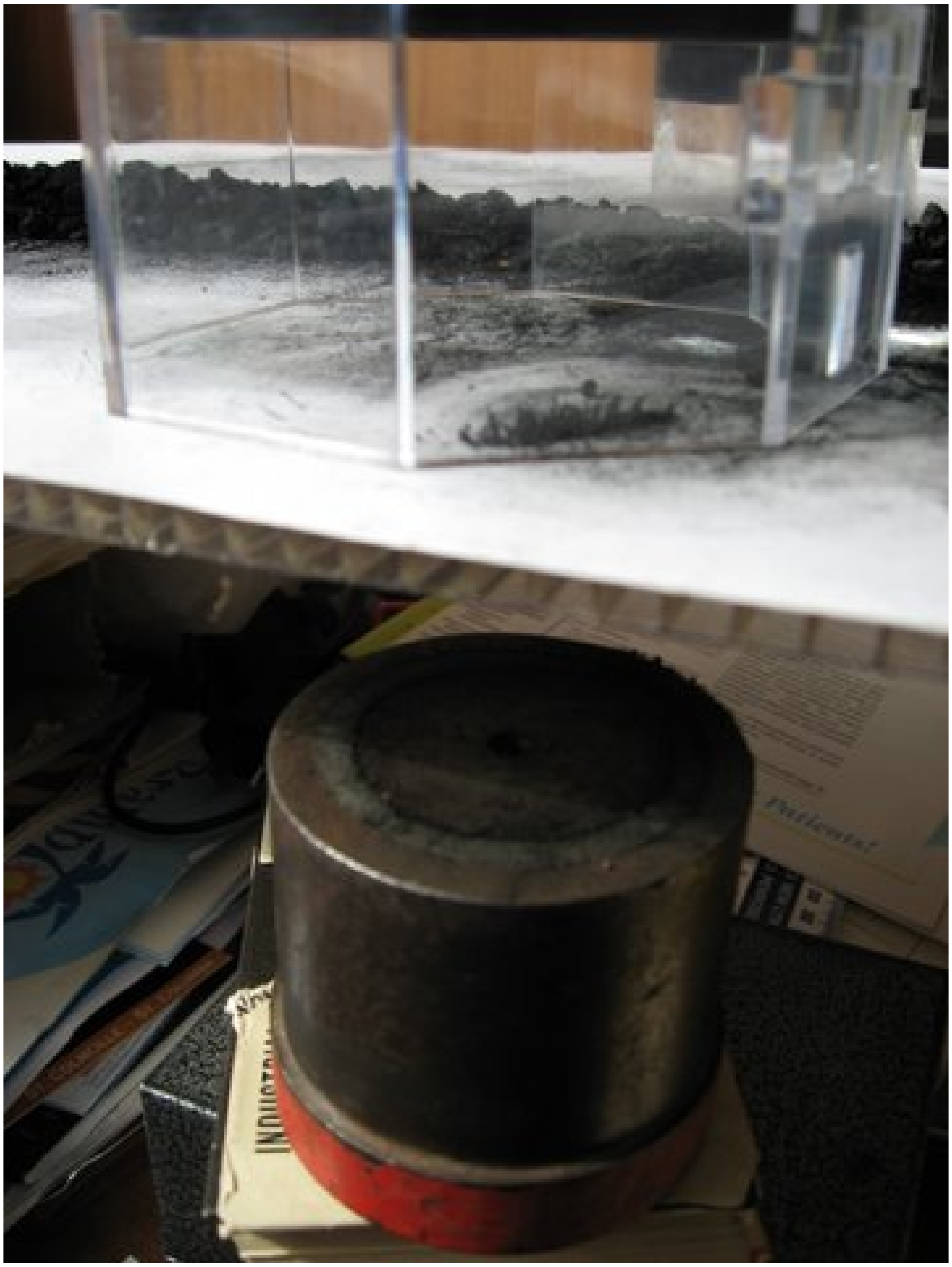


A side view through the container, shows the carbon trees standing.

A couple of rogue trees grow away from the main bunch!

Fuzzy, but just to show another view.

The magnet set



below the contained sample extracted from the mass in the back ground. Only a tiny proportion of the char sampled had this magnetic attraction.

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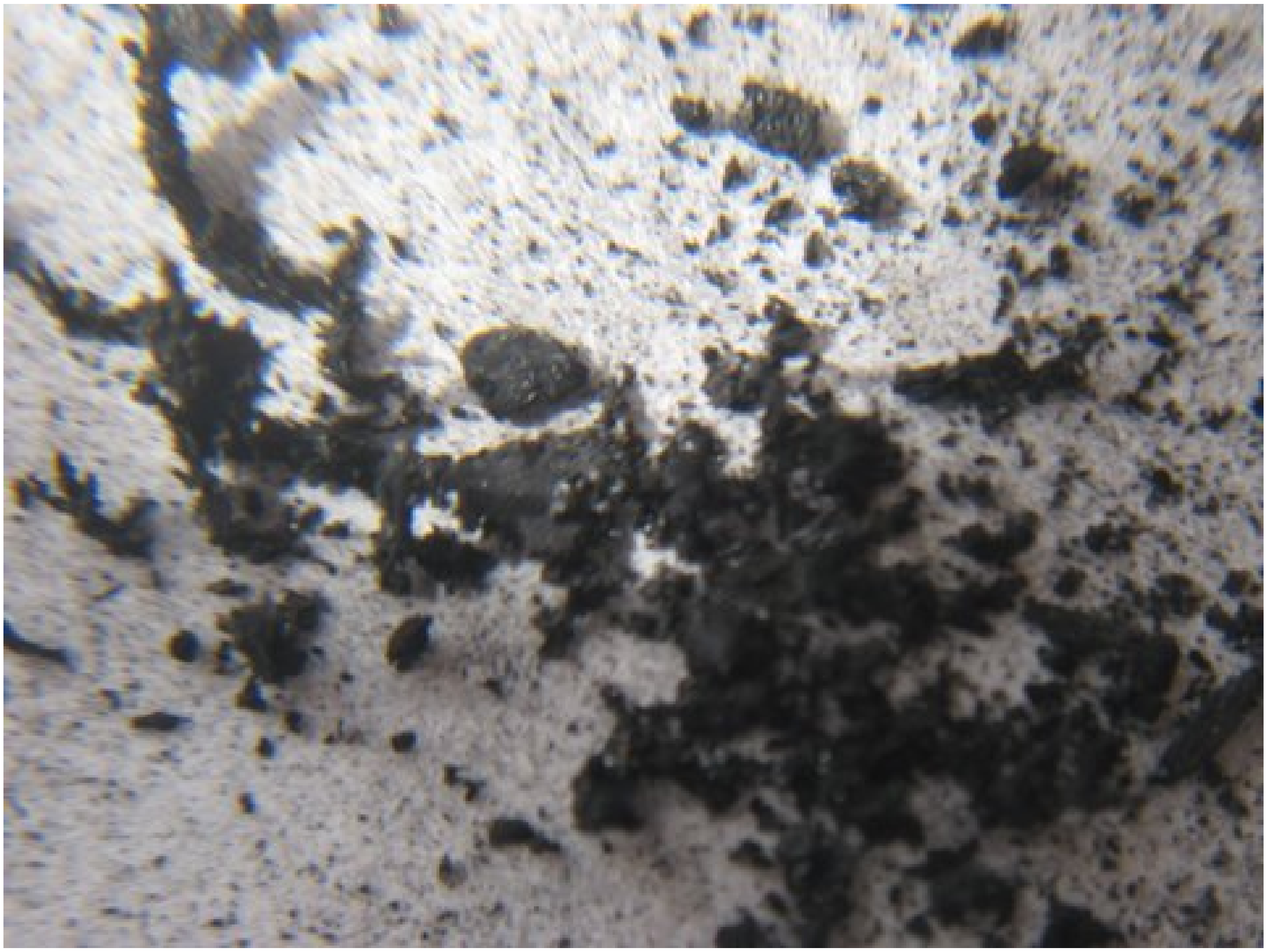

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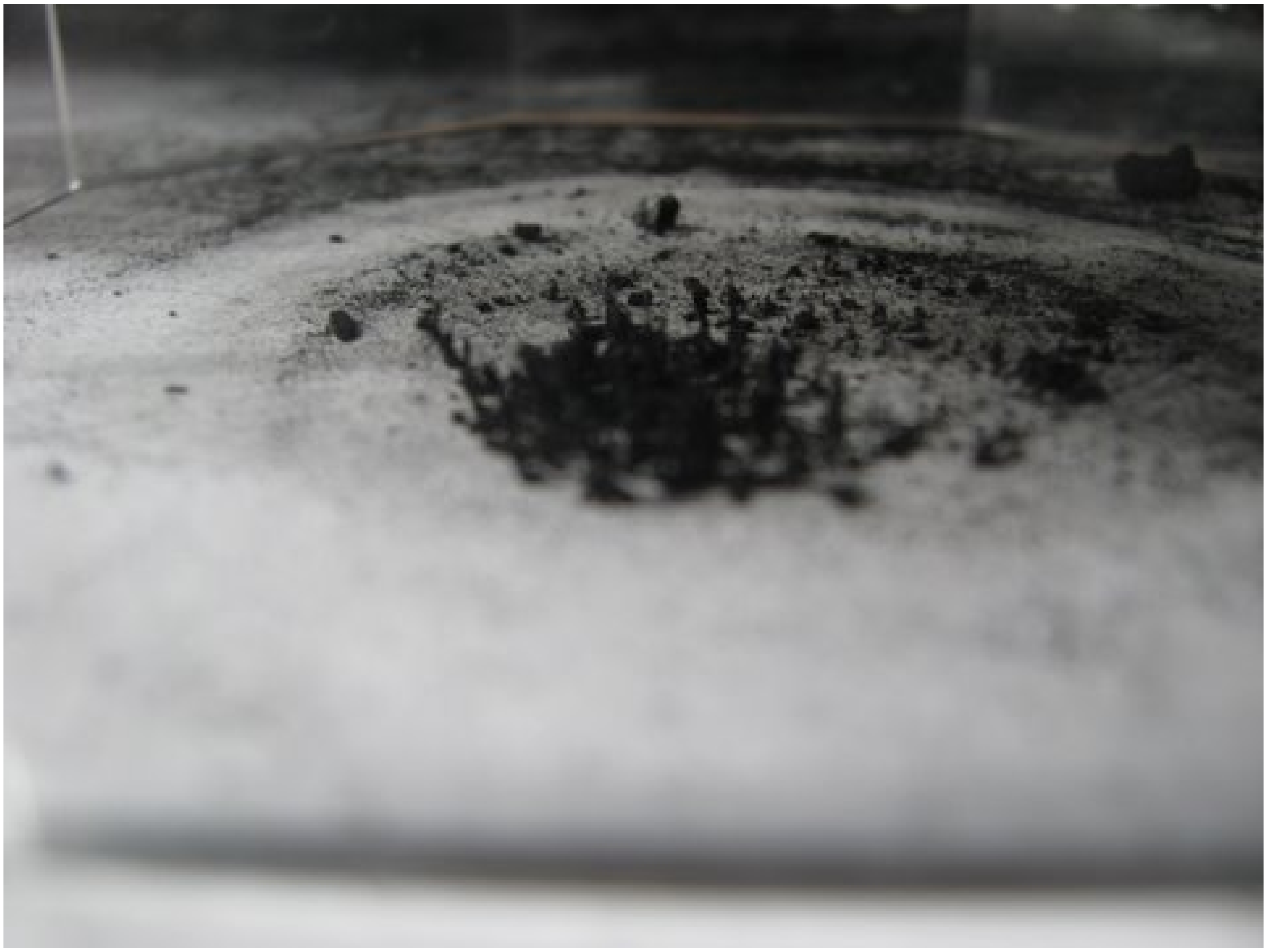

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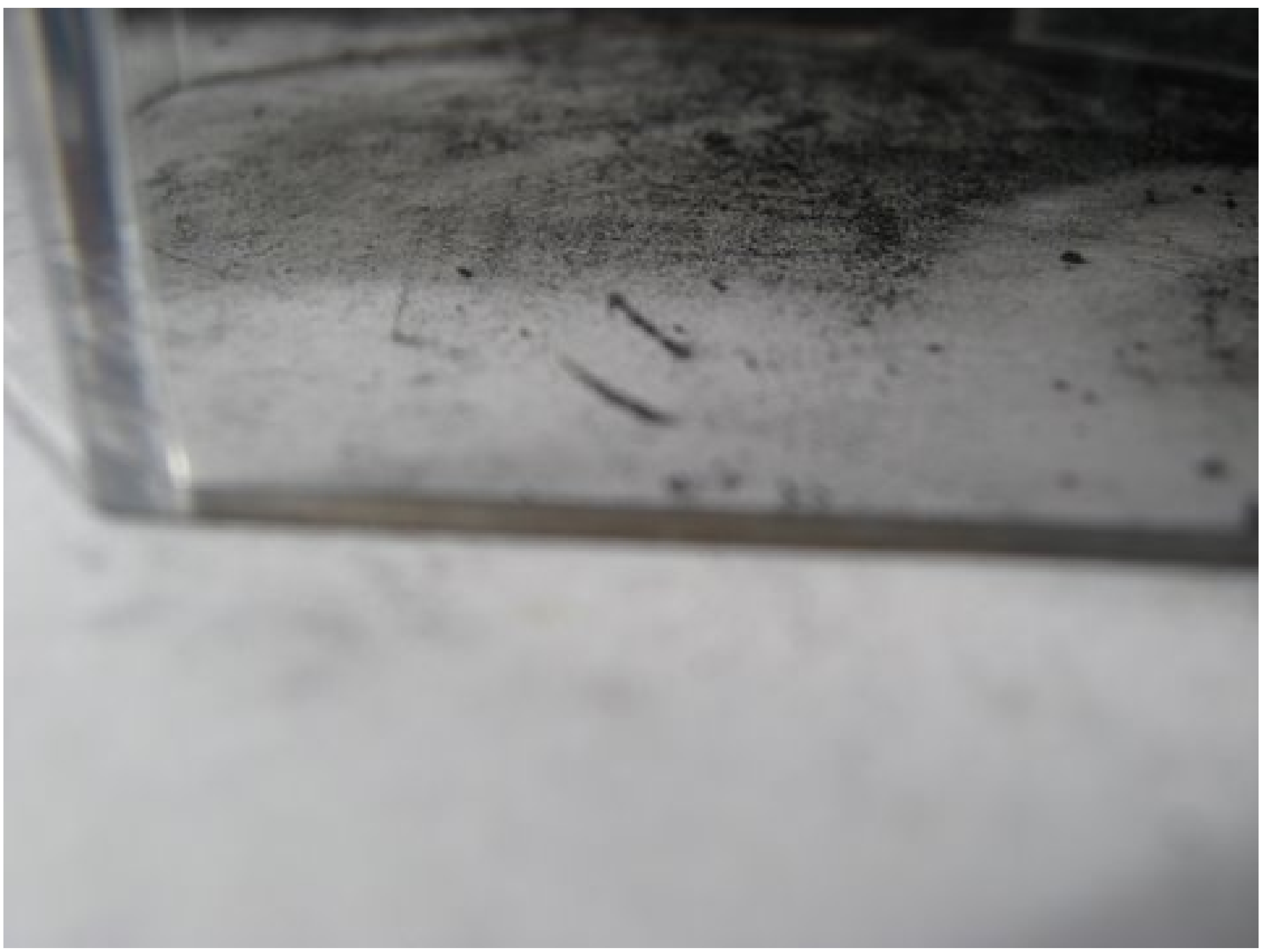

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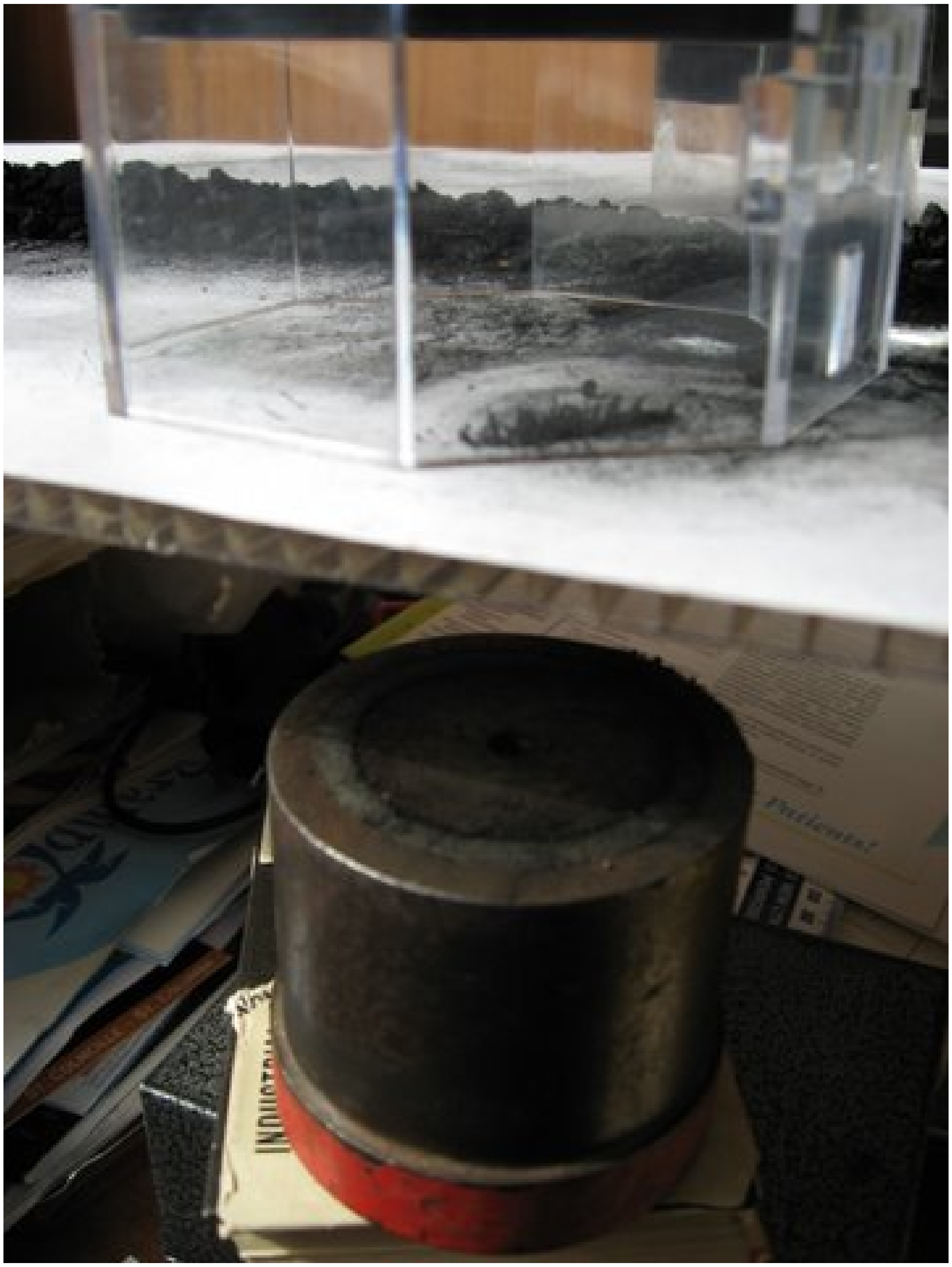

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MicroLab

In recent years, the interest in gasification has seen many researchers trying to set up projects for fuel testing, with equipment that is out of sync with the realities of applied gasification principles. Bench top testing of very small amounts of fuel, certainly provides useful information, but this often cannot be extended to apply to the realities of gasification on a usable commercial scale.

Small gasifiers are very rare to find from commercial manufactures, especially for raw biomass, as these sizes were proven to be more suited to charcoal fuels, and this project showing the Microlab gasifier, was prepared as a special favour to add a gasification facility to the University of Ulster, Northern Ireland. It is set up to enable the gas to be blown out hot with only cyclonic cleaning, or pass through a separated second cyclone and gas cooling cleaning system that can be used to run an engine of about 1 litre cylinder capacity (at 1500 rpm). As a micro gasification process, the small dimensions behave exactly as the larger systems, but still must conform to fuel specification in relation to the set parameters. As an opportunity to study gasification at this level, it provided me with a rare chance to compare charcoal and wood at a manageable level, and my own research stumbled a few steps forward during the proving trials.

Gasification gives up it's secrets very reluctantly, and it is my hope that this gasifier will assist to provide a new generation of informed people who choose to pursue this technology from an informed base line. Size might create the impression that it is perfect for domestic application, but that will be for others to decide, as a market cannot be developed building these one at a time. Having built this system to meet the evolving expectations of a modern World with regulations etc, it will provide a safe and reliable tool for many years to the students of Ulster University.

Specifications:

Gasifier Type.	**Downdraft (throated tar cracking)**
Maximum Output.	**9.8Nm3/hr**
Maximum Fuel Consumption	**4.5 kg/hr**
Fuel Hopper Test Volume	**3 litres**

Test Time Duration **20 minutes**

Front view showing the cabinet enclosure of all hot components, with basic instrumentation of three manometers and digital thermometer.

Interior components R-L Gasifier, Blast tube, Twin Cyclones with single soot pot (changed to separate pots later)

Rear view showing sawdust filter and main gas cooling fan.

Hot air exit, and air supply hoses to test flare nozzle, which acts as aspirator for suction ignition of hearth module

Test flare nozzle, showing hot gas suction aspirator under nozzle actuated with low pressure air, and tangential combustion air into nozzle.

Ready for testing inside building, shows that the instrument panel swings around to suit position of operator. Manometer hoses are concealed in pipe support.

First time ignition shows the classical

incandescent oxidation zone. While this indicates correct temperatures, it is only one factor of making a tar free gas

First gas, but camera flash killed the moment, but you can just see it against the back ground of the door.

As our day was long, this shot at night shows the test flare burning with all the fine particulate, which due to a glitch, the hot cyclone ejected.

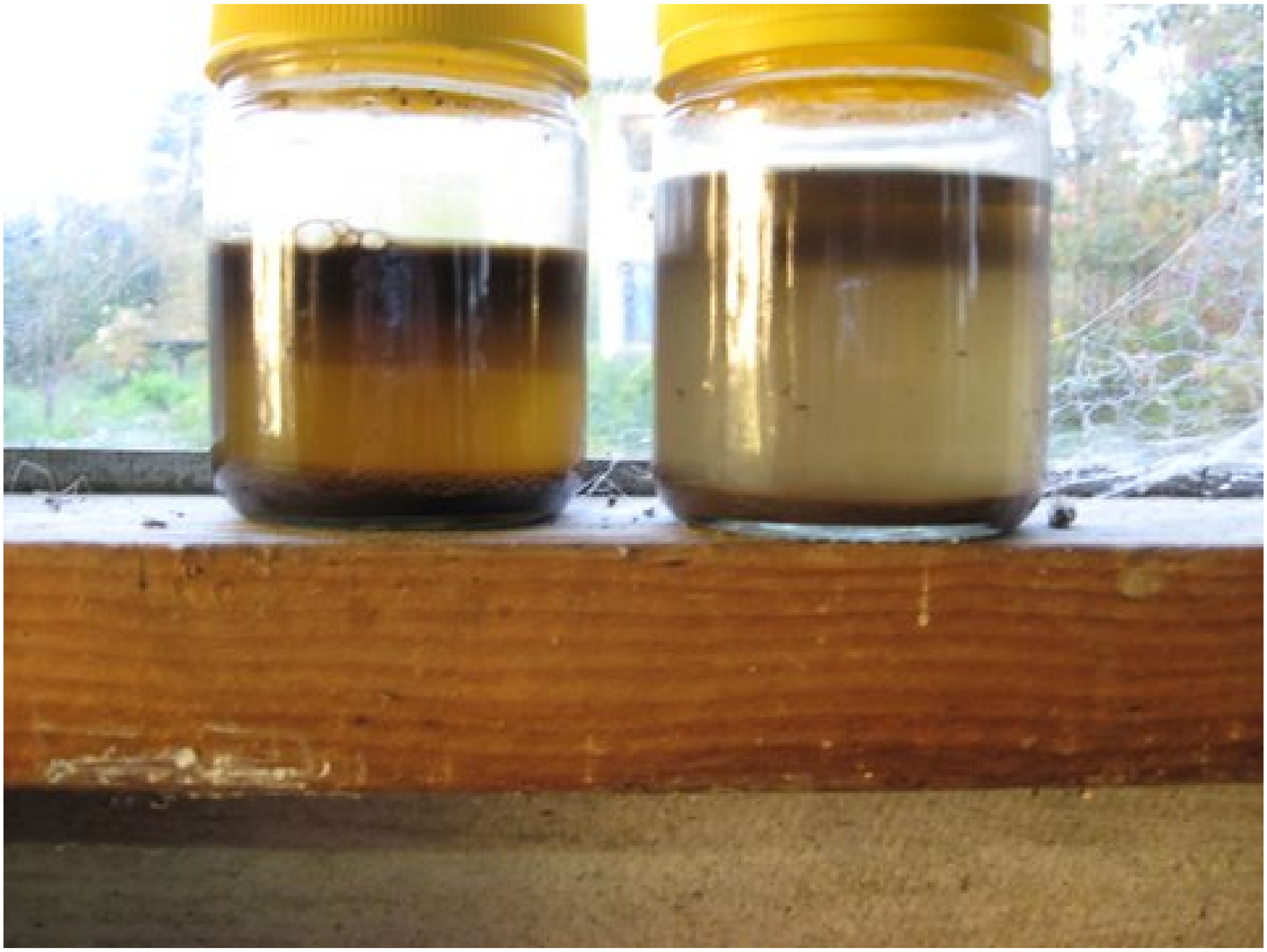
The dust ejection was fixed by separating the cyclones from a single soot box, into separated boxes

Now free of dust, the test flare has lost the red ting of burning soot. The temperature was pretty steady (+ or - 10C) over all tests at just under 700C.

As the first tests were also

to test the gas cooling, the dust ejection also went into the condensate resulting in this very black sample.

The first black condensate sample is on the left after a couple of days to settle. The sample on the right is after the soot boxes were fitted, and has only been standing one day. Both samples are particles in

	suspension which will settle out, not toxic black liquor which has hydrocarbons in solution. The brown colour comes from dissolved ash, giving the aqueous condensate a pH of 8.2
	The fuel for this size of gasifier can be thick small chips, or these sugar lump size sawn and chopped blocks. It is important that the charcoal formed is from a size that can carbonise, oxidize, and reduce as it shrinks in volume, without closing the interstitial space of the

	packed bed.
	This final photo shows the char as it changes both volume and size as it passes through each stage of this gasification process.

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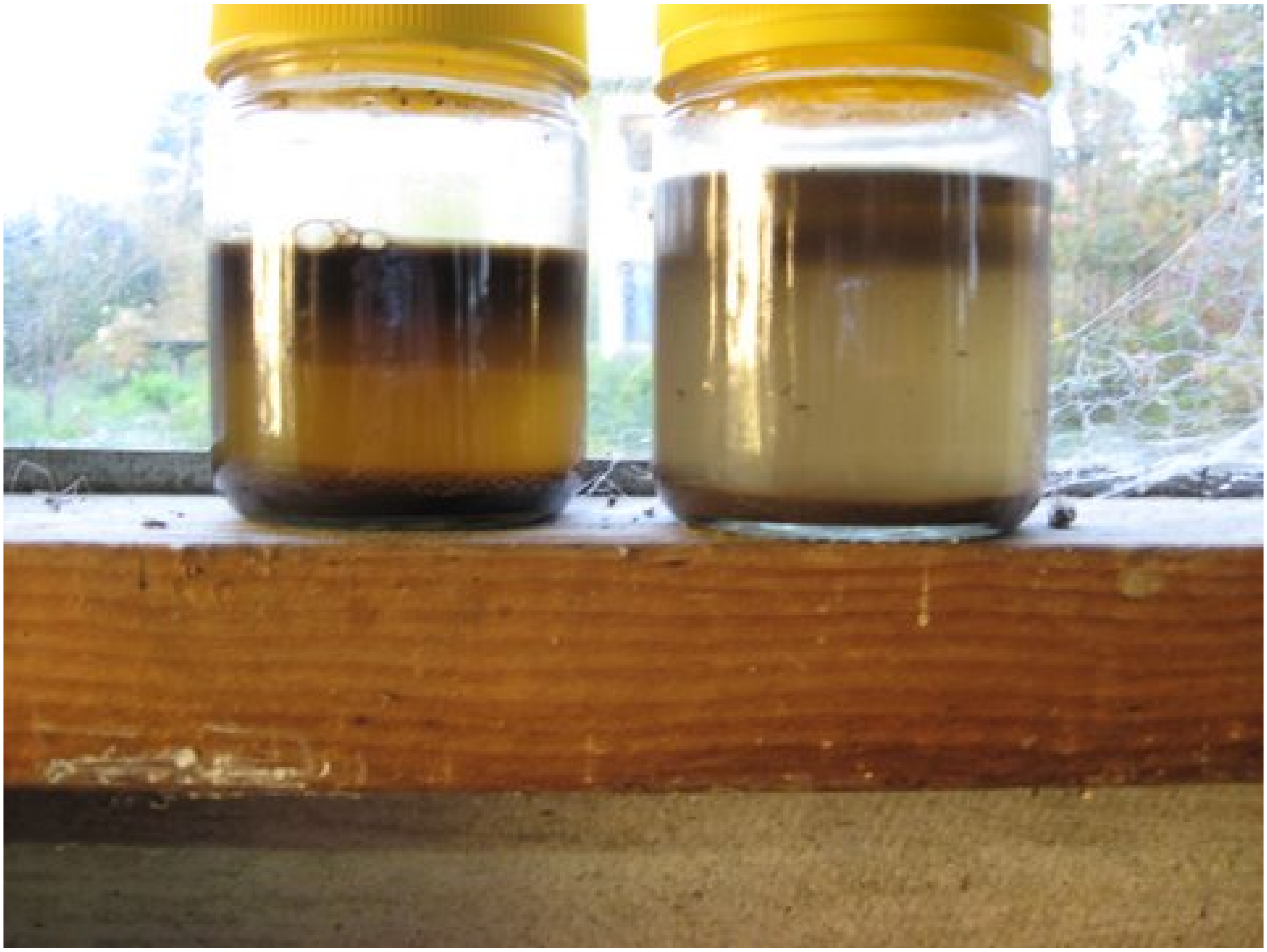	suspension which will settle out, not toxic black liquor which has hydrocarbons in solution. The brown colour comes from dissolved ash, giving the aqueous condensate a pH of 8.2
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Chile Gasification Testing

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When Douglas Diaz of Creapor SA. in Santiago Chile requested my assistance to assess gasification in April 2007 (See, Gasification comes to Chile), I agreed to provide Fluidyne Technology to explore the potential market applications using larger gasifiers. The following photos show some of the activity during my visit April 2008 to test the larger gasifier, which has been given the identification of the "Andes Class", in keeping with the regions for which it has been designed. The gasifier was constructed within a three week period, prior to my arrival.
In the test situation, none of the automation was fitted, although the internal mechanisms were in place, and could be, and were operated manually. This allowed an evaluation to be made to adapt locally available technology to these systems, and to provide operating experience as to why systems can be both beneficial or detrimental to a gasifiers operational reliability. It also enables a manufacturer to be tested on the level of understanding to each modal of technology transfer.

When conducting operator training programmes with the gasifier, first the manufacturer, then key company staff, are given a written and practical test, again in modular format, providing a capability to then work without direct supervision regarding the gasification process. Previous experience has proven that gasifiers supplied without training support, is a waste of time and investment to all concerned.

In providing this project profile, I have taken the opportunity to show how fast wood can turn into charcoal reducing in size, only as it begins to enter the oxidation zone, which in this blown gasifier, is slightly above the air nozzles. No raw wood should be seen in the oxidation zone, as the amount of endothermic heat needed to drive the gas making process, can only be achieved from a packed charcoal bed. Many incorrect descriptions exist of this process from wood to charcoal in a downdraft gasifier of this type, so take a minute to appreciate how critical this is to making a tar free gas. At full output of about 300kWt, the flow rate of fuel through this zone is 2kg/minute.

Also tested for the first time (by ourselves), was a ceramic combustion chamber concept of the "Cyclomix Burner", we developed for producer gas application. It was sized at only 25% of the gas output, so use your imagination to see four of these blocks all burning at the same time. The ceramic component concept is not new, but is an area of expertise that this company can add, providing a wider application for producer gas heating. This was only a test of concept, which considering the gas had no dust cleaning systems, burnt very cleanly without odour or smoke during the testing. Smoke does appear when producer gas is combusted, where high levels of CO_2 are in the gas before combustion.

Of special mention, the fuel wood preparation. It was an excellent use of my time to cut the wood blocks for these tests, having manually cut many tonnes during the last 32 years. It is not a waste of time where rural jobs are few, and incomes are desperately needed, where cut dry wood becomes a valuable local resource for gasified installations. Fuel wood chips specifically appropriate for gasifiers do not exist in the wider context of wood chipping, and is an ongoing priority in the work that I am associated.

The company Creapor SA. also manufacture hot water boiler heating systems, for which they have an active development programme, as well as an assembly line for popular sizes. They have allowed me to show you a couple of photos during factory testing, which was interesting for me to see a real gasifying type combustion process in application.

Doug Williams.
May 2008.

	IMG_0189.jpg 1. When there is no

prior experience of preparing gasifier fuel, there is only one way to begin, using basic manual labour, mine in this case.

	IMG_0188.jpg 2. After the logs are axe split into billets, a tungsten blade tip saw cut the blocks to a mixture of sizes.
	IMG_0076.jpg 3. The finished fuel had

	a bulk density of about 350kg/m3, average for block Eucalyptus fuel dry, ready for gasification.
	IMG_0043.jpg 4.

Checking the gasifier components before final assembly. This workshop works to ISO 2000.

	IMG_0064.jpg 5. Final assembly checks before painting and testing.

IMG_0253.jpg 6. Ready for testing with temporary removable start-up hose.

IMG_0256.jpg 7.

New design of ceramic combustion chambers were also being tested for this development programme. The hanging ball is the weight to hold the fuel lock closed during manually operated test programme.

IMG_0211.jpg 8. First start-up was in cold foggy conditions (10C), Ignition was 7 seconds, and first gas within 1.5 minutes.

IMG_0219.jpg 9.

First test is to check colour of oxidation zone, which shows desired colour like the sun.

IMG_0216.jpg 10.

First gas billowing out, and undergoing "sniff" test for odours. This is not a joke comment.

IMG_0205.jpg 11. Looking directly down the central combustion nozzle after combustion air added.

	IMG_0208.jpg 12. Douglas Diaz on the left, Doug Williams on the right, obviously happy with first test.
	IMG_0227.jpg 13. This is the fuel

150mm above air nozzles. Note char outer ring, and raw wood centrally. At full output, the fuel consumption is 2kg/minute.

IMG_0228.jpg 14. At 75mm above the air nozzles, the outer char ring increases,while the central raw, or torrified wood area shrinking.

	IMG_0229.jpg 15. At 50mm above the air nozzles, the raw wood has almost completely turned to char.
	IMG_0231.jpg 16. At 24mm above the air nozzles the

	central bed was almost complete charcoal, and at the air nozzle level, all 20mm beads of charcoal. This photo was missed due to flat camera batteries.

	IMG_0240.jpg 17. This is the first view of the waste char, which is low grade activated carbon. the amount depends on how the system is set to serve the end function of the gasifier.

	IMG_0244.jpg 18. With fines sieved out, it can be used as start-up char after any servicing that requires bed clean-out. Correctly sized char is important for first start-ups.
	IMG_0091.jpg 20.

	The company also designs and builds a variety of hot water heating boilers.
	IMG_0068.jpg 21. Two sizes of domestic heating boilers being tested during my visit.

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Also tested for the first time (by ourselves), was a ceramic combustion chamber concept of the "Cyclomix Burner", we developed for producer gas application. It was sized at only 25% of the gas output, so use your imagination to see four of these blocks all burning at the same time. The ceramic component concept is not new, but is an area of expertise that this company can add, providing a wider application for producer gas heating. This was only a test of concept, which considering the gas had no dust cleaning systems, burnt very cleanly without odour or smoke during the testing. Smoke does appear when producer gas is combusted, where high levels of CO_2 are in the gas before combustion.

Of special mention, the fuel wood preparation. It was an excellent use of my time to cut the wood blocks for these tests, having manually cut many tonnes during the last 32 years. It is not a waste of time where rural jobs are few, and incomes are desperately needed, where cut dry wood becomes a valuable local resource for gasified installations. Fuel wood chips specifically appropriate for gasifiers do not exist in the wider context of wood chipping, and is an ongoing priority in the work that I am associated.

The company Creapor SA. also manufacture hot water boiler heating systems, for which they have an active development programme, as well as an assembly line for popular sizes. They have allowed me to show you a couple of photos during factory testing, which was interesting for me to see a real gasifying type combustion process in application.

Doug Williams.
May 2008.

IMG_0189.jpg 1. When there is no

prior experience of preparing gasifier fuel, there is only one way to begin, using basic manual labour, mine in this case.

IMG_0188.jpg 2. After the logs are axe split into billets, a tungsten blade tip saw cut the blocks to a mixture of sizes.

IMG_0076.jpg 3. The finished fuel had

a bulk density of about 350kg/m3, average for block Eucalyptus fuel dry, ready for gasification.

IMG_0043.jpg 4.

Checking the gasifier components before final assembly. This workshop works to ISO 2000.

IMG_0064.jpg 5. Final assembly checks before painting and testing.

	IMG_0253.jpg 6. Ready for testing with temporary removable start-up hose.
	IMG_0256.jpg 7.

	New design of ceramic combustion chambers were also being tested for this development programme. The hanging ball is the weight to hold the fuel lock closed during manually operated test programme.

	IMG_0211.jpg 8. First start-up was in cold foggy conditions (10C), Ignition was 7 seconds, and first gas within 1.5 minutes.
	IMG_0219.jpg 9.

First test is to check colour of oxidation zone, which shows desired colour like the sun.

IMG_0216.jpg 10.

	First gas billowing out, and undergoing "sniff" test for odours. This is not a joke comment.

	IMG_0205.jpg 11. Looking directly down the central combustion nozzle after combustion air added.

	IMG_0208.jpg 12. Douglas Diaz on the left, Doug Williams on the right, obviously happy with first test.
	IMG_0227.jpg 13. This is the fuel

	150mm above air nozzles. Note char outer ring, and raw wood centrally. At full output, the fuel consumption is 2kg/minute.
	IMG_0228.jpg 14. At 75mm above the air nozzles, the outer char ring increases,while the central raw, or torrified wood area shrinking.

	IMG_0229.jpg 15. At 50mm above the air nozzles, the raw wood has almost completely turned to char.
	IMG_0231.jpg 16. At 24mm above the air nozzles the

	central bed was almost complete charcoal, and at the air nozzle level, all 20mm beads of charcoal. This photo was missed due to flat camera batteries.

IMG_0240.jpg 17. This is the first view of the waste char, which is low grade activated carbon. the amount depends on how the system is set to serve the end function of the gasifier.

IMG_0244.jpg 18. With fines sieved out, it can be used as start-up char after any servicing that requires bed clean-out. Correctly sized char is important for first start-ups.

IMG_0091.jpg 20.

The company also designs and builds a variety of hot water heating boilers.

IMG_0068.jpg 21. Two sizes of domestic heating boilers being tested during my visit.

Fluidyne Gasification
Archive - Since 1976

Mega Class Emission Report

Since we began this project in Winnipeg, Canada, to scale up the traditional way of making a tar free gas for engine applications, we have tried to keep the wider public informed on progress.

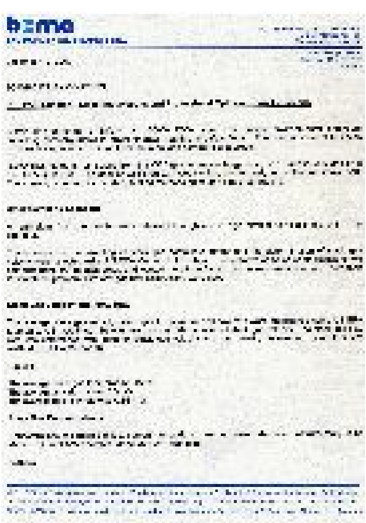
Unfortunately, it has been necessary to enforce an embargo on releasing information about the development programme, due to it being presented by others as their own work. The critical technology is not always the most obvious, the gasifier design, or the fuel that it converts into gas.

During my visit to Winnipeg in July, 2006, emission testing was able to commence in a very controlled manner. For the first time, the whole gasifier system and the gas it conditioned, was put to the test, and we are pleased to share the results. These are "Certified Results", and achieved with a system that has no filtration system of any description, but is cooled to nearly ambient temperatures before controlled combustion in the testing facility.

This is encouraging, and I can reveal that the 2008 programme should improve these results. The next phase is to extend the traditional gas making capability, but using lower value woody waste, that are normally excluded for high performance gas making.

For the many waiting for these Mega Class reports, I thank you for your interest, and patience. We have only one chance to do this right, and it's better to work in our facility, than learn on the job at your expense. If in your search for gasifiers, you are given emission reports to support the supplier, you would be well advised to check with the source who conducted the tests. This prevents fraudulent documentation being presented, and reduces your risk to project failure.

Doug Williams.
February 2008



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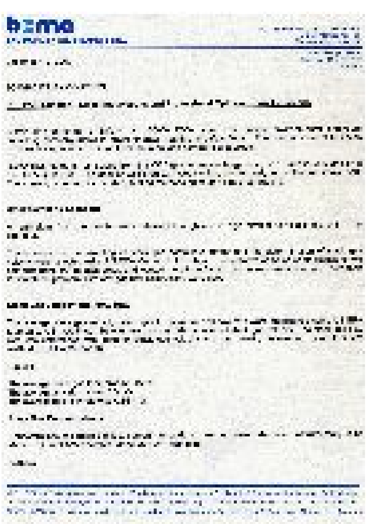

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Engine Tables Spreadsheet

Gasification Colleagues,

When the original Fluidyne Engine Tables were compiled by Jack Humphries back about 1978-9, they were to provide the user with a guide, as to how the engines at that time performed on Producer Gas. It simplified the mass of calculations that required inputs not readily available to those investigating engine powered generation, and as such, have proven to be reliable to this very day.

Now, nearly 28 years later, the original Tables have been given a new life, by Dr Oscar Jimenez, who has added additional features to help those interested in the evaluation of gasified engine power generation. It is not often that this type of information becomes available, free for public use, and I am pleased that I can assist Dr Jimenzes by making his Spreadsheet available on the Fluidyne Archive www.fluidynenz.250x.com

Like anything that will be used across a wide sector of people interested in renewable energy research, there will be questions regarding it's accuracy etc. Please direct all comment or inquiry to Dr Jimenez directly, oscar@geprop.cu and not through me at Fluidyne.

Doug Williams,
Fluidyne Gasification.

INTRODUCTORY WORDS TO THE TOOL

Dear Gasification Colleagues.

I am pleased to offer to the gasification community a simple tool aimed at assessing technical pre-feasibility studies of biomass gasification engine powered systems.

The tool, which has been set up on Excel spread sheet format, is based on the Engine Table from Fluidyne Gasification, New Zealand. www.fluidynenz.250x.com Each engine, depending on its rpm value, is modeled on a separate sheet.

In order to assist the gasification community, in having a tool capable of helping in assessing technical pre-feasibility analysis, it has been enhanced, by adding some further outputs such as:

- Gas engine efficiency
- Dual fuel engine efficiency
- Diesel replacement (liter/h and %)
- CO_2 offset.

These added outputs stem basically from integrating the original Engine Tables with other equations and data obtained from reported experiences and literature.

Diesel replacement is reported in two units providing choice of assessing how much diesel is saved, in dual fuelled engines, depending on how the information is to be used.

As you will see the tool allows the end user to handle basically two input data:

- The engine swept volume.
- Low calorific value of the gas exiting from gasifier.

The first input, of course, follows the same strategy previously defined by the Fluidyne Engine Table calculations, and the second added by myself. This allows a variable calorific value of producer gas to be taken into consideration, making this tool a little closer to real world gasifier functioning. When using the tool the author suggests first, to input gas calorific value and then, analyzing output of varying engine swept volume for a defined engine rpm.

Finally, I would encourage the gasification community to send comments, suggestions, or correction to help improving the tool.

Thanking you in advance.

Kindest regards.

Dr. Oscar L. Jimenez.

Energy Project Manager.

Centre for the Management of Information and Energy Development.

Phone: (537) 2027096, (537) 2061507

Email: oscar@geprop.cu

Download the spreadsheet here (right click and Save As...)

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Gasification Comes to Chile.

When enquiries are received At Fluidyne for Gasification Technology, generally it is a half hearted enquiry, with expectations of a wonder machine to convert any combustible material into a high quality fuel gas. Unfortunately the literature can create this impression, as many researchers report on gasifying strange fuels, but do not qualify this by saying, that it is not possible from a commercial perspective. Usually after a few letters are exchanged, the interest fades away, when the recipients realize that they are required to make it happen, if at all, for their situation, in that country.

Each country is surprisingly different in it's expectations of how gasifiers might fit into their energy equations, and then there is a very differing situation on the level of technical support for a gasifier that might require sophisticated servicing requirements. With this in mind, I am pleased to report on how an individual in Chile, handled my decline to supply ready made gasifiers for his perceived need in Chile.

After we exchanged a few letters with Douglas Diaz in Santiago, it was agreed that while a need existed, it was too early to try and enter the market with big gasifiers, due to the shortage of skilled staff to accomplish the technical transfer training. This detail alone should be noted as the greatest problem facing gasifier manufacturers, because they are usually made up of a small number of dedicated individuals,and do not have large industrial empires driving their development programmes. Supplying gasifiers across the World might be the dream, but the reality is that in ignorance, they step into a trap of their technology failing to work, outside the country of development, due to operational difficulties that exist within the local market.

As these realities can be very disappointing, I suggested that Douglas Diaz build a small gasifier to gain some experience of how they work, and to sample producer gas in a way that could be tested in ways appropriate for his needs. Using the simple plans provided from this Fluidyne Archive without deviating from the critical parameters, he was able to make gas on his first firing, (much to his surprise). Some local improvisation was included, which later resulted in very easy adjustment to key features.

To have a working gasifier built to a standard specification, is the first critical step to implementing any discussions of gasification with a prospective new Licensee, and when invited by Douglas Diaz to visit Chile to discuss this possibility, I accepted without reservation, because an ability existed to demonstrate, not talk about the demands of the technology, and he had demonstrated his own commitment to dealing with all the unknowns, for his situation.

After the first demonstration to me, we opened the gasifier and reset the internal parameters of the gas making process, and this was done after inspecting and analysing the behaviour of the charcoal produced from an unspecified source of waste timber. This took about 15 minutes, and it was then possible to provide instruction to restack the char bed in a size range, consistent with the natural evolution of the char in a working gas making process. Incorrect char size in the wrong place, can create problems which can be difficult to resolve, quite often leading to unnecessary modifications.

The much greater gas production was very noticeable, with the lesser pressure drops stabilizing quickly. Once these adjustments were made, the gasifier was displayed and demonstrated at a Conference convened by Douglas Diaz, with invited guests from Government Forestry, Industry, and Academic interests.

My Power Point presentation emphasised the need to prepare for change in the way energy was used, and to consider restructuring processes into smaller increments, so that gasification could full fill a role to supply that energy need. The need to establish the fuel supply infrastructure to supply gasifier users, had a positive slant, as it would be creating rural employment in economically deprived areas, and it appears that wood fuel could be supplied for less cost than natural gas, or LPG.

As the current situation in Chile sees supplies of natural gas cut off, and the threat to LPG supply as well, gasification does offer a sustainable energy future, but there must be change first. This led me to the key point for successful implementation of gasification programmes.

Change Begins with Attitude

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Doug Williams.

May, 2007

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136.00 KB

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Fluidyne Gasification

Archive - Since 1976

Australian Kent Charcoal Gasifier

During a visit to Melbourne Australia on August 2006, I had the opportunity to inspect an original gasifier made in Melbourne in the 1940's. It's condition was very poor, but had obviously been well used judging by the repair plate patches around the sides.

Built during a time when foundry castings were used instead of fabrication, they survive in new condition, while the steel components rusted away with time. As a design, it is as basic as gasification can be achieved, but at a price needing regular servicing every 10 bags of charcoal. Failure to do this, or lacking appreciation of understanding the problems of why clean-outs were so important, saw ash fuse into clinker around the air inlet, and the oxidation lobe diverted towards the sheet metal walls, burning out the sides. A clean out hinged lid in the bottom, under the air nozzle enabled the central char and ash to drop out, leaving the char around the sides and corners to remain in place up to the nozzle position.

The air nozzle appeared to be set into the air inlet pipe with a fire clay type cement, which considering the time is a bit unlikely. In Australia, the soil, or clay from termite mounds was used to line forges and other fire box applications, by first wetting it to a mud and and molding it around the surface to be protected. When fired it turned into a very hard and durable surface, and as a material, easy to obtain in remote places.

With the gas rising vertically up through the charcoal, not much char ejected from the bed, so a grill at the top, on the opposite side to the inlet air at the bottom, only stopped char from entering the gas outlet during filling operations. The cyclone is a very crude design, and I would doubt if it collected any dust which was emptied out the bottom via a missing removable lid.

As these gasifiers were used on tractors and cars, the mountings allowed their fitting to front or back of the vehicle, so the gas exit pipe has a little length for cooling, and a downwards vertical outlet. This usually went to a filter canister containing packed cotton or other fibrous filling, and was not found with this gasifier.

The success of these simple box type updraft gasifiers was due to the availability of high quality hard charcoal made from Australian hardwoods (Eucalyptus), and I doubt if the design would work well with softwood charcoal (Conifers). No steam was introduces with the air in this design, which possibly was a cheaper system than the inclined cross draft gasifiers that had self clearing air nozzles.

Doug Williams.
November 2006.

Instruction plate for operation.

IMG_2120.JPG
83.12 KB

Front view, size about 48”x18”x18” in size. Cyclone on the left, air inlet bottom right, gas outlet across back top to vertical outlet on right.

IMG_2121.JPG
81.85 KB

Cyclone rusted out.

IMG_2122.JPG

86.13 KB

Ditto

IMG_2133.JPG
92.76 KB

Rusted out cyclone gas exit pipe.

IMG_2132.JPG
68.45 KB

Vertical air inlet pipe has spaced cover pipe. Internal pipe possibly extends almost full length to reduce burning gas coming out during gear changes.

IMG_2123.JPG
94.35 KB

A Tee fitting forms the mounting of the air inlet pipe, and has a swivel plate (missing) over the end to cover the ignition port.

IMG_2125.JPG
98.26 KB

Cast iron lid and view of gas exit pipe across the back side.

IMG_2124.JPG
82.89 KB

Internal gas exit grill. Top hopper flange also cast in cast iron.

IMG_2126.JPG
91.49 KB

Asbestos lid gasket fits into cast grove in lid, lubricated with graphite.

IMG_2128.JPG
96.45 KB

Pivoting lid clamp, with spring steel lid bar.

IMG_2130.JPG
76.75 KB

Simple hinge point positioned to lift lid seal vertically off seal flange.

IMG_2131.JPG
81.02 KB

Air nozzle 3/4” pipe located just off centre on thick steel (1/2”)angled plate. This is to slide ash off nozzle and enable fire clay to be packed in around replacable pipe nozzle. Clean out port can be seen under the nozzle assembly.

IMG_2172.JPG
90.14 KB

Ditto

IMG_2173.JPG
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86.13 KB

Ditto

IMG_2133.JPG
92.76 KB

Rusted out cyclone gas exit pipe.

IMG_2132.JPG
68.45 KB

Vertical air inlet pipe has spaced cover pipe. Internal pipe possibly extends almost full length to reduce burning gas coming out during gear changes.

IMG_2123.JPG
94.35 KB

IMG_2125.JPG
98.26 KB

A Tee fitting forms the mounting of the air inlet pipe, and has a swivel plate (missing) over the end to cover the ignition port.

IMG_2124.JPG
82.89 KB

Cast iron lid and view of gas exit pipe across the back side.

IMG_2126.JPG
91.49 KB

Internal gas exit grill. Top hopper flange also cast in cast iron.

Asbestos lid gasket fits into cast grove in lid, lubricated with graphite.

IMG_2128.JPG
96.45 KB

Pivoting lid clamp, with spring steel lid bar.

IMG_2130.JPG
76.75 KB

Simple hinge point positioned to lift lid seal vertically off seal flange.

IMG_2131.JPG
81.02 KB

Air nozzle 3/4” pipe located just off centre on thick steel (1/2”)angled plate. This is to slide ash off nozzle and enable fire clay to be packed in around replacable pipe nozzle. Clean out port can be seen under the nozzle assembly.

IMG_2172.JPG
90.14 KB

Ditto

IMG_2173.JPG
105.09 KB

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IMG_2174.JPG
105.88 KB

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IMG_2176.JPG
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Tasman Class Gasifier

Gasification Australia, a newly established small company in Melbourne, Australia, has commenced the component trials for the 10-15 kWe Tasman Class gasifier in August 2006, using Licensed technology from Fluidyne Gasification.

Originally intended to supply a growing demand for a basic small gasifier from within Australia, wider interest has required variations to be considered within the design parameters.

The design criteria, requires that it be simple to operate without automated controls, or water for gas cleaning. Some degree of portability had to be considered, providing the capability for the system to be loaded for application in a transport role. Gas output to fit into this dual role took into consideration the average engine of a small pickup truck, and a 3 litre engine has been targeted.

Gas cooling in the extremes of tropical environments, is a focus of development to minimize loss of engine performance due to loss of volumetric efficiencies. Heat exchangers for producer gas are not a stock item for suppliers, and innovation is required to build a trouble free, simple system.

Licensed technology requires more than just a set of construction drawings to become a gasifier manufacturer, and experience has shown that what may be easy to do in one country, is impossible in other places. Most of the development work that has to be achieved using pre-production systems, is to redesign around locally available materials, and components, which if imported can increase the cost of production,.

Many potential users of gasifiers find that engine generators are not sized correctly for producer gas, loosing 50% of their power compared to gasoline. This does refer to spark ignition engines, as most small diesel generators have incompatible compression ratios.
To over come this problem, rebuilt engines from scrapped vehicles are considered a resource that cannot be ignored, and generators built using these engines. It is not thought that these could be offered for sale, as many clients have DIY capability, and practical advise will be offered to assist these projects.

The extreme hardwood fuels found in Australia are not a problem to gasify, but the universal problem of fuel preparation into small pieces remains to be resolved. We consider this to be one for local consideration if planning to use these gasifiers for stand alone power generation.

The following photographs were taken in August 2006 during these first trials of component testing. It is expected to be able to report on the finished design in October, and a further set of photos will be posted.

Doug Williams.
September, 2006.

Side view of gasifier set up to test cyclone and cooler/condenser concept with 12volt fan.

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81.78 KB

Air flows from 12 volt fan proved to be strictly limited for reliable continuous operation, but considered an option for special case installations.

IMG_2089.JPG
106.93 KB

Hinged panels will enclose the hot components, opening for clean out servicing.

The small fuel hopper is sized for the testing programme, and will be double height in final design allowing about 2hours operation between fills.

IMG_2109.JPG

90.58 KB

Simple manometers measure the pressure drops across assemblies.

IMG_2155.JPG
84.64 KB

This 3 litre engine has been set up to obtain information on how to build a DIY generator set. It is set up high to avoid bending, and provides plenty of space to work out how to best reject all the waste heat, for collection or disposal.

IMG_2092.JPG
151.16 KB

Engine speed governing is simplified by using a Pierce mechanical governor, driven from the fan belt.

IMG_2096.JPG
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Simple elbow connection for gas/air mix into throttle assembly. Gas/air mixer/condensate separator just showing on the left of the picture.

IMG_2116.JPG
142.07 KB

A small temporary electrical load bank was set up to consume the electrical output, and facilitate engine response to variable loading

IMG_2158.JPG
59.58 KB

These chunky hardwood nuggets were the best average size for the wood we tested. They could be replaced with thick chips, but would need to be a minimum of 30x30x5-10mm.

IMG_2137.JPG
107.04 KB

IMG_2142.JPG
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Conifer blocks cut from the urban waste roadside rubbish collection. First cut to 50x50x12mm, the large flat surfaces created flow problems in the fuel hopper. Re cut to 50x25x12mm as shown in 20 litre pail, they worked fine. The wood in the pail amounts to
5 kg, and will do the same work as 1.6 liters of diesel. Therefore has the same value as diesel fuel, and it's cost is not exported out of the local economy.

IMG_2145.JPG
49.30 KB

The down side of urban waste wood is nails, and in a high temperature gasifier, act as a catalyst for ash to form clinker. Once the clinker begins to form, the natural movement within the char bed is disturbed, and the gas making equilibrium moves out of balance.

IMG_2103.JPG
80.57 KB

Rarely seen as a separated solid from producer gas, these carbon blacks were collected from the gas/air mixer at the engine. They are a graphite structure and as such harmless to the engine, but if not removed, build up deposits in the inlet manifolds.

IMG_2164.JPG
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When producer gas is hot, it carries water vapor, which in turn, carries dust and carbon blacks. This test flare displays the radiance created by carbon blacks, as the cooling system was pushed way past it's heat rejection capability.

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Archive - Since 1976

Fluidyne Gasification in California

In 1985, one of the first four Pacific Class gasifiers built by NEI Fluidyne, was sent to the USA, and later in 1989-90, joined by two more, and stored in an Emergency Civil Defense Complex in Montana. Only the first was slightly used before storing.

Released for sale in 2006, they were purchased by Californian interests, and in July, was able to assist to set one up for evaluating both electrical generation, and process heat. The new owner wishes to remain anonymous, as visitors would interrupt his normal business activity. It is possible to say that he is a Forestry Nurseryman, and wishes to investigate in his own time, if any advantage can be found to grow a specific fuel wood forest. This work is to support the possible environmental changes that might affect existing forestry, and to ensure appropriate species are available for new energy forests. Wood chip size will also feature in these studies, and we will continue to work closely over the next few years on that aspect of gasifying forestry wastes.

For this project, a search of the Internet, found a Onan natural gas generator, driven by a 7.5 litre Ford engine, which at 1800RPM, gave us 28 kWe of electrical power on producer gas. As this engine had only 560 hours of operation, it was in reasonable condition, but the starter needed replacement. All that was required was a simple conversion of the throttle inlet, by the fitting of a pipe tee connection for the gas/air mixture. The gas and air were mixed off engine, using a pipeline terminal, mixer/condensate separation assembly so no that water was entrained into the engine. No alteration was made to the ignition timing.

High ambient temperatures (34°-36°C) combined with low humidity did require the assistance of an evaporative cooler to assist the gasifiers gas cooling system. The cooling phases were out of step with the components doing the work, but achieving an average 20°C drop in temperature soon sorted out the power drop caused by high gas humidity. We also found that engine stability improved when the combustion air was drawn from the colder air stream, as the volumetric efficiency increased. This confirms earlier engine trials we conducted in N. Ireland, that reheating producer gas to dispose of aqueous condensate, is detrimental to the power output of the engine.

Operating in the blown mode, the gasifier was able to be pushed to it's maximum output of 90 m3/hr, at 15” WG input air, and provided quite an impressive clean gas flare. In day light, it was difficult to see the flare colour, with only shimmering heat shadows on the wall, and the flame roar, to indicate that gas was burning. Possibly the process heat option will have the greatest application in colder climates as the increasing price for propane is creating a need for alternative heating.

The following photographs provide a glimpse of this project in the temporary site used for the Training Programme.

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Pacific Class Gasifier, built 1985, stored unused until 2006.

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Three types of conifer wood drying on concrete slab. Cut to first test block size, we made them smaller for later tests, and separated the wood types.

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Boxes of test wood were pre-weighed to establish fuel consumption against operating time.

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Relative size of smaller wood block found to be closer to optimum required for trouble free operation. I left the top of my thumb in California!

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Fine chip wood not considered suitable for gasification. Testing showed other methods could be employed to trick the packed bed into accepting finer chip.

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Fine chip at interface of fuel size change from larger block size test. Surprisingly, larger blocks allowed finer chip to flow between and gasify in the interstitial space, while maintaining bed porosity without plugging.

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Char fines can be seen collecting just above the throat, but core char remains clear for gas passage.

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Sadly, disease is attacking the tops of these Redwoods, North of San Fransisco.

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Fluidyne Gasification
Archive - Since 1976

Producer Gas Flares

Possibly the first experience most researchers and consultants have with gasification,is to see the producer gas burning as a flare. This first exposure to making a combustible gas from biomass can be very deceptive, and the viewer lead to believe that this burning gas demonstrates it's capability to fuel, either engines, or process heat applications.

While producer gas can be so impressively combusted, hot straight out of the gasifier, contamination in the gas determines it's quality, and ultimately, the most appropriate end use application. This gas can contain water, char dust, carbon blacks, and ash, plus uncracked hydrocarbons, all of which have to be removed, if the gas is for engine powered electrical generation.

During Fluidyne projects, we have collected many photos of producer gas flares, and flu stack emissions, which combined with certified testing procedures, has provided considerable information on the behavior of producer gas from it's transition from hot to cold gas. The photos offered in the Fluidyne Archive, are a selection of these test flares, and with some thought, can be used as a guide when observing combusting producer gas.

Observation is still one of the best free tools available, learn how to add this to your own knowledge.

August 2006.

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This is a peep into a correctly functioning downdraft gasifier.

IMG_1940.JPG

This flare is within 5 minutes of a cold start-up. Note how short and bushy, lots of red from fine char particles, and uncracked moisture from fuel wood. This gas has had only cyclone dust cleaning to approximately 10 micron.

IMG_1941.JPG

Now flare exhibits white glare as hydrogen peaks, as the gasifier is now at normal operating temperature, and fuel moisture is cracked to hydrogen.

IMG_1947.JPG

The glare is quite intense, but lots to observe during these test runs.

IMG_1949.JPG

The fuel wood moisture has just about been depleted, and the flare now begins to revert back to predominantly CO, although hydrogen will continue to form at a lower output.

This is consistent behavior for batch fed gasifiers.

IMG_1952.JPG

As the gas flow is closed down, the mixtures of gas can be observed in some cases to burn separately. This does depend on the type of burner nozzle phenomena, so care should be taken to ensure that test flares are provided with correct air ratios if emission tests are being conducted.

IMG_1953.JPG

Slowed right down, the flare is seen to be a well organized flame with gases burning right up to the air inlet interface. This type of cyclomix burner nozzle was developed by Fluidyne, and the gas will not blow out, or off the nozzle with changing gas quality.

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This flare is from cold filtered gas, and is the quality you need for engine application. It still contains water vapor, and carbon black, which will not burn in these flares. Water in the gas at this point is not desirable, and should be removed before the gas enters the engine.

131-3124_IMG.JPG

On a larger scale, this Winter flare displays it's angry red caused by uncracked hydrocarbons, char particles, and water vapor. Only cyclone cleaning of the gas dust to 10 micron has been done for this test.

IMG_0374.JPG

Flare inside the test flu stack during earlier testing, shows same angry red, and smoke in gas from uncracked hydrocarbons.

F1000018.JPG

Now flare exhibits yellow colour as hydrogen levels increase, and uncracked hydrocarbons are tuned out of the gas making process.

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This invisible emission would please most who see it, but it does not meet the EPA emission standards. Present are high levels of particulate formed from incorrect mixing of the gas and air. We have corrected this problem for our test programme, but do not be fooled by what appears to be the perfect combustion of producer gas.

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MDF Gasification

The Atlantic Class gasification MDF project is a tribute to Dr Brian Russell, Director of Innovation Technologies (Ireland) Ltd, who's unexpected sudden illness, resulted in his passing at the age of 43 years, in January 2006.

Brian's vision to develop gasification in Ireland for the inevitable problems of sustainable energy for industrial activity, is to be continued by his business partner Ian Milleken.

Disposal of Medium Density Fiberboard (MDF) can be a costly disposal problem for some manufacturing facilities that use this fabrication material. Apart from the solid waste streams, usually large amounts of saw, and sanding dust is produced from the manufacturing activity. Combustion of these wastes are regulated, and gasification is proving to provide an alternative and productive use for these waste streams.

Fluidynes Licensee and representation for the E.U. Is Innovation Technologies (Ireland)Ltd, have been researching the gasification of MDF for a number of years. Developing a gasifier that can be of a compatible size for most applications, is at best, a high financial risk activity, but the choice of a 70-80 kWe system was determined to fit the industrial criteria being presented for consideration.

Beginning early in 2005, the Atlantic Class gasifier was designed using parameters supplied by Fluidyne, then tuned to suit the fuel behavior during gasification. Fuel feeding components were developed in house based on earlier experimentation, as were fuel level sensing components.

Financial constraints, required a staged component development programme, with first the automated gasifier, followed by gas cooling and cleaning systems. A used gas engine generator was acquired, (Hino 13.3 litre), but required replacement of a stripped ignition, and electrical control systems. These were rebuilt with in hose expertise, and the engine was operational on gas, for my inspection and evaluation testing in June / July, 2005.

During this visit, I was able to observe the in house research programme into MDF dust agglomeration in preparation for it to be gasified. They were also conducting gasification trials on pelletised sewage sludge, and a number of other waste streams in palletized form. While the intent is not offer technology to gasify these difficult wastes, the experience provided from studying the gasification phenomena, provides valuable practical capability needed to advise clients when evaluating waste gasification technologies. Gasification of any fuel, must be conducted from a known baseline of performance criteria in a gasification process, and the experience acquired since 2000 by their small team is considerable.

A decision to install the proto-type Atlantic Class gasifier, did mean that the smaller cooling cleaning system would provide "limited"results, but enable the power output to be linked into a factory grid supply. This allowed the gasifier to be operated for 22 hour/day, with 2hours for cooling off, before manual clean outs.

It should be highlighted, that operational problems were not limited to the equipment. There was considerable time lost to deal with regulations, and perceived health issues by factory labour. These were officially inspected and cleared without problems by the appropriate authorities, but only by adding additional costs and lost time to the programme.

By the time of my visit in March / April 2006, to conduct a total review of the project, just over 400 hours of generation had been clocked. As part of my review, it was necesssary to run the system 24hr x 7days, but the factory operating schedule prevented this, so we had to accept 24hr x 4 day operation over each week of the three week period. On other days during the week, the system was used but stopped according to the factory schedule. This is not good for the acquisition of operating data, but a reality of what to expect when working within commercial industrial applications.

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June 2006

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MDF dust from sanders

IMG_1345.jpg
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Agglomerated dust in ball form.

IMG_1347.jpg
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Large thermally bonded MDFpellet.

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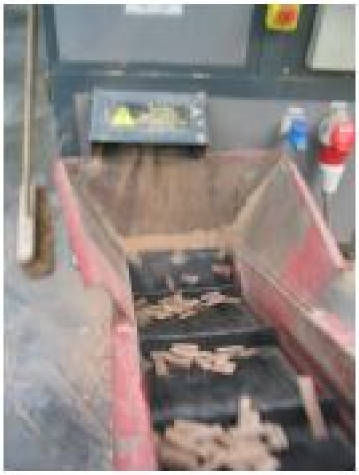
Waste MDF strips being fed into ITI 'Snapper" machine. MDF only.



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Snapped pieces feeding conveyer to bin storage.

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Full bin ready for transport to main fuel bin / conveyer.

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Main fuel bin / conveyer, adapted from potato grading machine.

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Gasifier module with temporary cyclones and gas cooler / condenser on the right.

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Proto-type Gasifier is designed to evaluate a number of considerations that have no precedence with this type of technology. Waste heat collection from the cooling of the gas has a number of applications, and final design will depend on how the clients will use this resource.

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This is a 13.3 litre Hino engine, turbo charged by ITI for producer gas.The two ducts bring in cold air from the outside. The green pipes are for the gas / air into the engine, and a hot air extraction from the engine to the air cleaner. It also scavenges oil valour from the engine sump breather.

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View of the red hot engine turbo.

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Engine information screen can be seen on line from any location, a separate control panel touch screen operates the gasifier showing all relevant information of the gas temperatures and pressure drops across the system.

Fluidyne Gasification
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MDF Gasification

The Atlantic Class gasification MDF project is a tribute to Dr Brian Russell, Director of Innovation Technologies (Ireland) Ltd, who's unexpected sudden illness, resulted in his passing at the age of 43 years, in January 2006.

Brian's vision to develop gasification in Ireland for the inevitable problems of sustainable energy for industrial activity, is to be continued by his business partner Ian Milleken.

Disposal of Medium Density Fiberboard (MDF) can be a costly disposal problem for some manufacturing facilities that use this fabrication material. Apart from the solid waste streams, usually large amounts of saw, and sanding dust is produced from the manufacturing activity. Combustion of these wastes are regulated, and gasification is proving to provide an alternative and productive use for these waste streams.

Fluidynes Licensee and representation for the E.U. Is Innovation Technologies (Ireland)Ltd, have been researching the gasification of MDF for a number of years. Developing a gasifier that can be of a compatible size for most applications, is at best, a high financial risk activity, but the choice of a 70-80 kWe system was determined to fit the industrial criteria being presented for consideration.

Beginning early in 2005, the Atlantic Class gasifier was designed using parameters supplied by Fluidyne, then tuned to suit the fuel behavior during gasification. Fuel feeding components were developed in house based on earlier experimentation, as were fuel level sensing components.

Financial constraints, required a staged component development programme, with first the automated gasifier, followed by gas cooling and cleaning systems. A used gas engine generator was acquired, (Hino 13.3 litre), but required replacement of a stripped ignition, and electrical control systems. These were rebuilt with in hose expertise, and the engine was operational on gas, for my inspection and evaluation testing in June / July, 2005.

During this visit, I was able to observe the in house research programme into MDF dust agglomeration in preparation for it to be gasified. They were also conducting gasification trials on pelletised sewage sludge, and a number of other waste streams in palletized form. While the intent is not offer technology to gasify these difficult wastes, the experience provided from studying the gasification phenomena, provides valuable practical capability needed to advise clients when evaluating waste gasification technologies. Gasification of any fuel, must be conducted from a known baseline of performance criteria in a gasification process, and the experience acquired since 2000 by their small team is considerable.

A decision to install the proto-type Atlantic Class gasifier, did mean that the smaller cooling cleaning system would provide “limited”results, but enable the power output to be linked into a factory grid supply. This allowed the gasifier to be operated for 22 hour/day, with 2hours for cooling off, before manual clean outs.

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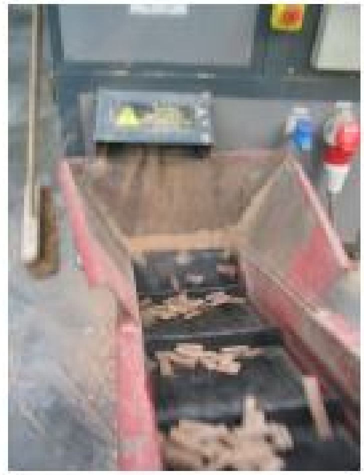

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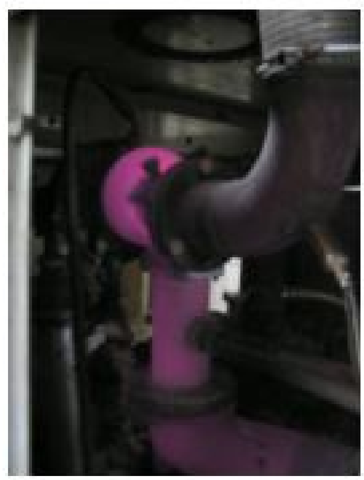

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POWER GENERATION IN THE HILLS

Since the closure of Fluidyne's manufacturing facility in 1998, there has been little opportunity to use the small Pioneer Class gasifier and 6.25 kva generator set that I used for demonstration training and testing fuels. Late in 2005, it became necessary to pull this equipment out of storage and set it up temporarily for a demonstration and training programme. This was held at the end of January 2006 here in New Zealand as the first stage of implementing a new project to manufacture a gasifier in Australia designed for their environmental conditions.

There was a need for a fuel drying facility with this project, as the exercise required us to cut down trees that I planted 29 years ago for gasifier fuel in 1977. The wood was sliced into 50mm rings then chopped into small blocks.

The dryer was made using an elliptical tube heat exchanger, heated by the 260°C engine exhaust. Air was blown into a chamber under the sloping exchanger that was collected from a simple box mounted around the engine. This provided a waste heat flow of 50°C and provided a real bonus to dry the green and very wet fuel blocks. This took about 8 to 10 hours of drying time.

Even though the installation was located out in the open, the close proximity of the gasifier and engine, created a very heated work area, and provided an indication of just how much waste heat could be recovered from such a small system. This does improve the economics of investing in this technology, but not all locations need waste heat, but its recovery for drying fuel wood, should be seriously considered.

Although not perfectly set up as one would install a permanent system, it is useful to see in a training situation, just how well the small gasified power stations can function. The whole system is manual without any sophisticated control systems. Most rural generation is operated morning and night, so an operating period of 4 hours from a single manual filling of the hopper, enables its operation with a minimum of attendance.

Gasified power generation needs a regular discipline of operation, and in return provides reliable performance.
Here are a few details:

Daily service: Clean out waste char – 5 minutes..
Change filter sawdust – 10 minutes.
Check engine oil/water – 5 minutes.
Refill fuel hopper to start – 5 minutes.

Gasifier ignition – 10 seconds.
Gas ignition at test flare – 2.5 minutes.
Engine start – 3 minutes.
Full power generation from start – 4 minutes.
Total system pressure drop – l.5”W.G.(37mmWG)

Making wood block fuel for gasifiers may be an onerous task, but remember a 20 litre bucket contains about 5-6 kg of wood, which can do the same work as about 1.6 litres of diesel fuel, slightly more for gasoline. It therefore is reasonable to say that it has the same value as liquid fuel for power generation, and has a value of $2.40 per bucket at the moment here in New Zealand. This would put a value of $400 per tonne, but in rural locations world wide, it would represent considerable savings, while providing useful employment and income for local labour.

The most important consideration for gasified power generation is to begin planting your fuel wood trees now, because you are surely going to need them within the next 30 year time span.

The following photographs show the temporary installation and its location on my 10 acre block. I erected a simple tarpaulin cover over the equipment just to keep the sun and rain off for the two weeks while in use. Consideration is now being given to create a permanent training facility under cover inside the shed.

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View from the installation.

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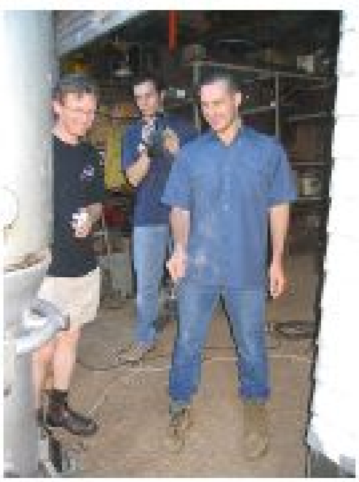 IMG_1617.jpg 80.83 KB	Clear smiles of relief from trainees at successful start-up.

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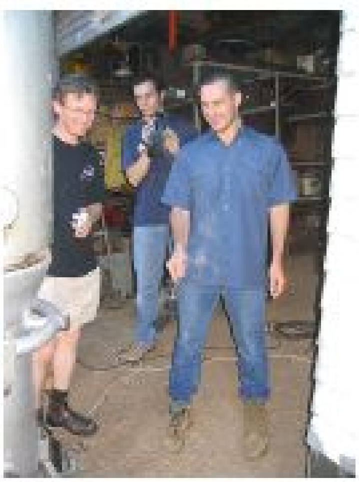 IMG_1617.jpg 80.83 KB	Clear smiles of relief from trainees at successful start-up.

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AGRICULTURAL WASTE

Many researching biomass energy, often promote agricultural wastes as a source of gasification fuel. Quite often, because these wastes are used as combustion fuels in boilers and furnaces, it is assumed, that these same fuels can be gasified if densified into pellets or briquettes. Some can, but many wastes have an uptake of minerals, such as silicon, and others, high levels of potassium and sodium. These three components of biomass make them very difficult fuels to use in high temperature gasification processes required to make a tar free gas for engines.

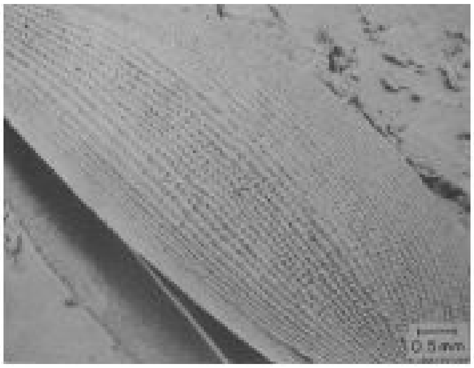
Probably the largest crop waste available is rice husks, and while these will burn, only the surface carbon surrounding the silica skeleton is consumed. The remaining silica core retains its structure, but once the surface carbon is consumed the oxidation stops, and the fire will slowly die. Only constant removal of hulls will maintain the fire or oxidation zone, making gas with a high tar. Other known crops with high silica content, are palm oil tree stems, and their palm nut shell, which resembles a miniature coconut. Coconut trees which are really a type of grass, have calcium oxalate crystals in the form of raphide bundles, but can be gasified in an appropriately designed gasifier. The biggest problem, is cutting these trees into small blocks as only tungsten blade saws can be used.

Bagasse from processed sugar cane can be a huge resource for gasification fuel, Usually the sugar mills use it in their own boilers, but emissions from these boilers are beginning to force mills to conform with EPA standards. Emissions from bagasse combustion is shown in the photographs, and compared to that from gasified fuel.

Many other seed crops have husks and outer cases that might be potential gasifiable fuel, but it will be necessary to eliminate those with silica. Only testing in a gasification process of known performance and operated by experienced staff can resolve these questions.

Updraught gasifiers can gasify most fuels with mineral content, but the resulting gas is best used in furnaces or boilers.

The above information is not presented as a complete summary of these agricultural wastes, but an indication of the problems one might expect when assessing these fuels for gasification, and that gas used in an engine.

 IMG_0341.jpg 128.56 KB	Single (flat) Rice Hull before gasification.
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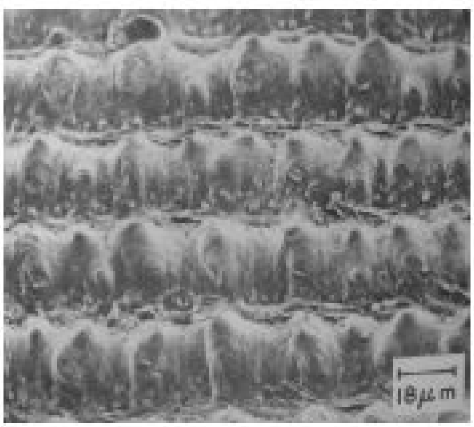
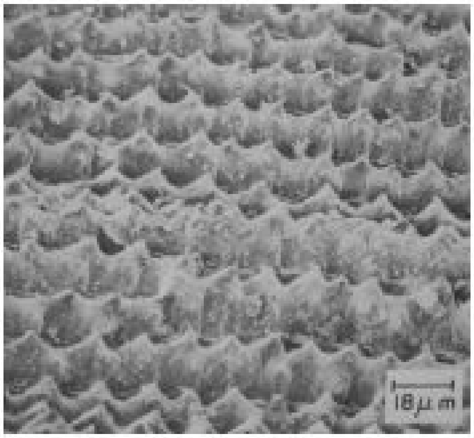
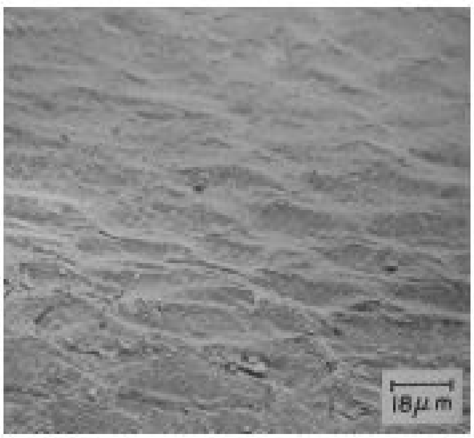
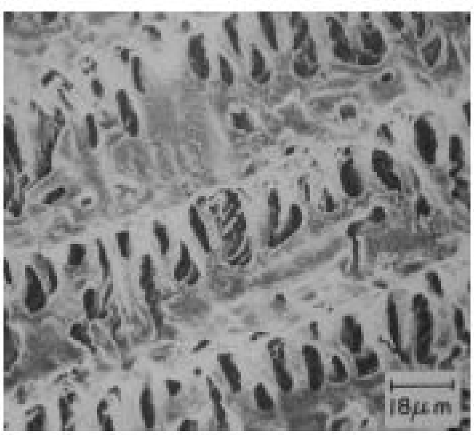
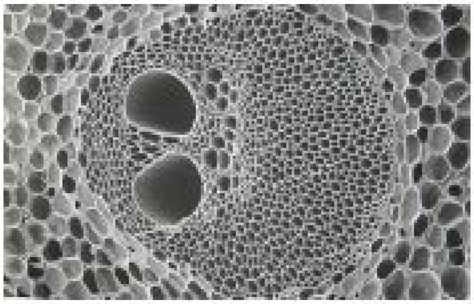
 IMG_0337.jpg 187.29 KB	Outer surface of rice hull before gasification.

 IMG_0338.jpg 201.30 KB	Outer surface of rice hull after gasification.
 IMG_0339.jpg 215.25 KB	Inner surface of rice hull before gasification.
 IMG_0340.jpg 186.19 KB	Inner surface of rice hull after gasification.

 IMG_0164.jpg 129.29 KB	This traverse section of coconut tree stem shows the porous top section of the trunk, making it unsuitable for milling. Although it has low density, it can be used as gasifier fuel.
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 Smoke.jpg 44.35 KB	Boiler stack emissions using bagasse fuel.
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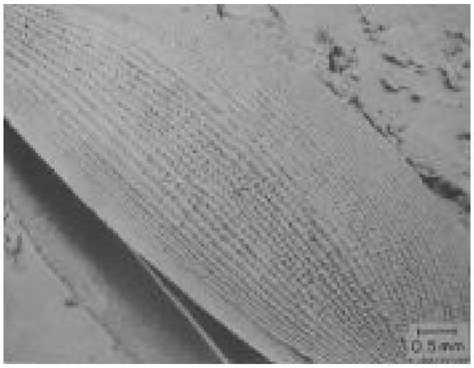 IMG_0341.jpg 128.56 KB	Single (flat) Rice Hull before gasification.
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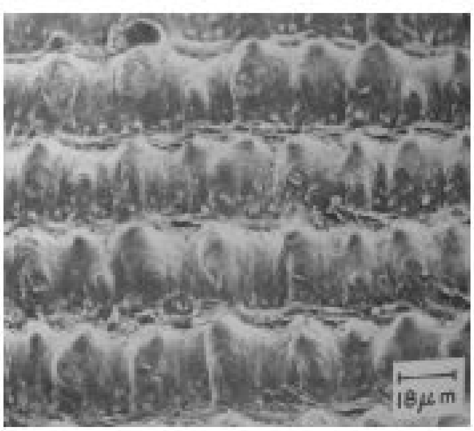
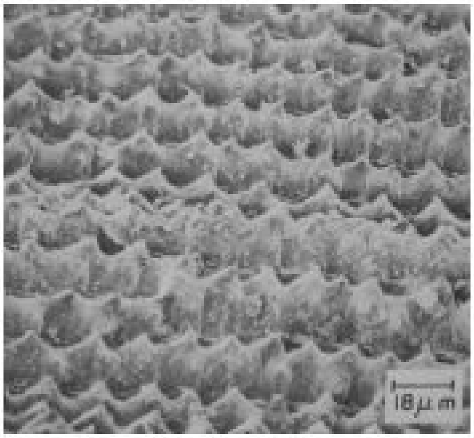
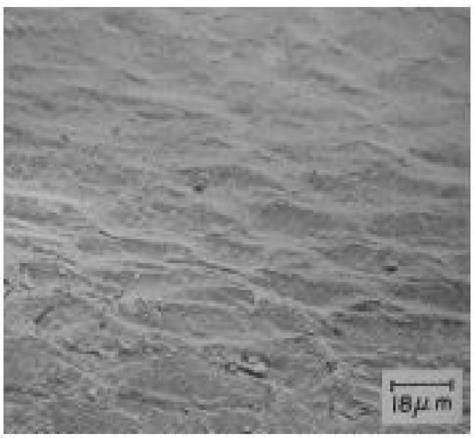
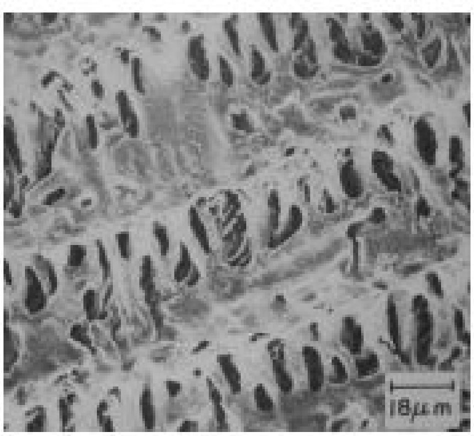
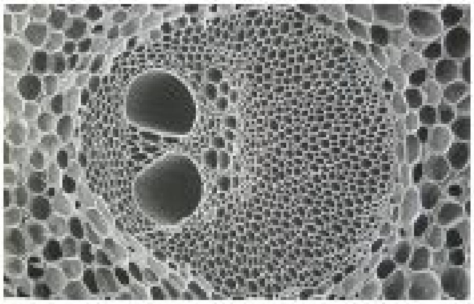
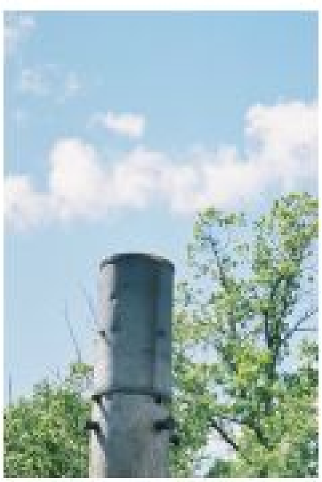
 IMG_0337.jpg 187.29 KB	Outer surface of rice hull before gasification.

 IMG_0338.jpg 201.30 KB	Outer surface of rice hull after gasification.
 IMG_0339.jpg 215.25 KB	Inner surface of rice hull before gasification.
 IMG_0340.jpg 186.19 KB	Inner surface of rice hull after gasification.

 IMG_0164.jpg 129.29 KB	This traverse section of coconut tree stem shows the porous top section of the trunk, making it unsuitable for milling. Although it has low density, it can be used as gasifier fuel.
 IMG_0168.jpg 77.39 KB	Calcium oxalate crystals

 IMG_0170.jpg 77.36 KB	Calcium oxalate crystals
 IMG_0166.jpg 98.61 KB	Bagasse stored as boiler fuel for next season's sugar mill start-up.
 IMG_0167.jpg 127.52 KB	Note how fibrous texture prevents bagasse from becoming a free flowing fuel.

 IMG_0934.jpg 34.80 KB	Fine waste residue that can be gasified, need a thermally bonded briquette similar to this one, obtained from Europe.
 Smoke.jpg 44.35 KB	Boiler stack emissions using bagasse fuel.
 F1000019.jpg 83.50 KB	Gasified fuel emissions are a cleaner option compared to combustion.

Fluidyne Gasification
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August 2005 Update

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Having resolved the condensate freezing problem, the large volume of gas produced from 2.5 tonnes/hr chip fuel had to be combusted in a more controlled manner before commencement of the summer EPA emission tests. As winter emission tests are invalid, emphasis was placed over the winter months on destructive component testing.

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It has now been five years (August 2000-2005) since the MK1 Mega Class concept was first tested, and 16 months since the beginning of the MK2 trials, Most of the gasifier operating time has been used for testing components, in some cases to destruction as maximum operating parameters were established.

When a new system of gasification is being tested, a series of expected outcomes are predicted based on experience. It came as a surprise therefore, that once continuous operation began, to experience new phenomena not characteristic of downdraught gasifier performance.

The char is almost totally converted in the reduction phase leaving only a granular ash, and very little activated carbon waste. The condensate runs clear without carbon black in suspension, and the gas burns almost without colour, and without any type of filtration system. The change of gas quality can be seen by reviewing the flame colour from the first start-up shown in the first Mk2 report.

Over this summer, testing has been conducted with the assistance from the University of Manitoba, and gas analysis being done at EERC in Grand Forks, by Darren Schmidt's team. This has resulted in a correction of when the gas tests commence in relation to the start-up time of the gasifier, so that the whole system is temperature stabilized before test samples are collected.

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GASIFIER CLEAN-OUT WASTES

In the discussion of gasification, little is said about the waste that results from biomass, and therefore little appreciation of the fact, that some Authorities may consider them to be toxic.

The amount and type of waste is dependent on the nature of the biomass, so it is important to establish for yourself, if it's disposal will constitute a threat to humans and the environment. It is not possible to discuss the many variations that could exist, but most of this information could be used as a guide for most systems.

There are usually three sources of waste, course charcoal and ash from the bottom of the gasifier, fine soot (carbon) and ash from the cyclones and filters, and aqueous condensate as a result of gas cooling.

Course charcoal removed during the operation of a down draft gasifier, has had the incandescent CO_2 produced in the oxidation zone, pass through it in the reduction phase, and the charcoal becomes low grade activated carbon. It is important to remember, that the degree of activation will be related to the temperature of the gas, and how it flows through the bottom char, as it can be quite uneven in some designs. If it is of a size that can be utilised, it should first be sieved to remove the ash and fines.

Dust from the cyclones and filters must be handled with caution. Cyclone dust is very much like talcum powder (about 10 micron) and filter dust cake can be even finer. If removing manually, the dust can easily become entrained in disturbed air, so a spray of water, or adding water to make a slurry makes it safer to handle. This dust is very good to add to soils or compost heaps, but location determines it's ultimate disposal.

Aqueous condensate from a correctly working gasifier, consists of water with suspended carbon solids, dissolved ash, and usually has a pH 8.2, or close to that figure. If the gasifier is malfunctioning, or incorrect fuels are trying to be gasified, the condensate becomes a toxic black liquor, and as such is a hazardous waste. It is very unpleasant to handle, and it's sticky tar scum will create a servicing problem within the cooler/condensers.

When the condensate is just dirty water, the course activated charcoal can be used to filter the solids and suspended colour out of the condensate before disposal down drainage systems. A simple test by spraying on a small patch of grass or weeds, can quickly show if it is detrimental to plant life, and if it is, then alternative disposal has to be considered.

The following photographs were taken during gasification fuel trials in June 2005.

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Fluidyne Update December 2004

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Regards,

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73.82 KB

These cluster cyclones have been well tested since this photo was taken. The collecting performance matches samples from previous work in Northern Ireland and Germany. The carbon and ash are very fluffy resembling talcum powder (about 10 micron). About 90% of the particles that escape cyclones are sub micron in size, and these have to be removed by other means to prevent their adding to an excessive particle emission count.

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This is the 'Cyclomix Burner' which has been designed to slip onto the gas inlet pipe of the oxidation tower, and connect to a fan for combustion air. Air and gas come in from opposing tangents, meeting and mixing just inside the outlet. No diffuser or swirl plates are required to hold the flame onto the burner, in fact the flame is impossible to blow off if gas is present to maintain ignition.

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Here is a sample of the wood chip made from the Blow Hog machine. The chip is quite thick compared to that from a drum type chipper.

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The 'German Reports'

Published October 1997

Report #1

Hello Gasification Colleagues

In response to our editor's plea earlier this year for more chat on this Network, I thought you may be interested in some comments regarding gasification in Germany. Having just spent four weeks there, I had the opportunity to see a few gasifiers, talk to many students (and their Professors), other gasifier manufacturers, engine designers, and anyone else unlucky enough to be caught up in discussion relating to gasification.

There were also a few project proposals to review for funding application, and gasification equipment assessment to see if their design had the capability to match their suppliers glowing specifications! With so much to cover, I think it is best to make a number of reports so that you don't get too bored ploughing through this in one go.

Gasification is a hot topic in Germany, and with the E.U. funding renewable energy research projects, it is natural everyone who can write a proposal is endeavoring to feed from the public purse. It was very hard not to believe there wasn't a special training centre hidden away somewhere on how to prepare E.U. funded proposals. Everyone trying so hard to dress up projects to sound new and exciting. It was difficult but necessary to point out that just about all there is to know of any relevance is already available in the literature.

Because my own speciality is high performance engine gasification, I was disappointed to find that engine gasifier projects were being proposed using process heat type gasifiers. It is a widely held belief to those I questioned, that if it makes gas, you can use it for anything. Furthermore if you make a big one and fuel it with rubbish demolition wood (shredded) you can power villages and small towns. This is tremendous enthusiasm but difficult to accept when none had even small gasifiers operating to commercial standards with engines.

On reflection, I haven't received any reports of reliably operating commercially manufactured wood gasifiers in Germany except our own in Furstenwalde. Anybody out there like to identify engine gasifiers that can be seen working anywhere in Europe?

Possibly the projects that caused me to bristle most were those proposing gasifier testing with different fuels, and comparing gasifiers ability to gasify standard fuels. In the first instance it is quite clear from reading the literature that few projects have gasifiers operating, expertise, and no appreciation of what constitutes a correctly functioning gasifier. Have a look in your own library and see how many references you can find describing behaviour of the gasifier when it is functioning correctly. One thing for sure, any gasifier test programme has to be invalid if the gasifier cannot be reliably demonstrated by the manufacturer using his own approved fuel., Then having demonstrated the gasifiers reliability, all gasifiers that meet this requirement should have the opportunity to participate in the test programme. If this isn't done, and some sort of random selection of gasifiers are tested, then whoever is conducting the tests could be seen in less than a credible light. This is how I commented to those who presented their proposals for scrutiny, and hopefully the rewrites will assist them to get funds eventually.

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Here are a few questions to ponder.

- Why did hardnosed businessmen in the UK, Germany and now Russia, have to get their questions answered and purchase equipment half a world away in New Zealand? What's wrong with EU technology?
- How can competing factions within the EU resolve biomass energy problems without co-ordination.
- Has poorly directed and monitored research actually created a Frankenstein within bureaucracies, lurching around swiping us with NG
- What can we do to rectify the above and lots more you can name yourself?

During the writing of these German Reports, which I must emphasise is pure biased opinion, I have stood up to show that a person is ultimately behind every company name and is responsible for the technology they present. In my chosen field of engine gasification, there are no competitors, only colleagues struggling to overcome the inertia of dictatorial administrations.

Possibly I have also spoken for the many friends within institutes consultancies and industry who cannot comment in such a public forum. They don't all agree with my views which keeps me ever vigilant to investigate and improve my own presentation of biomass energy.

Whilst I have named these as German Reports, its problems and comments are universal. I haven't written this to impress anyone, solicit work, sell equipment, or expand my non existent industrial empire. Sharing knowledge of each others' activities ultimately benefits us all.

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Archive - Since 1976

The 'German Reports'

Published October 1997

Report #1

Hello Gasification Colleagues

In response to our editor's plea earlier this year for more chat on this Network, I thought you may be interested in some comments regarding gasification in Germany. Having just spent four weeks there, I had the opportunity to see a few gasifiers, talk to many students (and their Professors), other gasifier manufacturers, engine designers, and anyone else unlucky enough to be caught up in discussion relating to gasification.

There were also a few project proposals to review for funding application, and gasification equipment assessment to see if their design had the capability to match their suppliers glowing specifications! With so much to cover, I think it is best to make a number of reports so that you don't get too bored ploughing through this in one go.

Gasification is a hot topic in Germany, and with the E.U. funding renewable energy research projects, it is natural everyone who can write a proposal is endeavoring to feed from the public purse. It was very hard not to believe there wasn't a special training centre hidden away somewhere on how to prepare E.U. funded proposals. Everyone trying so hard to dress up projects to sound new and exciting. It was difficult but necessary to point out that just about all there is to know of any relevance is already available in the literature.

Because my own speciality is high performance engine gasification, I was disappointed to find that engine gasifier projects were being proposed using process heat type gasifiers. It is a widely held belief to those I questioned, that if it makes gas, you can use it for anything. Furthermore if you make a big one and fuel it with rubbish demolition wood (shredded) you can power villages and small towns. This is tremendous enthusiasm but difficult to accept when none had even small gasifiers operating to commercial standards with engines.

On reflection, I haven't received any reports of reliably operating commercially manufactured wood gasifiers in Germany except our own in Furstenwalde. Anybody out there like to identify engine gasifiers that can be seen working anywhere in Europe?

Possibly the projects that caused me to bristle most were those proposing gasifier testing with different fuels, and comparing gasifiers ability to gasify standard fuels. In the first instance it is quite clear from reading the literature that few projects have gasifiers operating, expertise, and no appreciation of what constitutes a correctly functioning gasifier. Have a look in your own library and see how many references you can find describing behaviour of the gasifier when it is functioning correctly. One thing for sure, any gasifier test programme has to be invalid if the gasifier cannot be reliably demonstrated by the manufacturer using his own approved fuel., Then having demonstrated the gasifiers reliability, all gasifiers that meet this requirement should have the opportunity to participate in the test programme. If this isn't done, and some sort of random selection of gasifiers are tested, then whoever is conducting the tests could be seen in less than a credible light. This is how I commented to those who presented their proposals for scrutiny, and hopefully the rewrites will assist them to get funds eventually.

Whilst on the subject of fuel, at several different meetings I was asked my opinion of densified fuel (briquettes). As a gasifier fuel, sawdust briquettes worked O.K. in our Fluidyne gasifier, but other agricultural wastes have individual problems and unlikely to be good fuel. There is also the point that briquettes are energy consumptive to produce so therefore expensive. This could be offset if the sawdust is a waste disposal problem and the cost of briquetting charged to the waste source. The cost of the briquettes should then cost no more than that charged for wood chips. The idea is to produce energy from wood, not use energy to create the fuel. The debate was lively, and I can only conclude the briquette manufacturers are suggesting that their fuel will solve all gas making problems. Anybody like to comment on this?

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Here are a few questions to ponder.

- Why did hardnosed businessmen in the UK, Germany and now Russia, have to get their questions answered and purchase equipment half a world away in New Zealand? What's wrong with EU technology?
- How can competing factions within the EU resolve biomass energy problems without co-ordination.
- Has poorly directed and monitored research actually created a Frankenstein within bureaucracies, lurching around swiping us with NG
- What can we do to rectify the above and lots more you can name yourself?

During the writing of these German Reports, which I must emphasise is pure biased opinion, I have stood up to show that a person is ultimately behind every company name and is responsible for the technology they present. In my chosen field of engine gasification, there are no competitors, only colleagues struggling to overcome the inertia of dictatorial administrations.

Possibly I have also spoken for the many friends within institutes consultancies and industry who cannot comment in such a public forum. They don't all agree with my views which keeps me ever vigilant to investigate and improve my own presentation of biomass energy.

Whilst I have named these as German Reports, its problems and comments are universal. I haven't written this to impress anyone, solicit work, sell equipment, or expand my non existent industrial empire. Sharing knowledge of each others' activities ultimately benefits us all.

Doug Williams
Fluidyne Gasification

listserv.repp.org Mailing Lists

No such list *gasification*

Below is a listing of all the public mailing lists on listserv.repp.org. Click on a list name to get more information about the list, or to subscribe, unsubscribe, and change the preferences on your subscription. To visit the general information page for an unadvertised list, open a URL similar to this one, but with a '/' and the right list name appended.

List administrators, you can visit the list admin overview page to find the management interface for your list.

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List	Description
Bioconversion	Discussion of biological conversion to fuels and chemicals
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Gasification	Discussion of biomass pyrolysis and gasification
Greenbuilding	Environmentally-preferable design, construction, building elements
Stoves	Discussion of biomass cooking stoves
Strawbale	Strawbale Construction Discussion List

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Fluidyne Gasification
Archive - Since 1976

Mega Class Mk2 update - June July 2004

When we speak of gasification little attention is drawn to the complete system. While small systems are quite manageable in their need for fuel feeding, gas cleaning and cooling and waste clean outs, larger systems take on a dynamic that in itself is hard to initiate for the systems developer.

During June/July 2004 I spent four weeks in Winnipeg, Canada supervising the building of the prototype cleaning/cooling system for the Mark II Mega Class Gasifier Project, we also added a temporary fuel lock so that continuous operation of the gasifier could be maintained for the initial test programme. The fuel feeding alone became a little frantic during the operation of the gasifier as the consumption rate exceeded the expected 2T/hr to 2.5T/hr, producing some 5,400m^3/hr of gas. So the first tests were limited to a slightly shorter duration than expected until we built up a larger fuel stockpile.

Connecting the gas from the cooling system to the flare stack/oxidation chamber had to be at a high level across the yard, and was achieved by using 10"inch galvanised ducting salvaged from a scrap yard. The joints of the sections were sealed with duct tape and the whole system was set up in a very short time.

As can be imagined, cooling large quantities of gas down to ambient temperature from an input of 300°C requires a large heat exchanger and this project has provided the opportunity to design a component specifically for the needs of producer gas. The heat exchanger is supplied with hot gas from the first stage of the gas cleaning system from a pair of cluster cyclones with four cyclones to each cluster. This design has been in continuous evolvement since Fluidyne introduced the principle back in 1983 for the early model Pacific Class.

Because all the components of the cooling/cleaning system are prototypes, some used materials have been used in the construction to keep the development cost at an acceptable level. Once these designs have been fully tested during the Winter test programme, new modules will be built to incorporate the finer details not required in the prototype.

No actual emission tests or gas analyses have been done in this current test programme, nor has the condensate flow of one gallon per minute been tested. We expect the condensate to contain soot and dissolved ash from the first stage cooler because it looks like black water - similar to condensate previously tested. Condensate from the second stage is crystal clear water, so we don't expect to find much by way of contamination. There is no visible condensing tar at our tractor test engine and no visible contamination of the paper filter before the engine. All in all a very productive cleaning/cooling system test was achieved.

I am returning to Winnipeg on 14 September 2004 to set the Winter test programme, and evaluate the performance of a second cooling tower which has now been added to the assembly. It is expected that now the gas has been proven to be clean, we should be able to fire up the V8 engines and finalise the completion of the power generation module.

A further update on this project will be submitted to this forum later in the year.

Doug Williams
Fluidyne Gasification

Gasifier test installation with oxidation chamber / test flare standing across the yard. Test flare fills chamber from 4' up from the bottom to top.

F1000022.jpg
98.70 KB

Fluidyne cyclone cluster connecting gas to first stage cooler / condenser

F1000015.jpg
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F1000005.jpg
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Fuel lock from coal fired boiler salvaged from the scrap yard for $500. Original cost $30,000

IMG_0450.jpg
83.96 KB

This "Blow Hog" machine is 70 years old and was rescued from a sawmill swamp. It made very nice fuel particles, perfect for gasification and true to its name blew the fuel piece 40' across the yard!

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"Blow Hog" with elevator sending fuel chip into a moving floor box trailer. This was before we blew the chip into the trailer.

A better view of the six V8 engines driving the alternator seen at the rear, but not connected.

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This is the size of the 1.2 MWe alternator compared to one of the team

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The end result of flaring 5,400 M^3/hr gas. Only a heat shimmer with no visible emissions.

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Archive - Since 1976

WWII Australian Charcoal Gasifier

I am sure we all have an interest in simple gasification, but the rules of gasification are the same today as they were in WW11. It is true that the gasifiers used in Australia and New Zealand were simple compared to those used in Europe, but then ours were more likely to be home made, but they were built to a fairly common design. I should mention that Australia had a lot of very old ringbarked dead wood and this was often used instead of the charcoal, so you find some confusion in how people thought their gasifiers worked!

Most cars had charcoal or precarbonised coal/coke, so condensate and tar as experienced with wood gasifiers was less of a problem to the engines. Most simple to build were cross draught with one rather large air nozzle that had a water jacket round it to generate steam. This was introduced into the nozzle where it reacted with the incandescent char to produce the hydrogen. Some had a small control valve that dripped the water directly into the hot nozzle, while others had circulating water through the nozzle jacket to prevent it from melting. The nozzle could be moved in or out through a sleeve in the side wall to obtain the correct distance from the grate on the opposite wall.

Cooling and cleaning usually relied on long connecting pipes with a sawdust or cloth filter with many variations introduced by individual circumstances and availability of materials.

Manufactured gas/air mixers became quite elaborate and were cast in brass (I have one) but these were for only one model of car I believe, here in New Zealand.

While travelling in Queensland I actually found a charcoal gasifier at a kiosk park in the Bunya mountains west of Kingaroy. It still had charcoal in the bottom, but was complete in every way although a bit battered.

Front of gasifier. Eliptical shaped case showing:

* Clean out port in front bottom

*Single air nozzle bottom left with water tube connection on top and bottom of nozzle

* Gas outlet pipe rising from bottom right entering cyclone with bottom cone rusted away. Gas leaves cyclone out of top then

ausgas1.jpg
89.48 KB

crosses over to second cyclone on rear left

ausgas2.jpg
88.31 KB

Rear of gasifier showing

* Cyclone cross over gas pipe and gas outlet pipe (battered) exiting top of right hand cyclone

* Rectangular water tank for nozzle cooling and steam generation with side pipe being possibly hot water return connection

* Mounting brackets possibly for tractor or bumper bar mounting of car/truck

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Eliptical case has internal wall opposite air nozzle with vertical barred grate fitted into a simple slide so that it can be removed to clean out char between grate and gas outlet. Lid is just clamped down with central thrust, but with no pressure releasing safety valve function

New Zealand made cast brass gas/air mixer.

Gas enters through left hand end, air enters top left controlled by a butterfly valve. Throttle butterfly with connection lever is for gas/air mix speed control. Flange on top right mounts directly onto the engine manifold. Bottom flange right connects to gasoline carburetor

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Img_0610.jpg
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Img_0609.jpg
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Shaft passing lengthways through main body is sliding changeover valve that shuts off carburetor or gas/air mix.

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MK 2 Mega Class Project 2004

In September 2000, Fluidyne's first large scale engine gasifier was commissioned for testing in Canada; continuing until September 2003. On completion of these tests, a new MK II Mega Class has been built and was successfully test fired on 27 April 2004.

This new gasifier has been incresed in size again from the original one tonne to two tonne per hour providing sufficient gas to generate approximately 2 MWe/hr from an engine generating system.

The design of the gasifier was achieved with the assistance of our associated company Innovation Technologies Ireland (ITI) and the fabrication was completed in Winnepeg, Canada. Parallel development of gas cooling, waste heat recovery and gas cooling components are being built for this project. These ancilliary systems are expected to be in place June / July 2004, by which time the engines will be ready for connection to the gas.

The multiple engine concept being explored for this project is using spark ignition engines specifically modified for producer gas to overcome the cost of singular large engines. Details of the engines performance etc will be added to this file when available.

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Front of Gasifier showing air supply fan

IMG_0298.jpg
91.88 KB

Rear end and gas outlets fitted with temporary cyclones for first firing tests

100_3242.jpg
55.21 KB

Multiple engines, 6 x V8 502 cubic inch capacity connected to drive 1.5 MWe alternator. Engines and their individual gas/air ratio are computer controlled. This installation is to provide a working base from which to develop cheaper alternative options to expensive single large gas engines.

Canada5May2004.jpg
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Test flare flowing at approximately 25% of maximum gas flow. Red colour due to carbon blacks in gas, only coarse materials collected in cyclones 10> micron

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Pacific Class No. 15 2004

This project has been planned for some 25 years since the owner planted his forest on an uneconomic hill country farm. The pines from this forest have already been logged and it is now time for the hardwoods ie Eucalyptus, to be harvested and processed on site. In setting up this sawmill and drying facility, all powered on wastes from the forest, it is hoped to provide a show case from which to demonstrate technologies that provide visitors with a practical appreciation of sustainable renewable energy at work. Provision is also being made to locate a training facility for forestry engineering students on site.

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Pacific Class Gasifier No 15, built by contractor for client. Control panel is not fitted and gas pipe connections are temporary for testing. This gasifier has been modified to run on wood chips rather than wood blocks necessitating a small test programme to set the gas making parameters.

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Ignition port open to show incandescent oxidation zone. There is no starved air pyrolisis in this type of high performance engine gasification where the hearth temperatures range from 1200 – 1500°C.

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Test flare shows red carbon blacks burning that are normally collected in granular filter bed which was not filled for these tests.

warkworth pan2.jpg
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Eucalyptus forest as seen from the gasifier test site, where the gasifier is to generate power for the sawmill, dressing shed and timber dryer.

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Micro Class Wood Gasifier

The Micro Class Gasifier has been built to provide a research tool for Fluidyne to test sample amounts of fuel for high performance engine gasifiers. As shown, it has a small fuel stack holding 1kg which can be changed for larger capacity.

Fitted with gas cooling and dust separation components, the system has a maximum gas output of about 12 cubic metres/hr. This is of course dependent on the fuel type and specific air nozzle, throat and grate sizes. Shown in the photograph is a test flame from which colour and temperature are monitored providing indication of gas quality. Clean tar free gas has a temperature of about 1,050 degrees C.

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FISCHER-TROSPHE

The conversion of biomass into liquid transport fuels is frequently proposed as a substitute for fossil fuels. In some cases suggestions for micro scale plants do have potential, depending of course on the type of conversion process.

Where existing oil refineries can be utilised, the gasification of biomass using air as the oxidising medium offers interesting options.

As a feed stock, producer gas can be processed through a fairly simple Fischer-Trosphe system. The economics are of course driven by need, and when need is related to national wellbeing, things can happen with an acceptance of greater effort.

During the oil price crisis of the 1970s, New Zealand was caught without supplies of natural gas or oil from the reserves known to exist. The then Department of Scientific and Industrial Research (DSIR) conducted extensive investigation into biomass based fuels and their trials with oxygen blown gasification bought them to Fluidyne's workshop looking for assistance.

By choosing the oxygen blown gasification process, their first tests were very successful and it was thought the whole project would be completed in a couple of months. Then the accounts came in for the oxygen killing the trials stone dead as the gasifier wouldn't work with air.

Fluidyne's own development work was also in the early stages of evolving tar free gas, so we pooled our knowledge with the DSIR and facilitated each other to sort out some of the less understood phenomena.

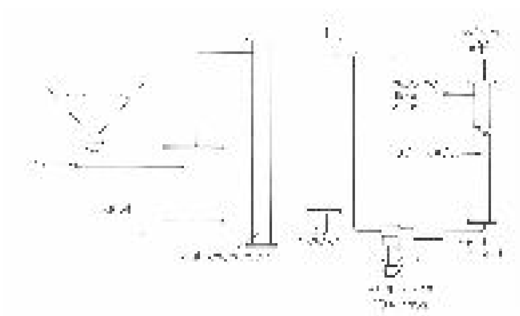
Once the DSIR started to make air blown producer gas, they constructed a small plant to simulate the Fischer-Trospche process. Producer gas was compressed to 10 atmospheres and released through a column of volcanic iron sand that had diesel fuel as the saturating agent. Off the top came petroleum wax which then could be refined into diesel or petrol. At that time (1976), the economics required 2,000T/D to supply all of New Zealand's transport fuels. One million hectares of pinus radiata forest would have produced more wood energy than New Zealand's then current annual fossil fuel and electrical energy usage of about 330 x 10^{15} J/yr.

Producer gas can meet lower expectations of national need if that need exists. We cannot control the politics or the economics that surround the implementation of renewable energies, but we should continue to be responsible for their technical evolvement.

Irrespective of how we perceive producer gas and gasification as a technology, it is but a stepping stone into the next phase of technical evolution.

fisc1.jpg
81.01 KB

A rare photo of Dr Jim Cousins on the right who was New Zealand's leading researcher into biomass energy in the 1970s. The gasifier is on the left end of the base, and the slightly modified standard air compressor for the gas compression is just visible at the rear. The only drawback to this process is the need for tar free gas.



fisc2.gif
42.45 KB

Basic layout of sawdust fed gasifier and simple Fischer-Trospche process.

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Once the DSIR started to make air blown producer gas, they constructed a small plant to simulate the Fischer-Trospche process. Producer gas was compressed to 10 atmospheres and released through a column of volcanic iron sand that had diesel fuel as the saturating agent. Off the top came petroleum wax which then could be refined into diesel or petrol. At that time (1976), the economics required 2,000T/D to supply all of New Zealand's transport fuels. One million hectares of pinus radiata forest would have produced more wood energy than New Zealand's then current annual fossil fuel and electrical energy usage of about 330×10^{15} J/yr.

Producer gas can meet lower expectations of national need if that need exists. We cannot control the politics or the economics that surround the implementation of renewable energies, but we should continue to be responsible for their technical evolvement.

Irrespective of how we perceive producer gas and gasification as a technology, it is but a stepping stone into the next phase of technical evolution.

fisc1.jpg
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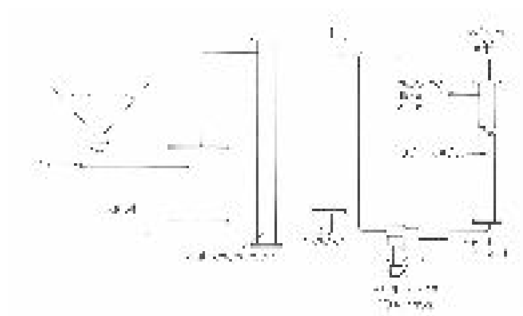
A rare photo of Dr Jim Cousins on the right who was New Zealand's leading researcher into biomass energy in the 1970s. The gasifier is on the left end of the base, and the slightly modified standard air compressor for the gas compression is just visible at the rear. The only drawback to this process is the need for tar free gas.



fisc2.gif
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Basic layout of sawdust fed gasifier and simple Fischer-Trospche process.

Fluidyne Gasification
Archive - Since 1976

DEATH OF A HABITAT

Eucalyptus trees are now growing in many countries, and their amazing ability to adapt to a vast range of environmental conditions make them ideal for renewable energy forestry projects. Generally speaking they are planted as a mono species, but in Australia - their country of origin, they belong to a huge community of trees that make up the scleraphyll forests of this
vast country.

Depending on the soil fertility, the predominance of one species or another can be seen quite distinctly and healthy specimens have an extraordinary beauty.

In the area of central Queensland where I lived as a teenager (1950's) I helped cut down the giant bluegums, quite widely distributed through the forest, and we were followed by the railway sleeper cutters who took out all the big Ironbarks. The remaining big eucalyptus not having any millable value were later ringbarked to clear the area for grazing.

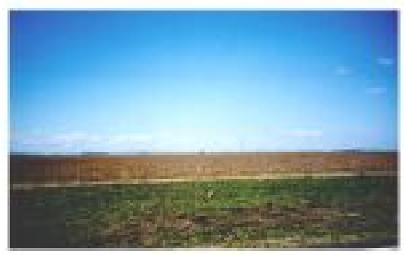
Revisiting this area 46 years later, the damage to this fragile environment is all too clear to see, but it's too late to restore this environment to the habitat it once formed.

The following photographs will give you some idea of how easy it is to destroy something that has protected the land for thousands of years.

August 2002

1. Cleared of all large trees, there remains only

2. All the large trees on the right and in the distance grow

the bleached skeletons of their existence. The smaller trees are mainly acacias and banksias	along the creek bank where the golden sand is now filled with silt washed from the surrounding paddocks
 3. All trees not considered as useful are ringbarked and left to die. The cuts of the axe are clear to see.	 4. Like accusing fingers pointing to nowhere, this is the cost to put meat in your hamburger.
 5. The final indignity to a once healthy environment as the trees still hang on to the soil they evolved to protect.	 6. Happy grazing country enjoy the view as the next stage will be to open cut mine the almost continuous coal deposits of central Queensland.

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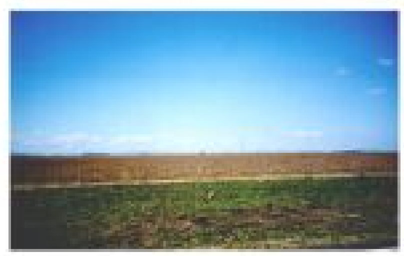
 5. The final indignity to a once healthy environment as the trees still hang on to the soil they evolved to protect.	 6. Happy grazing country enjoy the view as the next stage will be to open cut mine the almost continuous coal deposits of central Queensland.

Fluidyne Gasification
Archive - Since 1976

Wood Chip Bunker Drier

1. This small bunker was set up to test dry Coppice Willow chips at Long Ashton Agricultural Research Station, Bristol, UK. A central phlenum chamber received hot air from a CHP engine and then into floor ducts across the bunkers. There was no control on the ducts to shut them off, but they provided the information to build larger bunkers.

2. At Rural Generation in Londonderry, Northern Ireland, this grain drying shed is used between harvest times as a wood chip dryer. Grilled channels can be seen across the floor which are fed by a long phlenum chamber outside the wall. Hinged doors cover the duct ends so that the bunker can be dried in segments depending on how full the bunker becomes.

3. On top of the 9 foot stack, the boundary line can be seen between the Coppice Willow and larger wood chips. The willow has just been cut and is the harvest from 10 acres. Wood chips were stacked in to fill the storage area to maximum capacity.

4. Close up you can see the edge of the Willow boundary drying and then the surfaces darken as moisture increases as it passes out of the surface layer from the wet pile.

5. To separate fines out of the wood chip at RGL, we used a potato machine to shake the fines out of the chip. These fines on examination contained a lot of dirt and rotten wood, which in a gasification process results in an increase of ash and slagging.

1

2 **3**

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chip2.jpg
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chip3.jpg
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chip4.jpg
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chip5.jpg
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Fluidyne Gasification

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CHEAP WORKING GASIFIER

Using the dimension of Fluidyne's 25th Anniversary Gasifier design, two French engineering students built this Gasifier from salvaged scrap steel, during their Summer work experience at ITI (Innovation Technologies Ireland). The lower section is an old compressor tank, and the upper fuel hopper - a water tank. The hearth bowl is an old truck wheel with the hollow outer flange used to contain a rope of insulation material forming the seal. Three toggle bolts tighten the hopper down onto the seal. A spring loaded hinged sealed lid makes a good safety valve, and a 100mm gas outlet connects to the flare stack.

This size of gasifier can have 3, 4, 6 or 8 air nozzles and a manifold made from box section should be shaped accordingly. Shown here, we have the ability to use 6 air nozzles, but only 3 are used at the moment.

The air inlet design leaves a little to be desired, but blown with a good strong electric fan, the gasifier made excellent clean gas 3 minutes from ignition.

If you decide to make one of these gasifiers, you will need instructions on how to operate it correctly, so contact me direct and provide some information on what type of wood you will be using as a fuel.

The fuel wood consumption will be from 10kg/hr - 45kg/hr depending on the number of air nozzles.

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Fluidyne Gasification
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SIMPLE CHIP GUILLOTINE

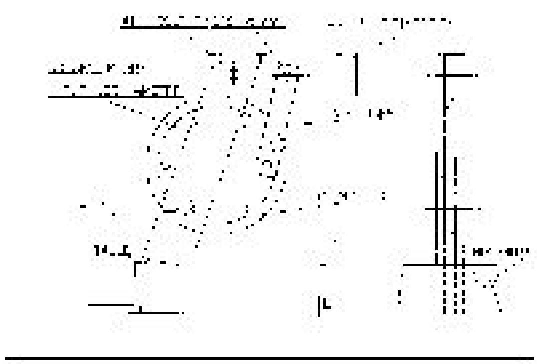
This drawing is only to illustrate the concept and principle of a double leverage blade which can be used to cut round wood into small pieces or chips.

The descending curved blade rotates slightly as it shears through the fibres. The hardness of the wood will limit the diameter cut.

As only a small segment of the rotary blade is in use, it can be rotated as the cutting edge becomes blunt. It could be sharpened with a hand held whetstone block.

For a robust design, the cheek plates should be square up the back to conceal the blade, and a pyramid shape gusset plate should be welded across the back to stiffen the assembly.

The handle pivot should allow clearance of the blade in the 'up' position, and operate from say chest to waist so that body weight can be applied to the handle. A few chain links can be welded to the handle and base so it can be locked down to prevent children playing with it.



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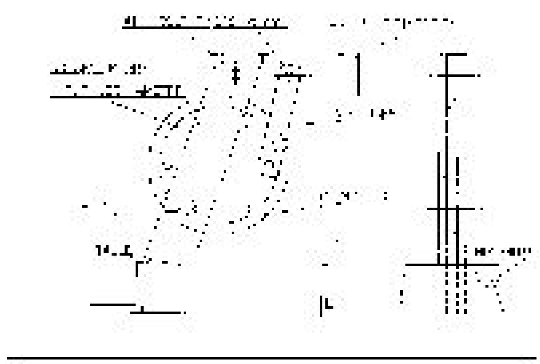

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Fluidyne Gasification
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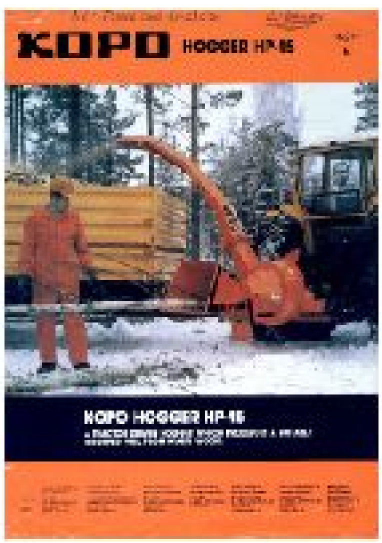
Screw Auger Chippers

The problem of fuel wood preparation for gasification projects is a universal problem and the easiest option is to use chipped wood. Many projects using chipped wood have failed even though the gasification equipment is considered "state of the art".

Chippers using rotary bladed drums or rotating plates with blades produce a fine chip, perfect for combustion but not suitable for gasification. In gasification the fine chip breaks down too quickly and fills the interstitial space between the particles preventing inflow of air and the outflow of gas.

Screw auger chippers provide the best chip size option and this brochure shows an ideal size for most gasifier projects.



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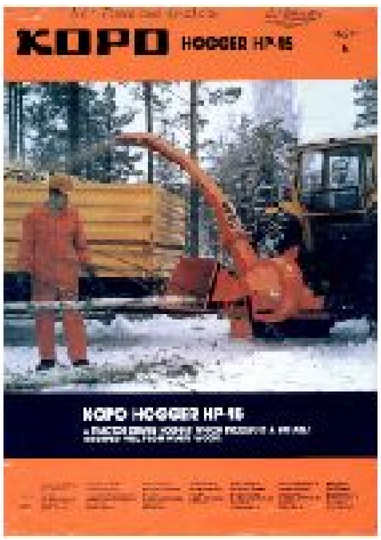

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Fluidyne Gasification
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Fluidyne Gasification

25 Years

1976 – 2001

Download the Pioneer Class gasifier design article (516kb Adobe PDF)

Introduction

2001 marks the 25th anniversary of our company Fluidyne becoming involved with the research and development of wood gasifiers for electrical power generation.

From a commercial perspective, gasification is still struggling to overcome the bad impressions created by prematurely implemented projects of the 70s and 80s and to a certain sector of our administrations these problems still exist into today's technology.

During the years we have all contributed to this forum I have endeavoured to assist those committed to using gasifiers within the limitations imposed by my commercial commitments and in part by paranoia of having other companies copy our designs.

On reflection for many interested in gasifiers, just having questions answered is not enough, and they have a real need to actually build a correctly designed gasifier that can run an engine without destroying it.

There is also a need by some to investigate the various changes that take place in the transition of wood to char to gas. Clearly its time to provide assistance in a more practical manner than just answering questions.

In 1989 Fluidyne was awarded a contract to supervise the gasification research team at Bremen University in the development of a simply constructed wood gasifier for developing countries.

The design was really just a larger more versatile gasifier based on Fluidyne's Pioneer Class gasifier that did not reach commercial production. Originally designed for 10kWe output consuming 14 kg of wood/hour, its an ideal little gasifier for running engines up to about 2000cc, or just flaring the gas for testing fuels etc. Construction could utilise existing scrap cylinders, and if you don't mind frequent cheap replacement parts, you can make everything out of standard steel pipe and plate. For more reliability however, using a heat resistant stainless steel, like Inconel, or Avesta 253MA for the reduction tube, grate and nozzle tips will give you years of operation (ours is about 13 years old).

This is a great little gasifier with no vices, and it tolerates beginner operators. Easily opened the fuel bed remains intact for examination layer by layer, enough data for any ardent researcher or student demonstrating renewable energy.

At the mention of students, this is not a toy or a model gasifier and all safety regulations must be applied to its use in any location.

Correctly operated, this little gasifier produces a tar free gas from a wide range of wood fuel particle sizes from chips or small blocks, so it should work on fuels available to most users. It does not however gasify sawdust, peat, MSW or other unmentionables which from years of experience we know don't work in our systems.

Gas cooling and cleaning can be complicated if built to commercial standards, so I will let you sort out the best option to suit your situation. Besides I still have to keep some secrets for myself!

The original Pioneer Class drawing is on the Fluidyne Archive with a basic description of parts. There is plenty of room for innovation, just don't change they key dimensions except in the manner prescribed.

As I am preparing for my 12th trip to Europe in as many years leaving on the 1st June, I don't have time to answer endless questions. Just build it and then in July when I'm back in New Zealand we can sort out your individual queries. With any luck several will be operational and others will be encouraged to join in the fun.

Looking forward to seeing your projects posted in July.

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http://members.nbci.com/whitools/

Operating Notes

A gasifier's performance is only as good as the fuel preparation, and each type of fuel or species of wood may require ad adjustment of the throat tube or grate to perform trouble free. All fuel must be dry (about 15-20%).

Fuel flow creates problems if the fuel doesn't flow, and we use a steel bar connecting the engine to the gasifier base leg to put a little vibration into the system.

Depending on whether you blow the gasifier or suck it, a manometer on the inlet or outlet will provide a resistance measurement across the hearth bed.   The actual measurement depends on the fuel but I like to see about 3-4" W.G. On suction.

For first time start-up set the internal measurements as shown in red (on the drawing) as this is OK for most wood types using small blocks or large chips. Fill the hearth with charcoal crushed to about the size of your thumb nail, until its about 100-l20mm over the nozzles then add about 40 litres of wood. If there is a large air space over the top of the wood, drop a couple of pages of burning newspaper inside and close the lid. This consumes the surplus oxygen and prevents start up explosions.

Now start the suction fan and offer a flaming rag or torch to one of the air nozzles. It should light instantly and gas should evolve within minutes.

The fire should burn very bright if you have plenty of suction and really you want to see it stay like this all the time. If for some reason your suction or engine isn't big enough you can squeeze down the end of the nozzle horizontally to get the right colour.

Should the hearth bed increase resistance lift the grate until the pressure stabilises, or lower it if resistance keeps dropping away.

Tar may be present in the gas if the throat tube is too low, so lift it slightly, but try to stay out of the oxidation lobe or it will melt or burn the throat inlet.

Producer gas from wood is very wet and as the gas cools it is important to strip the condensing water away from the gas steam.

Safety

Under no circumstances operate the gasifier in an unventilated situation and every care should be taken to avoid inhaling smoke or fumes from the system.

Regulations may exist that prevent you from operating these systems and it is important to check any restrictions that may apply to your situation.

Questions

All questions should be directed through the Gasification List in order for answers to become ongoing archive reference.

http://www.crest.org/discussion/gasification/current/

Fluidyne DIY Gasifier

Construction

The basic requirement for this project is two 3mm steel cylinders rolled out of sheet, or a long existing scrap cylinder that can be cut in two. Both cylinders should be about 460mm in diameter so that the taper above the nozzles is avoided.

Retain the same length for the hearth cylinder and taper as shown on the drawing, but the fuel hopper can be as long as you can practically handle. We found 60-80 litres is a good size.
Join the cylinders in the middle with a flange using 6 x 10mm bolts. You can use a H.T. Sealing rope or a joining compound, we use the rope.

The three nozzle mountings are half inch BSP pipe sockets or pipe joiner welded half in through the wall. The half inch pipe nozzles screw in from the inside, and a small sleeve of heat resistant stainless Avesta 253ma or equivalent, welded around the end make them last longer.

For safety reasons the air inlets on the outside should have a connecting manifold or a 90 degrees bend screwed in facing down. You need to cap these for shut down of the gasifier.

This prevents any flash backs blasting you with flaming charcoal.

The throat tube/reduction zone is 160mm long and passes through a support plate made out of 5 or 6mm steel plate. We cut two notches out of the plate on opposite sides of the central hole, and welded tits onto the tube so it can move up or down in small increments. The support plate sits on lugs so the whole inner assembly can be removed to access the bottom end.

Make the grate exactly as shown with clearance of the ends inside the throat tube. It really is best to use the heat resistant stainless for this job, but if nothing is available, make a heap of replacements out of steel bar.

A stalk hangs down from the centre of the grate and passes down the tube support through the bottom end. Weld a 12mm nut on the outside of this support tube so that a long bolt or threaded rod can be screwed in, to push the grate up or lower it a little. You can also tap this bolt and shock the grate a little if a plug develops.

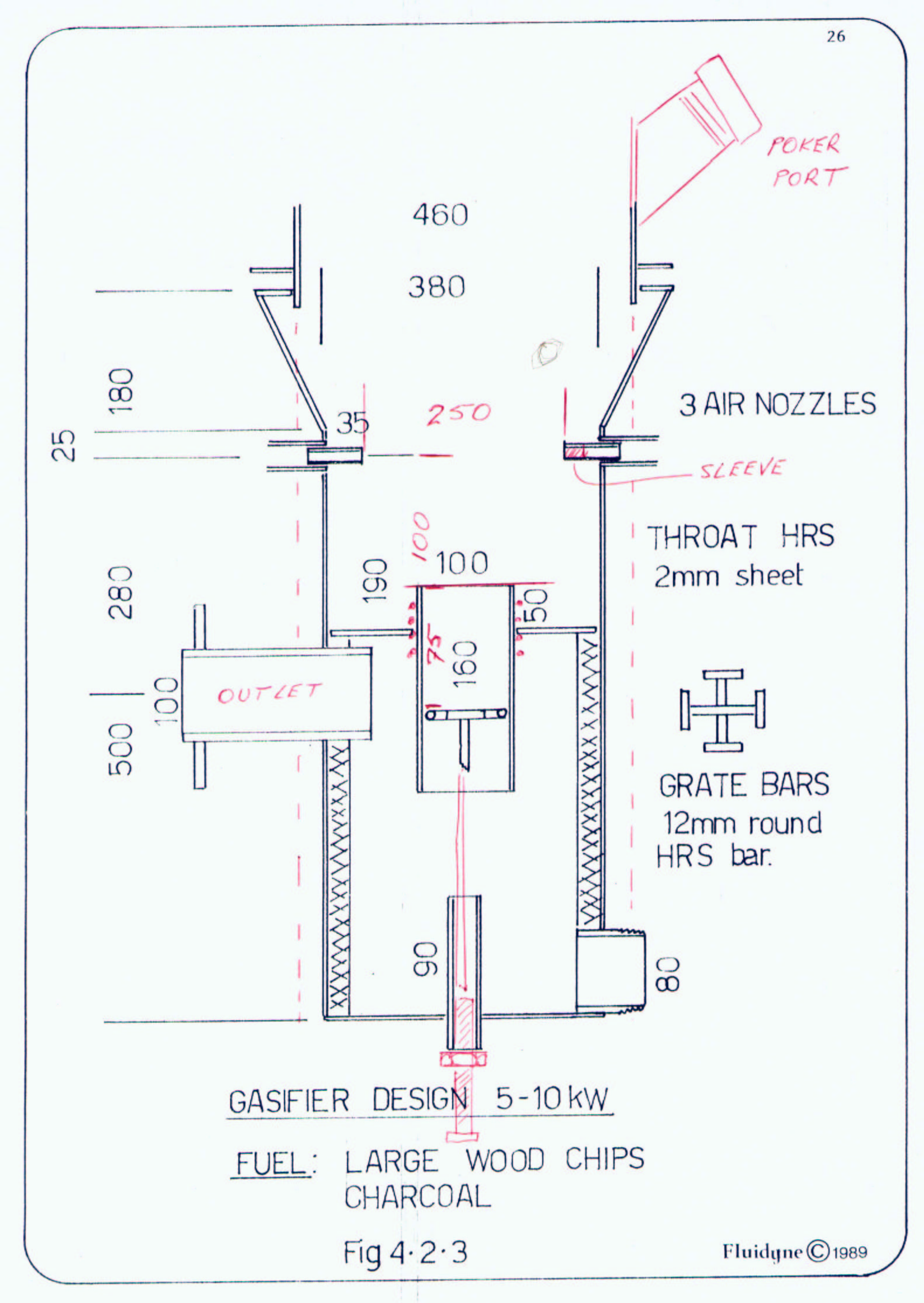
Clean-outs are through a short 80mm pipe barrel nipple cut in half and a pipe cap screws on to make a seal. Make sure it does seal or air will leak in or gas out!

It is important to make a large outlet connection or you will throttle the hot gases exiting, and flange it to whatever you are going to connect onto the hearth.

By necessity the fuel hopper must have a sealing lid and it should have a spring clamp as a safety valve. Any air leaks through the lid will cause repeated small explosions in the hopper. A poker port just above the flange is useful to ensure the bed is packed before start-ups.
Try to obtain Avesta 253ma or Inconel for the nozzle sleeves and throat tube (2mm) and 12mm for the grate bars.

Mountings can be welded to the hearth outer case and a clearance should be left underneath to access the grate adjustment and "tapper".

Drawing and picture



This was the original size of the Pioneer Class hearth and fuel hopper, but the narrow hopper caused fuel flow problems. We fitted a larger hopper, hence the taper on the drawing above the nozzles. It is easier to just have the larger parallel cylinders.

You can see the ignition port, and air inlet which is between two nozzles. The grate shaker lever didn't really work and tapping the bottom is OK.

Mount the vibrator arm from the engine about 150mm below the bottom on the leg mounting. Sandblast and paint with silicone manifold paint.

Fluidyne Gasification
Archive - Since 1976

The Mega Class Gasifier Project.

High performance gas making as required for large engines or turbine application has been inhibited by the dimensional limitations imposed by conventional gasifier designs. Fluidyne's work with packed carbon beds has also identified specific needs for different wood species requiring the gasification parameters to be changed or "tuned".

Tuning the gasifier requires small increments of change to create the optimum phenomena resulting in a gas with no condensible tars or pyrolysis oils when cooled.

The Mega Class project is drawing on the technical expertise from New Zealand, Canada, and Northern Ireland to develop an integrated package of power generating technology. Specific attention is being directed to fuel preparation, with emphasis on residue wastes not currently gasified or seen to be appropriate for incineration technologies. The photograph shows the first of this new design of gasifier set up for manual testing in Canada, and it should be noted that the tests are to establish limitations of component design rather than testing of the gas making process.

Initial tests using briquetted fuel indicate a fuel to gas conversion rate of 1 tonne/hour, sufficient gas to produce about 1MWe via established engine powered generation. It is expected to increase the output

capability once the automated fuel feeding equipment is installed and fuel storage bunkers put in place. For this existing test programme, the gas is burnt to waste via twin 250mm flu stacks with all emissions and waste residue being measured. Waste heat from the gas cooling, can if necessary be ducted for space or water heating.

This programme of design in New Zealand, and construction in Canada and first tests were conducted in a period of 12 weeks. The fuel systems are now in place and extended operational testing commenced on 18th September, 2000.

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How Gas Is Made

Beginning with a 'start-up' charge of charcoal in the combustion space of the hearth and air dry wood fuel piled on top, gasification proceeds as follows:

Along with the restricted supply of primary air admitted laterally into the charcoal bed, through 8 nozzles, a momentary flame enters to ignite the charcoal and within one minute, combustion is established.

Heat radiating upward from the combustion zone, drives moisture from the wood fuel and as charcoal is consumed beneath, the dried wood sinks closer to the source of heat. At this point, the higher temperature promotes the distillation of volatile substances from the wood which then carbonises to charcoal. In the lower levels of this carbonisation zone some of the volatile substances may ignite, increasing the temperature further and at about 600°C the charcoal ignites, producing a much more rapid temperature rise.

Much heat is produced by the process at this level when oxygen in the air admitted to the combustion zone, contacts and reacts with the incandescent charcoal surfaces to produce carbon monoxide. Carbon monoxide diffuses back into the gas-filled spaces between the charcoal pieces where it oxidises to form carbon dioxide. This reaction all takes place in the oxidation zone.

As the amount of carbon dioxide in the gas spaces builds up, there is a corresponding reduction in the amount of free oxygen available in the gas spaces and concentrations of both these gases will approach constant levels. At this point in the system, the carbon monoxide concentration reaches a constant low level which is maintained.

Simultaneously, steam also contacts and reacts with the incandescent charcoal surfaces to produce carbon monoxide and hydrogen. A little carbon dioxide may be produced. The additional carbon monoxide and the hydrogen diffuse back into the gas spaces where they are oxidised to form carbon dioxide and steam respectively. The net effect of the steam reaction is to supplement the carbon-oxygen reaction. Provided it is not excessive, the presence of steam confers the same result as an increase in the available oxygen. (Air dried wood waste and crop residues generate enough steam internally by chemical breakdown to promote the benefits of the steam reaction. Additional moisture can only be detrimental).

As the reactions continue, the amount of oxygen available for combustion decreases until eventually the amount of heat produced at this level in the system balances the amount of heat produced needed to run it. Here the flame temperature reaches its maximum and the amount of oxygen remaining is very small. This is the throat of the hearth and is where residual tar is cracked.

Much heat is consumed by the process below this level which is referred to as the reduction zone. After the maximum flame temperature has been reached and practically all the oxygen consumed, the temperature in the system begins to fall because less heat is being produced than is required to run it. At this stage, the carbon dioxide and steam in the gas spaces penetrates to and reacts with the hot charcoal surfaces to produce carbon monoxide and hydrogen, drawing heat from the charcoal bed in the course of the reactions. As the system temperature continues to decrease, the rates of these reactions also decrease. until when the temperature falls sufficiently or when the charcoal supply is exhausted, the gasification process stops.

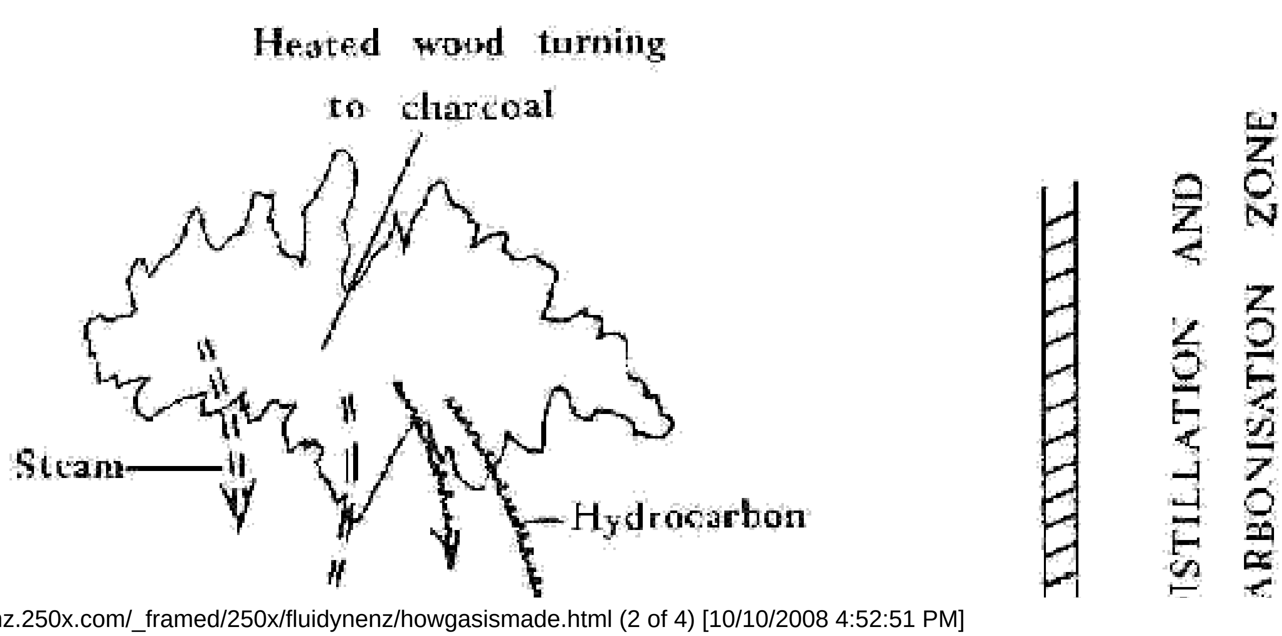
Except for the wood fuel drying phase, the other gasification processes described occur within the reaction vessel which we call the 'hearth module' and because of the high temperature, oxidising and reducing atmospheres which must be developed and sustained within it, the hearth module incorporates special refractory materials, surface treatment and thermal insulating materials, selectively placed to withstand the rigours of the main gasification processes.

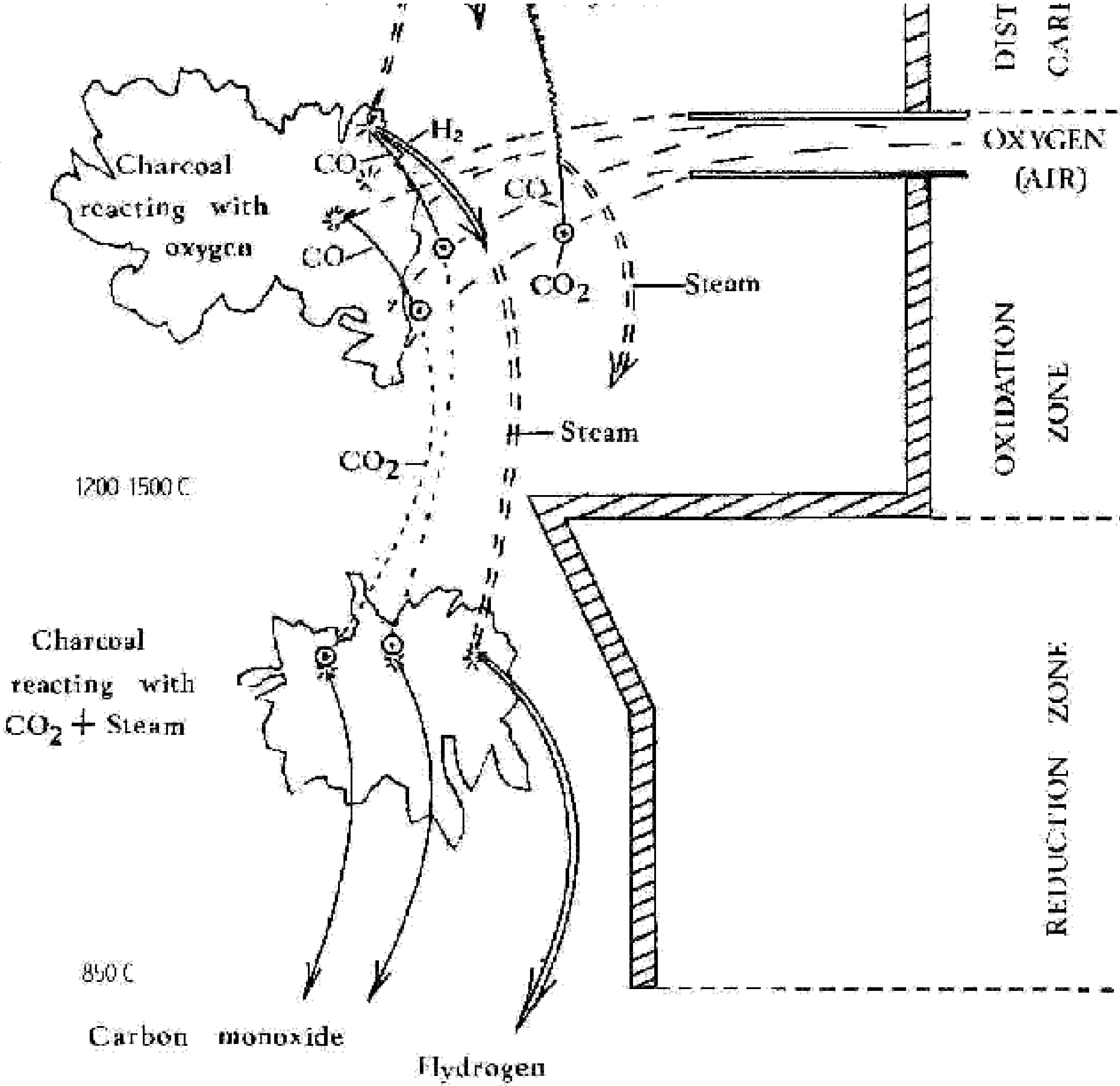
The Gas. The product gas leaves the gasifier hot, dirty and moist to undergo the degree of cleaning, cooling and drying appropriate to the end-use intended for it. Wood derived producer gas from the Pacific Class gasifier is comprised as follows:

Combustible fuel gases	20% carbon monoxide
	19% hydrogen
	1% methane
	0.1% ethylene
Non combustible gases	9% carbon dioxide
	51% nitrogen

For practical purposes the gas is given an average calorific value of 5.03MJ/Cu.m (135 BTU/Cu.ft). Calorific value is subject to wide variations due to the moisture content of the fuel, and its correct size preparation.

Remember: The drier the fuel, better the gas.
Correct fuel preparation, higher operating efficiencies.





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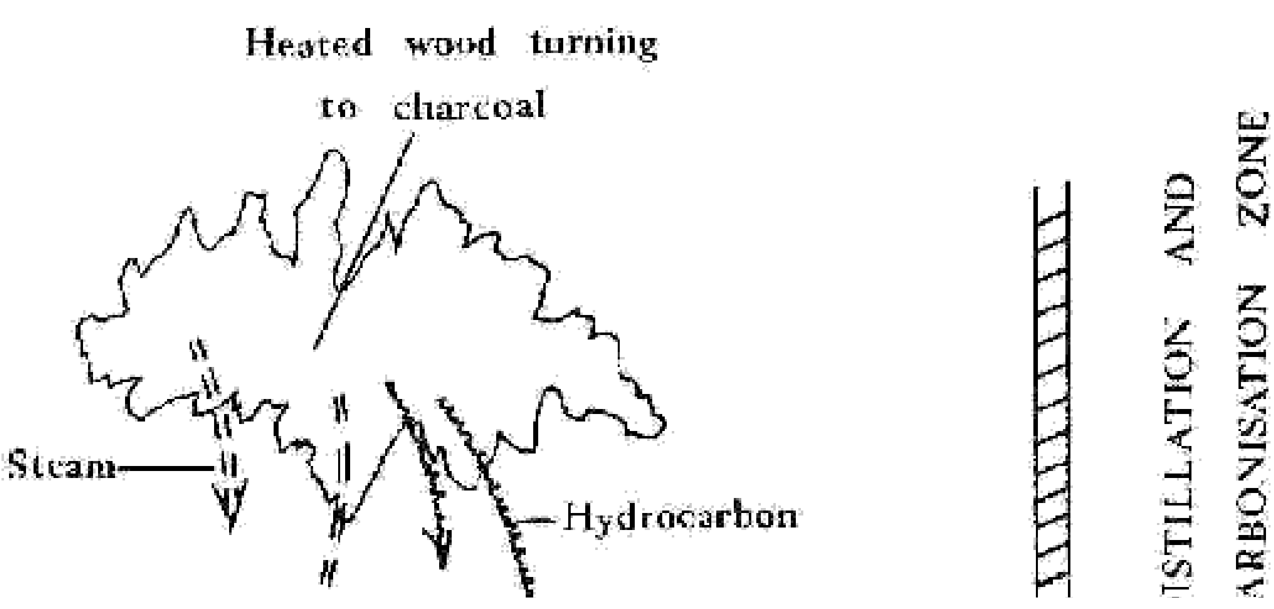

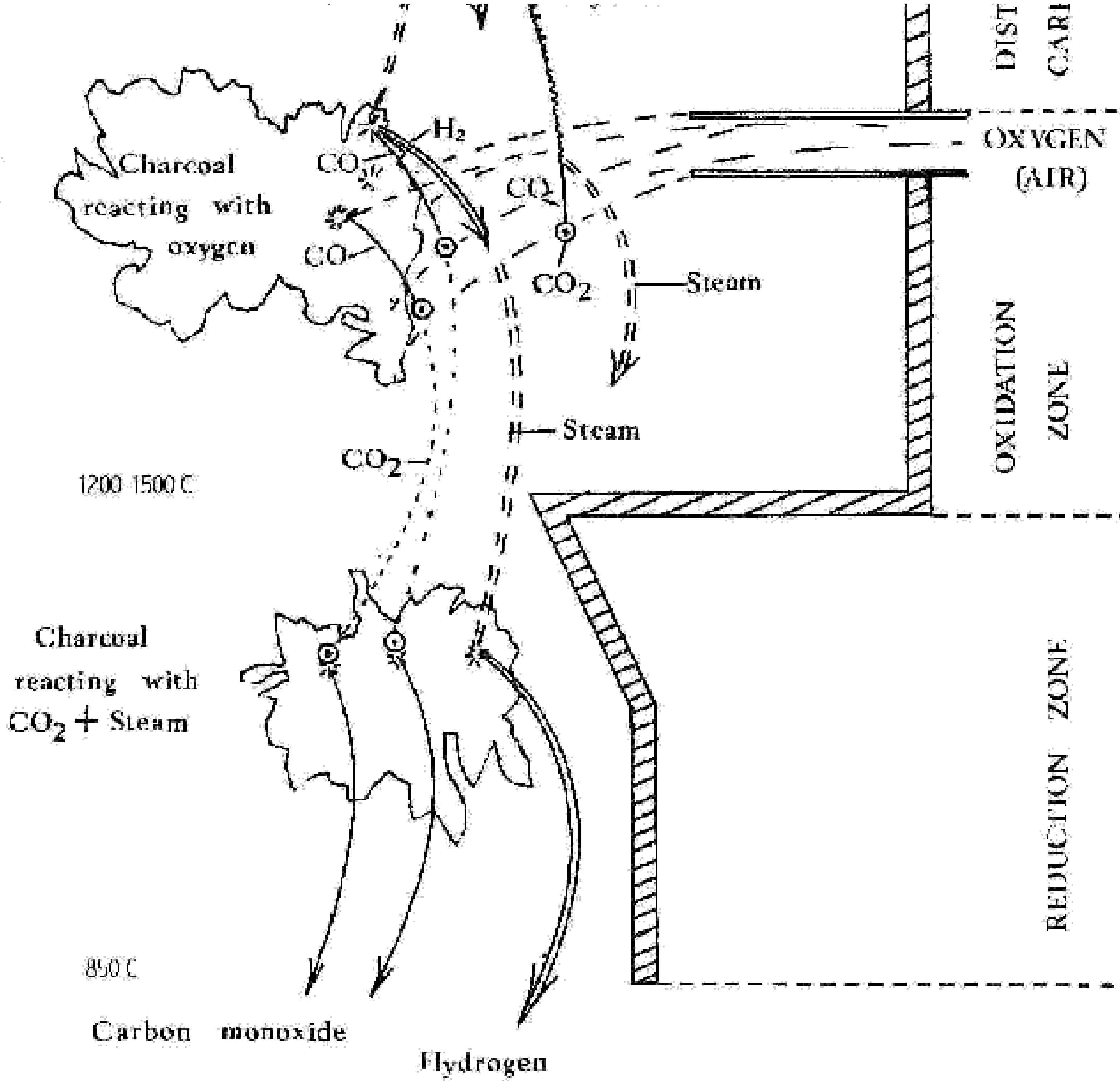

HOW GAS IS MADE

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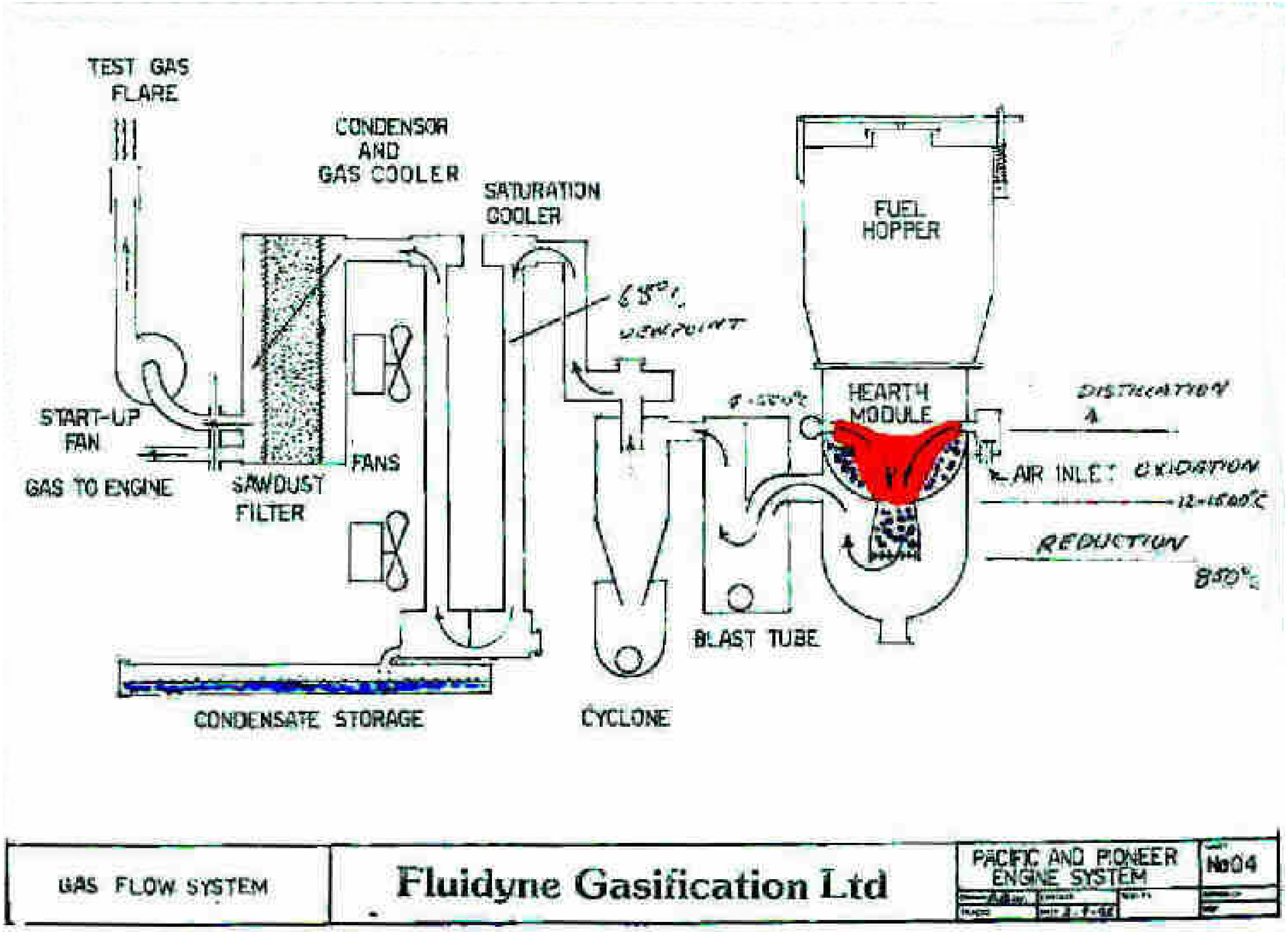
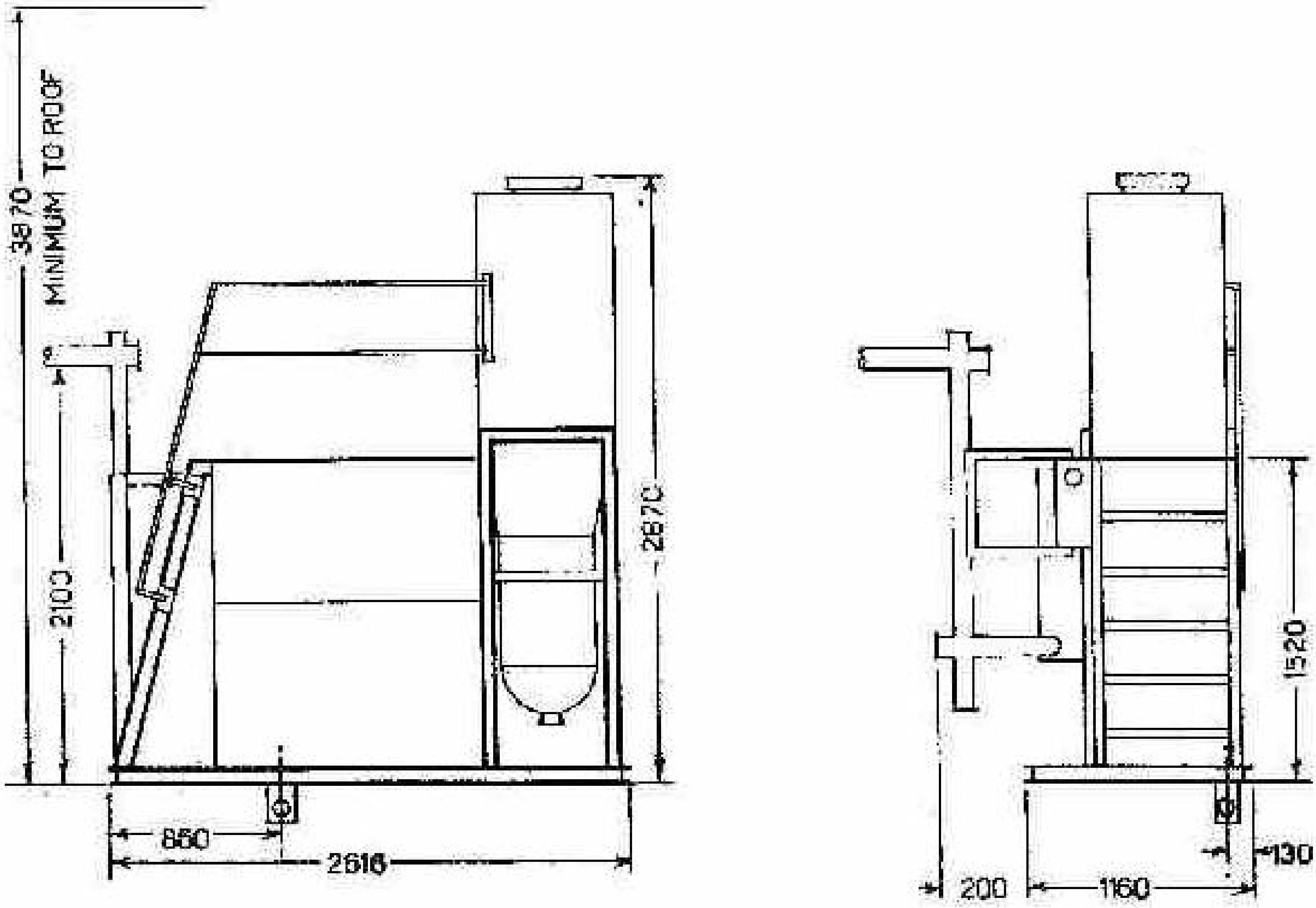
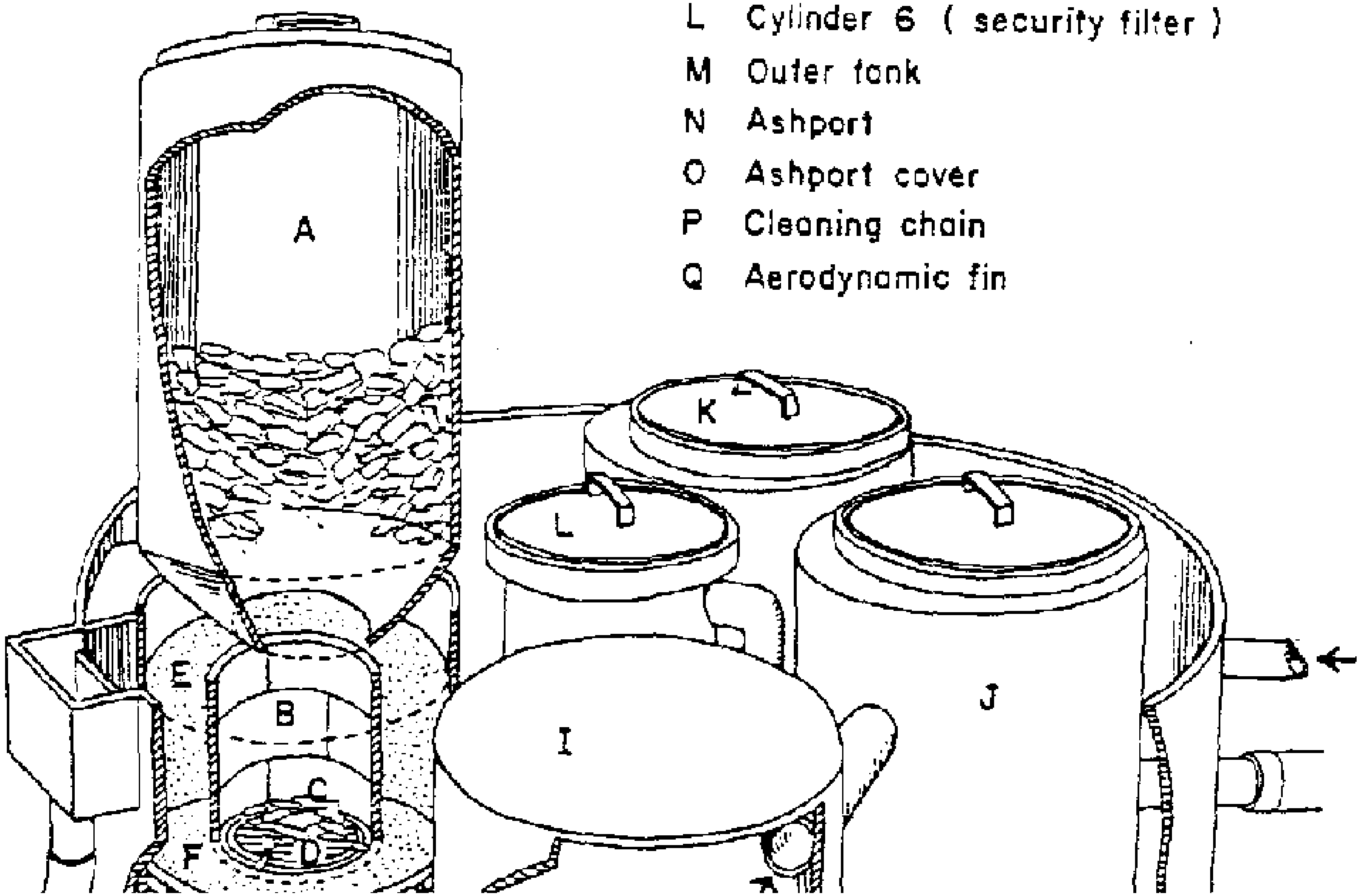

TEST GAS FLARE
CONDENSOR AND GAS COOLER
SATURATION COOLER
FUEL HOPPER
DEWPOINT
HEARTH MODULE
DISTILLATION
START-UP FAN
GAS TO ENGINE
SAWDUST FILTER
FANS
AIR INLET
OXIDATION
REDUCTION
BLAST TUBE
CONDENSATE STORAGE
CYCLONE
GAS FLOW SYSTEM
Fluidyne Gasification Ltd
PACIFIC AND PIONEER ENGINE SYSTEM
No 04



Fluidyne Gasification LTD Pacific Class

A Bunker
B Cast refractory reactor
C Charcoal fuel
D Metal grate
E Compacted rice hush ash
F Cast refractory dish
G Metal shroud
H Cylinder 1 (reactor)
I Cylinder 2 (settling tank)
J Cylinder 4 (cloth filter)
K Cylinder 5 (cloth filter)
L Cylinder 6 (security filter)
M Outer tank
N Ashport
O Ashport cover
P Cleaning chain
Q Aerodynamic fin



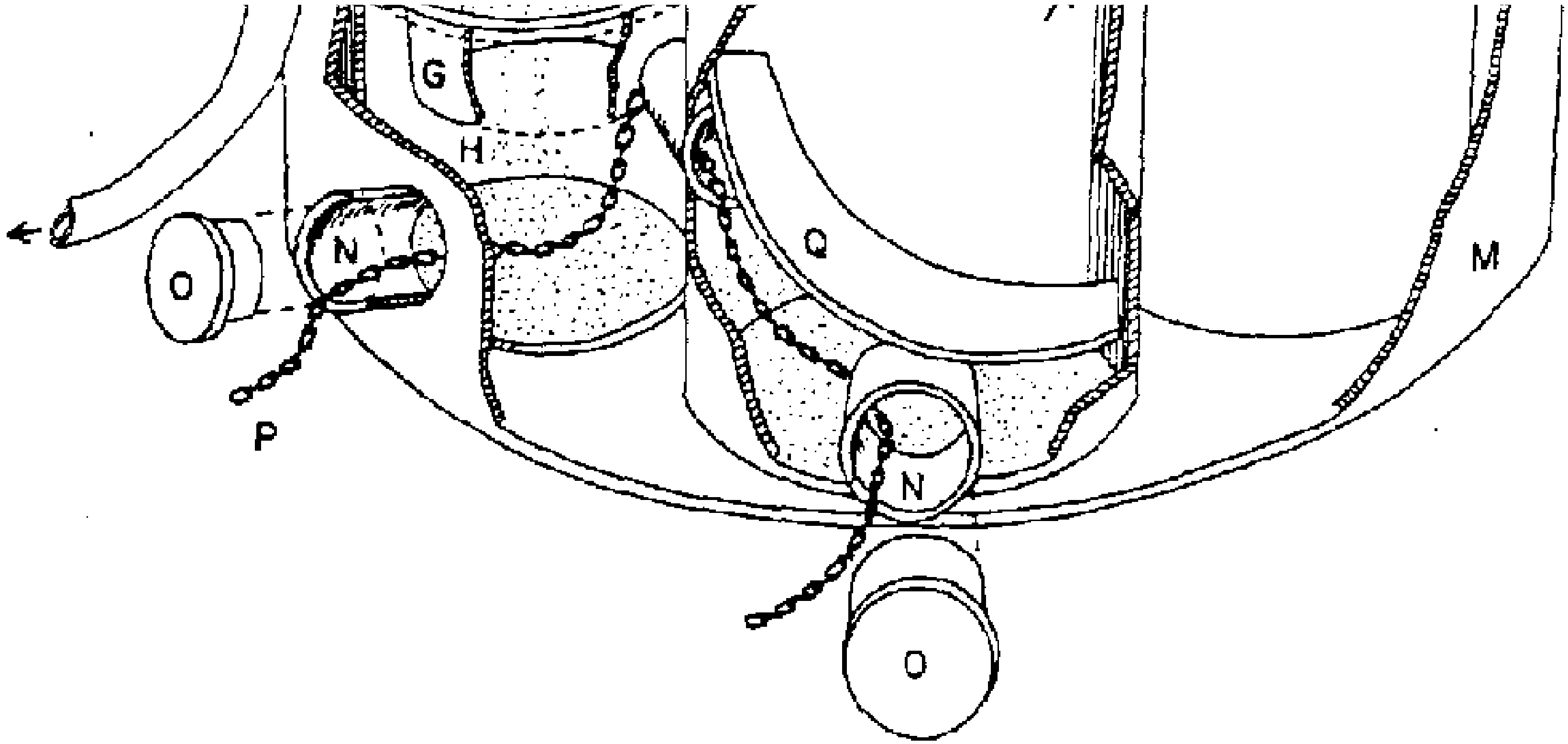


Fig. 1: The open-core ferrocement gasifier of Robert Reines

(Source: R.G. Reines,
Final Report GTZ Proj.Nr. 88-2001-1-01.100, August 1989

Pacific Class Wood Gasifier

- Gasifies up to 45 kg of wood/hour
- Sustaining the following range of power output:

Spark ignition engine

Shaft power:	to 37.8kw (50.7hp)
Electrical power:	to 34kw

Dual fuel, diesel engine

Shaft power:	to 47.8kw (60.7hp)
Electrical power:	to 40.8kw

(Actual power output is determined by engine specification. Optimum engine size is 6 litres)

Features

- Wood fuel hopper, 200 litre capacity, power agitated and thermally insulated.
- Twin fan, air cooled gas conditioning system designed for easy cleaning
- Quick change, sawdust gas filter with washable, final safety filter element (Rice husk or pulverised plant material may also be used).
- Change over valve
- Start up, suction fan complete
- Test flame, burner nozzle
- Hearth and filter manometers
  - Hearth, gas exit temperature gauge
  - Space frame chassis with built in steps and operators platform
  - 6 metres of 80mm PVC pipeline
  - Operating instructions

Dimensions

Length 2616 mm	Gasifier weight 900 kg
Width 1160mm	Shipping volume 11.66 cubic metres
Height 2870 mm	Shipping weight 1500 kg

This plant incorporates an automatically timed 0.37 KW electric motor for fuel agitation. It generally operates for about 5 seconds every 3 to 5 minutes.

The Start up fan is powered by a 0.37 KW electric motor, which normally operates for 3 to 5 minutes daily while the engine is running initially on liquid fuel as the gasifier warms up to operating temperature. A small petrol engine can also be used for this function. when the main engine runs on producer gas only.

A maximum of three (3) Pacific Class gasifiers may be manifolded together to obtain larger gas volume.

Pacific Class Wood Gasifier

Specification

Type	Downdraught
Maximum wood consumption	45kg/hour
Maximum gas production (in continuous operation)	98.3 Nm^3/hour
Minimum gas production	24.6Nm^3/hour
Gas heating maximum load	5030kJ/Mn^3
Gas heating value 60% load	4980kJ/Mn^3
Maximum fuel moisture content	24% (dry basis)
Maximum fuel ash content	2%
Fuel Size distribution	Assessed during commissioning
Minimum bulk fuel density	200 kg/m^3 (estimated and variable)
Type of ash removal system	Manual
Ash amount produced	0.055 kg ash/kg fuel (estimated)
Gasifier efficiency at maximum load	71%
Gasifier efficiency at 60% load	70%
Gasifier power consumption	0.992 kW/hour (approx)
Gasifier start up time	5 minutes
Suitable fuels	Wood coconut shells, corn cobs (no other fuel suitable)

Gas treatment section

Type Baffled settling chamber, multi cyclone, precipitation by condensation, volume filtration, impingement filtration.

Filter medium Sawdust plus washable reusable cellular sheet as final safety filter.

Filter efficiency (directly related to the size of sawdust particle used)

@ maximum flow rate of 95 Nm^3/hour	88.5%
@ minimum flow rate of 53 Nm^3/hour	93.7%

Cleaning	Manual
Maintenance requirements	0.00375 labour hours/kW
Condensate production at maximum load	Variable under different site conditions
Gas tar content after gas treatment section	None visible in equipment or engine, across gasifier operating range.
Gas dust content after gas treatment section	Acceptable to engine manufacturer, proven by site testing.

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The engine tables are not found in existing literature and have been tested over thousands of hours using various engines. Use them sensibly and you can do all sorts of cross calculations , that is with normally aspirated engines. No references apply to turbo charged engines.

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Regards
Doug Williams
Fluidyne Gasification.

Engine Tables

WOOD TO ENERGY CONVERSION DATA
BEFORE GASIFICATION

Based on wood moisture content of 15% wet basis
Woods gross heat energy content: 15,490kJ per kg
Woods gross heat energy content: 6,600 BTU per lb

Or 4.3kW heat per kg. Or 2.615HP per lb

Gasifiers energy conversion efficiency: 73.57% HOT GAS
Gasifiers energy conversion efficiency: 70.95% COLD GAS

AFTER GASIFICATION

Gas produced from 1kg of wood: 2.185 standard cubic metres
Gas produced from 1lb of wood: 35 standard cubic feet

Energy content of 1 standard cubic metre of gas: 5,030kJ
Energy content of 1 standard cubic foot of gas: 135 BTU

After gasification 1kg wood yields 2.185 cubic metres of gas which has a nett heat energy content of 3.05kW heat.

After gasification 1lb wood yields 35 cubic feet of gas which has a nett heat energy content of 1.8566HP heat. (Or 4,725 BTU)

1kg of wood produces 2.185 cubic metres of gas
or 3.165kW heat from burning gas direct
or 0.837kW of shaft power i.e engine
or 0.754kW of electric power generated

1lb of wood produces 35 cubic feet of gas
or 4,900 BTU heat from burning the gas direct
or 1.925HP heat from burning the gas direct
or 0.51 HP of shaft power i.e engine
or 0.459HP of electric power generated
or 0.342kW of electric power generated

1 litre of diesel has a heat energy content of 9.630 kW heat (or 32,895 BTU)

1 litre of petrol as a heat energy content of 8.79 kW heat (or 30,023 BTU)

1 litre of diesel has the same heat energy content as the cold gas from 3.1579kg of wood
1 litre of petrol has the same heat energy content as the cold gas from 2.882kg of wood

---

INDICATIVE, WOOD WEIGHTS AND GAS VOLUMES REQUIRED
AND
INDICATIVE, SHAFT AND ELECTRIC POWER OUTPUTS
FOR ENGINES AND GENERATOR SETS
Fuelled with PRODUCER GAS from biomass (wood)

(tabulated values are per litre of swept volume (4 cycle))

Engine RPM	**1200**	**1400**	**1500**	**1600**	**1800**	**2000**	**2200**	**2300**
Spark Ignition Engines								
Wood required in kg/hr	5.1	5.939	6.363	6.787	7.636	8.484	9.332	9.757
Gas required in m³/hr	11.2	13	14	14.932	16.8	18.665	20.532	21.465
Shaft power in kW	4.266	4.977	5.332	5.688	6.4	7.11	7.821	8.176
Electric power in kW.e	3.732	4.354	4.666	4.977	5.6	6.22	6.843	7.154

Dual fuel, diesel engines fuelled with diesel plus producer gas NOTE: Wood and gas required is the same as for spark ignition engines								
Shaft power in kW	5.332	6.221	6.665	7.11	8	8.887	9.776	10.22
Electric power in kW.e	4.665	5.443	5.832	6.221	7	7.776	8.554	8.942

To obtain wood and gas required plus power output values for a particular engine:

1. Select the required RPM column
2. Extract the required tabulated ‘per litre’ value
3. Multiply that value by the particular engines swept volume in litres

---

INDICATIVE, WOOD WEIGHTS AND GAS VOLUMES REQUIRED

AND

INDICATIVE, SHAFT AND ELECTRIC POWER OUTPUTS

FOR ENGINES AND GENERATOR SETS

Fuelled with PRODUCER GAS from biomass (wood)

(tabulated values are per 100 cubic inches of total cylinder displacement (4 cycle))

Engine RPM	**1200**	**1400**	**1500**	**1600**	**1800**	**2000**	**2200**	**2300**
Spark Ignition Engines								
Wood required in lbs/hr	18.426	21.457	22.989	24.521	27.588	30.652	33.715	35.251
Gas required in cu'ft'/hr	648.1	752.26	810.127	864.06	972.153	1080.07	1188.11	1242.1
Shaft horse power	9.375	10.937	11.717	12.5	14.065	15.625	17.187	17.968
Electric power in kW.e	6.116	7.135	7.646	8.156	9.177	10.193	11.214	11.724
Dual fuel, diesel engines fuelled with diesel plus producer gas NOTE: Wood and gas required is the same as for spark ignition engines								
Shaft horse power	11.718	13.671	14.647	15.625	17.581	19.53	21.484	22.46
Electric power in kW.e	7.645	8.92	9.557	10.195	11.471	12.743	14.018	14.654

To obtain wood and gas required plus power output values for a particular engine:

1. Select the required RPM column
2. Extract the required tabulated 'per 100 cubic inches' value
3. Multiply that value by the particular engines swept volume in whole 100s and decimals of 100 cubic inches. For example: 350 cubic inches = 3.5

Air Dry Wood Fuel Gross Heat Energy Content = 4.3kW per kg of wood

Wood > Gas > Energy Heat Yield (Hot Gas) = 3.165kW per kg of wood
Wood > Gas > Energy Heat Yield (Cold Gas) = 3.05kW per kg of wood

Wood to Gas Volume Yield = 2.185m³ gas per kg wood

Gas > Energy Heat Yield (Hot Gas) = 1.45kW per cubic metre hot gas
Gas > Energy Heat Yield (Cold Gas) = 1.4kW per cubic metre cold gas

Wood > Gas > Shaft Power Spark Ignition Engine (Petrol) = 0.837kW shaft per kg of wood
Wood > Gas > Shaft Power Spark Ignition Engine (Gas) = 0.82kW shaft per kg of wood
Wood > Gas > Shaft Power Dual Fuel Diesel Engine = 0.86kW shaft per kg of wood

Wood > Gas > Electricity Spark Ignition Petrol – Engine
Generator = 0.754kW/hr electricity per kg wood
Wood > Gas > Electricity Spark Ignition Gas – Engine
Generator = 0.697kW/hr electricity per kg wood
Wood > Gas > Electricity Dual Fuel Diesel – Engine
Generator = 0.731kW/hr electricity per kg wood

Wood > Gas > Process Heat (Direct) = 3.17kW heat per kg wood

Wood > Gas > Process Steam = 4.465kW steam per kg wood

Wood > Gas > Power Steam = 3.93kW steam per kg wood

Petrol engines run on Producer Gas at recommended, maximum continuous RPM.

High compression engines derate 37.3% approx to recover power including capacity x 1.6 times
Average high compression engines derate 42.5% approx to recover power including capacity x 1.74 times
Medium high compression engines derate 47.0% approx to recover power including capacity x 1.9 times
Low compression engines derate 56.3% approx to recover power including capacity x 2.3 times

Diesel (Dual Fuel) engines on pilot diesel plus Producer Gas at recommended, maximum continuous RPM – derate 20% approximately. To recover power including capacity x 1.25 times

Gas engines run on Producer Gas at recommended, maximum continuous RPM – companion ratio: 10 to 1 - derate 10% approximately. To recover power including capacity x 1.1 times

WOOD-TO-ENERGY CONVERSION DATA:

-BEFORE GASIFICATION-

Based on wood moisture content of 15% wet basis

Wood's gross heat energy content: 1,5490 kJ per kg
" " " " " : 6,660 BTU per lb

Or 4.3 kW heat per kg. Or 2.615 HP per LB.

Gasifier's energy conversion efficiency: 73.57% HOT GAS
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-AFTER GASIFICATION-

Gas produced from 1 kg of wood: 2.185 std cubic metres
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Energy content of 1 std cubic metre of gas: 5,030 kJ
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1kg of wood produces 2.185 cubic metres of gas
or 3.165kW heat from burning gas direct
or 0.837kW of shaft power i.e engine
or 0.754kW of electric power generated

1lb of wood produces 35 cubic feet of gas
or 4,900 BTU heat from burning the gas direct
or 1.925HP heat from burning the gas direct
or 0.51 HP of shaft power i.e engine
or 0.459HP of electric power generated
or 0.342kW of electric power generated

1 litre of diesel has a heat energy content of 9.630 kW heat (or 32,895 BTU)

1 litre of petrol as a heat energy content of 8.79 kW heat (or 30,023 BTU)

1 litre of diesel has the same heat energy content as the cold gas from 3.1579kg of wood
1 litre of petrol has the same heat energy content as the cold gas from 2.882kg of wood

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INDICATIVE, WOOD WEIGHTS AND GAS VOLUMES REQUIRED
AND
INDICATIVE, SHAFT AND ELECTRIC POWER OUTPUTS
FOR ENGINES AND GENERATOR SETS
Fuelled with PRODUCER GAS from biomass (wood)

(tabulated values are per litre of swept volume (4 cycle))

Engine RPM	**1200**	**1400**	**1500**	**1600**	**1800**	**2000**	**2200**	**2300**
Spark Ignition Engines								
Wood required in kg/hr	5.1	5.939	6.363	6.787	7.636	8.484	9.332	9.757
Gas required in m³/hr	11.2	13	14	14.932	16.8	18.665	20.532	21.465
Shaft power in kW	4.266	4.977	5.332	5.688	6.4	7.11	7.821	8.176
Electric power in kW.e	3.732	4.354	4.666	4.977	5.6	6.22	6.843	7.154

Dual fuel, diesel engines fuelled with diesel plus producer gas NOTE: Wood and gas required is the same as for spark ignition engines								
Shaft power in kW	5.332	6.221	6.665	7.11	8	8.887	9.776	10.22
Electric power in kW.e	4.665	5.443	5.832	6.221	7	7.776	8.554	8.942

To obtain wood and gas required plus power output values for a particular engine:

1. Select the required RPM column
2. Extract the required tabulated ‘per litre’ value
3. Multiply that value by the particular engines swept volume in litres

---

INDICATIVE, WOOD WEIGHTS AND GAS VOLUMES REQUIRED

AND

INDICATIVE, SHAFT AND ELECTRIC POWER OUTPUTS

FOR ENGINES AND GENERATOR SETS

Fuelled with PRODUCER GAS from biomass (wood)

(tabulated values are per 100 cubic inches of total cylinder displacement (4 cycle))

Engine RPM	**1200**	**1400**	**1500**	**1600**	**1800**	**2000**	**2200**	**2300**
Spark Ignition Engines								
Wood required in lbs/hr	18.426	21.457	22.989	24.521	27.588	30.652	33.715	35.251
Gas required in cu'ft'/hr	648.1	752.26	810.127	864.06	972.153	1080.07	1188.11	1242.1
Shaft horse power	9.375	10.937	11.717	12.5	14.065	15.625	17.187	17.968
Electric power in kW.e	6.116	7.135	7.646	8.156	9.177	10.193	11.214	11.724
Dual fuel, diesel engines fuelled with diesel plus producer gas NOTE: Wood and gas required is the same as for spark ignition engines								
Shaft horse power	11.718	13.671	14.647	15.625	17.581	19.53	21.484	22.46
Electric power in kW.e	7.645	8.92	9.557	10.195	11.471	12.743	14.018	14.654

To obtain wood and gas required plus power output values for a particular engine:

1. Select the required RPM column

2. Extract the required tabulated 'per 100 cubic inches' value

3. Multiply that value by the particular engines swept volume in whole 100s and decimals of 100 cubic inches. For example: 350 cubic inches = 3.5

Air Dry Wood Fuel Gross Heat Energy Content = 4.3kW per kg of wood

Wood > Gas > Energy Heat Yield (Hot Gas) = 3.165kW per kg of wood
Wood > Gas > Energy Heat Yield (Cold Gas) = 3.05kW per kg of wood

Wood to Gas Volume Yield = 2.185m^3 gas per kg wood

Gas > Energy Heat Yield (Hot Gas) = 1.45kW per cubic metre hot gas
Gas > Energy Heat Yield (Cold Gas) = 1.4kW per cubic metre cold gas

Wood > Gas > Shaft Power Spark Ignition Engine (Petrol) = 0.837kW shaft per kg of wood
Wood > Gas > Shaft Power Spark Ignition Engine (Gas) = 0.82kW shaft per kg of wood
Wood > Gas > Shaft Power Dual Fuel Diesel Engine = 0.86kW shaft per kg of wood

Wood > Gas > Electricity Spark Ignition Petrol – Engine
Generator = 0.754kW/hr electricity per kg wood
Wood > Gas > Electricity Spark Ignition Gas – Engine
Generator = 0.697kW/hr electricity per kg wood
Wood > Gas > Electricity Dual Fuel Diesel – Engine
Generator = 0.731kW/hr electricity per kg wood

Wood > Gas > Process Heat (Direct) = 3.17kW heat per kg wood

Wood > Gas > Process Steam = 4.465kW steam per kg wood

Wood > Gas > Power Steam = 3.93kW steam per kg wood

Petrol engines run on Producer Gas at recommended, maximum continuous RPM.

High compression engines derate 37.3% approx to recover power including capacity x 1.6 times
Average high compression engines derate 42.5% approx to recover power including capacity x 1.74 times
Medium high compression engines derate 47.0% approx to recover power including capacity x 1.9 times
Low compression engines derate 56.3% approx to recover power including capacity x 2.3 times

Diesel (Dual Fuel) engines on pilot diesel plus Producer Gas at recommended, maximum continuous RPM – derate 20% approximately. To recover power including capacity x 1.25 times

Gas engines run on Producer Gas at recommended, maximum continuous RPM – companion ratio: 10 to 1 - derate 10% approximately. To recover power including capacity x 1.1 times

WOOD-TO-ENERGY CONVERSION DATA:

-BEFORE GASIFICATION-

Based on wood moisture content of 15% wet basis

Wood's gross heat energy content: 1,5490 kJ per kg
" " " " " : 6,660 BTU per lb

Or 4.3 kW heat per kg. Or 2.615 HP per LB.

Gasifier's energy conversion efficiency: 73.57% HOT GAS
" " " " : 70.95% COLD GAS

-AFTER GASIFICATION-

Gas produced from 1 kg of wood: 2.185 std cubic metres
" " " 1 lb " " : 35 std cubic feet

Energy content of 1 std cubic metre of gas: 5,030 kJ
" " " 1 std cubic foot " " : 135 BTU

After gasification: 1 kg wood yields 2.185 Cu'm' of gas which has a nett heat energy content of 3.05 kW heat.

After gasification: 1 lb wood yields 35 Cu'ft' of gas which has a nett heat energy content of 1.8566 HP heat.
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Fluidyne Gasification
Archive - Since 1976

Producer Gas Engine Oil and Soot

Dear Colleagues

As this subject is relevant and of interest to readers of this list, I dug into the Fluidyne files for the following contribution.

From 1973 – 1983, Fluidyne manufactured By-Pass Engine Filters, the purpose of which was to control the contaminating factors in oil, extending oil life as well as the engine.

There is little appreciation of the fact that 2/3 of all engine wear is not wear, but acid erosion, which forms when moisture released by the combustion cycle enters the oil by ring blow-by etc.

Because distance, time, or even filters have little relevance to the actual condition of the oil, it was necessary to establish the go – no go parameters of the oil in the engine.

Fluidyne drew on existing oil company laboratory procedures for pre testing oil before the expensive metal tests, called Blotter Spots, refining it for basic tests in the field.

I introduced Blotter Spot testing to the international gasification engine expertise in Bremen in 1989, and the Beijer Institute in Sweden circulated an updated version in the old Producer Gas Round Table Newsletter. Some of the Indian researchers have found it useful. Basically we have to worry about three things in the oil when we use producer gas in the engine. Water, which forms acid and kills the pH of the detergent dispersant (which eats the engine) and the insolubles which thicken the oil.

Insolubles can come in a number of different forms, but we will worry about those caused by overheating and soot. As our engines are so derated on clean gas and can never be overloaded, overheating of the oil can only come from lack of cooling or combustion temperatures.

When tar or pyrolysis oil is ingested, power output increases dramatically, as does exhaust temperatures with burning gas exiting the engine. Engines with tar in the gas always have engine oil problems causing oxidation that thickens the oil. Oxidation products are asphalt and resins.

Blotter Spots of this condition will show a very dense blot with a brown or orange halo, and the oil will have a very acrid smell. Dump the oil! The anti oxidation additive also has another role to play, that of extreme boundary lubricant. Heat kills the ability of the organic metal skin (a type of zink phosphate) to keep the metal surfaces apart at high pressure points, and they start tearing off metal finally seizing.

Soot on the other hand will be just a dense blot of varying density. It usually has just a wet halo.

In our situation we need to know if there is too much soot or carbon in the oil, and this is determined by holding the paper up to the light and passing your finger behind it. If you see the shadow of your finger through the blot, then the insolubles are below the maximum allowable, but if you cannot see the shadow, dump the oil. Its too thick!

The maximum amount of moisture allowed in oil is invisible and you haven't got white scum or milk in the sump, but its easy to test.

You can use almost anything you can heat quickly with a lighter or candle (tin lid, glass tube, aluminium foil). Warm it first to dry anything of the test surface and place a few drops on it, heat and listen closely. If it pops and crackles, too much water – dump the oil. Hence the name Crackle Test.

The Blotter Spot also shows water as sharp feathered peaks radiating out through the halo.

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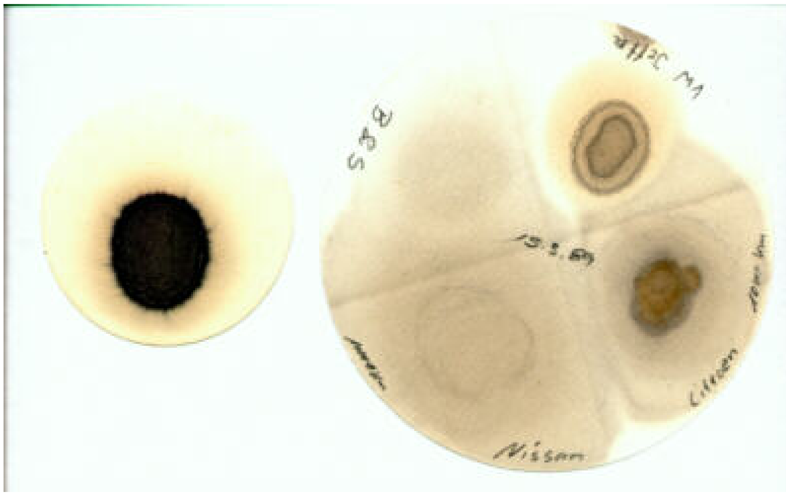

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OIL CONDITION MONITORING SYSTEM

Technical Bulletin

THE USED TISSUE ROLL FILTER

As an aid to oil condition monitoring.

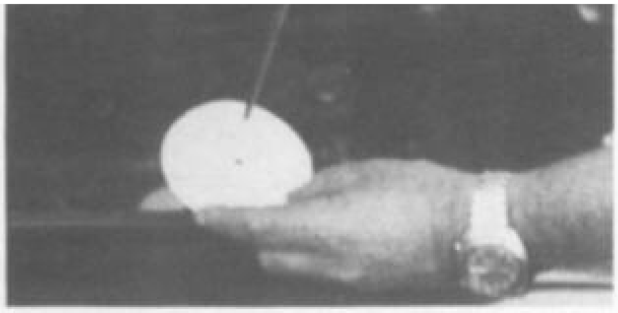
Changes in the physical and chemical properties of the engine oil during use causes Pressurmatic's used tissue roll filter to take on particular appearances depending on the cause of the change occurring in the oil.
Examination of the used tissue roll will provide the user with useful clues as to the ability of the oil to go on protecting engine surfaces from HEAT — WEAR — VARNISH & SLUDGE DEPOSITS — CORROSION. To confirm and supplement used tissue roll filter indications, use is made of the BLOTTER SPOT TEST to assess additive effectiveness and level of solid waste contamination, and the CRACKLE TEST to assess water contamination.

INITIAL PREPARATION

On the day before your Pressurmatic's filter is due for changing.
Every 2,000 miles/3,000 km/or 50 engine hours (1,000 miles/1,500 km in winter)

Taking the DIP STICK BLOTTER SPOT

1. **Ensure you will have replacement 2 ply toilet tissue rolls on hand.**



Use Whatman 5 or Durieux 122 Filter Paper. Available from Laboratory supply houses or FLUIDYNE, R & D LTD.

toilet tissue rolls on hand.

2. **Immediately after stopping engine, deposit one spot from dip stick held about ¾inch/ 2cm above BLOTTER.**
3. **Set BLOTTER aside in a sheltered, warm, dry place. Lying flat and supported clear of the surface beneath.**

NOTE: Blotter developing time can be shortened using a low heat source such as a lead light or reading lamp. Comparison with previous Blotter Spots is helpful in indicating trends in the oil's additive chemistry and level of solid waste contamination for a particular engine.

Test preparation during filter roll change

1. **Place old newspaper on ground beside your engine.**
2. **Unscrew roll container, raise container & roll together.**
3. **Invert container to avoid spill while carrying clear.**
4. **Drain a small sample of oil into a thoroughly dried metal or pyrex glass container for CRACKLE TESTING.**
5. **Holding the roll container, open end down, over the paper, shake the used roll out to permit the top of it to be examined.**

Taking the oil sample for the CRACKLE TEST

CRACKLE TESTING: is a simple method of heating an oil sample in a dried container to detect water contamination. (See also photograph of Crackle Test in progress on page 3).

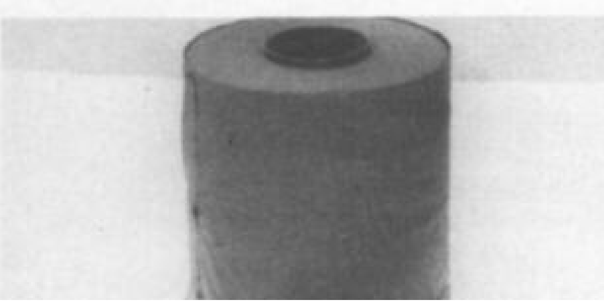
OIL CONDITION MONITORING

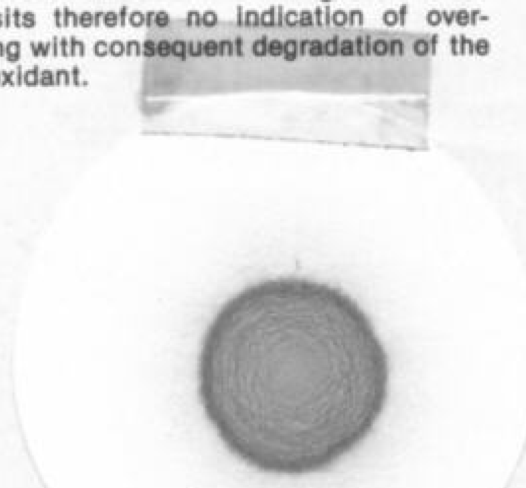
Description 1 *Disregarding the cardboard centre core*

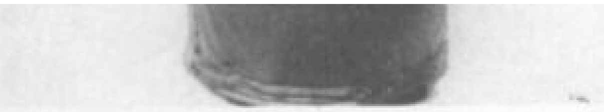
1. End of roll is flat
2. Has no smell of fuel
3. Coloured dark brown to black
4. Has no large cracks between paper layers and/or loosening around the centre core
5. Does not feel soggy or slimy with the mixture of oil and water
6. No slick or shiny, scrapeable deposits.

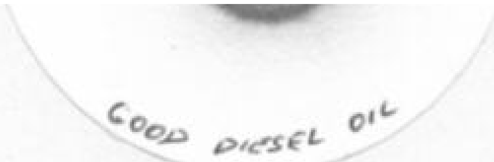
Interpretation 1 *The tissue roll has been filtering oil which has:*

1. No excessive fuel dilution
2. No excessive water contamination
3. No excessive amount of sludge & varnish deposits therefore no indication of overheating with consequent degradation of the anti oxidant.









TO CONFIRM YOUR INTERPRETATION

[a] Examine the BLOTTER SPOT taken the day before. You should see: a light to medium dark, widely dispersed deposit of waste material such as carbon and [from petrol engines, oxidised lead compound] etc with no marked amber darkening within the outer halo. No marked reduction in the overall area occupied by the waste material when compared with the previous test blot. Such a Blotter Spot indicates:—

[1] The Detergent/Dispersant additive is functioning properly and indicating that an acid free condition is being maintained.

[2] No marked amber darkening within the outer halo confirms that the anti oxidant is functioning properly.

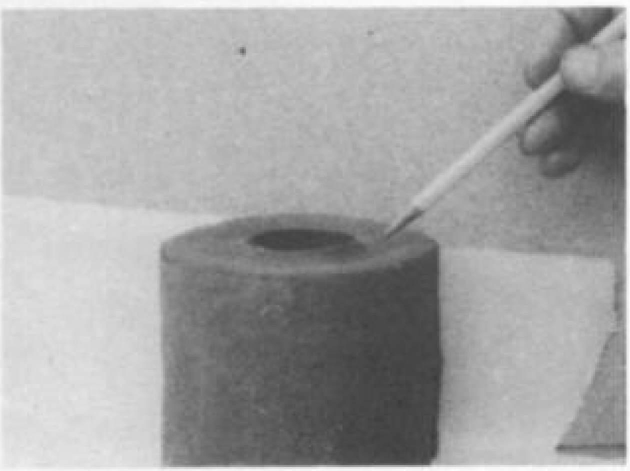
[b] Carry out a CRACKLE TEST for water contamination. You should observe: Quiet fuming of the sample or only one or two cracks during the period of heating. This indicates an acceptable trace of water.

RECOMMENDED ACTION 1

Indications from the used Tissue Roll Filter, Blotter Spot and Crackle Test show that the oil in the sump would be fit for further use after renewal of the Pressurmatic, tissue roll, filter element and topping up with fresh oil.

Description 2 *Disregarding the cardboard centre core*

[a] End of roll shows a circular valley located about halfway between the cardboard core and the outside edge of the roll. The roll may also smell of fuel and be lighter in colour than previous flat topped rolls from the same engine.



Interpretation 2 *The tissue roll has been filtering oil which has*

[a] Been carrying unburned fuel and is therefore reduced from its original viscosity and load carrying capability. Such fuel-contaminated oil will burn at lower temperatures, producing more soot deposits also.

TO CONFIRM YOUR INTERPRETATION 2

Examine Blotter Spot taken the day before. Excessive fuel produces high levels of soot & [from petrol engines, oxidised lead compound]. The darker and more dense the Blot, the higher the level of fuel soot, indicating a greater probability of fuel dilution of the oil.

RECOMMENDED ACTION 2

If the circular valley is only shallow and there is no strong smell of fuel:—

(a) Renew the tissue roll filter, top-up with fresh oil and continue using.

(b) Check all those items and operating practices which might cause poor combustion or otherwise cause too much fuel to become mixed with the lubricating oil.

Note: During cold weather and short trip, city driving this condition of the oil is not uncommon and provided that those items in (b) are known to be functioning properly, oil draining is not necessary. A beneficial practise during the winter months is to renew the tissue roll filter and top-up with fresh oil once a month if short trip, stop-start driving is normal for the particular vehicle.

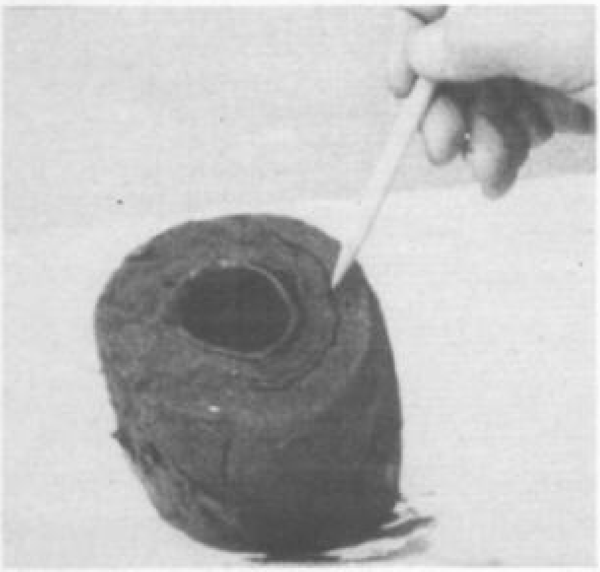
If the circular valley is deep:—

(a) Drain all the oil and replace with fresh. Renew tissue roll filter and top-up with fresh oil as necessary.

(b) Carry out checks in (b) above and rectify faults found.

Description 3 *Disregarding the cardboard centre core*

[a] **The end of the roll shows large cracks between the paper layers, may be dirty gray coloured, paper may be loosened around core, roll may feel soggy or slimy when pinched between thumb and forefinger.**



TO CONFIRM YOUR INTERPRETATION

Carry out a Crackle Test for water contamination.

1. **If only one or two cracks are heard during the period of heating, the trace of water detected is acceptable.**
2. **If frequent, sustained bursts of crackling are heard this would indicate an unacceptable level of water contamination.**
3. **If the sample** boils after only a short period of heating, **with or without crackling this would indicate a gross and unacceptable level of water contamination.**

Interpretation 3 *The Tissue Roll has been filtering oil which has*

[a] **An excessive amount of water contamination.**

RECOMMENDED ACTION 3

If your interpretation is confirmed by Crackle Test observations 2 or 3

(a) Drain all the oil and replace with fresh. Renew tissue roll filter and top-up with fresh oil as necessary.

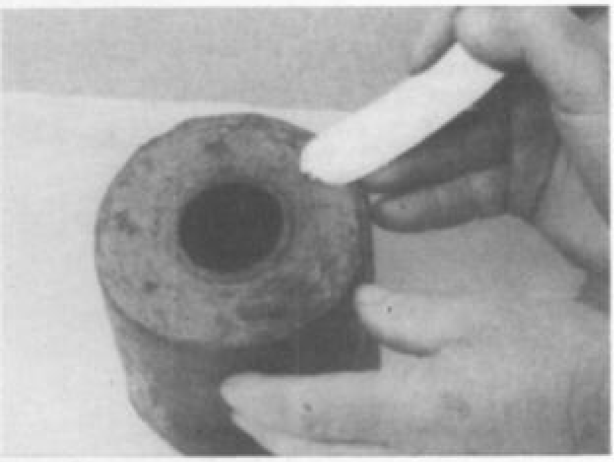
(b) Change the fullflow filter. Membrane may be clogged with a water/oil emulsion.

(c) Check all possible sources of water leakage into the sump or oil circulation system. Rectify faults found.

Note: Provided that outside water or coolant water is not getting into the oil and tissue roll changing with fresh oil top-up is being carried out at the recommended intervals, the tissue roll copes very well in its ability to attract and hold the water arising from combustion and condensation.

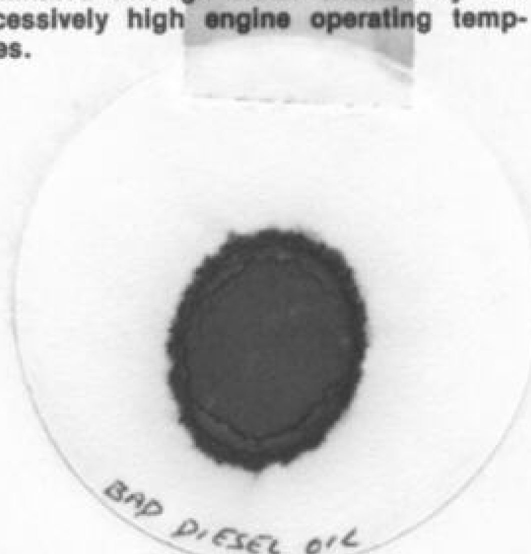
Description 4 *Disregarding the cardboard centre core*

[a] **The end of the roll shows a slick, shiny, scrapeable deposit of carbon sludge, varnish and oxidised oil particles.**



Interpretation 4

Used rolls which have this general appearance have been filtering oil which has been contaminated through either excessively low or excessively high engine operating temperatures.



To confirm which engine temperature condition applies:—

(a) A CRACKLE TEST indicating an unacceptable level of water contamination would confirm that the contaminants visible on the roll are arising from excessively LOW engine operating temperatures.

(b) A BLOTTER SPOT indicating marked amber darkening of the outer halo would confirm that contaminants are arising from excessively HIGH engine operating temperatures.

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RECOMMENDED ACTION 4

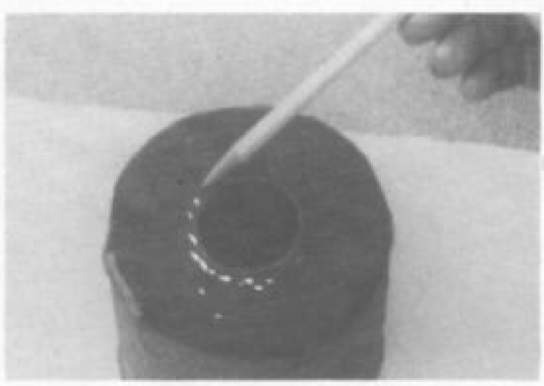
(a) Drain all the oil and replace with fresh, change the Pressurmatic, tissue roll, filter element.
Change the Full Flow filter. Membrane may be clogged with sludge. Top up with additional fresh oil to allow for filter changes.

(b) If LOW engine operating temperature is cause of problem: Check all those items and operating practices which would cause engine to run at low temperature.

(c) If HIGH engine operating temperature is cause of problem: Check all those items and operating practises which would cause engine to overheat.

VISIBLE WEAR METALS

This used tissue roll filter displays flecks of metal. Not unusual in new or newly reconditioned engines. However, such deposits bear monitoring in any engine out of its running-in period.



Any increase in the amount of metal observed during subsequent filter roll changes, would warrant inspection of bearings and other engine components which could be losing metal particles large enough to be visible on the top of the used tissue roll filter.

BEAR IN MIND **These basic observations and tests are intended as a guide only to the used oil's condition and do not purport to be a full laboratory analysis. However, if used regularly and compared with previous test results recorded, the user will gain valuable information as to trends in the state of his oil and the condition of his engine. Further information on basic, in-service oil testing is available from:**

FLUIDYNE R&D Ltd

Fluidyne Gasification
Archive - Since 1976

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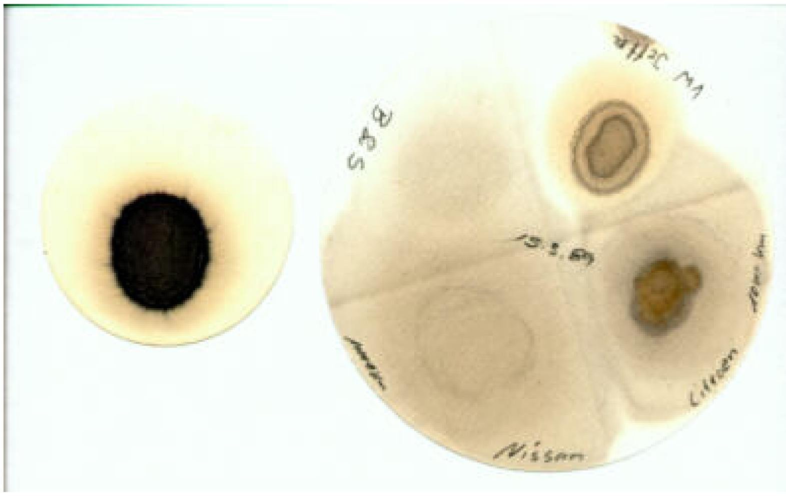

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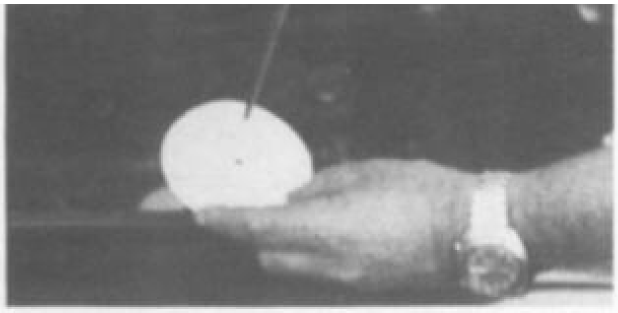
Examination of the used tissue roll will provide the user with useful clues as to the ability of the oil to go on protecting engine surfaces from HEAT — WEAR — VARNISH & SLUDGE DEPOSITS — CORROSION. To confirm and supplement used tissue roll filter indications, use is made of the BLOTTER SPOT TEST to assess additive effectiveness and level of solid waste contamination, and the CRACKLE TEST to assess water contamination.

INITIAL PREPARATION

On the day before your Pressurmatic's filter is due for changing.
Every 2,000 miles/3,000 km/or 50 engine hours (1,000 miles/1,500 km in winter)

Taking the DIP STICK BLOTTER SPOT

1. **Ensure you will have replacement 2 ply toilet tissue rolls on hand.**



Use Whatman 5 or Durieux 122 Filter Paper. Available from Laboratory supply houses or FLUIDYNE, R & D LTD.

toilet tissue rolls on hand.

2. Immediately after stopping engine, deposit one spot from dip stick held about ¾inch/2cm above BLOTTER.
3. Set BLOTTER aside in a sheltered, warm, dry place. Lying flat and supported clear of the surface beneath.

NOTE: Blotter developing time can be shortened using a low heat source such as a lead light or reading lamp. Comparison with previous Blotter Spots is helpful in indicating trends in the oil's additive chemistry and level of solid waste contamination for a particular engine.

Test preparation during filter roll change

1. Place old newspaper on ground beside your engine.
2. Unscrew roll container, raise container & roll together.
3. Invert container to avoid spill while carrying clear.
4. Drain a small sample of oil into a thoroughly dried metal or pyrex glass container for CRACKLE TESTING.
5. Holding the roll container, open end down, over the paper, shake the used roll out to permit the top of it to be examined.

Taking the oil sample for the CRACKLE TEST

CRACKLE TESTING: is a simple method of heating an oil sample in a dried container to detect water contamination. (See also photograph of Crackle Test in progress on page 3).

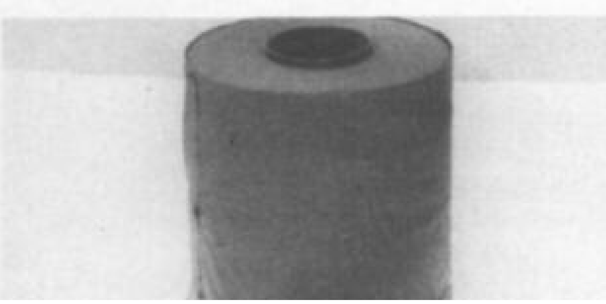
OIL CONDITION MONITORING

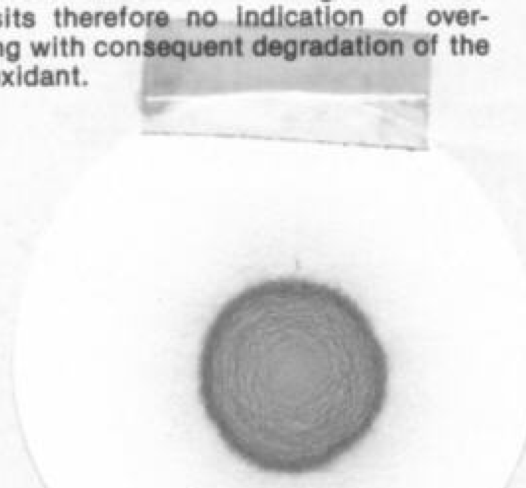
Description 1 *Disregarding the cardboard centre core*

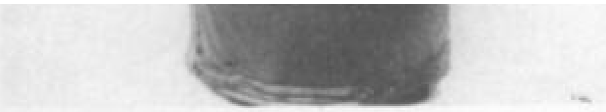
1. End of roll is flat
2. Has no smell of fuel
3. Coloured dark brown to black
4. Has no large cracks between paper layers and/or loosening around the centre core
5. Does not feel soggy or slimy with the mixture of oil and water
6. No slick or shiny, scrapeable deposits.

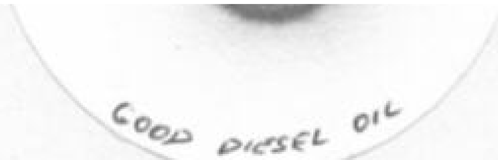
Interpretation 1 *The tissue roll has been filtering oil which has:*

1. No excessive fuel dilution
2. No excessive water contamination
3. No excessive amount of sludge & varnish deposits therefore no indication of overheating with consequent degradation of the anti oxidant.









TO CONFIRM YOUR INTERPRETATION

[a] Examine the BLOTTER SPOT taken the day before. You should see: a light to medium dark, widely dispersed deposit of waste material such as carbon and [from petrol engines, oxidised lead compound] etc with no marked amber darkening within the outer halo. No marked reduction in the overall area occupied by the waste material when compared with the previous test blot. Such a Blotter Spot indicates:—

[1] The Detergent/Dispersant additive is functioning properly and indicating that an acid free condition is being maintained.

[2] No marked amber darkening within the outer halo confirms that the anti oxidant is functioning properly.

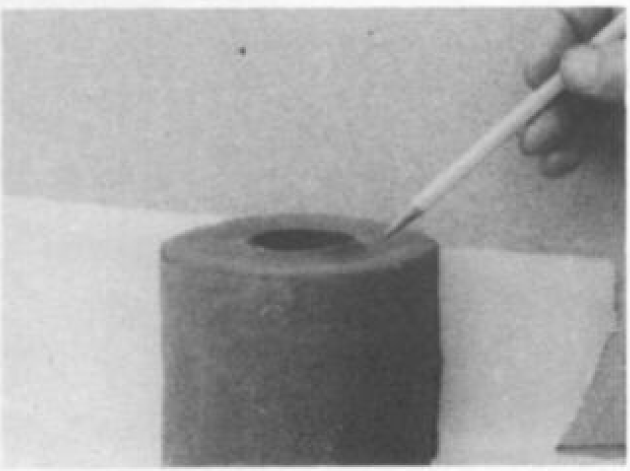
[b] Carry out a CRACKLE TEST for water contamination. You should observe: Quiet fuming of the sample or only one or two cracks during the period of heating. This indicates an acceptable trace of water.

RECOMMENDED ACTION 1

Indications from the used Tissue Roll Filter, Blotter Spot and Crackle Test show that the oil in the sump would be fit for further use after renewal of the Pressurmatic, tissue roll, filter element and topping up with fresh oil.

Description 2 *Disregarding the cardboard centre core*

[a] End of roll shows a circular valley located about halfway between the cardboard core and the outside edge of the roll. The roll may also smell of fuel and be lighter in colour than previous flat topped rolls from the same engine.



Interpretation 2 *The tissue roll has been filtering oil which has*

[a] Been carrying unburned fuel and is therefore reduced from its original viscosity and load carrying capability. Such fuel-contaminated oil will burn at lower temperatures, producing more soot deposits also.

TO CONFIRM YOUR INTERPRETATION 2

Examine Blotter Spot taken the day before. Excessive fuel produces high levels of soot & [from petrol engines, oxidised lead compound]. The darker and more dense the Blot, the higher the level of fuel soot, indicating a greater probability of fuel dilution of the oil.

RECOMMENDED ACTION 2

If the circular valley is only shallow and there is no strong smell of fuel:—

(a) Renew the tissue roll filter, top-up with fresh oil and continue using.
(b) Check all those items and operating practices which might cause poor combustion or otherwise cause too much fuel to become mixed with the lubricating oil.

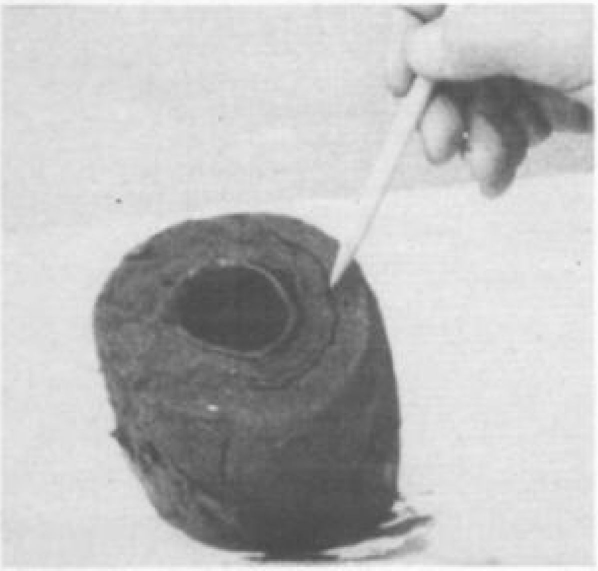
Note: During cold weather and short trip, city driving this condition of the oil is not uncommon and provided that those items in (b) are known to be functioning properly, oil draining is not necessary. A beneficial practise during the winter months is to renew the tissue roll filter and top-up with fresh oil once a month if short trip, stop-start driving is normal for the particular vehicle.

If the circular valley is deep:—

(a) Drain all the oil and replace with fresh. Renew tissue roll filter and top-up with fresh oil as necessary.
(b) Carry out checks in (b) above and rectify faults found.

Description 3 *Disregarding the cardboard centre core*

[a] **The end of the roll shows large cracks between the paper layers, may be dirty gray coloured, paper may be loosened around core, roll may feel soggy or slimy when pinched between thumb and forefinger.**



Interpretation 3 *The Tissue Roll has been filtering oil which has*

[a] **An excessive amount of water contamination.**

TO CONFIRM YOUR INTERPRETATION

Carry out a Crackle Test for water contamination.

1. **If only one or two cracks are heard during the period of heating, the trace of water detected is acceptable.**
2. **If frequent, sustained bursts of crackling are heard this would indicate an unacceptable level of water contamination.**
3. **If the sample** boils after only a short period of heating, **with or without crackling this would indicate a gross and unacceptable level of water contamination.**

RECOMMENDED ACTION 3

If your interpretation is confirmed by Crackle Test observations 2 or 3

(a) Drain all the oil and replace with fresh. Renew tissue roll filter and top-up with fresh oil as necessary.

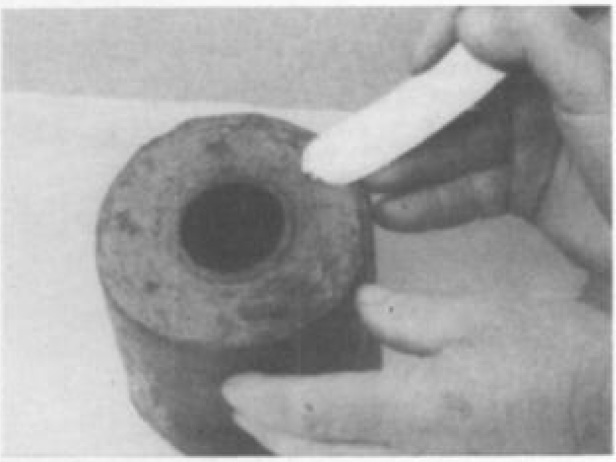
(b) Change the fullflow filter. Membrane may be clogged with a water/oil emulsion.

(c) Check all possible sources of water leakage into the sump or oil circulation system. Rectify faults found.

Note: Provided that outside water or coolant water is not getting into the oil and tissue roll changing with fresh oil top-up is being carried out at the recommended intervals, the tissue roll copes very well in its ability to attract and hold the water arising from combustion and condensation.

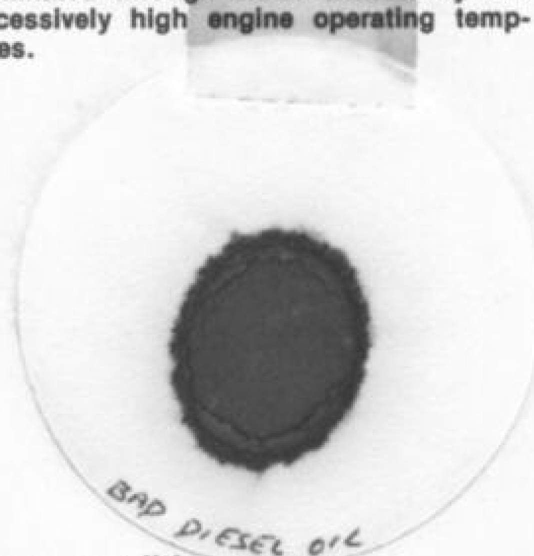
Description 4 *Disregarding the cardboard centre core*

[a] The end of the roll shows a slick, shiny, scrapeable deposit of carbon sludge, varnish and oxidised oil particles.



Interpretation 4

Used rolls which have this general appearance have been filtering oil which has been contaminated through either excessively low or excessively high engine operating temperatures.



To confirm which engine temperature condition applies:—

(a) A CRACKLE TEST indicating an unacceptable level of water contamination would confirm that the contaminants visible on the roll are arising from excessively LOW engine operating temperatures.

(b) A BLOTTER SPOT indicating marked amber darkening of the outer halo would confirm that contaminants are arising from excessively HIGH engine operating temperatures.

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RECOMMENDED ACTION 4

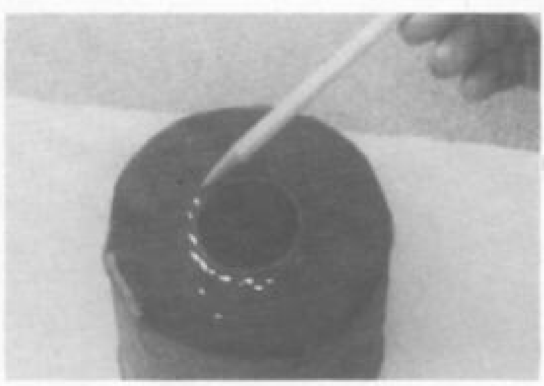
(a) Drain all the oil and replace with fresh, change the Pressurmatic, tissue roll, filter element.
Change the Full Flow filter. Membrane may be clogged with sludge. Top up with additional fresh oil to allow for filter changes.

(b) If LOW engine operating temperature is cause of problem: Check all those items and operating practices which would cause engine to run at low temperature.

(c) If HIGH engine operating temperature is cause of problem: Check all those items and operating practises which would cause engine to overheat.

VISIBLE WEAR METALS

This used tissue roll filter displays flecks of metal. Not unusual in new or newly reconditioned engines. However, such deposits bear monitoring in any engine out of its running-in period.



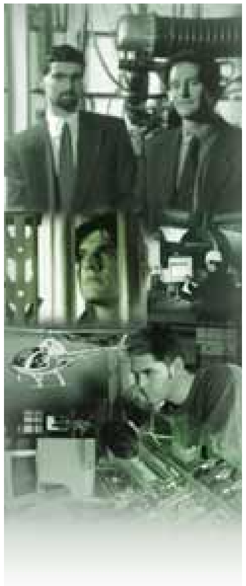
Any increase in the amount of metal observed during subsequent filter roll changes, would warrant inspection of bearings and other engine components which could be losing metal particles large enough to be visible on the top of the used tissue roll filter.

BEAR IN MIND These basic observations and tests are intended as a guide only to the used oil's condition and do not purport to be a full laboratory analysis. However, if used regularly and compared with previous test results recorded, the user will gain valuable information as to trends in the state of his oil and the condition of his engine. Further information on basic, in-service oil testing is available from:

FLUIDYNE R&D Ltd

Innovation Technologies
(Ireland) Ltd.

Company | Products & Services | Case Studies | Clients | Testimonials | Contact



The Company

Our office

Innovation Technologies (Ireland) Ltd is a Northern Ireland based engineering company serving the needs of local industry and beyond. We focus on providing cost-effective and innovative design & build solutions using our extensive experience in mechanical, electrical and electronic engineering. Since formation in 1998, we have carried out a wide variety of projects, some of which are highlighted below.

Please contact us to discuss your engineering needs.

What we do

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SIEMENS

IMO

Instrumentation, Control and Automation

- Control & Automation systems (e.g. new build or upgrades)
- PLC Programming
- Data acquisition & Product Test Rigs (hardware & software development)
- Electronic circuit design, including design and build of industrial/medical/consumer prototypes (PIC uControllers)
- Continuous Emissions Monitoring - monitoring and logger panels, Dust sensors, etc for compliance with Pollution Prevention Control (PPC)
- Strain Gauging

Engineering Design

- Machine Building - design, develop & build of special purpose machines
- Product design & development support
- Detailed engineering drawings & 3D modeling (SolidWorks)
- Conceptual design & problem solving

Energy-from-Waste

- Wood Gasification Expertise
- Gasifier CHP Product Development

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Home

Newsflash

We would like to present our vision for a pragmatic solution for integrating bioenergy into the landscape. It is the Emerald Plan. The name is derived from the title “Multi Role Integrated Indigenous Landscape Design” or MRIILD. It is a integrated solution for energy, biodiversity and climate change.

Please read the Emerald Plan in our downloads and news sections and feel free to comment, we are most appreciative of any feedback.

E-mail

Welcome to Gasification Australia Pty. Ltd.

Gasification Australia Pty. Ltd. is dedicated to promoting the growing alternative to fossil fuel. Our vision is for a world where sustainable energy production meets responsible energy use; where biomass is valued for its contribution to biodiversity and a diversified energy market.

Mission Goals

• Present an integrated philosophy for sustainable forestry, energy production and carbon cycle management.
• Provide information and expertise in resource management and biomass gasification to government, industry and the public.
• To catalyse the practical uptake of sustainable biomass gasification systems for rural, industrial and transport applications.

We are now taking orders for our 15kwe Tasman Class Gasifier

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Fluidyne Gasification
Archive - Since 1976

Carbon Black

From the time we became involved in gasification back in the 70s, down here in New Zealand, our isolation from the centres responsible for evolving tar measurement and the lack of measuring equipment required us to adopt a practical approach to this issue.

As the only reason to measure tar levels is to determine its acceptability for use in engines, turbines, compressors, etc. the first question to ask is "can this gas do the job", not "how much and what sort of tar is in the gas". Even the smallest amounts of condensible hydro carbons cause problems in a commercial application, and I haven't found an answer to my question of how much measurable hydrocarbons exist when they no longer condense in the high vacuum of the engine manifolds.

Rather than waste money measuring a gas too dirty in the first place, a simple screen test can be applied, that will justify any further tests.

There are several options actually depending on your situation.

A: Gas analysis to determine CH_4; a distillation gas which almost disappears if thermal cracking is efficient. Over 3% and light pyrolisis oils and heavier hydrocarbons begin to condense in various places.

B: Using a preferably cold gas stream, (-65 degrees C) pass it through a Watman 5 filter paper. There should be condensate present that wets the paper. If just clear when dry O.K., but if brown stain appears, condensable hydrocarbon present. Reject!

C: The filter paper is also useful to collect particle samples that can be classified if a high resolution or even better an electron microscope if available. Engine quality gas has carbon black present, and although we haven't had need to explore the possibility, believe them to include C60 and C70 carbons. Their size will take them through any collector if moisture is present in the gas.

D: A test flame of engine quality gas has little radiant heat although there is a small amount from the carbon blacks. Flame temperatures are usually around 1,050 0C with 1,100 OC the absolute maximum temperature.

E: Failing all else, use a small single cylinder engine and see if tar forms in its manifold.

While this whole issue of tar measurement tries to establish what is acceptable, the onus is on gasifier manufacturers to deliver appropriate equipment and prove what is possible.

It is possible to make producer gas without condensable hydrocarbons, and the term low tar gas cannot be applied to these systems if you have no condensate to measure. Having said this, I should mention water. In the absence of hydrocarbons it will be slightly mauve or clear, contain particles that settle out, and be about pH 8.2.

So to sum this all up, nothing should condense out of the gas other than water and carbon particles in a vacuum situation similar to an engine manifold. This should be the type of test to develop with zero acceptance in the presence of hydrocarbon condensate. If we don't allow gas with these distillations into an engine or turbine, we don't have to figure out which or what is causing the problems. We must aim for a zero standard as I am sure that our technology will not reach the degree of reliability demanded of commercial technologies without this incentive in place.

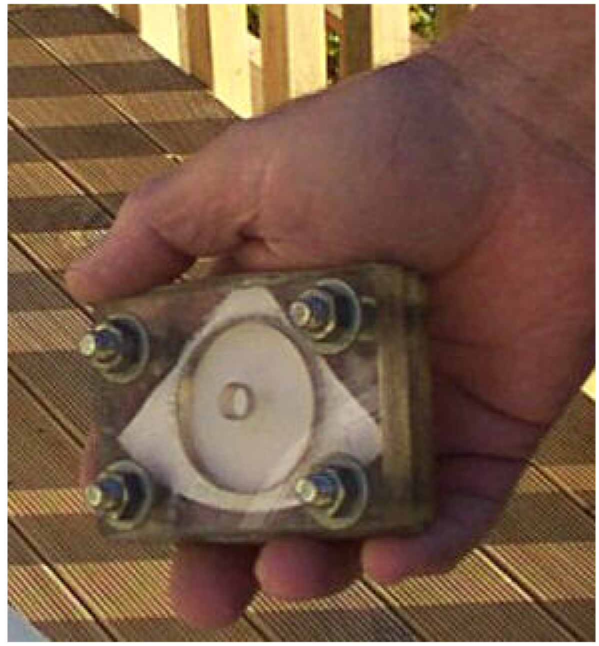
The screen test method was evolved with the assistance of Dr Jim Cousins, New Zealand's top scientist in gasification and biomass, who worked in our old DSIR laboratory in Wellington. It was the only method available and we resolved our design problems of condensable hydrocarbons.

I did see a mention of Benzine in the gas and yes this is another indication that the gasifier is not cracking the distillation gases. You should only have CO and H_2 with traces (maybe) of CH_4 with the rest being inert.

Our newest project in Canada has just taken delivery of the gas and emission equipment for the EPA testing programme. It is all state of the art stuff and we will settle once and for all whether down draught gasifiers can be no tar at the same time!

Graeme has put up a carbon black photo on the Fluidyne Archive and the simple holder for the filter paper. I found some of the original test filters which came out of my International van during the time of developing granular bed filters. You can see the colour of the paper.

Front view



Back view

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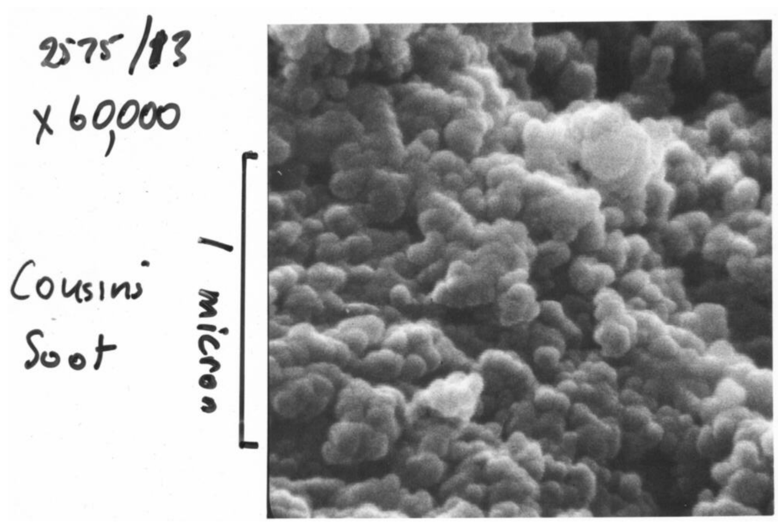

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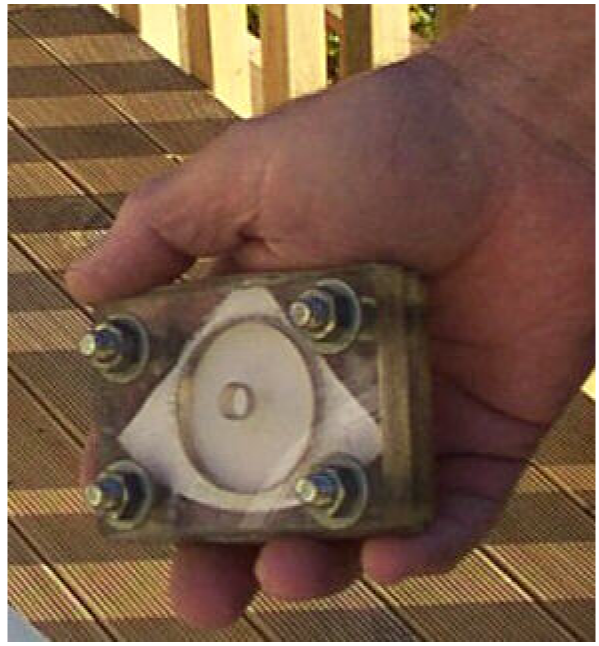

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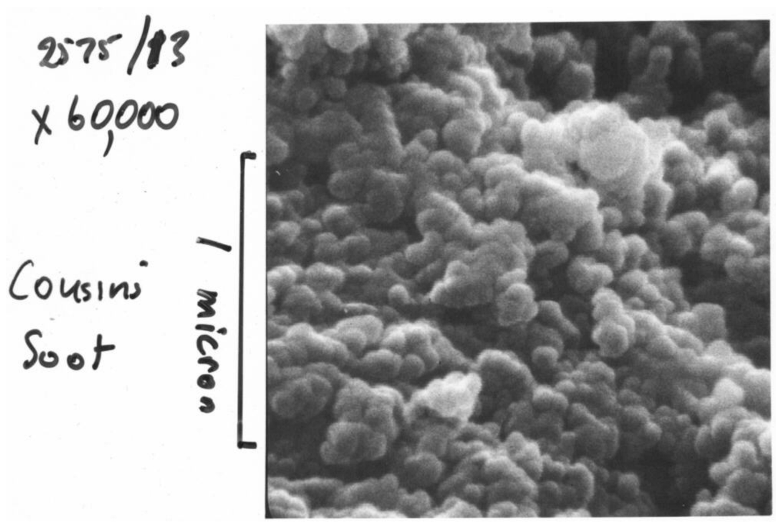

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Fluidyne Gasification
Archive - Since 1976

WWII Gasifiers

Dear Gasification Colleagues

With a resurgence of interest in old WWII gasifiers by this forum, it pays to remember about this period of time. With very few of these gasifiers surviving 50-60 years, the literature can give the reader a confusing and sometimes conflicting understanding of how they worked.

In 1989, I had the opportunity to inspect a collection of WWII gasifiers actually purchased from the original agents that sold them throughout Germany. The collection is complete with original operating manuals, and I understand a huge range of documentation obtained from the government archives.

The owner of the collection is Harold Steppart, and he is often in attendance at biomass conferences in Germany, but I personally have no current contact details. Harold's intentions were to one day set up a working museum and as its now 11 years since I last spoke with him, maybe its already a reality. He is by the way an engine designer and is the best I have met when it comes to discussion on dual fuel engines. The designs of the gasifiers speak for themselves, and give the thin sheet steel available, the skill of their manufacture is clear to see. It is however one thing to be an innovative manufacturer, and another to make a reliable product.

With so many companies making gasifiers in Germany, the railways engineers were given the task to test them, and duds are included in the collection.

In hindsight, its easy to see why some of these designs had problems, but time and materials were not on their side.

The photographs are without text and my only comment is that some only just work given their dimensional parameters. Unfortunately I didn't record the names of the manufactures.

Regards
Doug Williams
Fluidyne Gasification.

	
	

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Archive - Since 1976

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Fluidyne Gasification

Archive - Since 1976

Fluidyne Forestry

During the 1970s oil crisis, it became clear that if trapped within a city environment, the ability to survive without fossil fuels would create difficulties.

As Fluidyne had begun to develop wood gasification equipment, it was also necessary to learn about the realities of growing wood. Doug and family bought 10 acres of marginal farmland in 1978 to begin the learning curve, which continues to this day.
The plan was to plant eucalyptus and coppice every seven years, and according to the New Zealand Forestry Department, this small plantation was the first purpose planted energy plantation in New Zealand. They even borrowed a few trees to cut down for a T.V. Programme, so if nothing else, this plantation has served a useful purpose of education for they still stand today.

Our pine trees are planted as boundary windbreaks and at 100 ft have now reached the end of their stability. It is unlikely that any will be milled as it costs more than you can recover from treating and selling the timber. We do have a more recent planting of 300 pines which are being pruned to clear wood.

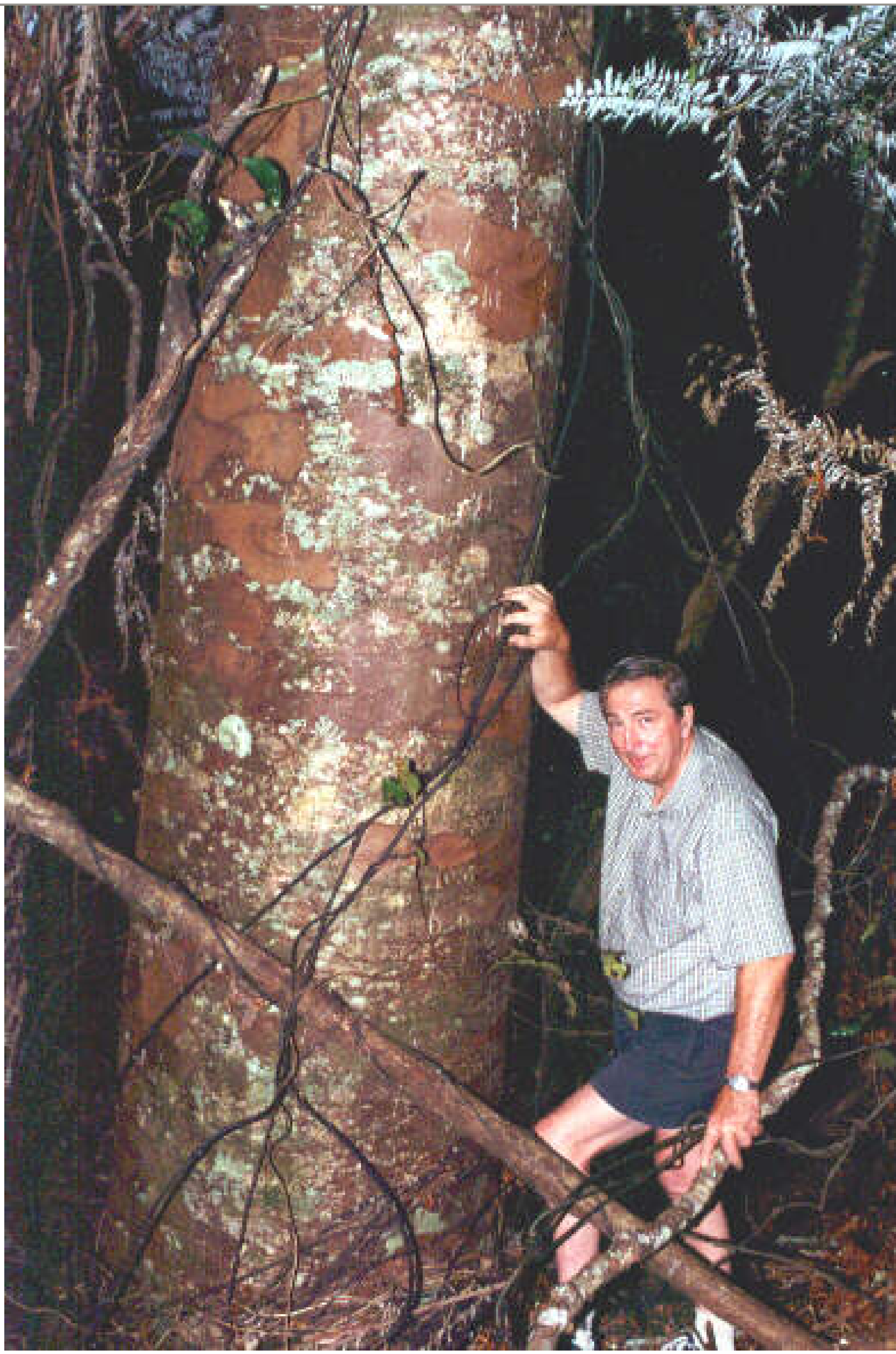
The back of the farm has a reserved block of native forest regenerating from Kauri timber cutting early in the 1900s, We have also shut off adjacent areas to keep stock out and it is regenerating the native species. New Zealand natural forests link back to the earliest plants before the continents separated, and its a very tough eco-system, that is until you start trampling the surface feeder roots.

No native animals trod the forest floor until introduced by early explorers

Regeneration of New Zealand native forests usually begins with this hardwood manuka tree showering hair like seeds which germinate on the surface of bare clay soils. Grass, ferns, then other natives germinate, often from seeds dormant for untold years. Manuka is renowned for its honey producing pollen and the healing properties of "Tea Tree Oil" distilled from the leaves. It is also New Zealand's most sought after firewood, but at 20 years old this tree isn't much of a resource.

Fighting for light, this boundary of native forest has an amazing number of plant and tree species. These forests thrive on the very geologically young clay soil of New Zealand.

Under the canopy of the forest is very dark and our flash hides the background trees. This is the famous New Zealand Kauri about 200 years old, and this butt log is parallel up to the first branch at 50 ft.



The largest Kauri in the block is still only a small tree and will continue to grow (maybe) for another 1 – 1.5 thousand years.

Replacing or complimenting native forests with species more receptive to growing conditions is a reality, and these 100 ft eucalypts at 22 years old provide options for the grower and the environment.

Shelter belts of New Zealand's super pine Pinus Radiata. Another example of 22 year old 100 ft trees. The measurements were obtained give or take a bit from recently felled trees.

At 6 years old, we are pruning this plantation for clear wood. The best will be selected and the rest thinned to firewood.

	Doug ponders the future of biomass transport and his conclusion is that it needs a financial push!
	What goes up must eventually come down

Fluidyne Gasification
Archive - Since 1976

Fluidyne Forestry

During the 1970s oil crisis, it became clear that if trapped within a city environment, the ability to survive without fossil fuels would create difficulties.

As Fluidyne had begun to develop wood gasification equipment, it was also necessary to learn about the realities of growing wood. Doug and family bought 10 acres of marginal farmland in 1978 to begin the learning curve, which continues to this day.
The plan was to plant eucalyptus and coppice every seven years, and according to the New Zealand Forestry Department, this small plantation was the first purpose planted energy plantation in New Zealand. They even borrowed a few trees to cut down for a T.V. Programme, so if nothing else, this plantation has served a useful purpose of education for they still stand today.

Our pine trees are planted as boundary windbreaks and at 100 ft have now reached the end of their stability. It is unlikely that any will be milled as it costs more than you can recover from treating and selling the timber. We do have a more recent planting of 300 pines which are being pruned to clear wood.

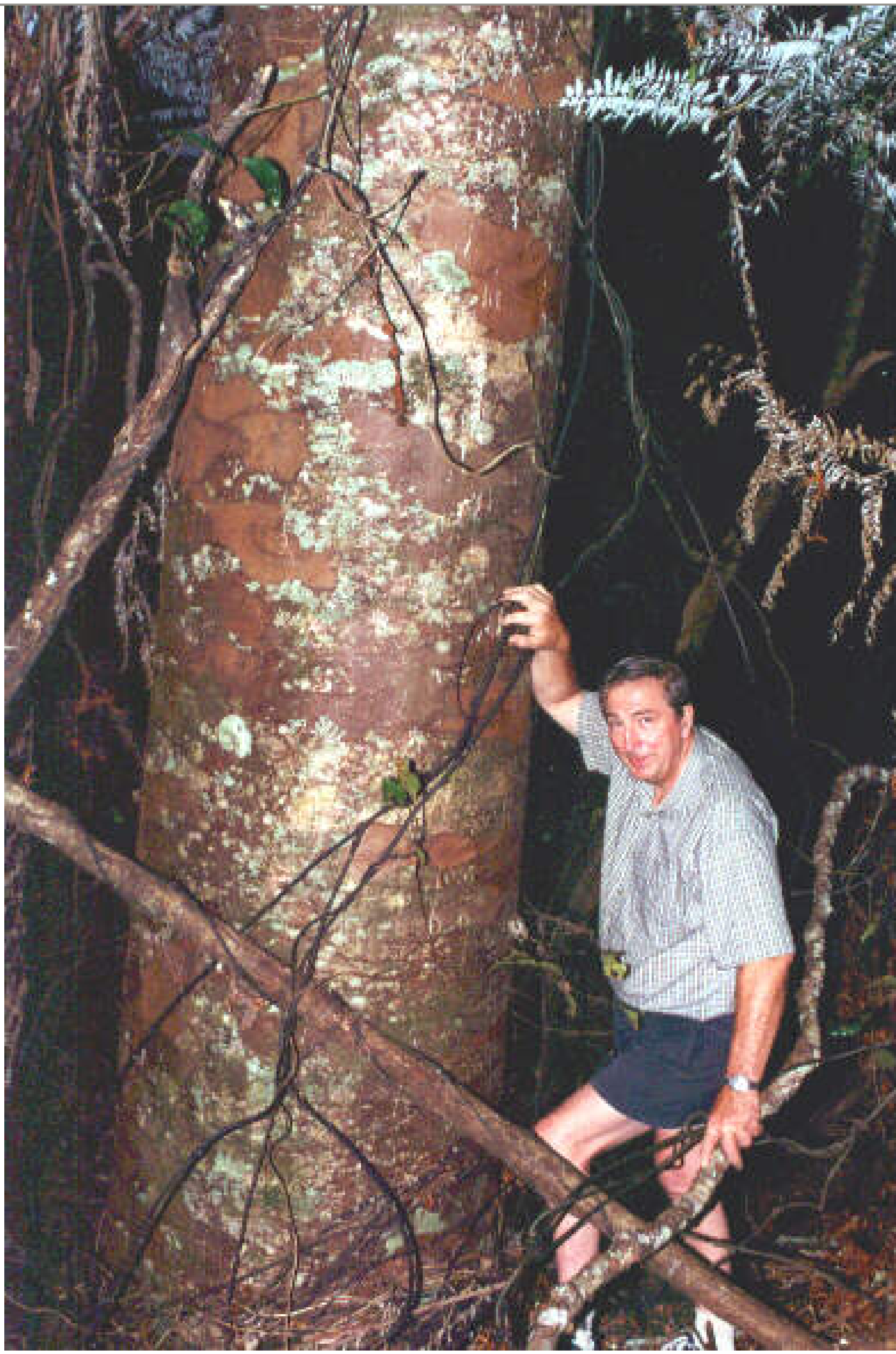
The back of the farm has a reserved block of native forest regenerating from Kauri timber cutting early in the 1900s, We have also shut off adjacent areas to keep stock out and it is regenerating the native species. New Zealand natural forests link back to the earliest plants before the continents separated, and its a very tough eco-system, that is until you start trampling the surface feeder roots.

No native animals trod the forest floor until introduced by early explorers

Regeneration of New Zealand native forests usually begins with this hardwood manuka tree showering hair like seeds which germinate on the surface of bare clay soils. Grass, ferns, then other natives germinate, often from seeds dormant for untold years. Manuka is renowned for its honey producing pollen and the healing properties of "Tea Tree Oil" distilled from the leaves. It is also New Zealand's most sought after firewood, but at 20 years old this tree isn't much of a resource.

Fighting for light, this boundary of native forest has an amazing number of plant and tree species. These forests thrive on the very geologically young clay soil of New Zealand.

Under the canopy of the forest is very dark and our flash hides the background trees. This is the famous New Zealand Kauri about 200 years old, and this butt log is parallel up to the first branch at 50 ft.



The largest Kauri in the block is still only a small tree and will continue to grow (maybe) for another 1 – 1.5 thousand years.

Replacing or complimenting native forests with species more receptive to growing conditions is a reality, and these 100 ft eucalypts at 22 years old provide options for the grower and the environment.

Shelter belts of New Zealand's super pine Pinus Radiata. Another example of 22 year old 100 ft trees. The measurements were obtained give or take a bit from recently felled trees.

At 6 years old, we are pruning this plantation for clear wood. The best will be selected and the rest thinned to firewood.

	Doug ponders the future of biomass transport and his conclusion is that it needs a financial push!
	What goes up must eventually come down

Fluidyne Gasification
Archive - Since 1976

FLUIDYNE ARCHIVE PHOTOGRAPHS

SweetWaters Gasification

Dear Colleagues

As I haven't been available to contribute much to gasification for the last few months, thought you may be interested to hear about Sweetwaters, New Zealand's equivalent to Woodstock which as most know was a huge rock music venue in the U.S.A.

I was asked last September if I could put on a gasification demonstration and possibly supply electric power to some of the stands for the four day event, January 22-25. As it wasn't going to cost anything for the site, and was really to show the attending Greenies what could be done with renewable energy, it was a chance to get some suntan.
Massey University was also invited to show their work with biomass and gasification, so we set up a joint exhibit using their Datson J4 generator set and Fluidyne's 10kWe Pioneer Class wood gasifier. Fluidyne supplied Massey their gasifier and built the genset a few years ago, and it has enabled the University to build up their capability to expand renewable energy studies under the watchful eye of Ralph Sims a friend from way back.

Both my gasifier and their engine hadn't been used for over a year, so anything that could go wrong didn't. The gasifier fired up in 10 seconds and the engine started on gas in just under 4 minutes, and the power flowed! The output of the genset is only 5 K.V.A. 240V, so we didn't have a huge wood consumption to worry about.

The 10kWe Pioneer Class was built way back in 1987, to see if a simple design could be as reliable as the larger Pacific Class. It was never considered for commercial sales even though its proven itself time and again over 12 years.

Also in attendance were the do it yourself gasifier enthusiasts, some spending four days trying to get their engines started on gasoline. Only one drove itself on site and left the same way on gas, which for a small bus (top speed 120km/hr on flat) is a real performer.

It was an opportunity to provide assistance to those building gasifiers and sort out their operating procedures. Even the crudest design will make gas albeit terry, but not even that when the fuel was firewood stove billets!

Surprisingly, I was informed that two of the earliest gasifier hearths we sold (about 79-80) were still in use on pottery kilns. When built these hearths had an unknown life span, so our later models should still be making gas in 2020 and beyond, that is if anyone around still knows how to operate them.

Shell and BP were present with their P.V. cells and as Shell were using the P.V. cells to power an electric water cylinder (for a coffee stall) they ended up using a genset for part of the time as nobody likes cold coffee.

Regards
Doug Williams

Datsun JA engine, 5 KVA alternator gas come from gasifier to engine and via tee valve to start-up fan between truck and gasifier.

The Pioneer Class gasifier.

The gasified small bus with personalised number plate "Wood"

DIY red drum gasifier, silver drum water cooling, silver framed white panel water jacketed tubed gas cooling, stainless cylinder sawdust filter, engine unknown. Enthusiasm isn't enough to design and build gasifiers.

Here is Ralph Sims waiting for his cell phone to ring.

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ENGINES

When the fuel supply price hit rural electrification back in the 1970's, nearly all engine generators were diesels and few spark ignition (SI) generators existed.

Fluidyne's early gasifier development used old car engines, that is up until the gas was clean enough to try in new engines. Like many other companies developing gasifiers at that time (well over 100), the main interest was for mobile transport, and our customers took the risk with their engines just to keep themselves mobile. We only supplied the hearth module to these guys and they did everything else themselves.

Multiple application and maximum use of the Gasifier itself was truly proven with these modules, one of which I built myself (240 Cub/inch International Van). With a top speed of approximately 62mph, it was quite acceptable driving for a 2 1/2 tonne vehicle, but slow up the hills.

The stationary application was also developing quickly, although we had to build our own SI genset. The first diesel engine mounted on a portable sawmill really caused us to misunderstand dual fuelling due to it being vacuum governing with a speed control butterfly, just the same as SI engines. It worked perfectly and created the impression that dual fuel generation was easier than first thought!

Listers, the English engine manufacturer via their New Zealand branch office were really interested, as most generation in the rural Pacific used their engines. They not only made engines available, but provided staff and facilities to support the development of the bolt on conversion kit needed to fit existing diesel installations. Again we were lean into a technical trap by circumstances, as our first engine was the HR3 Lister with an in line injection pump with separate governor. This was the only engine with this type of pump, and other engines in service had rotary injection pumps with very sensitive integrated governors. Because our conversion system was linked to this pump governor manually, as huge effort was made to modify the pumps which not only proved impractical, but didn't work.

Using one of the working HR3 engines, we found that the thermal behaviour of the exhaust changed dramatically during load changes and this change via a flow sensor to provide control of the gas air ratio going into the engine.

This was a major breakthrough and enables a conversion kit to be fitted to any design of diesel engine used for power generation. Listers were highly delighted with the performance of these conversion kits which actually improved the engine governing response time to load change. Lister Isuzu and Caterpillar engines were eventually fitted with these systems which we now use to incorporate the gas pipeline terminal, mixer and condensate water separator.

The theoretical maximum dual fuel efficiency is achieved when the engine is operating at 80% of it's maximum output on diesel. In a fixed load situation, this can mean a reduction of diesel consumption by up to 80% at this power output. The best we ever achieved was 82.23% replacement, but conditions were very tightly controlled to maximise the performance. For a normal working variable load situation, replacement is between 65 - 75% depending on the average load.

For rural electrification to be successful, any engine supplied for gasified projects should be the most popular brand of engine in that country. If diesel, it should be in no way modified that it prevents its normal operation on diesel, retaining its serviceability from locally available spare parts.

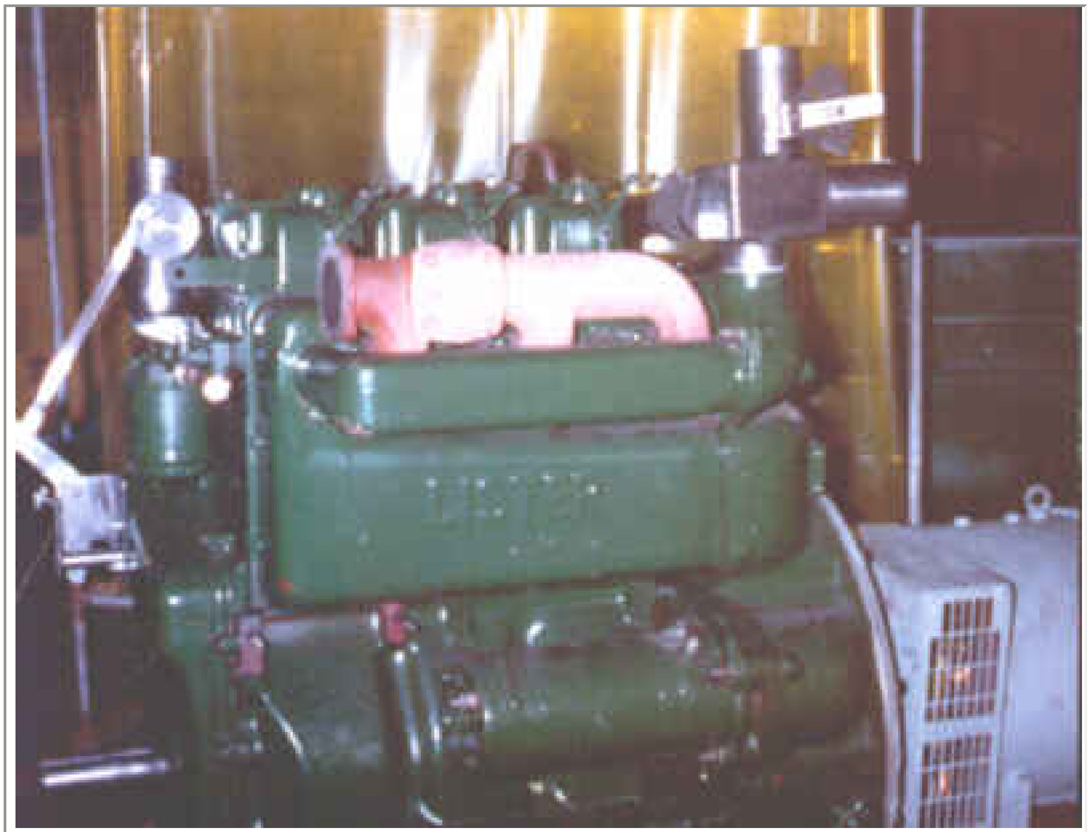
It should be noted that when large increments of power are required, using multiple standard engines is far cheaper than singular large engines specifically built for that project. The multiple engine concept also provides for alternative servicing, not possible with single engine options.

In recent years, the advent on CHP systems in developed countries using natural gas has provided SI engines most suitable for producer gas. With compensation ratios of between 10 - 12.5:1, their ignition timing can remain the same and alternate from natural gas and producer gas without problems. Fluidyne projects have used SI engines built for natural gas from Lister, Ford, MAN and Caterpillar.

Please note not all the photographs are available of these engines as there is nothing to see except the casing around the engine.

It's 1977, and Fluidyne's

uninsulated gasifier fuels a three cylinder diesel with vacuum governor. This little project really worked well on this portable Gatman sawmill.



Lister HR3 was the first dual fuel system developed by Fluidyne, and was monitored by Lister for the 2,000 hour engine test. Was used to generate electricity on Great Barrier Island (NZ). This engine clocked up over 7,000 hours without problems.

Lister HR6 Diesel showing the first attempts to modify the DPA rotary ignition pump. The governor system proved to be unsuitable for our purpose of mechanical linkage, and it also highlighted this impractical approach for other engines. This engine and gasifier went to Pitcairn Island

Lister JA6 diesel set up in Listers test cell (under construction) for eight hour preacceptance test by a NZ Government engineer. Supplied from two Pacific Class Gasifiers the rigid PVC piping can be seen vertically entering the pipeline terminal. This project was destined for Papua New Guinea and as a NZ Government project, it was also tested after installation in PNG by the same engineer. It is as close as possible to receiving government certification for the performance of the Pacific Class Gasifier.

This Lister HL4 diesel also shows the condensate pipeline terminal and mixer control. The gas enters vertically into the mixer to join the air before entering the condensate separator. We achieved an 82.23% reduction of diesel fuel for this Mozambique project. NEI Fluidynes managers forbade us to install this project.

Lister HR3G spark ignition engine built for natural gas in the USA by Listers; and the first purpose built gas engine tested by Fluidyne. Note: Fluidyne was testing the engine - not the gasifier.

	This truck was the first mobile and it's owner set it up with a generator mounted on the opposite side and a fan blower which could be used at the same time to blow gas into a small kiln.
	Doug's own personal gasified International van, which became the test apparatus that gave Fluidyne so many answers to so many problems. It also nearly killed Doug with CO poisoning resulting in Fluidyne placing greater emphasis on operational safety procedures.

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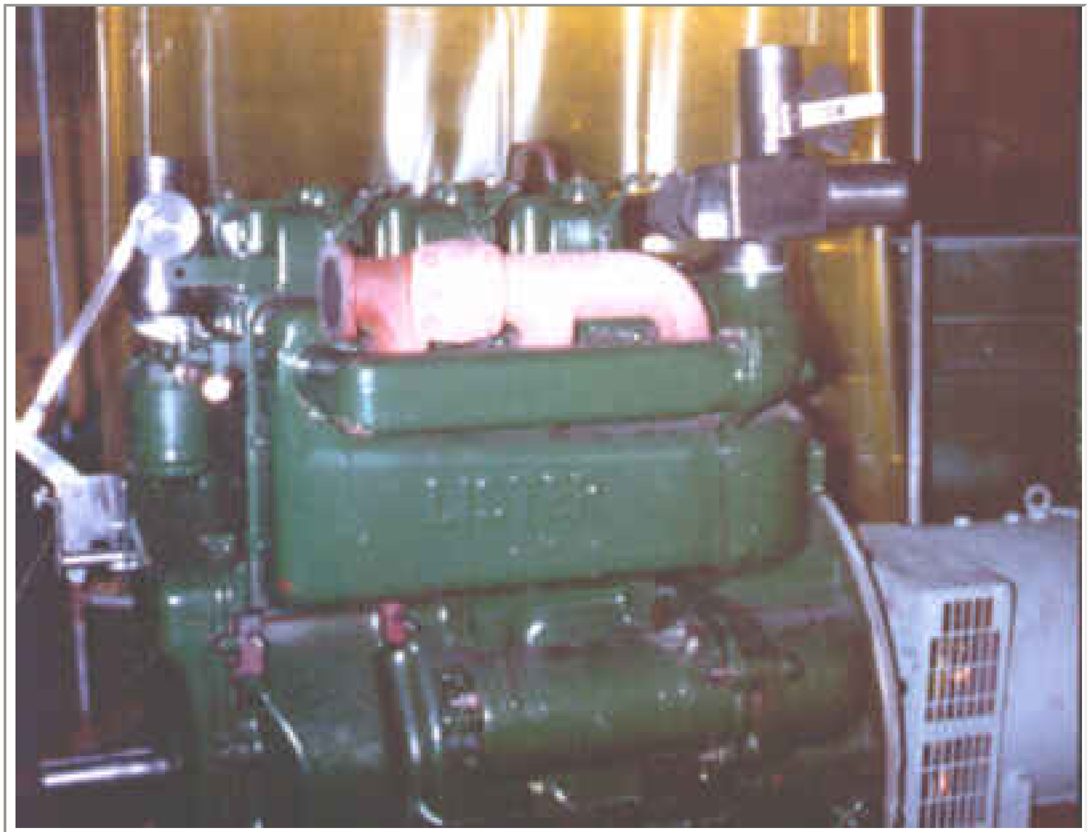	Lister HR3 was the first dual fuel system developed by Fluidyne, and was monitored by Lister for the 2,000 hour engine test. Was used to generate electricity on Great Barrier Island (NZ). This engine clocked up over 7,000 hours without problems.

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FLUIDYNE PACIFIC CLASS GASIFIER

The Pacific Class gasifier was designed to meet the specific needs of remote electric power generation in the tropical areas of the Pacific Ocean. Its final design requirement was conceived sitting on top of a hill 360° of very empty Pacific Ocean on the island of Atiu in the Cook Islands.

In these places all the local people have is their environment,, still reasonably intact. Anything that comes into that environment of a technical nature must be reliable and in the case of a gasifier have no effluents that can pollute the ground water.

Simplicity of servicing by the rural operators decreed that all systems be basic manual nut and bolt technology. Released for environmental testing in 1984, the first four units were sent to Fiji, Malaysia, South Africa and North America (Maine). In altitudes from sea level to 1500 feet, in temperatures from -15°C to 34°C, performance matched that established as a base line proven in New Zealand.

Only 14 Pacific Class were built and supplied to projects in Fiji, Malaysia, South Africa, Indonesia, USA, Mozambique, Pitcairn Island, Papua New Guinea, Uruguay, UK and Germany.

Haven taken seven years to develop the Pacific Class technology, the final design was winner of the industrial section of the (1984) New Zealand Steel Awards and outright winner (1984) of all categories entered.

The Pacific Class wood gasifier is a complete package plant unit. Thermal insulation of the fuel hopper and gas making hearth module prevent heat losses and protects operators from hot surfaces. Hot components of the gas cooling section are enclosed behind opening panels. Built-in steps and hand rail provide the operator with easy access to the refuelling deck. Refuelling of the gasifier is manual with the wood fuel tipped into the fuel hopper by opening the safety spring loaded hatch lid.

The side panelling covers the hot components acting as a duct to direct air from the fans over the hot surfaces, and out through the exit grill on the back side. The hot air discharge temperature varies with engine load on the gasifier and is typically 20-30 degrees C hotter than the ambient air at a flow rate of 6,000cfm. For cleanout servicing, the panel hinges upwards to expose the servicing ports.

Daily servicing of the gasifier is a simple task made easy by the use of screw caps and taper threads. These hot clean-outs require no seals other than lubrication to the taper threads. Side opening panel duct cooling air over hot components and discharges hot air out through exit grill on rear side.

Instrumentation of the gasifier is basic and provides the operator with visual aids to the gasifier performance.

The manometer provides pressure drop information from two sensor points, the hearth and filter. On the side of the instrument panel can be seen the yellow handle of the manometer two way control valve. Changes of pressure allows the operator to identify operational problems.

A thermocouple in the blast tube measures gas

temperatures and combined with the manometer, enables the operator to see if the gasifier is operating according to known operating conditions. This combination of instruments allows the operator to identify potential problems before the process is affected.

Contained inside the control panel are the electrical components for the shaker fuel timer and electric motor switching.

Cooling of the hot gas is by electrically powered twin fans. No water is used for gas cooling or cleaning.

Condensate water from the gas contains no tar or other

harmful contaminants. The condensate liquid is water containing some dissolved ash, small carbon particles, and has a P.H. of 8.2. This can change under certain conditions dependant on fuel wood and operating output.

Under the instrument panel can be seen the electric start-up fan and gas changeover valve.

Rear view showing agitator

motor, hot air exit grill, granular bed filter, startup fan and test flare stack

The Pacific Class gasifier design allows it to be used for process heat in the blown mode or engine application under suction. This dual purpose capability was conceived to meet the needs of institutional training programmes where both applications could be used and demonstrated in a practical manner. The burner nozzle on the end of the gas outlet pipe is the Cyclonix burner developed by Fluidyne for producer gas.

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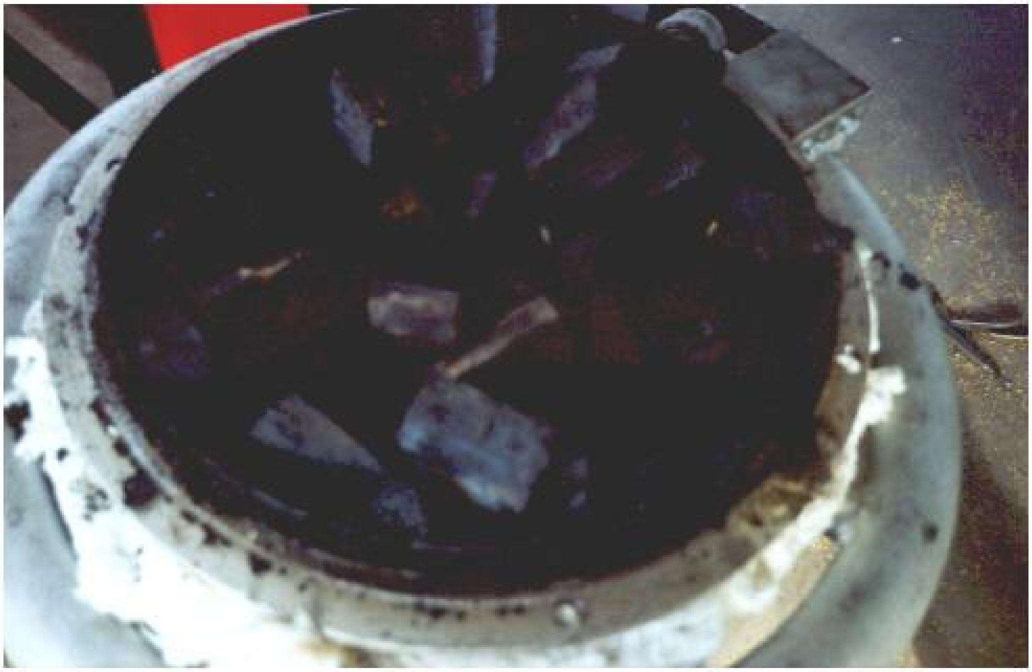
Wood to Char Pictures

1: These are about as big as you can go for pine block fuel, the easiest way for rural people to convert trees into gasifier fuel.



2: Above the air nozzles (about 5") the descending wood blocks are carbonising in the heat radiating upwards from the oxidation zone, releasing the products of distillation or pyrolysis gas. To many, the pyrolysis gas is the only end product gas and then goon to invent ways to clean and filter it for use in engines.

3: By the time the block reaches the incoming air at the nozzle level, the pyrolysis is complete and the block has begun to disintegrate into small pieces about quarter size. As the air begins to contact the char, combustion causes it to break down into smaller pieces as it moves with the oxidising gas stream towards the throat. In the presence of free oxygen the reactions of $C+O2 = CO$ revert back to CO_2 with an increase in temperature each time until the free oxygen is consumed, which prevents the formation of CO and result in only incandescent CO_2 gas entering the reduction zone under the throat. In the absence of free oxygen, reduction of the CO_2 into CO consumes the reduction char which is shrinking in size continuously. All fuel and char is in continuous motion and in this case, goes from block to reduction char in about 6-8 minutes. The highest temperature is at the throat orifice where the temperature should stabilise around 1200 degrees C.

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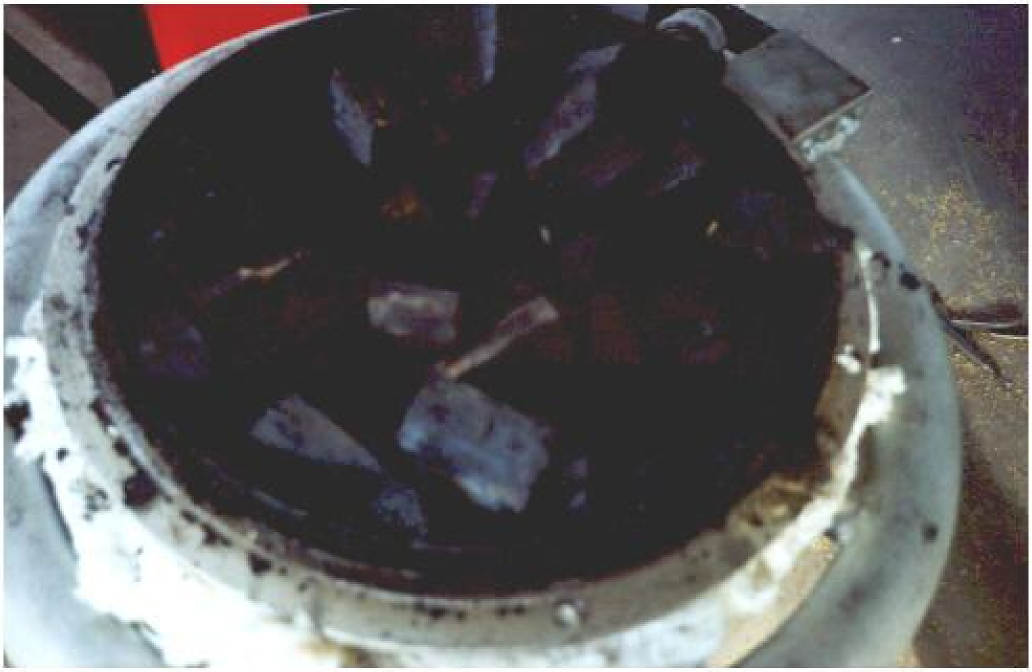

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Archive - Since 1976

Coppice Willow

The activity of growing coppice willow as a renewable energy fuel crop has been widely promoted as the answer for gasification projects. How this assumption was made without wide consultation with gasifier manufacturers will remain a mystery, but it is a decision and if successfully implemented can contribute substantial amounts to the U.K. grid network.

Based on the set aside land programme implemented by an E.U. edict, a census shows that potentially 100,000 30kWe and 25,000 100kWe gasifier systems could be installed generating some 25TWh/year. This is equivalent to Drax, the largest thermal station in the U.K.

While the logistics associated with such a system are considerable, dispersed generation using the grid connection at the farm gate and having that power on stream in less than 30 minutes should be a powerful motivator to make it happen. The costs I have been told are only a small percentage of the annual U.K. power budget.

As a fuel crop, willow is very wet when cut and drying must commence straight out of the field. Failure to do so results in rapid decomposition and the fuel stack ends up a compost heap. Air flow through the stack is critical and the end result is a lightweight bulky fuel with high sodium and potassium content. This forms clinker if gasified incorrectly.

Harvesting this fuel and its final piece size is controlled by the cutter speed and rate of feed, and the blades must be very sharp. The principle is to cut a piece without shattering the stem, or all you get is a mulch or pin chip, useless for engine gasifier fuel.

Fluidyne were asked to investigate coppice willow for gasification by a U.K. landfill company in 1993, and after trials in New Zealand, a project was implemented at Long Ashton in the U.K. This project was to establish the actual gasifying parameters of the coppice willow and sort out the unknown aspects of harvesting and drying. Since this project was initiated further work on fine chip fuels has been conducted in New Zealand and Germany by Fluidyne in preparation for larger gasified engine CHP systems.
At Long Ashton, a Champion Rotary Crop Header was used on a Claas tractor, and the chopped fuel was then blown into a trailer. The blown distance can be used to drop out all the fines which have to be separated before gasification.

The Irish single row harvester also blows the chopped fuel into the trailer, and ongoing development work is to perfect the piece size without shattering.

Other harvesting techniques are used to cut and bundle mainly for planting stock, but drying in bundles, then chipping may cause sizing problems.

The success of using coppice willow for a gasifier fuel will depend on its local application and not as a source for large central power generation. Transporting large volumes of low density fuel has its own problems and in very large cropping situations drying and storage becomes a major activity. Clearly supplementary chip wood will be needed for all year generation and that then requires the gasifier to handle multi fuel, for the two fuels have very different characteristics, and then again across hard and soft woods.

All comments regarding coppice willow relate to gasification for engine CHP systems and does not apply to combustion applications.

Champion Rotary Crop Header

Irish Single Row Header

Original Coppice Willow N.Z. test sample 1993

	Long Ashton original sample 1994
	Irish sample first trial cutting 2000

Irish wood chip comparison

Fluidyne Gasification
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Irish wood chip comparison

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Hello, Doug

It was a real plessure for me to meet You in Belfast.

We have an Association of Ecological Motoristis in Finland for vehicles using renewable energy sourses in trafic. Beeing chairman of the club, it was very interesting to have a litle bit larger view of the gasification technology
programs. We are about one hundred members and the members have about a dozen of vehicles which are energized using gasification technology. Modifications of down draft cocurrent gasifiers are used. None is using the other technologies in trafic to utilize non fossile energy sources.

As you know, mobile gasifyers were very common in continental Europe during the war time 1940 - 1945. In Finland and Sweden, mainly woodbased fuels were used. Since 1995, I have driven over 40 000 km on peat based fuel. Wood would do just as well, but it is not commercially available at appropriate form.

As I do work to promote gasification aplications for trafic, I do send You some information concerning the mobile gasification technology.

The GMC truck belongs to Urho Kari, the Ford truck to Osmo Ylikarkela and the white Buick is mine, all in Finland.

All the information enclosed is public. Please, You may deliver it further to anyone who asks or is interested.

Truly Yours,

Vesa


FORD

Fluidyne Gasification
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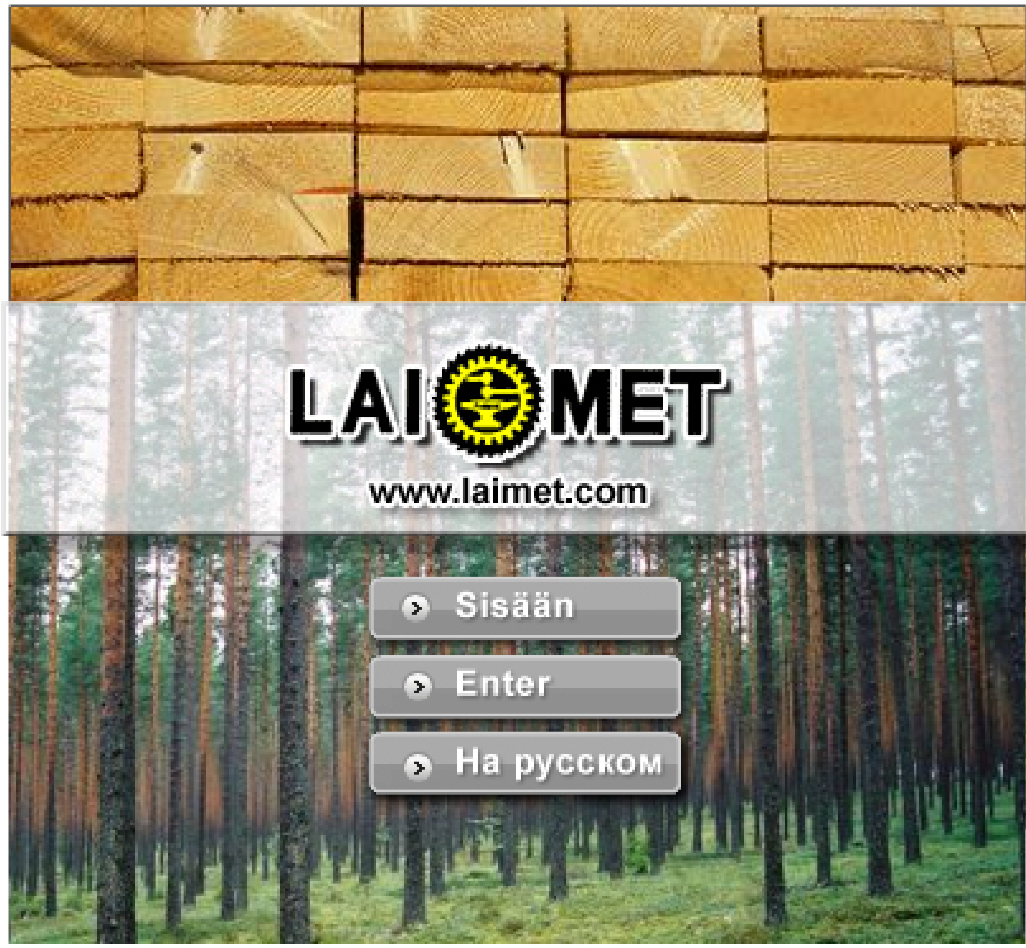
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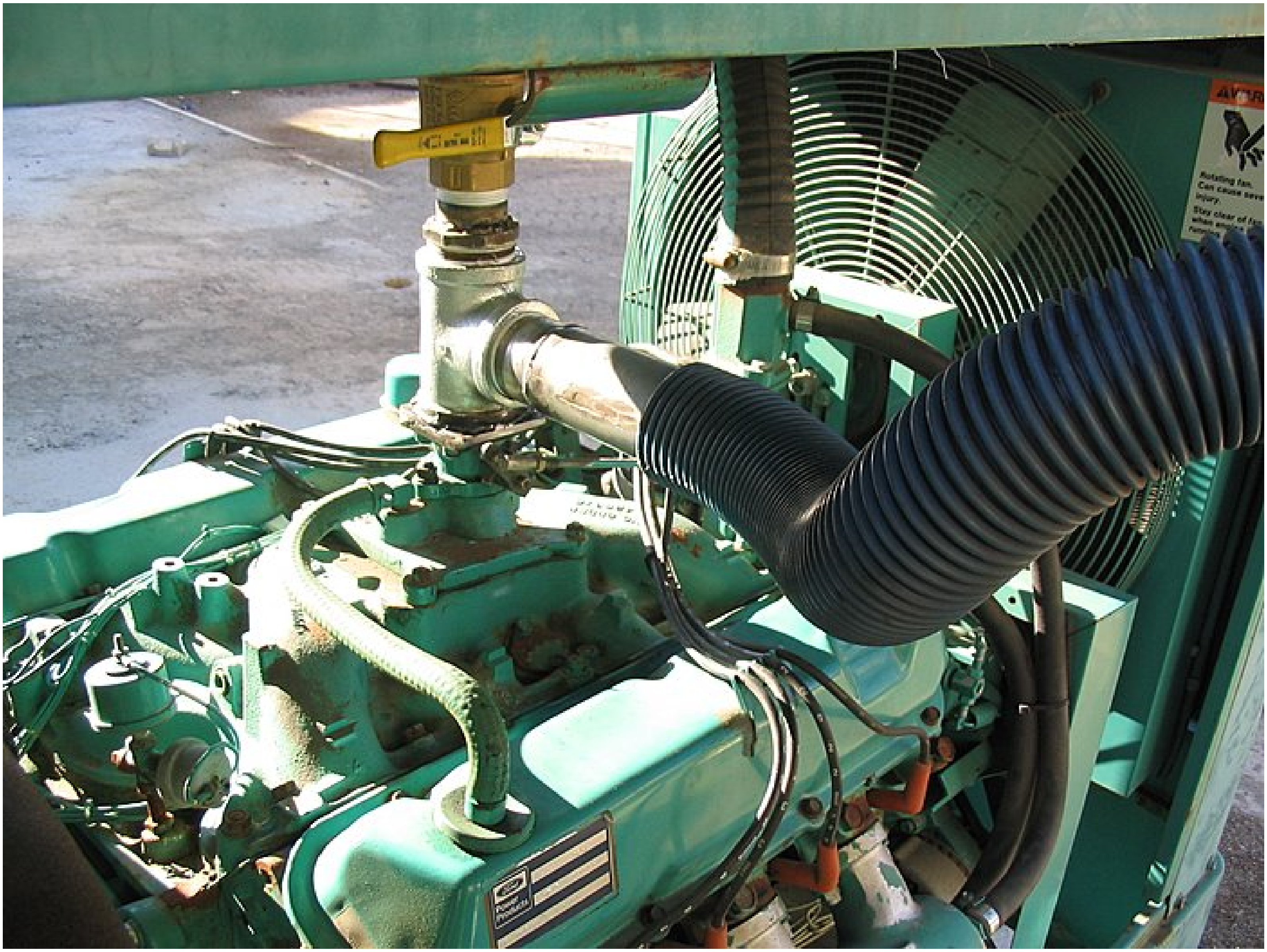

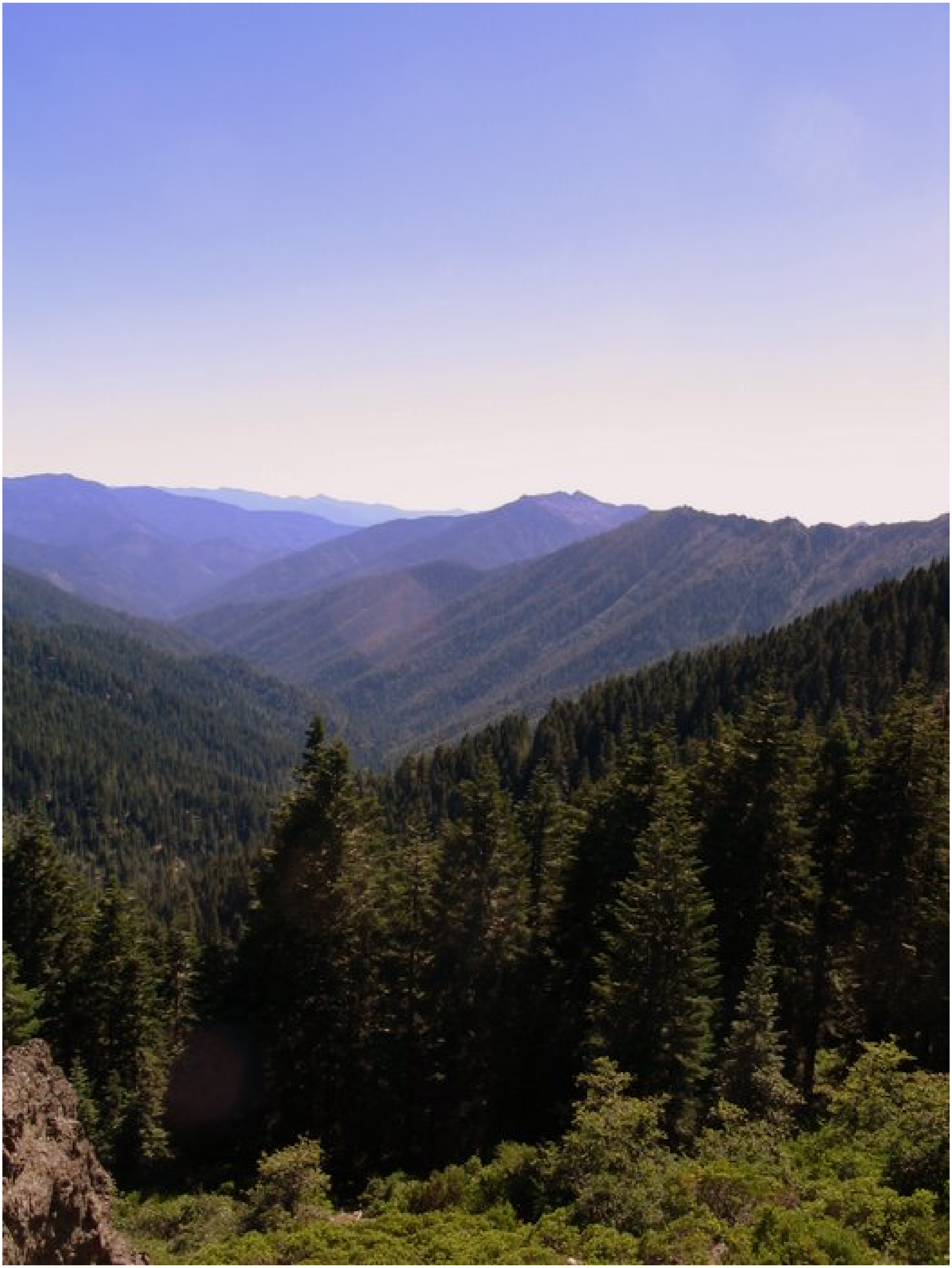

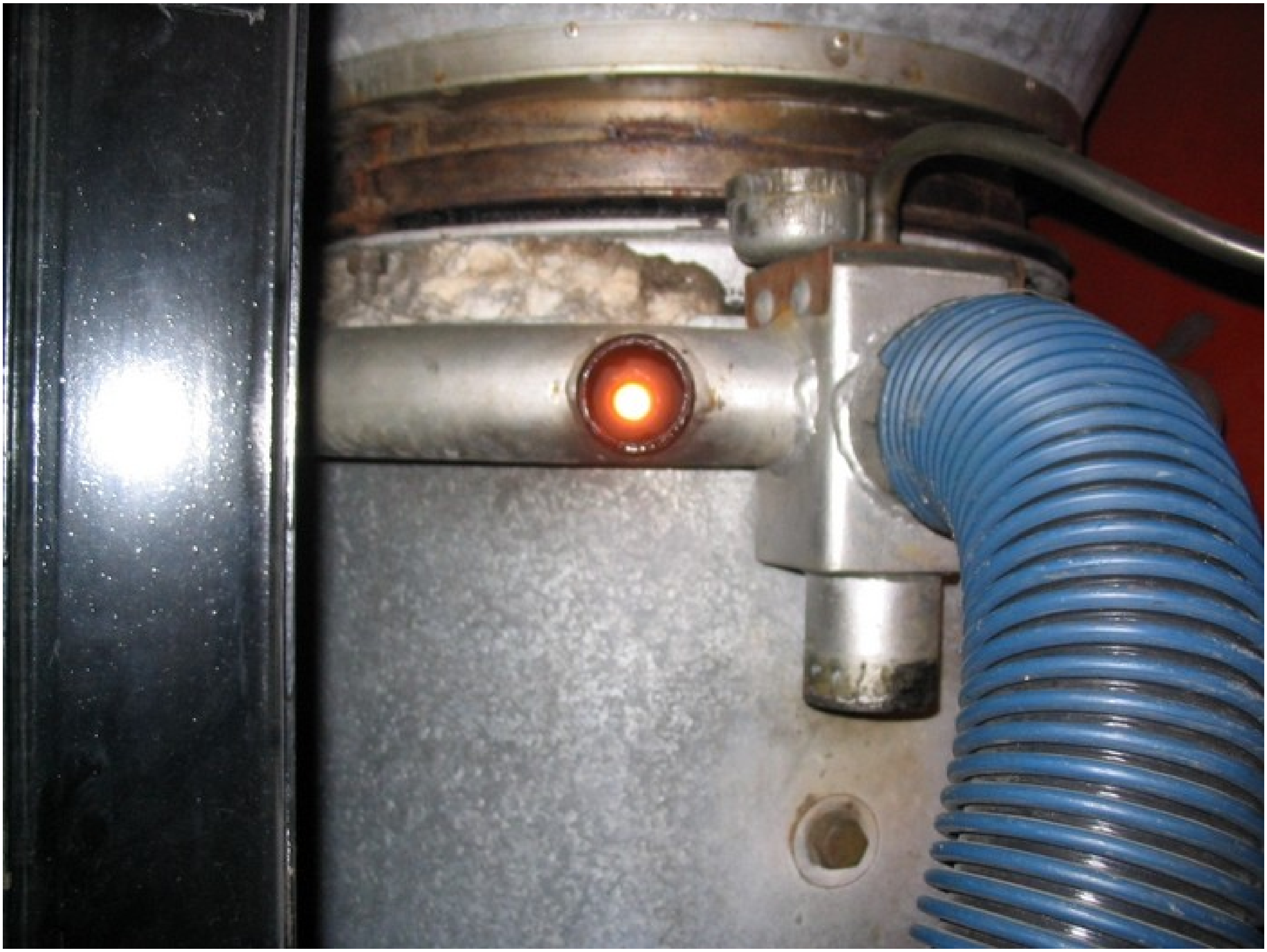


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E-mail: info@bomaes.ca
Website: www.bomaes.ca

203 - 2621 Portage Avenue
Winnipeg, MB, R3J 0P7
Canada

December 12, 2007

TO WHO IT MAY CONCERN

RE: W2E Gasifier – Stack Test Results and Professional Opinion on Air Emissions

BOMA Environmental & Safety Inc. (BOMA E&S) is an independent environmental engineers consulting company active in environmental, health and safety fields. The company line of business includes testing of air emissions from industrial and commercial sources.

BOMA E&S tested air emissions from the W2E gasifier, model Megaclass, on 16 and 29 July and on 8 and 14 August 2006. The gasifier was fired with wood chips, continuously fed to the fuel intake port. The following summarizes the stack testing methodologies and stack test results.

Stack Sampling Locations

Air emissions from the gasifier were released through a 7 m high circular vertical stack, 0.41 m in diameter.

The locations for the sampling of stack gas particulate matter and the determination of stack gas velocity were selected using US EPA Method 1. To obtain representative samples of air emissions two sampling ports, 90° at each other, and located more than 8 stack diameters downstream and more than 2 diameters upstream from any gas flow obstruction, were used.

Stack Gas Velocity and Flow Rate

The average stack gas velocity, stack gas temperature and flow rate were determined using US EPA Method 2. A S-type Pitot tube was used for the determination of stack gas velocity. The stack gas flow rate was determined from data on stack gas velocity and gas density determined by another test method (US EPA Method 3).

Results:

The average stack gas temperature: 457°C
The average air velocity was 6.5 m/s
The average gas flow rate was 0.86 m^3/s

Stack Gas Concentrations

Concentrations of carbon dioxide, carbon monoxide and oxygen were determined instrumentally using Method 3A. A NOVA Analyzer, Model 376 WP, was used.

Results:

Carbon dioxide, CO_2:	12.6% (w/w)
Carbon monoxide, CO:	0 % (w/w)
Oxygen, O_2:	8.4%

Stack Gas Moisture

The concentration of water vapour in the stack gas was determined gravimetrically, using US EPA Method 4.

The average moisture content in the stack gas was 8.6%

Particulate Matter in Stack Gas

The concentration of particulate matter in the stack gas was determined isokinetically, using US Method 5.

The concentration of PM, average of three runs, was 0.164 g/m^3 @ STP, corrected to 12% CO_2. This value was significantly lower than the current Manitoba emission limit of 0.230 g/m^3. The isokinetic coefficient was 100.8%.

Testing of Air Emissions from Diesel Engine Fired with a Mixture of Syngas and Diesel Fuel

BOMA E&S was also involved in testing air emissions from a Merlees marine diesel engine. The tests included the sampling and analysis of air emissions from the engine when fired with 100% diesel oil and with a mixture of 90% (w/w) of syngas and 10% (w/w) of diesel oil. The tests were performed on December 28 and 30, 2006 and January 1 and 2, 2007.

While the tests could not be completed because of an operational problem with the feed of wood chips to the gasifier, visual observations of the glass fiber filters and exhaust gas opacity showed a significant decrease in particulate emissions when the engine was fired with the mixture of syngas and diesel oil.

BOMA Environmental & Safety Inc.

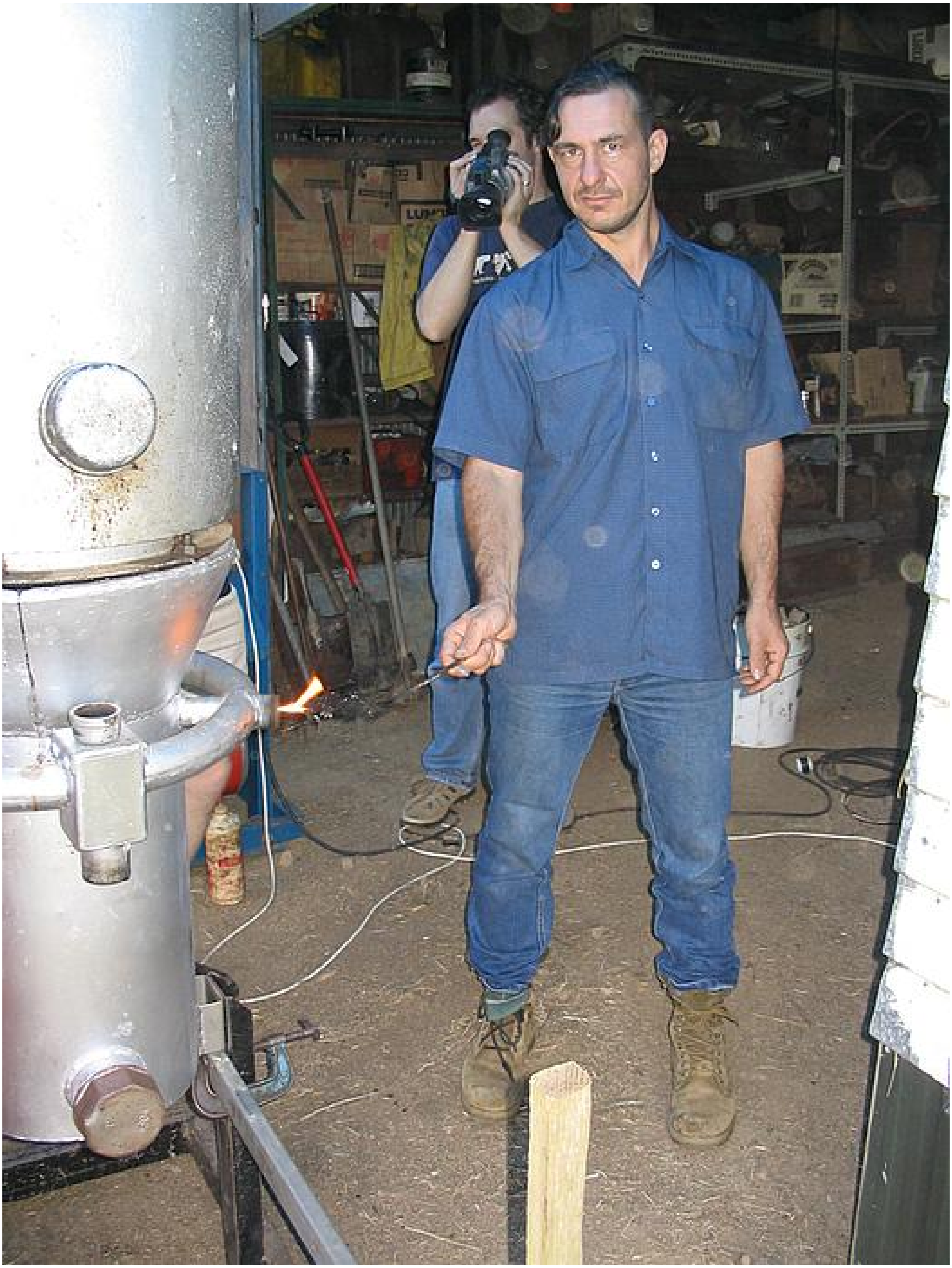
Per Dinko Tuhtar

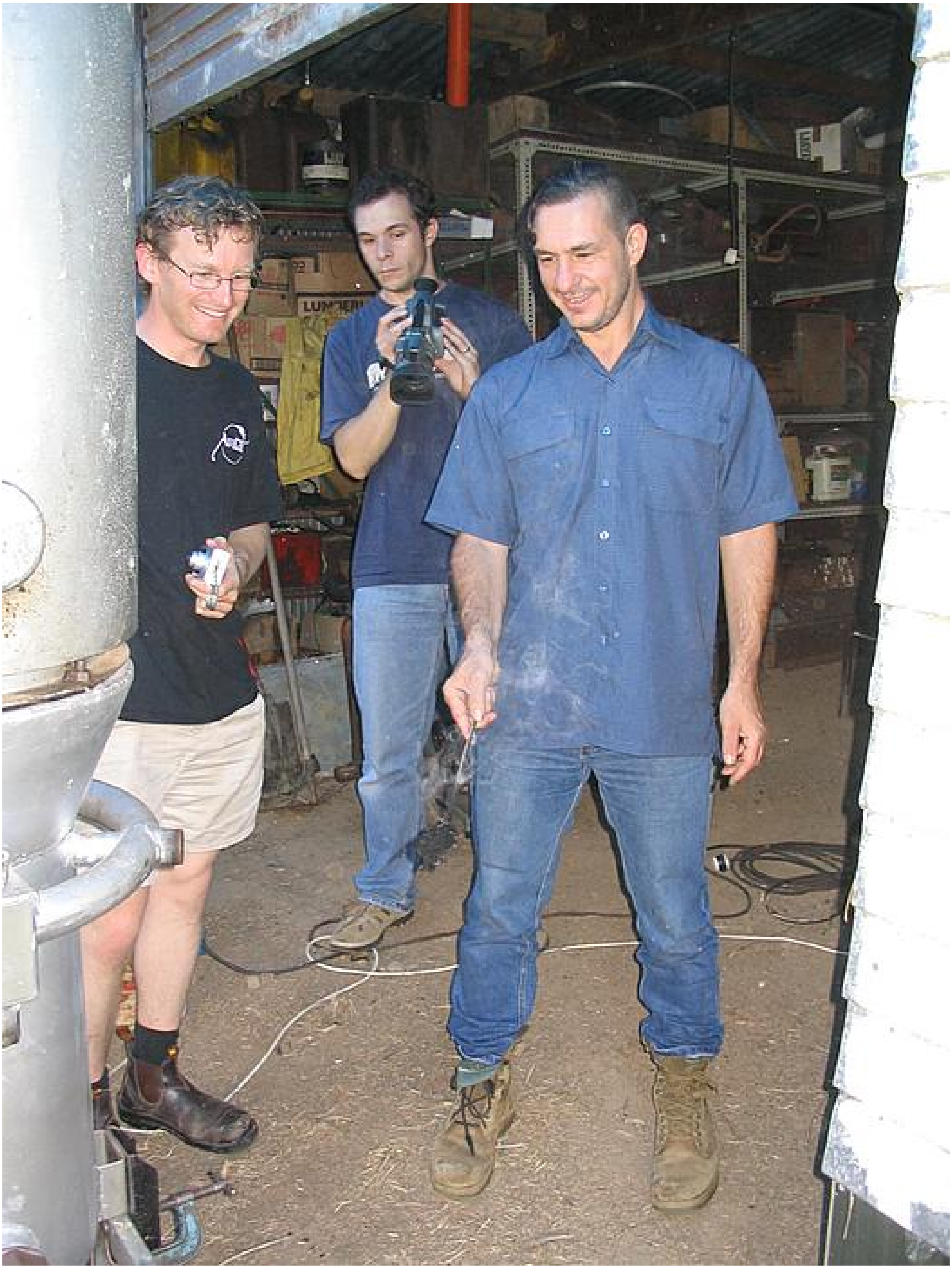
Dr. Dinko Tuhtar, P.Eng.

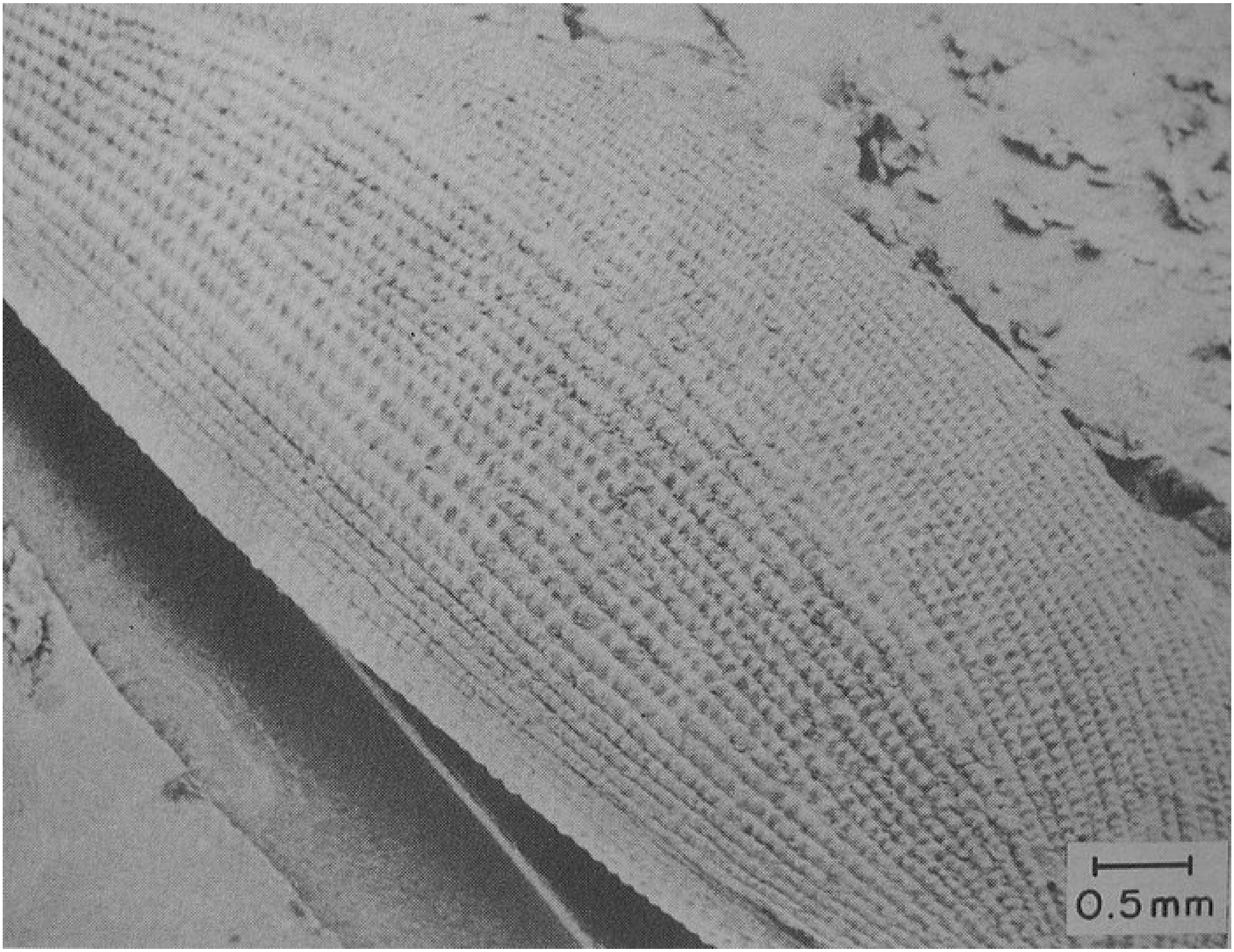
PROVINCE OF MANITOBA
D.T.
D. TUHTAR
Dec. 12, 07
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
BOMA Environmental & Safety Inc.
No. 1591 Date: 12/12/2007


FLUIDYNE (NZ) LTD
Pioneer Class
WOOD GASIFIER



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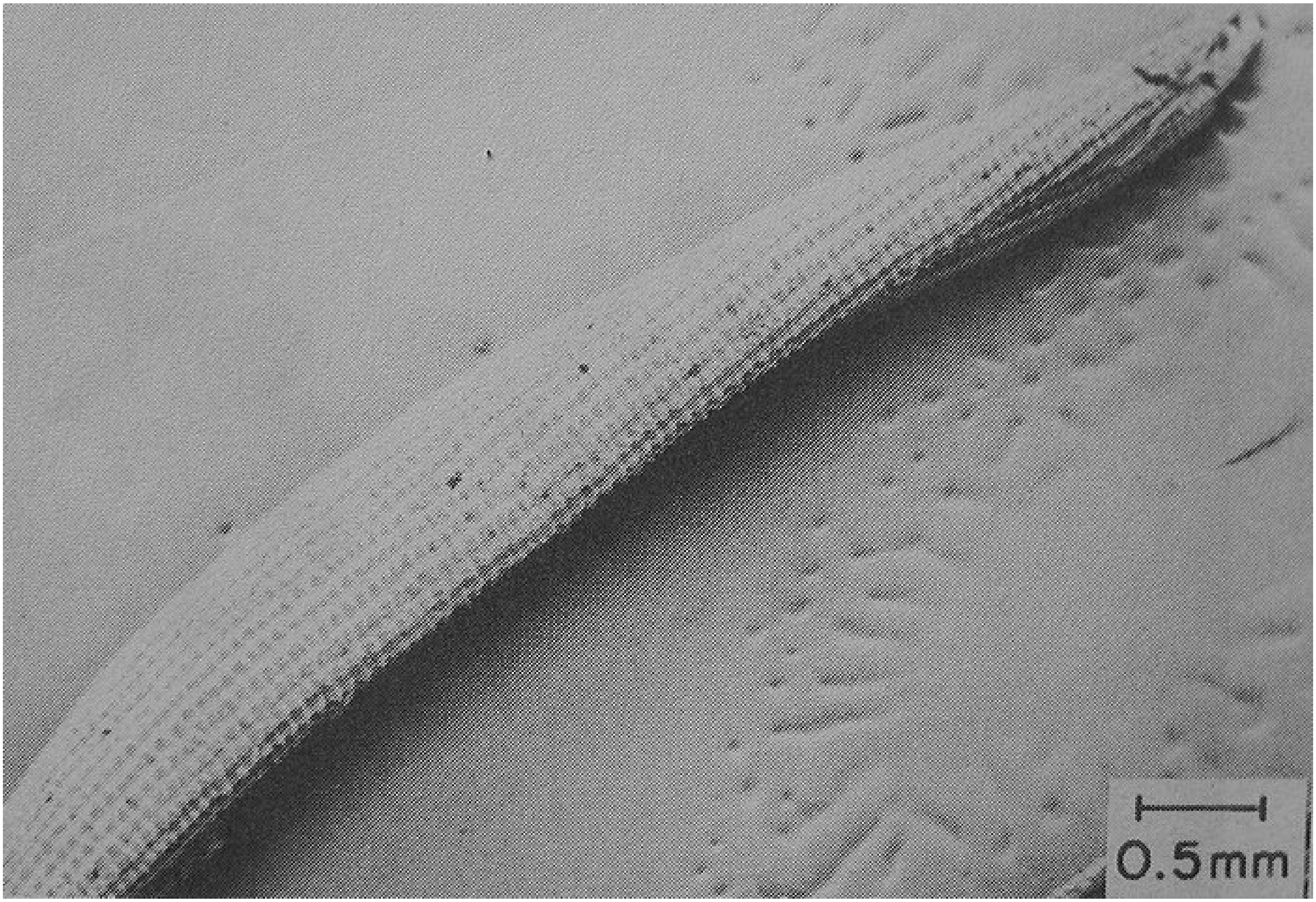
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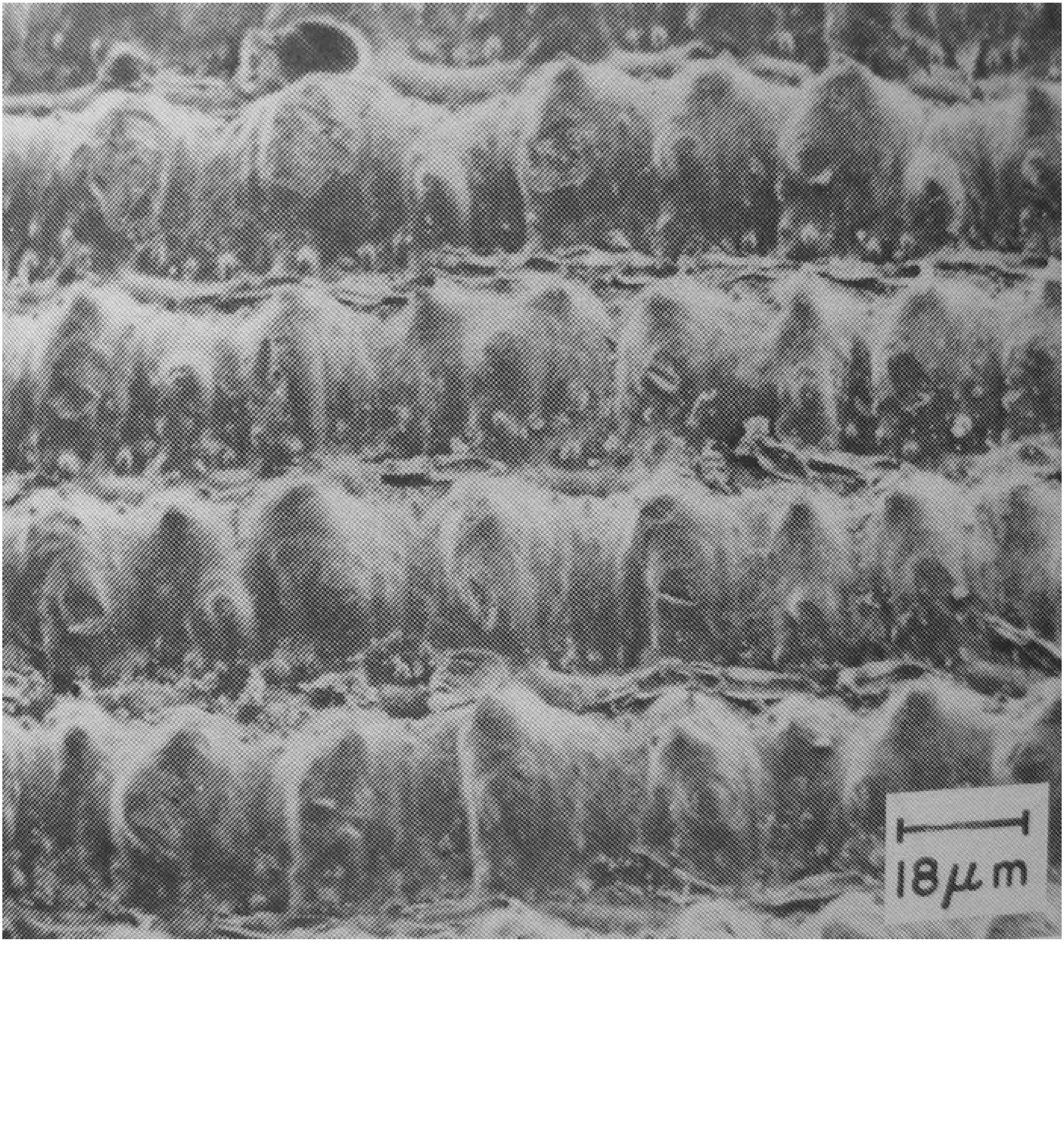
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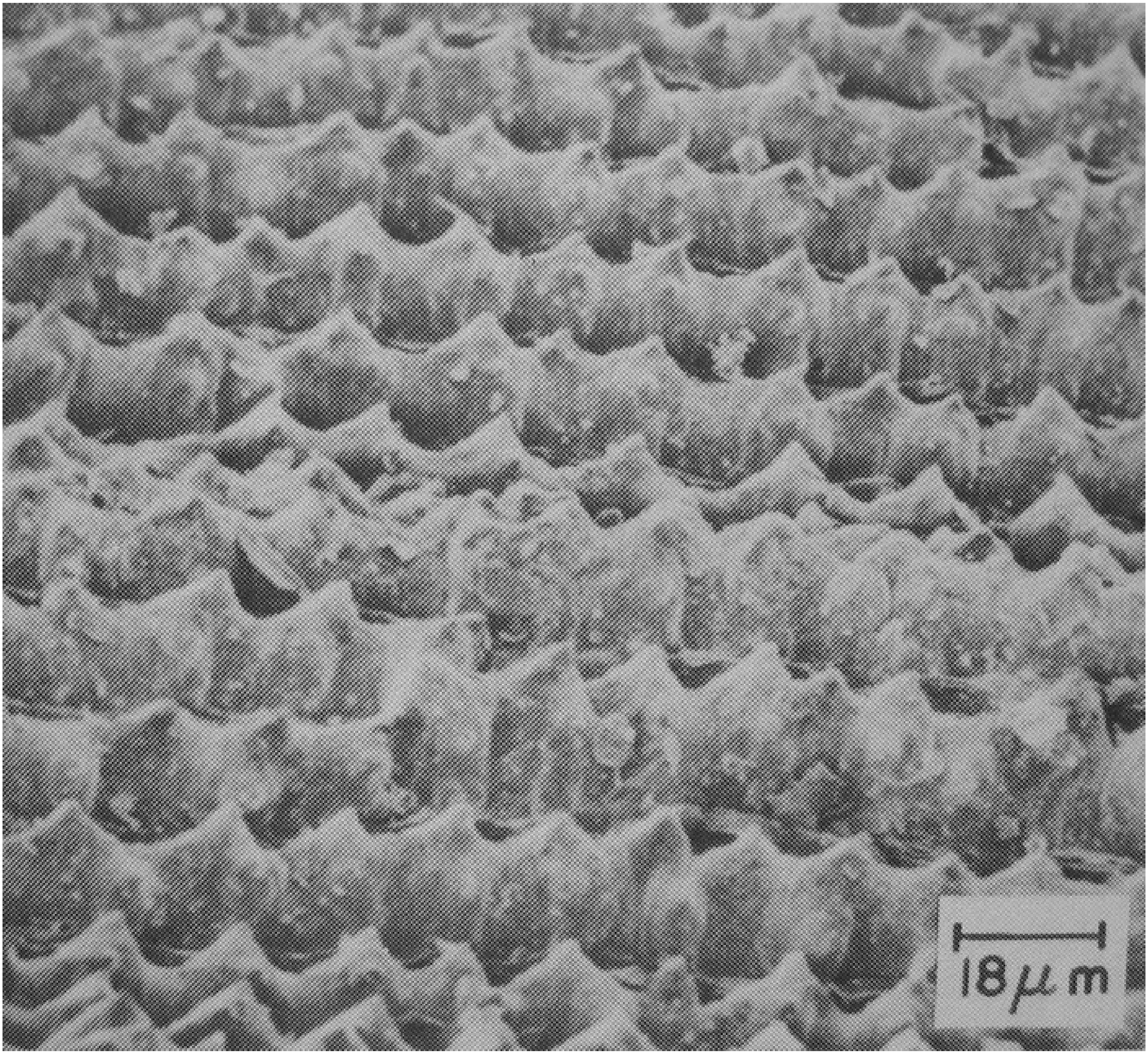
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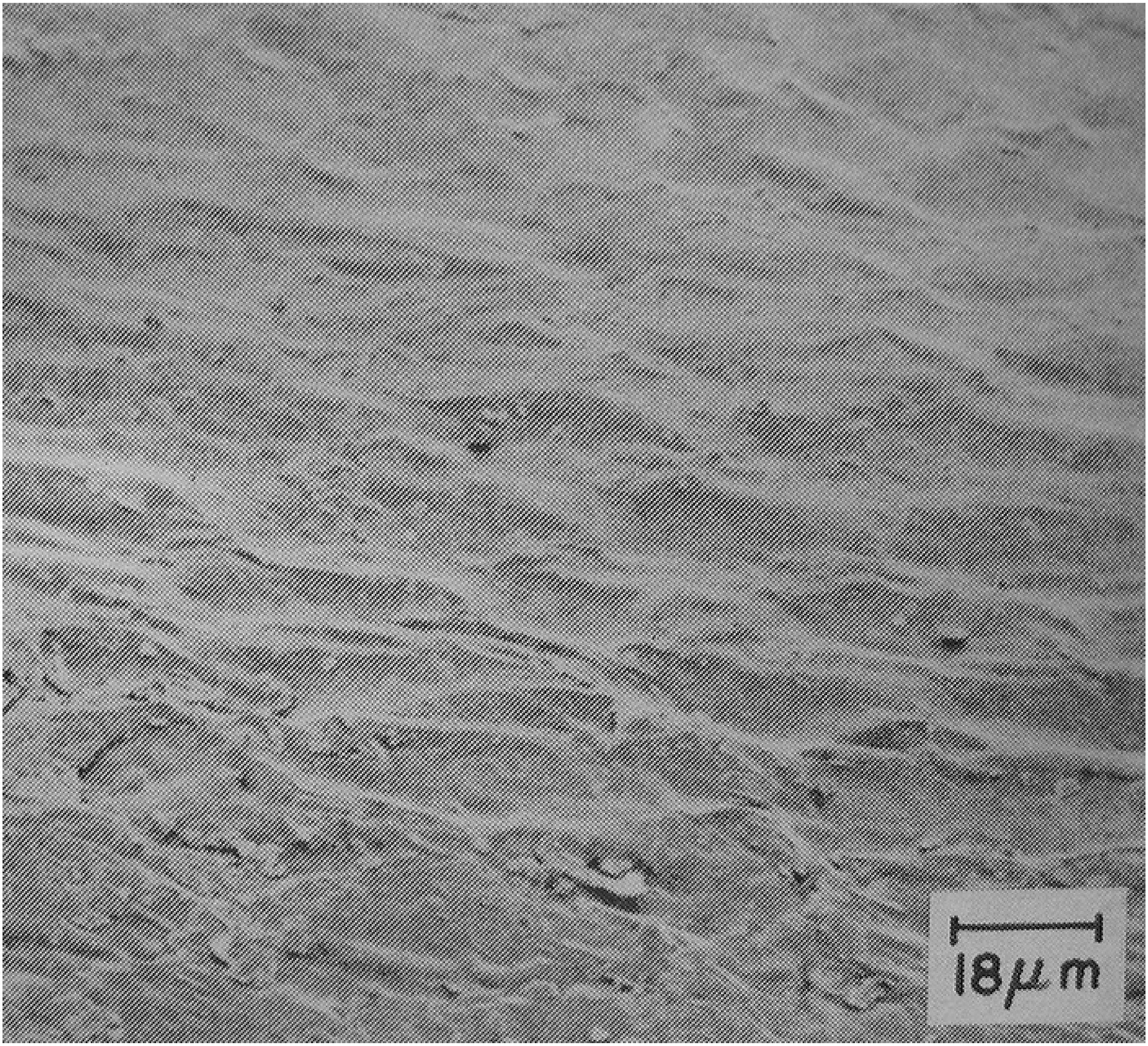
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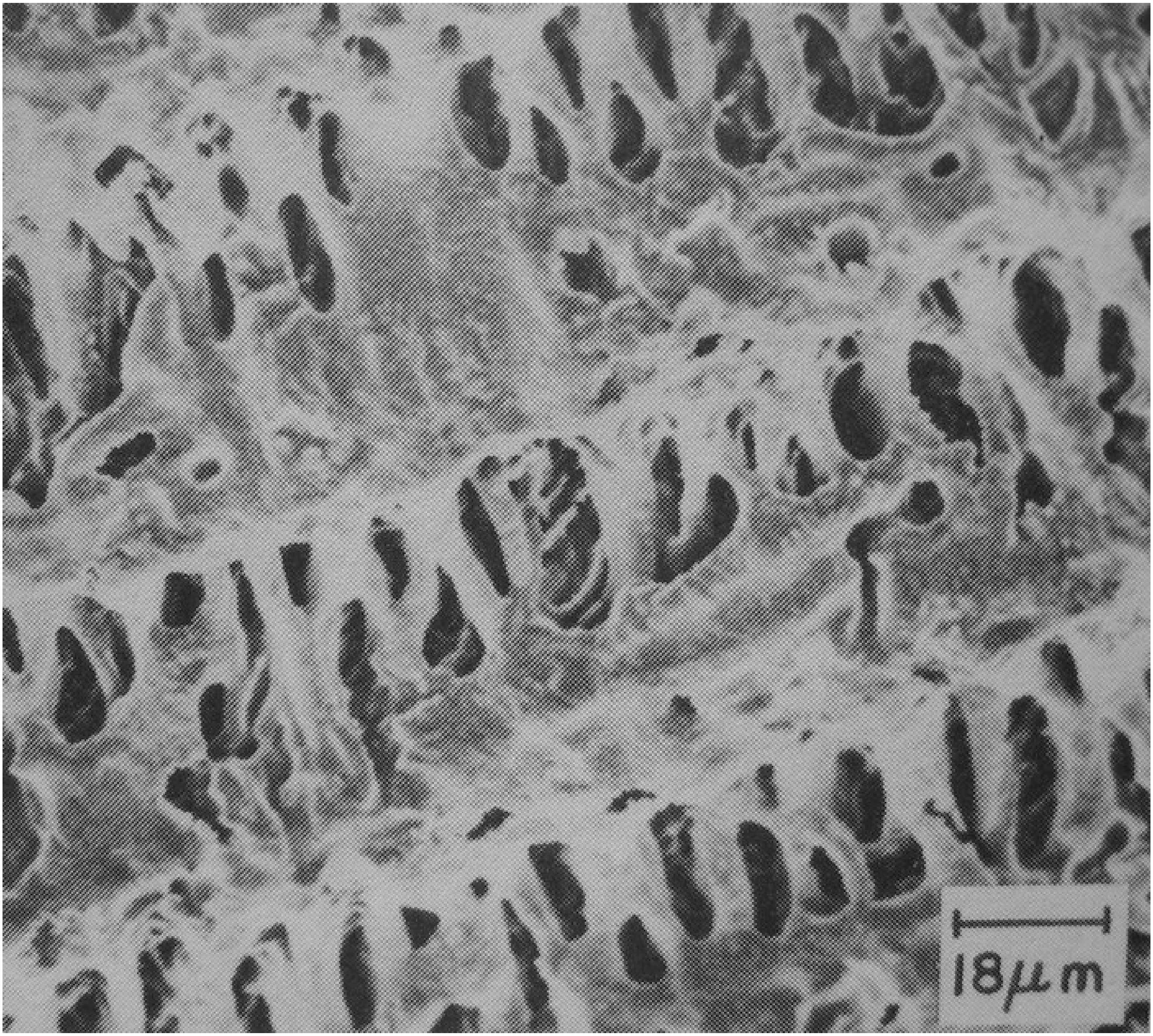
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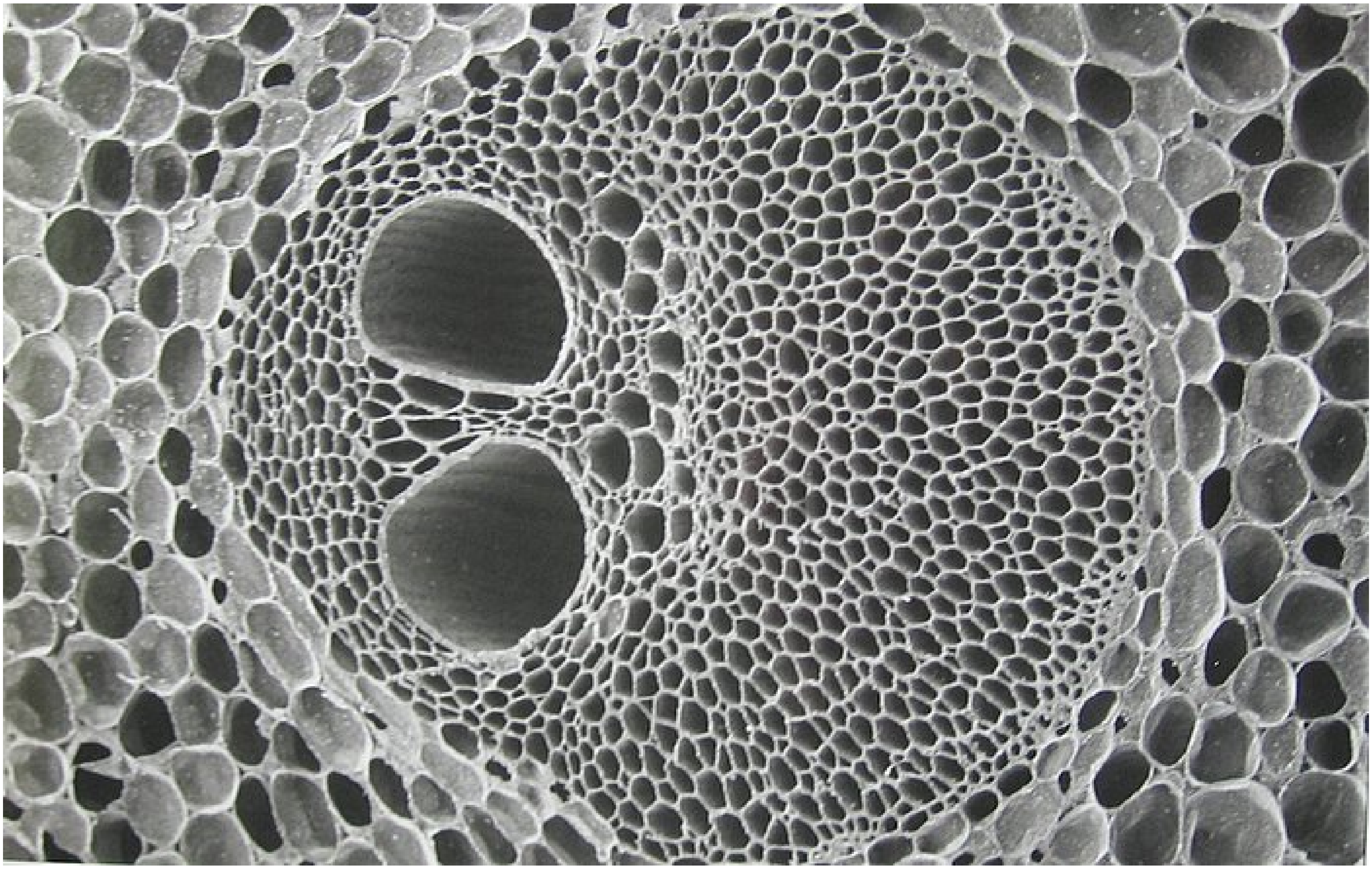

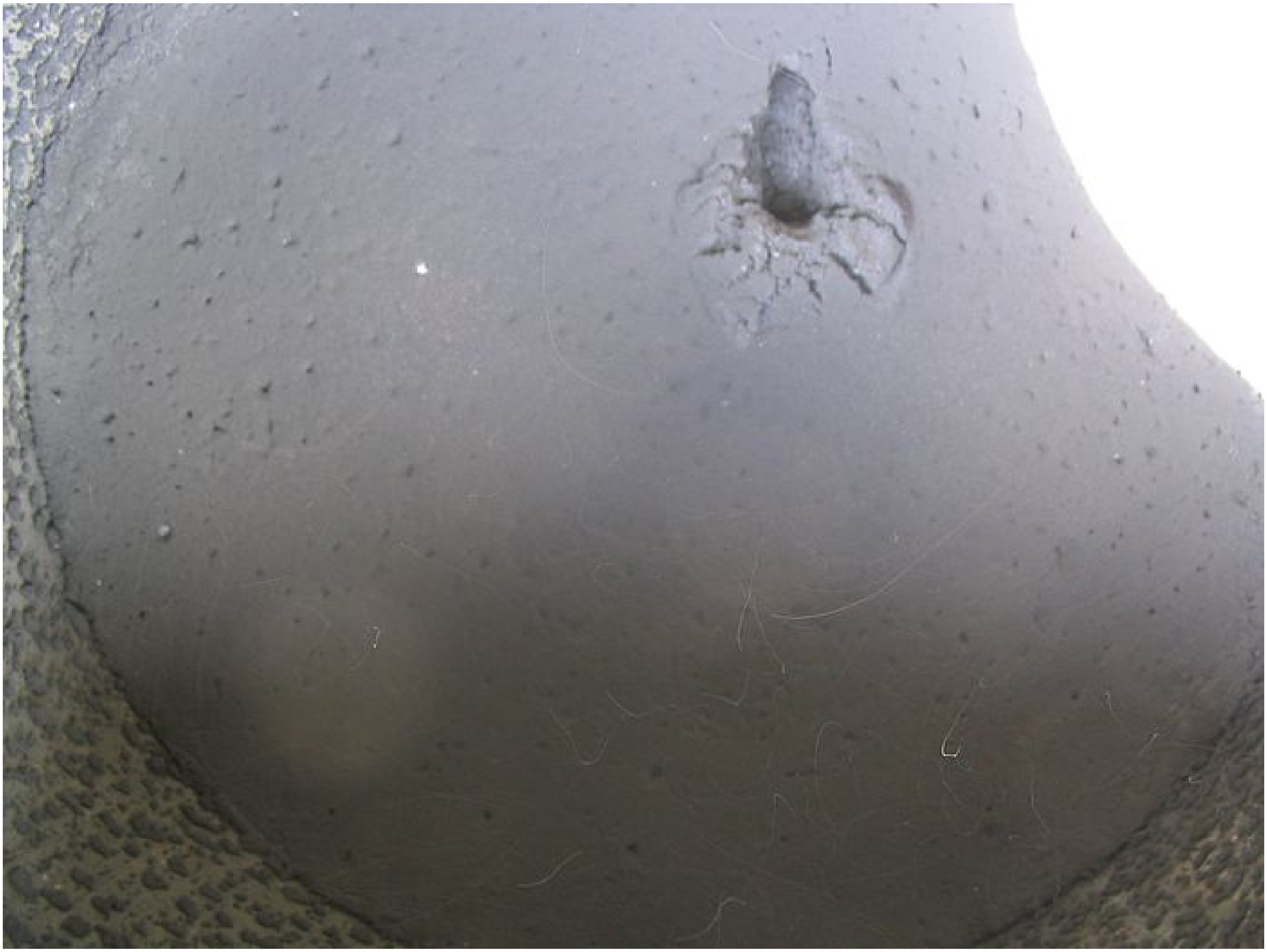


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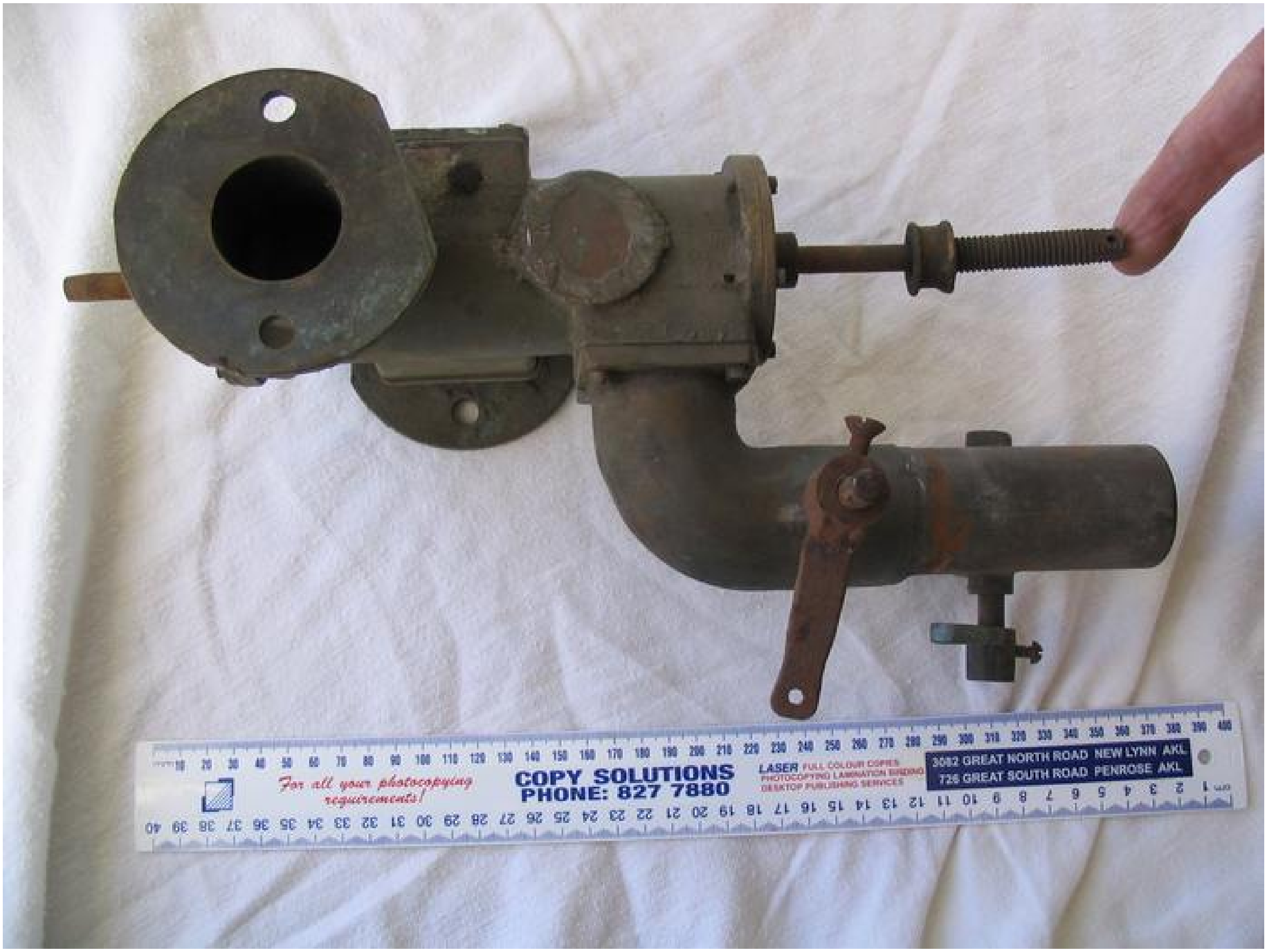
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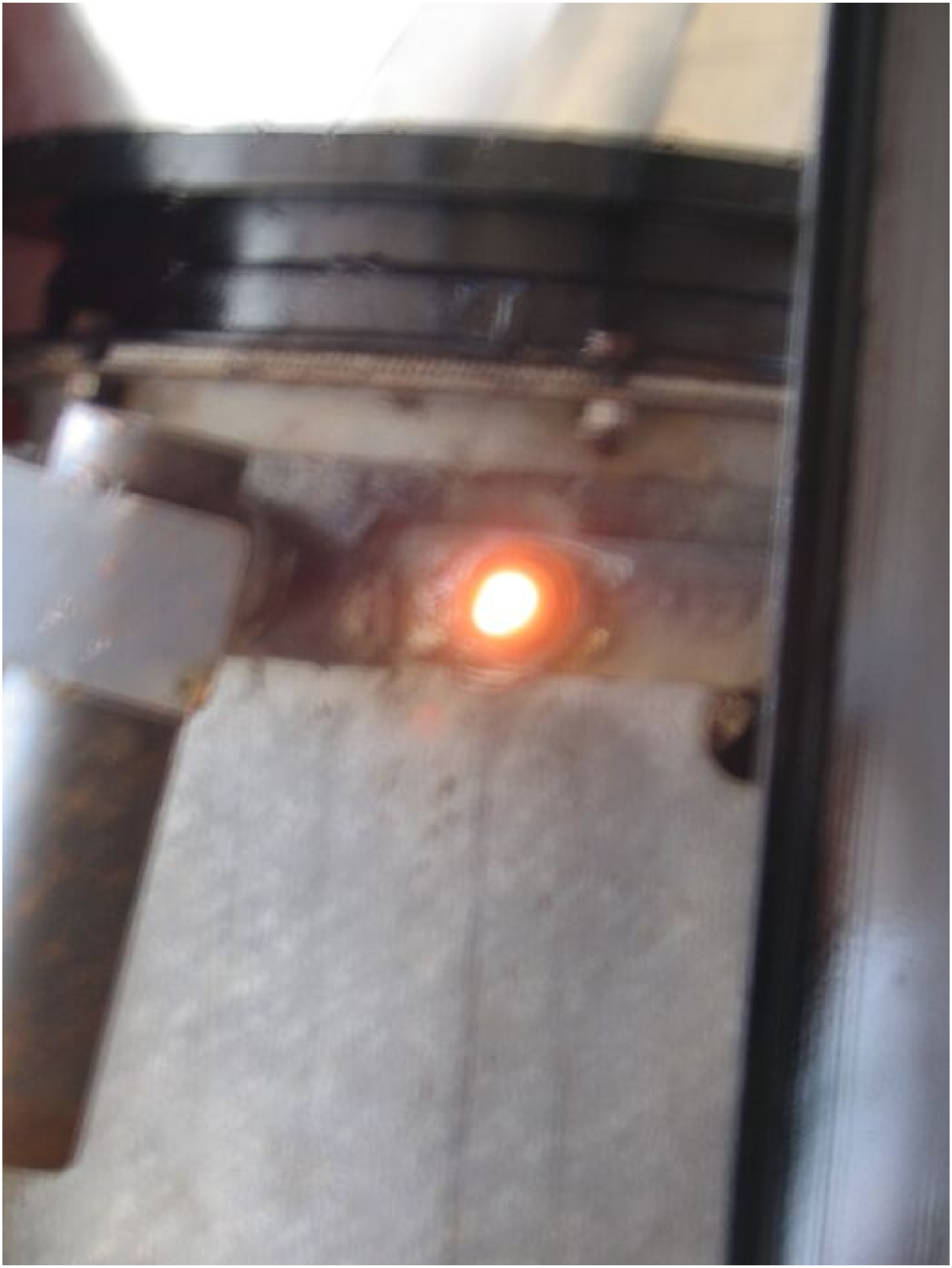


FLUIDYNE
Micro Class
WOOD GASIFIER


FLUIDYNE
Micro Class
WOOD GASIFIER


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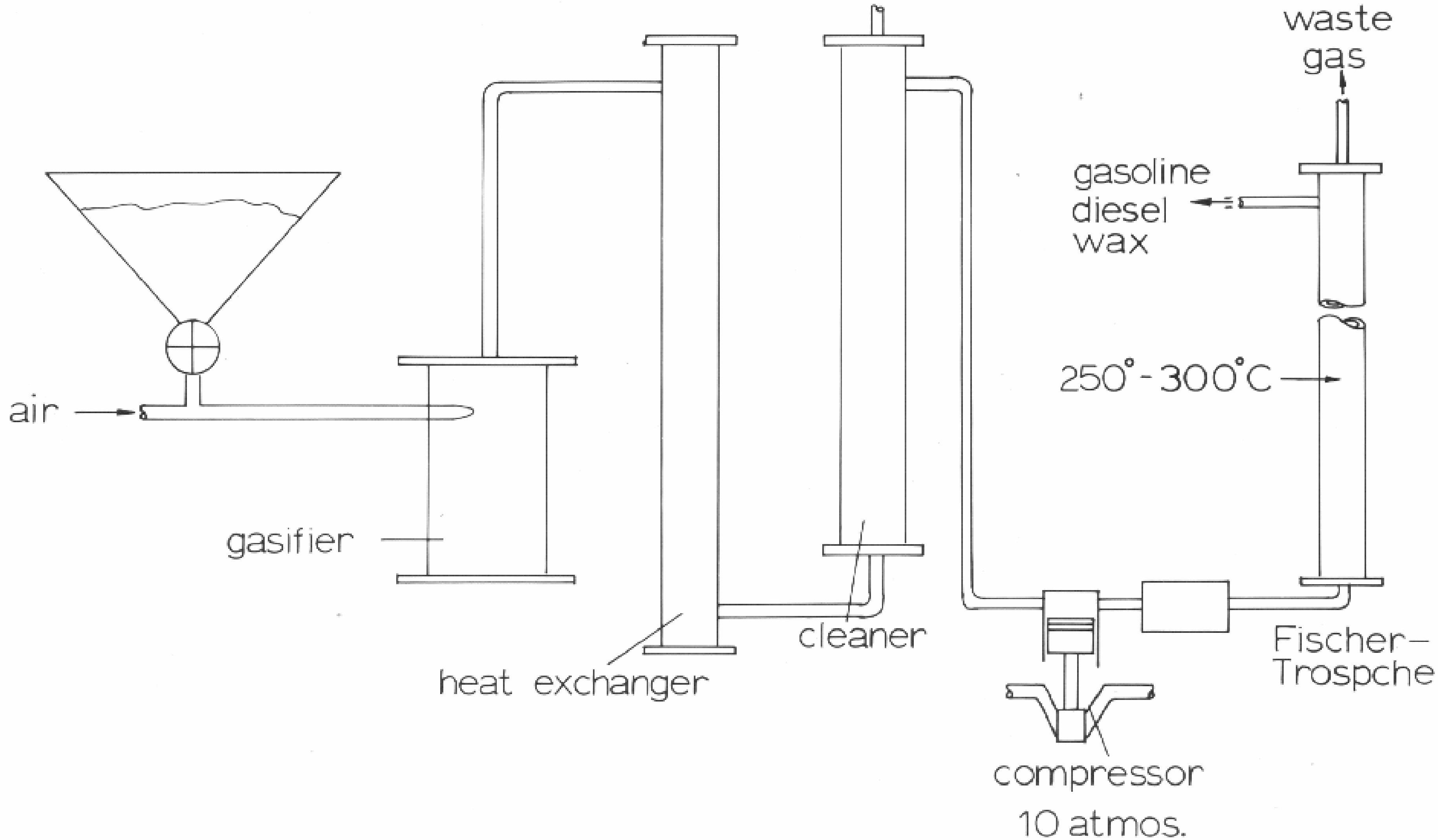
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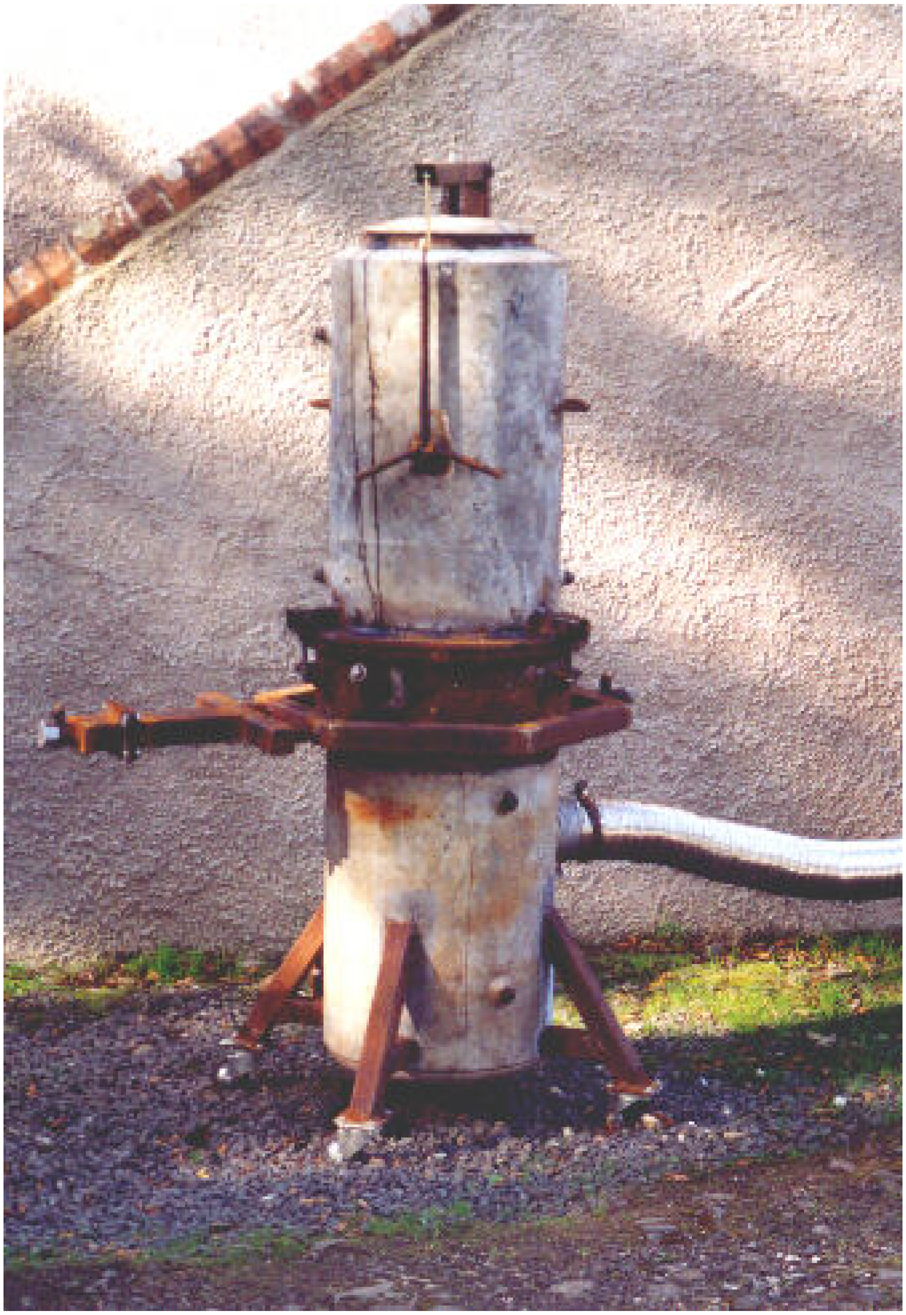

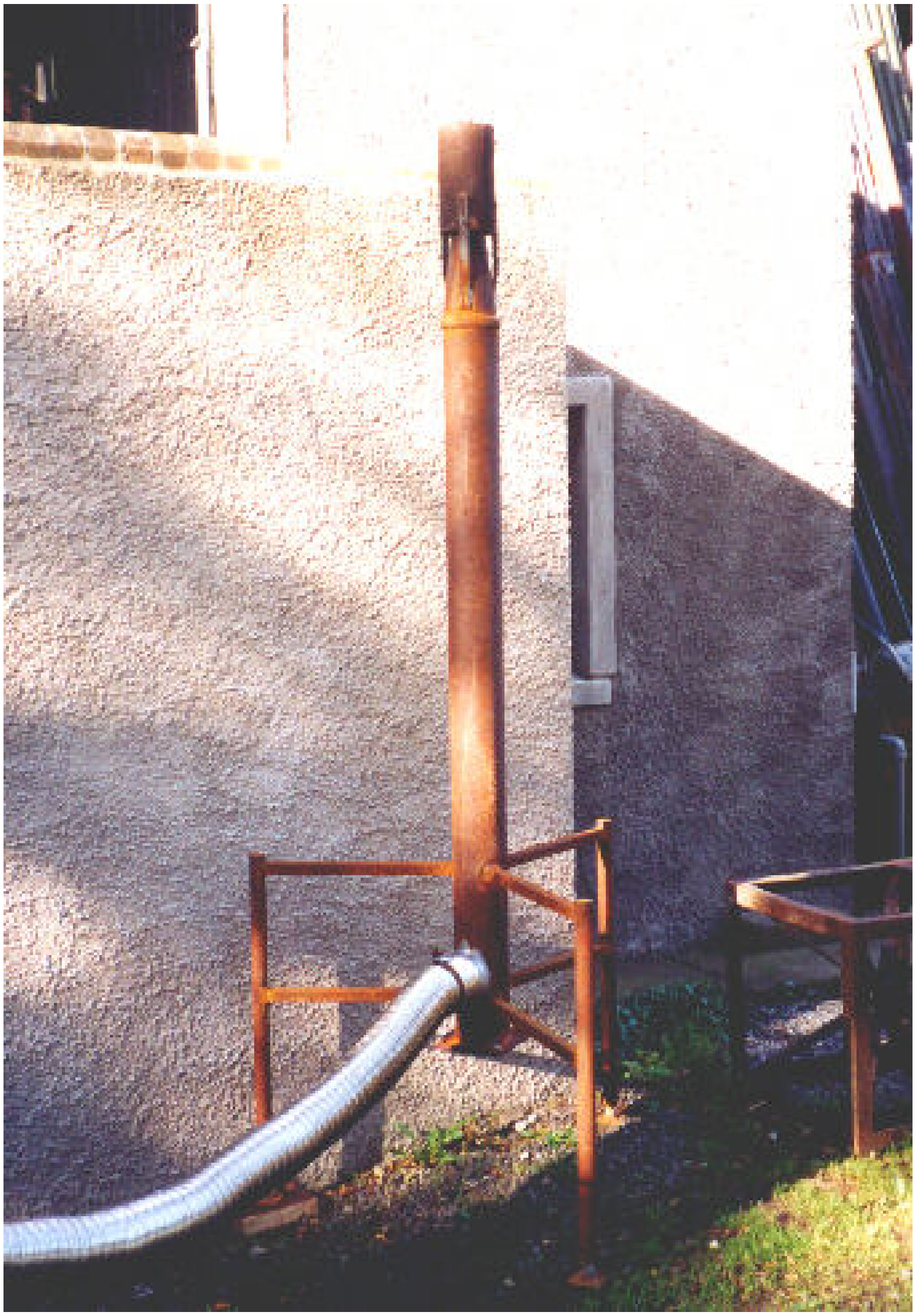

KOPO HOGGER HP-15

16211
E

KOPO HOGGER HP-15

A TRACTOR DRIVEN HOGGER WHICH PRODUCES A SUITABLY CHOPPED FUEL FROM WASTE WOOD.

	KOPO-KONEPOHJA Oulu Finland	KOPO-MASCHINEN Frankfurt Germany	KOPO MASKIN Haparanda Sweden	KOPO NORGE Mo i Rana Norge	KOPO TEMENT Stockholm Sweden	NEKALAN KONEPAJA Tampere Finland	PROTEKNO Oulu Finland
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Phone	981-348611	0611-281894	0922-21250	087-53555	08-7140320	931-30202	981-226691
Telex	32105 kopo sf	0414611 mhtfm d	80452 kopo s		13286 tement s	22506 neka sf	32105 kopo sf

TECHNICAL DATA

Weight	380	kg	820	lbs
Maximum input Ø	150	mm	6	inches
Chopped piece lenght	70—80	mm	2,5—3	inches
Capacity	10—20	m³/hr	8—15	cu.yds/hr
Power requirement	20—60	kW	50—100	HP
Input speed of wood	0,5—0,6	m/sec.	1.7—2.7	feet/sec.
Speed of rotation	540—1000	rpm		

Patent applied for. US 148.060
CA 351.041
EP 80102070.2

WHY CHOPPED WOOD

The usual type chips burn poorly on the normal type of grates and in storage only the surface of the stock-pile dries.
The KOPO hogger produces pieces 7—8 cm (2,5") long and 3—4 cm (1" to 1½") thick on avarage. Due to this larger chunk size air can circulate deeper into the stockpile thus improving dryind even to the very bottom of the pile. The chopped wood does not therefore rot, even when stored for prolonged periods, not to mention its better burning characteristics.

WHO CAN USE CHOPPED WOOD

The KOPO hogger produces a chopped wood suitable for use on standard type boiler grates. In the woods and forests are large quantities of waste wood available at low or no cost. By means of the KOPO hogger this wood can be made into an easily usable fuel. A standard farm tractor is a suitable power source.

WHY THE KOPO HOGGER

The conical screw of the KOPO hogger produces larger pieces. An ingenious principle of operation makes the KOPO hogger quiet and yet powerful. The hard surface welded blade cannot work loose and needs no adjustment. As a result of its construction the KOPO hogger is extremely reliable and does not produce extreme loads on the power source.
KOPO hogger will self-feed any length wood end placed in the input chute which is horizontal and thus requires minimum amount of lifting of the input material.


Manufacturer:
the KOPO companies

KOPO
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(612) 546-2590

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