GASOGENS

Original report dated 1944

Information Reviewed and Reaffirmed

July 1962

No. 1463

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

GASOGENS[1]

By

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Summary

Widespread use of motor vehicles to which were attached generators (commonly called gasogens) has declined since such use reached its wartime peak in Europe in 1942. Described are the fuels used, principles, design and equipment for the engines, and special skills and precautions required in their operation. Some mobile units are still in use, while larger stationary generators continue to find current use under special conditions throughout the world.

Introduction

The gasification of wood or charcoal in generators, commonly called gasogens, attached to trucks, busses, passenger cars, tractors, and motor boats for use in place of gasoline developed vigorously in several foreign countries before and during the second World War. It is applicable for use with stationary as well as mobile internal combustion engines.

Gas producers for operating vehicles have not been widely used since World War II, but stationary large-size gas producers still find application in the more remote regions of the world. Probably the most active development took place in Sweden and Germany. In countries where the gasoline supply seemed to be adequate, the interest in gasogen units was relatively small. In 1942, over 90 percent of the motor vehicles registered as operating in Sweden were equipped with gasogens. About 700,000 gasogens were reported in use in European countries in 1942.

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[1]Original report dated November 1944 written by Raymond H. P. Miller, former Forest Products Laboratory engineer.

[2]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

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Widespread commercial adoption of gasogens in the United States is not expected. In remote regions under special conditions, gasogen operations might be practical and acceptable. Under emergency conditions when liquid fuel is not available at any reasonable price, the use of gasogen units may be necessary, especially for trucks, tractors, and other heavy-duty equipment and services adjacent to abundant wood supplies.

The U. S. Forest Products Laboratory carried out a limited study of the performance of gasogens in 1942. Road tests were made on one of the most promising and available gasogens. This make of gasogen was one of the 14 tested later by the National Research Council of Canada and was found to be as satisfactory as any. The results of the complete and thorough tests of these units were published by the National Research Council of Canada under the title "Gas Producers for Motor Vehicles," second general report by E. A. Allcut and R. H. Patten.

Fuels for Gasogens

Different fuels, such as nut shells, coke, anthracite coal, wood or charcoal, can be used in properly designed gasogens. Of these charcoal is generally considered the best fuel, for it is relatively free of resins, tars, oils, and of acid-forming substances, such as sulfur, which would be injurious to the unit and to the engine. The danger of tar or acetic acid formation, which is present in using wood, is absent when good charcoal is used. A charcoal gasogen unit weighs less than a wood unit. For these reasons charcoal gasogens are in more common use in foreign countries even though wood is a cheaper fuel. If wood is used for fuel in the gasogen, hardwood species are preferred. The prevailing opinion is that wood must be dried to a moisture content between 10 and 20 percent and be cut into pieces about the size of a man's fist.

When charcoal is used, the moisture content should be less than 10 percent, the volatile matter should not exceed 20 percent, and the charcoal should be sized to pass through a 1-1/4-inch-mesh screen, but retained on a 1/4-inch screen. Charcoal produced from dense hardwoods will usually give the hardest and densest charcoal.

Equipment and Principles of Gas Generation

A gasogen unit is made of three main parts; namely, the gas generator, the cleaning and cooling equipment, and a mixing device. A diagrammatic sketch of a typical gasogen unit is shown in figure 1.

The gas generator is usually cylindrical in shape and consists of a gas-tight fuel hopper, which feeds the fuel by gravity into the fire zone.

Producer gas is formed in the generator by incomplete combustion of the fuel. The rate of production is controlled by the suction of the engine. Air is delivered at one zone in the fuel bed where the glowing carbon combines readily with the available oxygen to form carbon dioxide with the evolution of much heat. The fuel through which the carbon dioxide passes must be sufficiently hot so that the glowing carbon reduces the carbon dioxide to carbon monoxide. Water vapor passing through the glowing carbon is changed to hydrogen and carbon monoxide while the volatile matter is changed to methane and carbon monoxide.

The gas leaving the generator passes through the cleaning and cooling equipment before it enters the engine. When the gas leaves the generator it carries with it particles of charcoal dust, soot, ash, and tarry substances which must all be removed in the filters.

The gas must be cooled to as low a temperature as possible before entering the engine so that its density is as high as possible. In some gasogen systems, the surfaces of the filters and the interconnecting pipes are sufficient to give good cooling. In others, special coolers are provided. The mixing device provides the proper proportions of gas and air to form a combustible mixture before it enters the engine.

The space and weight requirements of the gasogen are such that the pay load is reduced by about 10 percent.

Operation

After the generator is filled with fuel, the fuel door is clamped down and the fuel is ignited. A draft is created through the fuel bed either with a hand-operated blower or with the suction of the engine started on gasoline. When starting with gasoline, the change-over valve or the gasogen accelerator butterfly valve in the mixing device, depending upon the system used, is partly opened so that the engine draws air through the fire. The air passing through the fire is gradually increased and the suction through the carburetor is reduced until the engine is running completely on producer gas. In the test runs the gasoline supply was cut off, but in ordinary operation this would not be necessary and the engine could be quickly changed over to gasoline operation on steep hills. In the gasogen tested, the engine was first started on gasoline and the suction of the engine created a draft through the fuel. In less than two minutes after the flame from a lighted newspaper had been sucked into the fuel bed, the engine could be running 100 percent on producer gas. It was best to run about a mile to build up the fire zone before shifting into high gear. After the motor had been operating for a while, stops of an hour could be made without relighting or using gasoline.

A truck driver must be trained to operate a gasogen properly; however, this can be accomplished in a very short time. He must remember that gas must be manufactured before it can be used in the engine, and, therefore, the engine should be operated to favor the fire zone. It is necessary to keep the speed of the engine up and not let it drag on heavy pulls. For this reason, and also due to reduction in power, it is necessary to shift gears more frequently.

Although the gas produced contains carbon monoxide, which is highly poisonous, no unusual precautions must be made when running with gasogen units. While the engine is running, gas has little chance of escaping, due to the suction from the engine. When the engine stops a slight pressure is created, and the gas will leak out of the air inlet and through the mixing device. An absolutely essential precaution is that the unit should not be placed in a closed space immediately after stopping the engine. When opening the filters for cleaning, the operator should be careful not to inhale the gas. When refueling the gasogen, the operator should keep free of the fuel opening, for the gas accumulated in the top of the generator may catch on fire after the door has been opened.

In gasogen operation, additional time is required for starting and refueling. With charcoal, the driver will need to stop to refuel about three times as often as he formerly refueled with gasoline. In addition, 5 percent of the operator's time will be spent in cleaning filters and the generator.

Comparison of Power Developed by Gasoline and Producer Gas

About 13 pounds of charcoal are the equivalent of 1 gallon of gasoline. The gas produced by a gasogen with good operation will have a heating value of about 140 B.t.u. per cubic foot. Air must be mixed with the gas before it can be burned in the engine, and the heat value of this mixture is about 68 B.t.u. per cubic foot. The heat value of combustible gasoline vapor mixture is usually quoted as about 94 B.t.u. per cubic foot. This means that an engine operating on gasoline will develop between 30 and 40 percent more power than when running on producer gas. The resistance of the flow of gases through the fuel bed, piping, and filters is also greater than the resistance through the carburetor. These two factors mean that about 50 percent as much power can be expected when operating on producer gas as when operating with gasoline. Unless a truck is overpowered, therefore, either an increase in running time or a reduction in the load will result. As a general rule, on hills and on heavy pulls a truck using producer gas will need to be operated one gear lower than when gasoline is used. The acceleration with the gasogen will also be poorer.

To compensate in part for the power loss, the most common European practice is to increase the compression ratio. By increasing the compression ratio from 6.5 to 8, about 70 percent as much power can be expected when operating on producer gas as when operating on gasoline. A higher ratio could be used with producer gas, but this would introduce difficulties when operating with gasoline.

On gasogens equipped with valves for readily changing from one fuel to the other, it is possible to step up the power by operating partly on gasoline. If necessary, gasoline alone can be used on extremely hard pulls.

Construction

Gasogen units are largely constructed of mild sheet steel, steel tubing, and malleable iron castings. The generator and filter shells are fabricated of welded sheet steel. The total amount of metal required depends on the type and size of the gasogen. For a cross-draft charcoal unit the weight may vary from 250 to 600 pounds. The charcoal gasogen for a 2-ton truck weighed about 400 pounds.

Results of Road Tests with a Gasogen-equipped Truck

In general, the results of the road tests by the Laboratory have verified reported European and Australian performance. On long steep hills the gasogen-operated truck had to drop one gear lower than when operating on gasoline.

Only with vehicles that require a large annual consumption of gasoline can the cost of the equipment be written off by savings in fuel cost in this country. Where gasoline is not available at the usual prices and with usual ease, the case for gasogens is better.

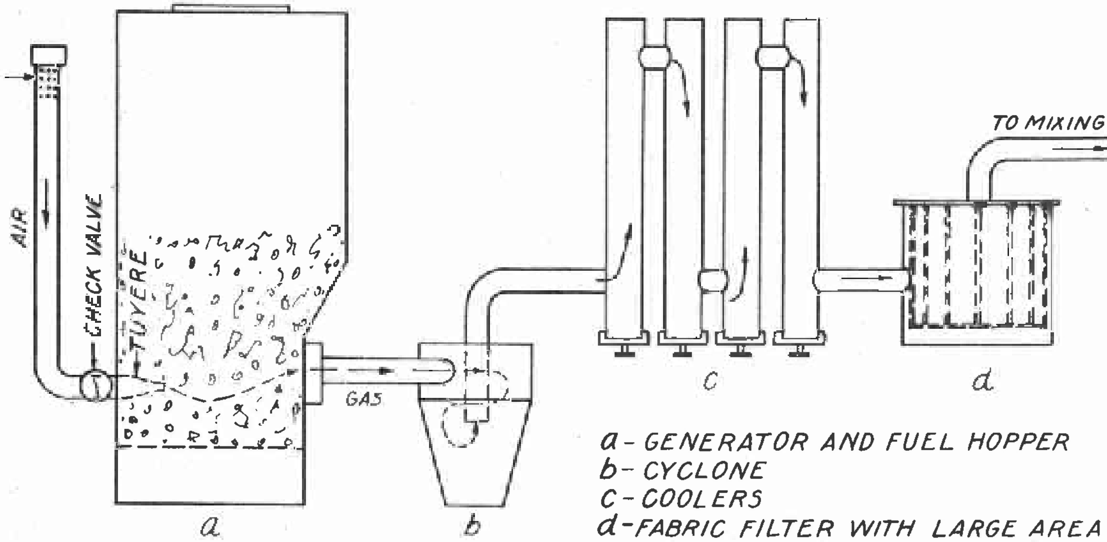

Figure 1.--Schematic drawing showing the principal parts of a charcoal-burning gasogen.