Wood gas generator

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A **wood gas generator** is a gasification unit which converts timber or charcoal into wood gas, a syngas consisting of carbon monoxide, hydrogen, traces of methane, and other gases, which - after cooling and filtering - can then be used to power an internal combustion engine or for other purposes. Historically wood gas generators were often mounted on vehicles, but present studies and developments concentrate mostly on stationary plants.

Wood gasifier on a Ford truck converted to a tractor

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Gasification had been an important and common technology which was widely used to generate Town gas from coal mainly for lighting purposes during the 19th and early 20th century. When the first stationary internal combustion engines based on the Otto cycle became available in the 1870s, they began displacing steam engines as prime movers in many works requiring stationary motive power. Adoption accelerated after the Otto engine's patent expired.[*when?*] The potential and practical applicability of gasification to internal combustion engines were well-understood from the earliest days of their development.

In 1873, Thaddeus S. C. Lowe developed and patented the water gas process by which large amounts of hydrogen gas could be generated for residential and commercial use in heating and lighting. Unlike the common coal gas, or coke gas which was used in municipal service, this gas provided a more efficient heating fuel.

During the late 19th century internal combustion engines were sometimes fueled by town gas and during the early 20th century many stationary engines switched to using producer gas created from

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coke which was substantially cheaper than town gas which was based on the distillation (pyrolysis) of more expensive coal.

In about 1920 French inventor Georges Imbert created the "Imbert" downdraft generator.

During World War II gasoline was rationed and in short supply in both Great Britain and in the United States and large numbers of such generators were constructed or even improvised to convert wood and coal into fuel for vehicles. Commercial generators were in production before and after the war for use in special circumstances or in distressed economies.

Post WWII [edit]

The US Federal Emergency Management Agency (FEMA) published a book in March 1989 describing how to build a gas generator in an emergency when oil was not available.

Saab 99 running on wood gas in Finland. The gas generator is on the trailer.

A project about the energy future of Europe was begun in 2005 in Güssing, Austria with contribution of European Union research furtherance. The project consisted of a power plant with a wood gas generator and a gas engine to convert the wood gas into 2 MW electric power and 4.5 MW heat. At the wood gas power plant are also two containers for experiments with wood gas. In one container is an experiment to convert wood gas, using the Fischer-Tropsch process, to a diesel-like fuel. By October 2005, it was possible to convert 5 kg wood into 1 litre fuel.

Design [edit]

There is a rich literature on gas-works, town-gas, gas-generation, wood-gas, and producer gas, that is now in the public domain due to its age.[1]

Most successful wood gas generators in use in Europe and the United States are some variation of the earlier Imbert design. Wood gas generators often use wood, however charcoal can also be used as a fuel, it is denser and produces a cleaner gas without the tarry volatiles and excessive water content of wood.

The FEMA unit from 1989 has distinct benefits over the earlier European units such as easier refueling and construction but is less popular than the earlier Imbert design because of significant new problems, which include a lack of a fixed oxidization zone and allows the oxidization zone to creep to a larger area, causing a drop in temperature; a lower operating temperature leads to tar production and it lacks a true reduction zone further increasing this design's propensity to produce tar. Tar in the wood gas stream is considered a dirty gas and tar will gum up a motor quickly, possibly leading to stuck valves, and rings.

The United Nations produced the FOA 72 document with details about their wood gas generator design and construction, as does World Bank technical paper 296.[2][3]

Advantages [edit]

Wood gas generators have a number of advantages over use of petroleum fuels:

- They can be used to run internal-combustion engines (or even gas turbines, for maximal efficiency) using wood, a renewable resource, and in the absence of petroleum or natural gas, for example, during a fuel shortage.
- They have a closed carbon cycle, contribute less to global warming, and are sustainable in nature.
- They can be relatively easily fabricated in a crisis using materials on hand.
- They are far cleaner burning than, say, a wood fire or even a gasoline-powered engine is (without

emissions controls), producing little if any soot.
- When used in a stationary design, they reach their true potential, as they are feasible to use in small combined heat and power scenarios (with heat recovery from the wood gas producer, and possibly the engine/generator, for example, to heat water for hydronic heating), even in industrialized countries, even during good economic times, provided that a sufficient supply of wood is attainable. Larger-scale installations can reap even better efficiencies, and are useful for district heating as well.

Disadvantages [edit]

The disadvantages of wood gas generators are:

- the large specific size
- the relatively slow starting speed; the time to heat the initially cold batch of wood to the necessary temperature level can take many minutes and in bigger plants even hours until the designed power is reached.
- a batch burning operation, that some designs feature, and that regularly interrupts the gas producing process.
- the stop operation out of a high load level is difficult (for example the stop of the engine using the gas): the residual heat still produces gas, which for a certain time leaves the gasifier either without control, or has to be used in a burner
- the primary combustible fuel-gas produced during gasification is carbon monoxide: it is an intentional fuel-product, and is subsequently burned to safe carbon dioxide in the engine (or other application) along with the other fuel-gases; however, continuous exposure to carbon-monoxide can be fatal to humans even in small to moderate concentrations.
- the humidity of the wood (usually 15 to 20%) and the water vapor created by the O- and H-atoms of the dry wood itself (about 0.4 liters of water loaded with organic substances per kg of dry wood) condenses during the gas cooling and filtering procedure and yields a liquid (see also wood tar), which needs specific waste water treatment. This treatment requires about 25 to 35 % of the created wood gas energy.

Safety consideration [edit]

When not carefully designed and used, there exists considerable potential for injury or death due to wood gas containing a large percentage of poisonous carbon monoxide (CO) gas. Wood gasifiers of proven design and thoroughly tested construction are considered safe to use outdoors, or in a partially enclosed space, for example, under a shelter open to the air on two sides; they may also be considered relatively safe to use in an extremely well ventilated (e.g. negative pressure) indoor area not connected to any indoor area used for sleeping, equipped with redundant (more than 1), completely independent, battery-powered, regularly tested carbon-monoxide detectors. However, prudence must dictate that any sort of experimental wood gasifier design or new construction be thoroughly tested outdoors, and only outdoors, with a "buddy" at all times, and with constant vigilance for any sign of headache, drowsiness, or nausea, as these are the first symptoms of carbon monoxide poisoning.

In addition, mixtures of excessive quantities of air and gas should be avoided as this could lead to the deflagration (explosion) of the gas in question if a combustion source is present. Long-term storage of wood-gas, except through the use of a gasholder-type water-displacement apparatus, should not be attempted, due to the volatile elements present in the gas, which, if allowed to excessively precipitate, will condense in the storage vessel. Under no circumstances should wood-gas ever be compressed to more than 15 pounds per square inch (1.0 bar) above ambient, as this may induce condensation of volatiles, as well as lead to the likelihood of severe injury or death due to carbon monoxide or deflagration if the vessel leaks or fails.[*citation needed*]

Media coverage [edit]

In 2008, an example of designing and constructing a working wood gas generator powered truck was shown on the National Geographic Channel's *Planet Mechanics* in the eighth episode, "Tree Powered Car".[4]

In 2009, another example of designing and constructing a working wood gas powered generator engine was in the TV series *The Colony* in the second episode of the first season "Power Struggle". Also used in the tenth episode "Exodus" to power an escape vehicle.

In 2009 21stCenturyMotorworks was reported on mass media[*citation needed*] to have developed gasification technology in a prototype pickup truck that could use any biomass materials for fuel. The vehicle was displayed at multiple events including the 2009 Boston Greenfest. 21stcenturymotorworks has since been involved in developing a circumferential engine technology to improve the efficiency of biomass fueled energy systems. A new subsidiary, Eden Energy Solutions of Ct, is furthering development of residential based energy units involving a combination of these two technologies.

A 2010 Mother Earth News article discussed and showed pictures of a wood gas powered engine installed in a pickup truck.[5]

As part of the BBC science series "Bang Goes The Theory", a Volkswagen Scirocco was converted to a design by Martin Bacon to run on used coffee grounds, and after its build in 2010 was driven solely on coffee from London to Manchester successfully. Part of the team are now working on a more advanced design leaning towards top speed as opposed to range.

See also [edit]

- Gas engine

References [edit]

1. ^ Literature about the history and manufacture of wood and coal gas generators can be found using online book digitization projects, such as Google Books, and these often have such materials downloadable in full, as they have passed into the public domain due to their age. For example, searching for "Producer Gas", "Gas manufacture and works", or "Gas Generators" on http://books.google.com will yield many complete books on the subject that can sate the appetite of one interested in the history of technology or serve the amateur experimenter well, even dated as they are.
2. ^ United Nations FOA 72 document
3. ^ World Bank technical paper 296
4. ^ [1] Google search
5. ^ Rick Bates (February/March 2010). "Use a Wood-gas Generator to Power Your Truck". Mother Earth News. Retrieved 2010-05-11.

Further reading [edit]

- "Holzbrenner Strength through Joy Wagon" (Volkswagen Beetle, 1940–1945)

External links [edit]

- 2 schematics of the most common downdraft generator systems
- p93; full downdraft generator system
- Information on the design and principles of the gasifier
- Woodgas powered trucks and cars in the United States
- Intro of the Planet Mechanics episode 'Tree Powered Car' on You tube describing how to make

'wood gas generator'

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