Engineering Heritage Victoria

Guest Speakers' Series

Producer Gas …

& the

Australian Motorist

… an alternative fuel during the "crisis" of 1939-45.

A presentation to Engineering Heritage Victoria

Don Bartlett

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This talk has been researched and presented by Don Bartlett. It was first presented to Engineering Heritage Victoria (EHV) on 21 February 2008 as part of the EHV Guest Speakers' Series.

Due to time constraints, the version as presented did not contain much of the dialogue contained in this full text version. A video of the actual presentation is available for streaming at **http://ea.mediavisionz.com.au/vic/** Scroll down the page to find the Gas Producer Talk.

An audio version of this talk (MP3), the "*Show Notes*" and some of the historical references are available for download at **www.consuleng.com.au**

TITLE : **PRODUCER GAS & THE AUSTRALIAN MOTORIST**

An alternative Fuel during the "Crisis" of 1939-45.

1 INTRODUCTION

Anyone who legally drove a vehicle fitted with a Gas Producer in wartime Australia would now be in their eighties. There will not be all that many around with first hand knowledge of the use of these units. The purpose of this talk is to encourage discussion on this fascinating aspect of our not-so-distant past, in an effort to retain some of the anecdotal byways before the links with personal experience are lost.

This is not intended to be a dissertation on the theory of gas utilization in motor vehicles. There are many conflicting statements in the full chronology and it is not possible to explore or even to highlight them all in a talk of 45 minutes. Generalizations have been made in order to avoid unnecessary technical comparisons. However, every attempt has been made to present a balanced picture with the intent of promoting further discussion, revision and hopefully the inclusion of new material.

2 PRODUCER GAS

Producer Gas is a carbon monoxide rich gas, "comparatively" easily produced in useable quantities by "units" that were small enough to mount on a motor vehicle. I say "comparatively" because ease of use tends to be measured against the convenience or availability of alternatives. **Compared** to petrol, the use of producer gas is quite complicated.

In the years between the First and Second World Wars, technology, driven by demand saw considerable change in transportation methods. Perhaps unnoticed at first, reliance on liquid fuel increased steadily but was masked by the retention of the older forms of transport. Horses, carts, steam engines etc were still in widespread use up to the end of the Second World War.

Gas Producers came to the fore because, for several years during the Second Word War, the supply of petrol to Australian motorists was severely restricted. This was due in part to the war situation but also to currency restrictions and pressure from the British Government for Australian residents to be seen to be suffering rationing hardships as well[1]. The gas producer provided an alternative fuel supply where the other option was the enforced immobility of much of the national motor vehicle fleet.

Petrol rationing was introduced into Australia in July 1940. It was severe, restricting private motorists to about 40 miles per week although the effects were not immediately noticeable because the canny motorists had been "stockpiling". The ration was doubled in October because the authorities feared that forcing private motorists off the roads may result in members of the motor-trade being thrown out of work. The ration was reduced in Jan 1941 as the war situation became increasingly grave and in June 1941, the Prime Minister announced[2] that private motorists' rations would be cut to 1,000 miles per year. Many motorists put their cars up on blocks for the duration.

There were two primary obstacles to the public acceptance of producer gas.

- Firstly, the early entrants into the field found the supply and quality charcoal was unreliable. Word gets around! Eventually, the government found it necessary to take a significant role in the production of charcoal in an attempt to offset this view.
- Secondly, there was a deep suspicion that the "gas" would wear out an engine more quickly than would the use of petrol[3], that there was a significant loss of power and that Gas Producer Units were unreliable. The Government[4], aided by organizations like the RACV and the NRMA etc, undertook a significant national publicity campaign to overturn this view.

2.1 Some Terms Used

- A Gas Producer is a unit or plant that converts a solid fuel into a useable gas capable of being burned in an engine, to provide power.

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[1] Ref AWM Journal, http://www.awm.gov.au/journal/j36/petrol.htm

[2] AWM Journal at http://www.awm.gov.au/journal/j36/petrol.htm.

[3] This had a lot to do with poor quality charcoal, particularly that containing excessive sand and grit.

[4] In reality, both the Commonwealth and the State Governments were involved.

- In the context of this talk, a Gas Producer Unit (GPU) is a unit mounted on a vehicle.
- Charcoal is 90% carbon.
- One horse-power (hp) for one hour equates to about 2560 BThU[5] at 100% efficiency.
- 1000 BThU **per hour** equals 0.293 kW.

3 SOCIAL SNAPSHOT

At the time of Federation, the population of Australia was about 3.7 million.[6] About 1.2 million lived in Victoria and less than half of those lived in Melbourne.

In 1901, there were probably less than 100 motor cars and motorcycles on Australian roads. Registration of Motor Vehicles commenced in about 1910. Further details on the Social Snapshot can be found on Slide 5 in the "*GPU Show Notes*", downloadable at www.consuleng.com.au.

At the outbreak of the War, the State fleet consisted of :

- ☑ 150 000 private cars,
- ☑ 36 000 commercial vehicles,
- ☑ 47 000 primary producers vehicles,
- ☑ 400 buses,
- ☑ nearly as many registered traction engines,
- ☑ 360 000 Victorians held drivers licences,
- ☑ 421 people were killed in vehicle accidents during 1941 (60% in Metro Area).
- ☑ The fatality figures displayed a significant bulge in the 18-29 year old bracket

An indication of the extent to which Melburnians felt the bite of fuel rationing can be seen in the annual returns of the Melbourne & Metropolitan Tramways Board for 1940-41. They show an **increase in net earnings of 36%** for an increase of **only 2% in the "Tram Miles**" run![7]

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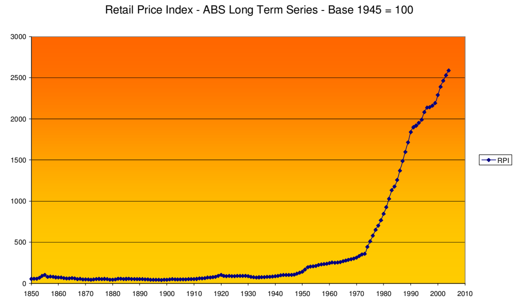
[5] **Erratum** : It was pointed out during the presentation that the correct term is "**BThU**" not "BTU" as was shown on the slides used for the presentation (and captured on the live video streaming). The text of this document and the Show Notes (Slides) have been changed to comply with convention. Also, Slide 4 in the presentation (as streamed) contained a transcript omission – watts and kilowatts relate to BThU **per hour**.

[6] ABS Yearbook 1989, p120.

[7] Victorian Yearbook 1941-41, p 188.



Other relevant statistics include :

- The minimum weekly wage in 1939-40 was about $10 per week.
- In 1920, petrol was 22^{d} per gallon ($1^{s}/10^{d}$).[8]
- By 1938 [9] it was 20^{d} per gallon.[10]
- Applying a Long-term ABS RPI to the 1938 petrol price translates to about $1.09 per litre in 2001 (actual was $0.93).
- Charcoal prices[11] in Melbourne in 1938 were 16^{d} per 50 lb bag.
- Charcoal in 1940 had risen to 18^{d} per bag.
- Tests in 1938-39, indicated savings in the order 80% for truck operations for producer gas over the cost of petrol.
- In 1938-40, a gas producer unit for a passenger vehicle cost about £45 - £70 per unit.
- At the time, a new car, if you could get one, cost around £250 for an Austin and £525 for a Buick.

4 THE CHEMISTRY

Oxygen will combine with carbon (C) to form two different gases – carbon dioxide (CO_2) and carbon monoxide (CO).

We are interested in the production of carbon monoxide. It is combustible (and explosive), odourless, colourless, highly poisonous – indeed it is nasty stuff and very dangerous. That we ever had a government encouraging its widespread use and a population somewhat eager to embrace the

[8] "*The Application of Producer Gas to Motor Vehicles*", Rennie, Edward James Cadell. ME, Assoc Member of IE Aust in the Transactions of the Institution of Engineers (Aust), 1930, p 108.

[9] *Producer Gas Vehicles*", Woods, Macdonnell Watkyn, D Phil (Oxon), BSc, BE in the Transaction of the Institution of Engineers (Aust), 1938, p96.

[10] This is about 3.67 cents per litre. Based on the Avenora Retail Price Index, changes would take that to about $1.09 per litre in 2001 as against an actual price of $0.93 in Jan 2001.

[11] Woods, IE Aust March 1938, p96.

habit of making the stuff in the back of the car and indeed carting the whole "factory" around with them, is a sign of the moment.

The chemical composition of wood varies only marginally between most species. It contains about 50% Carbon. Charcoal contains around 90% Carbon and is made by heating wood in an atmosphere lacking oxygen – in this case, in a kiln where normal air is excluded. We will go into the Charcoal production process in a moment.

4.1 Producer Gas

Producer Gas contains carbon monoxide as the working gas. It is made by passing air through a core of glowing charcoal at normal atmospheric pressure.

- ☑ The temperature of the core[12] should be above 900 degrees Celsius (or else you just get Carbon Dioxide)
- ☑ The temperature can be as high as 1920 degrees Celsius.
- ☑ The temperature of the gas as it leaves the unit is about 700-800 degrees.

Producer Gas is a mixture of gases – mainly Nitrogen (N_2) and Carbon Monoxide (CO) in the ratio of about 2:1.

Keep in mind that for each unit of oxygen used in the process, four times as much nitrogen (by volume) joins the party. Being totally inert, the nitrogen passes along to the engine. As air, again containing four times as much nitrogen as oxygen, must be taken in at the engine to make a combustible mixture with the carbon monoxide, nitrogen become responsible for a double-dilution of gas volumes. This is a significant cause of the loss of efficiency in engines powered by producer gas.

4.2 Water Gas

When a mixture of steam and air is passed through glowing charcoal, we get a kind of "Water Gas" (N_2, CO, H_2). Superficially, this is not a bad deal - two useful gases from two inert substances - carbon and water. However, we only get steam by heating water. Overall, the production of *water gas* takes heat out of the system.

Because charcoal contains some moisture, in practical terms, there is a component of water gas in a simple producer gas system. But if there is too much moisture in the charcoal and no excess of heat to "convert" it, we again have problems. The gas production process stops.

[12] Largely determined by the "suction" of the engine.

There was a further variation to the water gas method achieved by spraying crude oil (also sump oil) into the "thermal cracking chamber" during the steaming cycle. The method is covered in theory but there appears to be no evidence of the method being in widespread use in Australia.

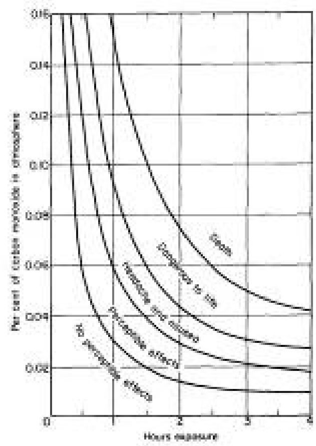
For optimum operation, water should be at the rate of 1 drop per second for each horse power (hp) that the engine **<u>is developing at the time</u>**. However, the hint of trouble comes from the term "developing – at the time." This implies the need to constantly adjust the water flow as the engine load changes or the added water will extinguish the gas production process.

In general, it would appear that the use of water gas was seen as an unjustifiable complication of the producer gas unit and its controls.

4.3 Dangers

Carbon-monoxide is an odourless, colourless gas.

- It has perceptible effects on humans at concentrations in the air as low as **0.01%** and
- is dangerous to life if exposure continues for about 1 hour at concentrations of only **0.1%**.
- Its explosive limits in air are between **12.5% and 75%**
- (compared to Propane at **2.4% – 9.5%**).



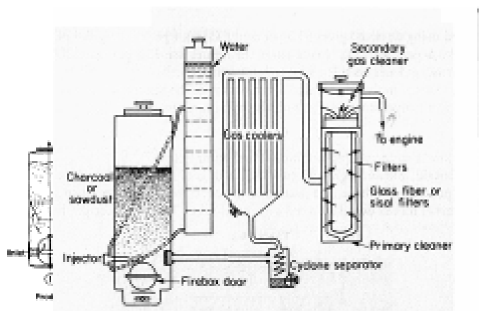
Effects of carbon monoxide for a given time on human beings. [Data from Bureau of Standards Tech. Paper 212.]

5 GPU COMPONENTS

The layout of the GPU varied enormously but in general, they were roughly 900-1200 mm wide and about 900-1200 mm high. By regulation, the unit was not to protrude more than 4 feet either side of the centre line of the vehicle.

The basic components are :

- Hopper : (or Producer or Retort) which is an airtight container in which the charcoal is stored and burned.
- Radiator : to cool the hot gases and
- Filter : (or scrubber) to clean the gas before it enters the engine.



GAS PRODUCER UNIT - WATER INJECTION

The weight of the typical GPU was between 400-500 lbs (empty) for a passenger vehicle unit. Add another 50-100 lbs for the charcoal.

5.1 Types of Units

There are three basic types of GPU, classified according to the direction of flow of the gas through the hopper. They are :

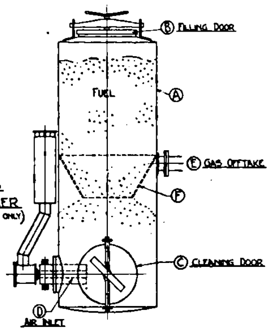
- Updraught Units which draw air upwards through the charcoal (usually heavy units and have an extensive vertical combustion zone).
- Downdraught Units which draw air down through the charcoal (good if using tarry charcoal because gravity tends to hold the "muck" in the base of the hopper.
- Cross-flow types take in air through a nozzle (called a tuyere) in the lower side of the unit and drawn off on the other side – slightly higher (quick start-up and flexibility of gas demand).

For simplicity, this talk tends to use a *cross-flow* system as the typical example. The basic principles remain the same regardless of the configuration of the gas flow.

5.2 Hopper or Retort

The hopper was usually made of sheet steel about 3 mm thick and large enough to hold at least a bag (50 lbs) of charcoal. Some units (particularly earlier versions) had refractory lining but this added significantly to the weight.

FIG.3 PRODUCER (DIAGRAMMATIC ONLY)



There was an opening at the top of the hopper into which the charcoal was poured. It was fitted with an airtight lid (asbestos rope of course). There was an arrangement near the base for cleaning. Air entered through a restricted opening on the side.

The charcoal burns near the point where the tuyere ends – usually around the middle of the lower portion of the hopper. We can call this the "combustion zone" – not all of the charcoal in the hopper is alight at any one moment. The size of the combustion zone is self regulating (according to the demand for gas from the engine) and is indicatively a spherical zone about 200-300 mm diameter. As the charcoal is burned, the action of the vehicle moving along the road shakes the unburned charcoal down the hopper and replenishes the fuel in the combustion zone.

Residual heat rises through the hopper and conditions the charcoal above – this includes drying wet charcoal with the consequent production of a quantity of water gas (not always desirable).

There were many types of air inlets (tuyere), some having water cooled outer jackets and others being made of ceramics. In the simplest form a tuyere is merely a piece of steel pipe of about 30-50 mm diameter and long enough to reach from the outside to the middle of the Hopper (ie reach to the combustion zone).

5.3 Radiator

The gas is very hot when it leaves the Unit – about 700-800 degrees Celsius. It needs to be cooled. Cool gas is denser than hot gas thus, more can be packed into the engine cylinders at each intake stroke of the piston. The radiator is merely a simple heat exchange device that takes heat out of the gas by transferring it to a cooler medium – in our case, the ambient air. No chemical change takes place although cooling will cause condensation of vapours (including tar and water). It was advisable to place the radiator before the filter to avoid burning the filter material.

5.4 Filter

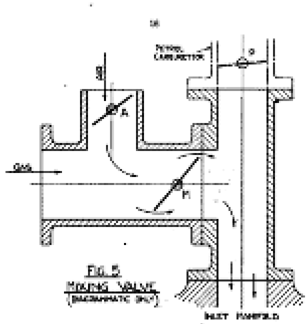
Various types of filter were used. Some used water, some used oil, and some were mechanical types (cyclones) along with variant combinations. In the simplest form, a filter could be just a wad of sisal or felt (or both). Filters had to be kept clean and, if made of felt, had to be kept dry.

Primarily, filters were to remove particulate matter (dust, grit, clinker etc) but could also be clogged up by condensed water and tars. Indeed, some authorities cautioned that if a motor was to be rebored for use with producer gas, the tolerances should be increased by 30% to allow for the tackiness imparted to the oil from the traces of tar still contained in the gas when it gets to the engine.

5.5 Conduit

A pipe or hose leading from the GPU to the engine was needed to carry the gas. A combination of seamless steel tubing of about 2" diameter was used with rubber tubing for the bends. Since this type of piping has a cooling effect, it was advisable to put drain plugs in the low spots of the conduit.

5.6 Mixing Valve



A mixing valve and gas flow controls were mounted between the Carburettor and the Inlet Manifold. Configurations varied of course but in general, it was essential to have one valve (a butterfly valve) to close off the supply of petrol when the supply of gas was adequate to power the engine. In addition, most systems allowed for the adjustment of the air - gas mixture with the use of another set of butterfly valves. It was essential to have a tap fitted to the fuel line so the driver could turn off the petrol to the carburettor when the vehicle was running on gas.

5.7 Blowers

Some units were fitted with small hand operated blowers to provide an initial flow of air through the hopper to assist in cold starting. Electric blowers were also available. If a blower was used while the engine was stationary, there was a significant risk of carbon monoxide entering the vehicle.

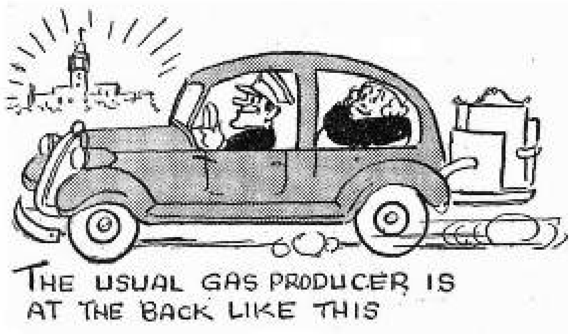
5.8 Flame Trap

Gas Producer Units suffered the odd "blow-back". Regulations were introduced that required all units to have a flame trap on all air inlets to the system (essentially at the outer end of the tuyere). The flame trap had to be at least 15 inches from the fire in the generator and the mesh made from a non-ferrous metal.

Any opening in the unit (including the filler and grate) had to be more than two feet from the petrol filler or car windows.

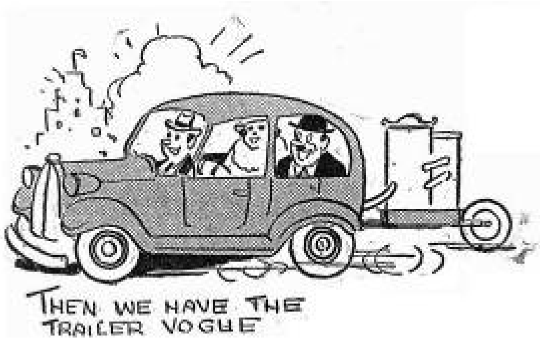
After a serious outbreak of summertime bushfires caused by faulty or irresponsible operation of gas producer units, regulations were introduced that prohibited the indiscriminate dumping of burning ash on the sides of roads.

6 MOUNTING ON VEHICLES



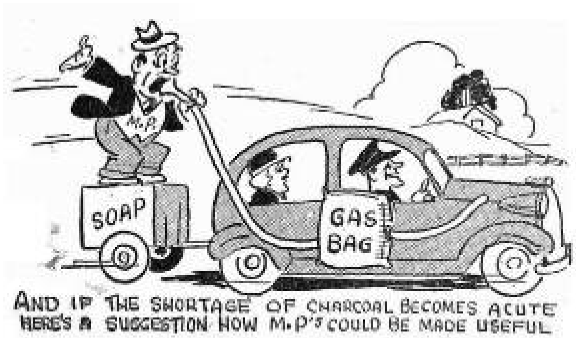
In the conventional case, the GPU was mounted on the rear of the vehicle. Some rear mounted versions were hinged on one side to allow the unit to be swung out of the way for access to the boot.

Usually, trucks had the units mounted on the side, behind the doors. A mounting forward of the radiator was available and sometimes on either side of the cabin, forward of the doors. The use of GPU's in the trucking fleet appeared to be quite widespread and was an enforced government policy within its own fleet (eg Forest Commission, Tramways and Victorian Railways etc).



One and two wheel trailer arrangements were used and provided some additional space for spare fuel. The one wheel trailer was favoured because it was easier to park.

But for all round efficiency, …



… an endless supply of natural gas could be tapped from your local MP[13]!

Cartoon sketches courtesy of the "*The Radiator*", RACV, 1941 and were concurrent with a campaign to get a greater level of public acceptance of the use of Gas Producer Units.

[13] Sketches courtesy of the RACV Archives.

6.1 Other Uses for Producer Gas

The Victorian Railways operated many trucks in their fleet on producer gas. In addition, several Rail Motors and Rail Cars were converted to gas. One such vehicle is presently being restored at the Workshops of the Daylesford Spa Country Railway. The picture is of a VR AEC Rail Motor[14].

We know of at least two motor cycles converted to run on producer gas. Graeme Tibbett built a gas producer unit for his Harley Davidson, using bits and pieces, including the aluminium sugar bowl from his mother's kitchen. He rode that machine to work daily until the experiment came to an untimely end in Elizabeth Street Melbourne.

Tractors were (and some still are) run on producer gas. Producer gas was used for pumping water in the irrigation areas - a fascinating topic in its own right.

In 1939, a Bentley fitted with a gas producer raced at Mt Panorama. At about the same time, a road race for cars powered solely by carbon monoxide gas was conducted in the Perth suburb of Applecross.[15]

Producer Gas engines were installed in Power Stations in places like Rushworth, Hamilton and Coleraine where there was an abundant supply of local wood. In these cases, the gas produced was technically "wood gas", the charcoal being formed as a short-lived phase in the burning process inside the retort. These units were cheap to operate because of the local fuel and were often used for the base load or night-time generation – diesel units being held *on standby* for peak loads.

During the War, 17 MMTB petrol engined buses ran on compressed town gas held in steel cylinders.[16] The cylinders held just enough for the bus to do a return trip from the Clifton Hill Cable depot to Point Ormond. Some buses also ran on town gas stored in large bags carried on the roof. In the UK, buses towed producer gas units on trailers. In France, the GPU was fitted inside the buses.

[14] Photo of VR AEC Rail Motor and other VR Vehicles with GPU are by courtesy of Michael Schrader.

[15] For some reason, Perth seemed to develop as the GPU Capital of Australia. "*J. of the Classic & Historical Automobile Club of Aust*" – July 2006, Vol 41, No 1.

[16] Michael Schrader documents.

7 HISTORY

About a year ago, I picked up a copy of the Motor Traffic Act, 1909 (as Amended). That Act had been through quite a few amendments because its issue date was 1953. However, what surprised me was that it still contained regulations relating to the operation of "Producer Gas Vehicles". I thought that by 1953, Gas Producer Units would have been merely an unpleasant memory to most motorists. Sometimes it takes a while for the law to catch up! However, that fleeing moment of "curiosity" – along with input from numerous others - eventually produced the mass of material from which this talk has been developed. It has been an interesting research project and at every turn, one can only be impressed with the diligence and persistence of the motorists, the engineers, the mechanics, the bureaucrats and the pure "backyarders" who implemented and improved the process. Equally impressive is the trail of paperwork covering legislation, wartime supplies, pure research, testing and of course, documentation. Very little was left to chance. Regulations soon multiplied to meet the need.

Early developments in producer gas technology commenced in Europe.

7.1 Europe

- 1839 : Bischof (a German Chemist) developed the first known gas producer unit.
- 1857 : Siemens Bros are credited with an early GPU.
- 1860 : Lenoir (a French-Belgian engineer) invented the first successful gas engine. It operated on coal gas.
- 1862 Dr Jacques Arbos of Barcelona invented the first Suction Gas Producer.
- Sometime before 1872, a German Engineer, Paul Haenlein developed the first dirigible airship. He was also a pioneer of flight and his airship was powered by a Lenoir type gas motor.
- In 1901, the first gas producer driven vehicle was reported to have been built by JW Parker in the UK.
- During the 1914-1918 war, producer gas technology had not progressed to the point where it was considered as a substitute for petrol.

7.2 Rennie

In 1930, EJC Rennie ME[17] presented a paper called "The Application of Producer Gas to Motor Vehicles" at a meeting of the Melbourne Division of the Institution of Engineers (Aust). He dealt mainly with technical considerations of the application of gas to motor vehicles and tractors. Results of bench tests were given. Rennie concluded that gas powered vehicles were practical where work consisted of long runs, charcoal was cheap and petrol was dear.

The date of his paper (1930) suggests that it was prepared as a consequence of the effects of the Great Depression and freight transport costs in remote areas. He noted that the weight of the GPU was a **significant** addition to the gross weight to the vehicle. He cited options to fit modified cams to increase the valve lift, raising the compression ratio, supercharging or fitting a larger engine.

His paper detailed Gas Producer Units (mainly European) that were somewhat more complicated than the generally simple and basic units popularised a decade later. It is also clear that vehicles fitted with GPU's were in use on Victorian roads at that time. Guy Motors Ltd was one such company quoted. The firm conducted tests and concluded that operating their truck on producer gas cost about one quarter that of using petrol.

Rennie also suggested that the added controls needed for producer gas operation would require "*a little more skill*" when driving, compared to a petrol powered vehicle.

7.3 Woods

In 1938, Macdonell Watkyn Woods[18] delivered a paper to the Melbourne Division of the Institution of Engineers (Aust) entitled "Producer Gas Vehicles". His paper was a review of recent developments in the application of producer gas plants to motor vehicles in France, Germany, Italy and England. Clearly, the clouds of war were gathering because he mentions the possibility of military weakness caused by lack of fuel supplies in his opening paragraphs. He presented an outline of typical "plants" and gave notes on the performance of producer gas powered vehicles. It is also evident that developments had simplified the layout and fabrication of gas producer units in the decade since Rennie.

Woods noted the similarity between France and Australia in terms of their reliance on imported petroleum. He noted that France had a charcoal burning industry with a history of several hundred years while there was no such expertise in Australia.

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[17] "*The Application of Producer Gas to Motor Vehicles*", Rennie, Edward James Cadell. ME, Assoc Member of IE Aust in the Transactions of the Institution of Engineers (Aust), 1930.

[18] "*Producer Gas Vehicles*", Woods, Macdonell Watkyn, D Phil (Oxon), BSc, BE in the Transaction of the Institution of Engineers (Aust), 1938.

At the time of delivering his paper, Woods was a D Phil (Oxon), BSc, BE. Woods was a Student member of IE Aust, a Rhodes Scholar (from Tasmania), Commonwealth Research Fellow of the Engineering School, Melbourne University and worked under Prof Burstall. Woods was eventually awarded an OBE and died 1981. He appears to have been involved in the Aeronautical Research Laboratories (ARL) during and after WW2.

7.4 Department of Defence

In August 1939, the Directorate of Mechanization (Army Head-Quarters, Department of Defence - Melbourne) issued a very comprehensive 55 page booklet entitled "Producer Gas Vehicles". They were clearly promoting the use of producer gas and they could, with the value of historic hindsight, have been taking part in a well orchestrated public relations campaign. The report included the statement by Col TR Williams :

> … *"It may be necessary to change down a little earlier on hills, but, generally speaking, there is little difference in the overall time of a journey whether the engine is petrol or producer gas operated …".*

This is a bit of a glib comment, with which many would not have agreed!

7.5 Council for Scientific & Industrial Research

In 1940, the CSIR published the results of some hurried research into the suitability charcoals made from Australian Hardwood Timbers.[19] They tested 33 samples of commonly obtained charcoal and noted that these had been produced by commercial burners using the "timber" most readily available in their local district. The Commonwealth Department of Supply had earlier issued a provisional specification for Wood Charcoal. The CSIR analysed the commercially bought charcoal against the Department of Supply Standard - and recommended modifications to both.

They reported little difference in the calorific value of any of the various tree species tested. The difference was almost entirely due to the method of burning. Kiln burned "Red Ironbark" gave the highest value (13 820 BThU/lb), most (including Red Gum) were around 13 000 BThU/lb and the lowest (Turpentine) was 12 030 BThU/lb.

By way of comparison, the calorific value of 1920 Vintage petrol was about 19 000 BThU/lb.

[19] Photo from AWM Collection at http://www.awm.gov.au/journal/j36/petrol.htm

7.6 The Cash Book

Probably the best known text on the use of producer gas was written by John & Martin Cash of Kew, Victoria. Called "Producer Gas for Motor Vehicles" it was published in 1940. The stated aim of the book was to contribute to the solving of Australia's war-time transport problem. It offered factual information for the enlightenment of "*engineers, garage-men, students and experimenters*" as a form of protection against the "*extravagant claims of over-enthusiastic salesmen*". It has survived as the definitive bible on the techno-practical side of producer gas.

Some points from the Cash book are :

- Fuel consumption is between 0.8 and 1 lb of charcoal per brake horse power (bhp) hour.

- The GPU is effective without the addition of water or steam. Indeed, the introduction of either can complicate the operation for the average motorist. Although water does increase the power and decrease the cost, it takes heat from the system, which is not always a good thing.

- The GPU is an inconvenient, bulky and in most cases, unsightly piece of apparatus but you must balance your prejudice against the fact that it enables you to move around.

- When using producer gas, there is a loss of efficiency in the system due to the cooling of the gas and the losses in the engine. In general, the producer gas system is only about 25% efficient and thus about 10 000 BThU are required to produce 1 horse-power.

7.7 Authorities & Associations

The Forest Commission of Victoria was made the lead Authority for the production of Charcoal from a very early stage in the War. They took a strong position in favour of the use of Gas Producer Units.

Other groups included :

- The Liquid Fuel Control Board.

- State Producer Gas Committee.

- Victorian Government Motor Transport Committee.

- Gas Producers Association : a group of manufacturers of GPUs.

- Royal Automobile Club of Victoria did considerable work in encouraging motorists to use producer gas. They ran reliability trials and conducted a significant campaign to publicise the results. They too produced a booklet on the operation of the GPU on (mainly) passenger vehicles. Thrift was an avenue pushed consistently and not only by the RACV. One such article referred to a trial made in a Club owned roadster. The vehicle had covered "*45 000 miles on petrol with a valve grind 30 000 miles previous to the conversion". The article went on to relate that " …laden with a producer unit of $1^3/_4$ bag capacity, the boot crammed with amplifying equipment and luggage, the overflow of luggage and equipment stacked behind the rear seat*' (it was a roadster), "*three spare bags of charcoal lashed to the guards and carrying three passengers, the vehicle weighed 35½ cwt – 14½ cwt in excess of normal*". … … "*Not withstanding the widely publicised maximum power loss inherent to producer gas operation, the engine handled the extreme load excellently*" … with speeds up to 50 mph (60 mph with the help of a tail wind). They must have been up north of the state because they hit an emu!

8 OPERATION OF GPU

8.1 Start Up

From an Oral History interview with Graeme Tibbett :

"Firstly check the charcoal and top up the hopper. Lock down the lid. Turn on the petrol".

In Tibby's case, there was a one gallon can on the firewall containing petrol and the normal petrol tank was filled with power kerosene.

"You turned the (small) petrol tank on and filled the carburettor with petrol. You started the engine on petrol and got it running but before the carburettor ran out, you turned over to kerosene. Now the car was running on kerosene although it really needed to be hotter than just off a fresh start. However, it would run – and you were saving precious petrol. Then adjust the choke and the throttle so that it was idling fairly fast. Next, you "cracked" open the butterfly valve in the mixer unit to start to draw air through the GPU at the rear of the car".

At this stage, two or three minutes had passed.

"You then went to the Hopper where you had a tin with kerosene and a wire with a piece of rag attached to the end. You dipped the rag in the kerosene and lit it. Then, you poked the whole thing down the tuyere. Because the motor was running and the mixer butterfly was very slightly open, there would be a vacuum in the conduit to the engine. This sucks the flame from the burning rag into the charcoal and almost immediately, the charcoal would catch fire. Then you stamped out your bit of rag and put it back for use next time. Returning to the driver's seat, for the next four or five minutes, you fiddled around with the choke, the throttle and the gas valves. You kept on altering things until

you got to the stage where the engine would run on gas at which time you turned off the kerosene supply and let the carburettor run out".

You were then running on gas - after about 10-12 minutes.

8.2 Driving

It is easy for the present generation of drivers, attuned to modern vehicles where electronic gadgets abound, to be ignorant of the simple facts about pre-war - and even many post-war vehicles. Automatic transmissions were rare. Synchro-mesh gearboxes were not common either.

When slowing down for an intersection or when stopping, it was usually necessary to manually adjust "the spark". You were required by law to extend your right arm out the window and wave it up and down like a wounded albatross to warn other motorists of your intention to reduce speed.

Stop lights at the rear were optional but in effect, you were still required to signal your intention to stop, by holding your arm out the window with your elbow bent upwards to 90 degrees and the palm of your hand opened forward with the fingers, all of the fingers, pointing up. A right-turn indication was also mandatory and was made with the unbent arm extended straight out of the window. The stop or turn signal had to be given continuously for at least 100 feet before the stop or turn.

I mention all of this, not in an attempt to be humorous but because many drivers on the road toady would not have experienced that type of motoring. It needs to be understood in order to comprehend the conditions in which the gas producer system operated. As the vehicle slowed down for the intersection, in addition to spark adjustments and hand signals, the driver had to use the left hand to make the gear shift – invariably, the gear lever was mounted on the floor. With one hand out the window and the other on the gear shift, there was not much left to steer the vehicle – although the law said that you must have effective control of the vehicle at all times!

Meantime, your feet were moving rhythmically on the clutch and accelerator as gear changes required the now forgotten art of "*double de-clutching"*. Then there is the added complication of the producer gas controls. In Tibby's words, "*you just played with all of the controls (choke, throttle, butterflies etc) at your disposal until you got things going OK"*.

One contemporary report suggested that "*bare feet, prehensile toes and experience at the Wurlitzer organ could be a distinct advantage*".

Before entering the intersection, you had to ensure that the gas flow was adequate and, if on water injection, that the setting was appropriate for the load on the engine. Then of course, there were the other motorists going through the same ritual and approaching the same intersection.

If it was night-time and near the coast in 1942, there was the added hassle of the blackout. There were no street lights and your headlights (poor enough anyway by modern standards) had to be masked to allow only a narrow slit of light to the front.

As I said at the outset of this talk, **relative** & **convenience** are the operative words. Life as a motorist was tough enough without the added complications of the 500lb GPU hanging out the back. On the other hand, don't forget that using a gas producer in February 2008 would mean an effective fuel price of about 28 cents per litre[20].

8.3 Parking & Garaging

Particularly in country towns, cars powered by gas producers were often left running outside shops while the driver and passengers went shopping. Stop-start motoring was not easy!

The Motor Traffic Act imposed quite stringent requirements on flaring off before leaving a vehicle unattended – due to the risk of carbon monoxide poisoning and the potential for explosion in enclosed spaces.

It was necessary to flare off residual gas before you returned the vehicle to your "motor house" at the end of the journey. You just stopped outside, opened the lid of the hopper, stood back and threw in a lighted match, then pushed your pride and joy into its shell!

8.4 Servicing & Refuelling

Refuelling was necessary every hour or so on trips. When opening the hopper of a heated gas producer, it was wise to stand back - and to windward.

It was acknowledge that maintenance was more time consuming than for petrol or diesel but not as difficult as the detractors would have you believe

Daily Maintenance

- ☑ Clean the combustion chamber and gas hopper.
- ☑ Clean the tuyere (also necessary during the day if using high clinker fuel).
- ☑ Keep all ports tightly closed.
- ☑ Check for leaks at joints – with a flame. If the flame is drawn in, there is a leak!

600 Mile Maintenance

- ☑ Clean the exterior (polish if a military vehicle).

[20] Using the Woods projection of an 80% saving over petrol – for a truck. The present cost could be considerably less due to excise levels and other taxes on present day fuel.

- ☑ Empty the ash hopper
- ☑ Brush cooling tubes.
- ☑ Clean the filter block etc.

<u>Every 1000 miles</u>, empty the hopper and clean the combustion chamber.

8.5 <u>Troubleshooting</u>

The Department of Defence booklet gave detailed advice on "trouble shooting," including advice to check the charcoal level in the hopper if your car mysteriously runs out of power. After that, wet charcoal and clogged filters were the usual suspects.

9 <u>THE MANUFACTURERES</u>

In addition to those motorists who made their own, there was a proliferation of companies making Producer Gas Units for cars and trucks. Here are some :

Ford Australia – Ford V8 with gas producer fitted in the Body-work (Exhibited at the Melbourne Motor Show 1940). Ford eventually dropped out of the GPU field, apparently feeling that the use of GPU's was not being fully supported by the Government and thus saw little commercial opportunity.

The "Precision Built" Electrolux Gas Producer (see photo on right). Sold by Neale Motors Pty Limited, 140 Exhibition St Melbourne for £42/10/- with an optional electric blower unit for a further £10.

Alan Coffey Auto Service of 334 William St, Melb were selling "Fleetway" Gas Producers for trucks at £69 each – with immediate delivery.

HSG (High Speed Gas).

Powell Gas Producers (Perth).

Lange Gas Producer Plants.

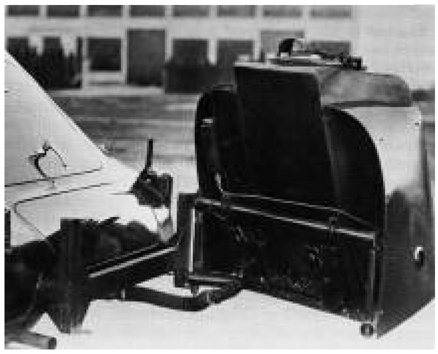
Fleet Forge Ltd (Lorimer St, S Melb).

French Gas Producer Plants include Panhard, Berliet Generator, the De Dion-Bouter Generator, the Gohin-Poulenc Generator and the Sabatier-Decauville.

Malcolm Moore Ltd.

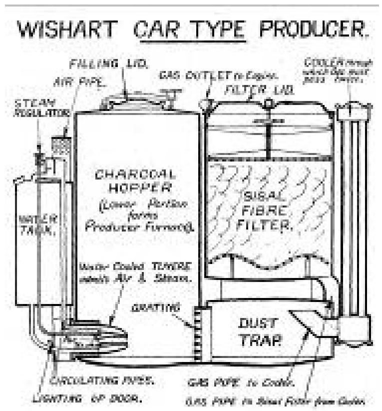
WR Humes Ltd.

The *Incomparable* "**Brig**" Gas Producer from Alan Coffey (Melb) – ***allegedly***, **<u>not</u>** stopped by wet charcoal (see advert on right). They claimed that the "Brig" had not only solved the rationing problem but "*has come to stay, regardless of the Price or Availability of Petrol*".



Smith Suction Gas Plant (Backhouse Ltd, Adelaide).

McGregor Engineering Co Pty Ltd of West Melbourne.



The Grieg Gas Producer (Power Gas Co Pty Ltd of Melbourne).

NASCO (GMH) produced Units. This photo (right) from the La Trobe Library collection demonstrates the side hinged version to allow boot and spare tyre access.

Pederick (Cheney Pty Ltd).

A large group of early pioneers of the system – mostly DIY Enthusiasts. Many held jobs where welding and metal forming could be done "out of hours". From about 1941 onwards, all GPU's had to have a compliance plate affixed. This measure was introduced to put a stop to allegedly shoddy workmanship. It may also have come from the lobbying of the GPU Manufacturers Association.

Wishart Car Type Gas Producer (Blackburn, Victoria). They were manufacturing units before 1938 and had developed an ingenious automatic device to control the amount of water added.

10 <u>CHARCOAL</u>

One authority states that the ***<u>ideal gas producer fuel</u>*** *would be:*

- ☑ a compact fuel with free burning qualities,
- ☑ free from dust,

- ☑ regular in size,
- ☑ giving a rich gas free from tars and injurious products,
- ☑ should not "coke" the generator,
- ☑ should not absorb water,
- ☑ should not soil the clothes,
- ☑ should not have an offensive odour…..

No such fuel existed. Certainly charcoal met few of these criteria. If not stored well away from moisture, it will take up more than its own weight in water. It was, and still is, dirty stuff. Soil and sand from the burning process was a significant threat as this became unwanted clinker (silica) in the retort and was of course highly abrasive if any got through to the engine. One passenger is quoted as saying that she "*left Adelaide a platinum-blonde and arrived in Melbourne a dusky brunette*".

The closest then available to the ideal fuel was *briquetted charcoal*. Known in France as "*carbonite*" it was available in limited quantities in Australia. Carbonite is made from wood chopped into small pieces and distilled with the recovery of the tars and acids etc. These are then treated and used as the binder for the charcoal briquette. The yield is 700 lb of carbonite from 2240 lbs of a (French) pine.

10.1 <u>Charcoal Production</u>

Charcoal is produced by burning wood in an atmosphere from which air can be excluded.

There are a number of different types of kiln, examples are :

- Beehive & Heap Kilns are "one-time-only" structures, "built" on the ground to a height of about 8 feet. Graded lengths of wood are stacked on the ground, usually around a formed central chimney. Each contained about 50 cords[21] of wood. The external surface is covered with earth, sand, corrugated iron etc. The heap is set alight and when properly burning, the free entry of air is stopped by covering the openings with earth, sand etc. Pit Kilns are much the same but are contained within the ground. The fire buns for 1½ - 3 days before quenching with water, tamping and cooling for a further day or so. The charcoal in the middle is not too bad but the charcoal on the outer surfaces is likely to be contaminated with soil and sand which must be filtered out of the gas stream before it gets to the engine.

- Brick Kilns were purpose build and capable of producing good quality charcoal. Absence of contact with soil and sand is a positive factor. About 12 days are required to complete the cycle of charging, burning, cooling and discharging.

[21] 1 cord of wood is 128 cubic feet – as stacked (with air voids).

- Metal Kilns are readily assembled and easily transported. Humes Ltd made several models. An 8 foot diameter, 10 foot high unit with ¼ inch steel plate cost £77/10/- ex works (August 1940).

- 44 gallon drums could be used. This was a common Backyarder and Cockies method. Produced charcoal in about 24 hours. Quality varied enormously.

- The RACV published instructions on how to use a 44 gallon drum to make your own charcoal. … "*first, take any old oil drum*!"

- The Department of Defence noted that "any wood will do, but the most suitable is box, red gum and bull-oak as these woods contain less ash".

Along the Murray and other rivers, the Forest Commission ran charcoal production facilities using local red gum. There are anecdotal reports of the use of Internees and Prisoners of War being allowed a reasonably relaxed life in return for a reasonable output.

The Kurth Kiln near Gembrook was built by the Forrest Commission of Victoria in 1941. Designed by Prof Ernest Kurth of the University of Tasmania, it was one of a number of State Government initiatives to overcome the wartime energy crisis. Kurth Kiln and kindred FCV operations eventually produced about 1000 tons of charcoal per month (in addition to the commercial and DIY operators). The Kiln is supported by the Friends of Kurth Kiln having been preserved and is in the process of further restoration. It is well worth a visit.

10.2 Other fuels

Coal, Coke, Peat and Wood are amongst a large number of substances that can be used to produce gas. Towards the end of the War, wheat was widely used and yielded acceptable results. In 1942, MJ Martin, a Melbourne Engineer developed a system to overcome some of the difficulties of wheat as a fuel. Today, cane trash and even bananas can be used to produce gas!!

The Shell Oil Co produced Shellkol (85% petrol and 15% alcohol) and commenced an oil extraction operation from oil-bearing shales at Glen Davis in 1937.

Cumming Smith (Sickle Brand) had a wood distillation operation at Britannia Creek (Warburton) during the First World War. It produced formalin, acetate, wood spirit, tar and creosote oils – plus charcoal. It was closed in 1925.

11 CONCLUSION

The fuel crisis in Australia eased as the Japanese were forced from the Pacific. Some historians suggest that there was no fuel crisis in the first place. Such statements are perhaps easily made with the clarity of hindsight.

At the end of the war, Australians' expected the rationing of fuel to end. However, the Commonwealth Government, under currency pressure from the British Government, used its powers under the Defence Act to retain rationing but increased the allowance for private individuals to 180 miles per month (3500 km per year).

By February 1946, the government was selling (or trying to sell) its holding of second-hand GPU's. The rationale was that removing the units from the vehicles and running on petrol would not wear out the governments motor-car engines as quickly as did producer gas. This was quite different to what they were saying in 1939-40. In true "Yes Minister" style, "Sir Humphrey" went on to explain how … *discontinuing the use of the units on government vehicles would mean less demand for new cars and result in lower imports. Of course, this would help relieve the national currency problem, assist the balance of payments and it was surely the responsibility of governments' to show the way, etc, etc*!

Rationing was finally abandoned after a High Court Decision in June 1949.[22]

Wood Gassifiers for automobiles as well as power generation are still manufactured in Singapore, China and Russia.

Engineering Heritage Victoria conducts an Oral History program. One of our aims is to record interviews (brief or otherwise) with people who have professional knowledge or personal experiences that they might never commit to writing but would like to have preserved. If you are, or know of, such a person, please consider making contact with us to discuss options.

Contact re Oral History or Comments about this Talk can be made through Engineers Australia, Victoria Division Office, 21 Bedford St North Melbourne, 3051, Victoria or

Email : **heritage@consuleng.com.au**

[22] See AWM Journal at http://www.awm.gov.au/journal/j36/petrol.htm

12 CREDITS

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Allan Bell	Anon….*(for anyone I have overlooked)*

13 REFERENCES

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Further details relating to references and other material can be obtained by contacting heritage@consuleng.com.au.

Additional photographs and illustrations not used in the Presentation can be found in the "*GPU Show Notes*" which are downloadable at www.consuleng.com.au.