FUEL FROM WOOD

Venkata Phani Babu.V[1], D. Ajay Kumar[2], G. Mahender Reddy[2], M. Karthik Goud[2], G. Rajendra Prasad[2]

[1]*Assistant Professor, Department of Mechanical Engineering, Hyderabad Institute Of Technology And Management*

[2]*Student, Department of Mechanical Engineering, Hyderabad Institute Of Technology And Management*

ABSTRACT

This report is one in a series of emergency technology assessments spoil soared by the Federal Emergency Management Agency (FEMA). The purpose of this report is to develop detailed, illustrated instructions for the fabrication, installation, and operation of a biomass gasified unit (k, "producer gas"a generator, also called a "wood gas" generator) that is capable of providing emergency fuel for vehicles, such as tractors and trucks, in the event that normal petroleum sources were disrupted for an extended period of time.

Keyword - *Federal Emergency Management Agency (FEMA)*, *fabrication, installation, biomass gasified unit,etc.*

---

1. INTRODUCTION

Fuel gas, produced by the reduction of coal and peat, was used for heating, as early as 1840 in Europe, and by 1854 it had been adapted to fuel engines in England. Before 1940, gas generator units were a familiar, but not extensively utilized, technology. However, petroleum shortages during World War I1 led to widespread gas generator applications in the transportation industries of Western Europe. (Charcoal-burning taxis, a related application, were still common in Korea as late as 1970) The United States, never faced with such prolonged or severe oil shortages, has lagged far behind Europe and the Orient in familiarity with and application of this technology; however, a catastrophe could so severely disrupt the supply o f petroleum in this country that this technology might be critical in meeting the energy needs of some essential economic activities, such as the production and distribution of food.

This report attempts to preserve the knowledge about wood gasification as put into practical use during, World War 11. Detailed, step-by-step procedures are presented in this report for constructing a simplified version of the World War 11, Impart wood gas generator. This simple, stratified, downdraft gasify unit can be constructed from materials that would be widely available in the United States in a prolonged petroleum crisis. For example, the body of the unit consists of a galvanize metal garbage can atop a small metal drum; common plumbing Getting's throughout; and a large, stainless steel making bowl for the grate. A prototype gasify unit was fabricated from these instructions. This unit was then mounted onto the front of a gasoline-engine Farm tractor and successfully field tested, using wood chips as the only fuel. Photographic documentation of the actual assembly of the unit, as well as its operational field test, is included in this report. The use of wood gas generators need not be limited to transportation applications.

Stationary engines can also be fueled by wood gasifies to run electric generators, pumps, and industrial equipment. In fact, the use of wood gas as a fuel is not even restricted to gasoline engines; if a small amount of diesel fuel is used for ignition, a properly adjusted diesel engine can be operated primarily on wood gas introduced through the intake manifold.

However, this report is concerned with the operation of four-cycle gasoline engines rated from 10 to 150 horsepower. If more information is needed about operating gasifies on other fuels (such as coal, charcoal, peat, sawdust or seaweed), a list of relevant literature is contained in the Bibliography at the end of (his report. The goal of this report is to furnish information for building a homemade wood gas generator made out of ordinary, available hardware, in order to get tractors, trucks, and other vehicles operating without delay, if a sever liquid fuel emergency should arise. Section 1 describes gasification principles and wood gas generators, in general, and gives some historical background about their operation and effectiveness. Section 2 contains detailed step-by step instructions for constructing your own wood gas generator unit; illustrations and photographs arc included to prevent confusion. Section 3 contains information on operating, maintaining, and trouble-shooting your wood gas generator; also included are some very important guidelines on safety when using your gasify system. The wood gasify design presented in this report has as its origin the proven technology used in World War 11 during actual shortages of gasoline and diesel fuel. It should be acknowledged that there are alternate technologies (such as methane production or use of alcohol fuels) for keeping internal combustion engines in operation during a prolonged petroleum crisis; the wood gasify unit described in this report represents only one solution to the problem.

1.1 PRINCIPLES OF SOLID FUEL GASIFICATION:

All internal combustion engines actually run on vapor, not liquid. The liquid fuels used in gasoline engines are vaporized before they enter the combustion chamber above the pistons. In diesel engines, the fuel is sprayed into the combustion chamber as fine droplets which burn as they vaporize. The purpose of gasify is to transform solid fuels into gaseous ones and to keep the gas free of harmful constituents. A gas generator unit is, simultaneously, an energy converter and a filter. In these twin tasks lie its advantages and its difficulties.

The first question many people ask about gasifies is, "Where does the combustible gas come from?" Light a wooden match; hold it in a horizontal position; and notice that while the wood becomes charcoal, it is not actually burning but is releasing a gas that begins to burn brightly a short distance away from the matchstick. Notice the gap between the matchstick and the luminous flame; this gap contains the wood gas which starts burning only when properly mixed with air (which contains oxygen). By weight, this gas (wood gas) from the charring wood contains approximately 20% hydrogen (H2), 20% carbon monoxide (CO), band small amounts of methane, all of which are combustible, plus 50 to 60% nitrogen (N2). The nitrogen is not combustible; however, it does occupy volume and dilutes the wood gas as it enters and burns in an engine. As the wood gas burns, the products of combustion are carbon dioxide (CO,) and water vapor (H20). The same chemical laws which govern combustion processes also apply to gasification. The solid, biomass fuels suitable for gasification cover a wide range, from wood and paper to peat, lignite, and coal, including coke derived from coal. All of these solid fuels are composed primarily of carbon with varying amounts of hydrogen, oxygen, and impurities, such as sculpture, ash, and moisture. Thus, the aim of gasification is the almost complete transformation of these constituents into gaseous form SO that only the ashes and inert materials remain. In a sense, gasification is a form of incomplete combustion; heat from the burning solid fuel creates gases which are unable to burn completely, due to insufficient amounts of oxygen from the available supply of air. In the matchstick example above, as the wood was burned and polymerized into charcoal, wood gas was created, but the gas was also consumed by combustion. In creating wood gas €or fueling internal combustion engines, it is important at the gas not only be properly produced, but also preserved and not consume until it is introduced into the engine where it may be appropriately burned.

Gasification is a process in which chemical transformations occur along with the conversion. The chemical reactions and thermo chemical conversions which occur inside a wood gas generator are too long and too complicated to be covered here. Such knowledge is not necessary for constructing and operating a wood gasifies. Books with such information are listed in the Reference Section (see, for example, Reed 1979, Vol. 11; or Reed and Das 1988)

1.2 BACKGROUND INFORMATION;

The use of wood to provide heat is as old as mankind; but by burning the wood we only utilize about one-third of its energy. Two-thirds is lost into the environment with the smoke. Gasification is a method of collecting the smoke and its combustible components. Making a combustible gas from coal and wood began around 1790 in Europe. Such manufactured gas was used for street lights and was piped into houses for heating, lighting, and cooking. Factories used it for steam boilers, and farmers operated their machinery on wood gas and coal gas. After the discovery of large petroleum reserves in Pennsylvania in 1859, the entire world changed to oil-a cheaper and more convenient Fuel. Thousands of gas works all over the world were eventually dismantled.

Wood gas generators are not technological marvels that can totally eliminate our current dependence on oil, reduce the impacts of an energy crunch, or produce long-term economic relief from high fossil fuel prices, but they are a proven emergency solution when such fuels become unobtainable in case of war, civil upheaval, or natural disaster. In fact, many people can recall a widespread use of wood gas generators during World War 11, when petroleum products were not available for the civilian populations in many countries. Naturally, the people most affected by oil and petroleum scarcity made the greatest advancements in wood gas generator technology.

In occupied Denmark during World War 11, 95% of all mobile farm machinery, tractors, trucks, stationary engines, fishing and ferry boats were powered by wood gas generators. Even in neutral Sweden, 40% of all motor traffic operated on gas derived from wood or charcoal (Reed and Janzen 1979). All over Europe, Asia, and Australia, millions of gas generators were in operation between 1940 and 1946. Because of the wood gasolier's somewhat low efficiency, the inconvenience of operation, and the potential health risks. From toxic fumes, most old such units were abandoned when oil again became available in 1945. Except for the technology of producing alternate fuels, such as methane or alcohol, the only solution for operating existing internal combustion engines, when oil and petroleum products are not available, has been these simple, inexpensive gasify units.

2. BUILDING OF WOOD GAS GENERATOR

The following fabrication instructions, parts lists, and illustrations scribe: the prototype gasify unit shown schematically, plissé are simples and easy ~to follow. The dimensions in the plans are given in inches rather than in millimeters to make construction cashier for those who might be faith the metric system and to allow the builder to take advantage of available, alternate construction materials. The will be obvious to the experienced engineer, mechanic, or builder that most of the des (floor exams plea, plate thicknesses and cleanout diameters) arc not critical to the acceptable performance of the finished gasify unit.

The prototype gasify unit described in the following next was actually constructed and field tested on a gasoline-engine farm tractor (a 35-hp, John Deere 1010 Special); The unit operated very well, and on par with the European, World War 11 designs, but it has not had the test of time nor the millions of operating hours like the older Impart design. This new stratified design was developed for the Construction of simple, inexpensive emergency wood gas generator units. The prototype design below should be considered to be the absolute minimum in regard to materials, piping and filter arrangement, and carburetor system connections,

The gasify unit, as described below, is designed to maintain proper cooling, even at moderate vehicle speeds. If this unit is to be used on stationary engines or on slow-moving vehicles, a gas cooler and a secondary filter must be placed in the piping system between the generator unit and the carburetor. The ideal temperature for the wood gas at the inlet to the carburetor manifold would be 7PF, with acceptable peaks of 140 to 1WF. For every 10 degrees above, an estimated 1% horsepower is lost. Cooler gas has higher density and, therefore, contains more combustible components per unit volume.

The millions of wood gasify built during World War II proved that shape, form, and construction material had little or no effect on the performance of the unit. Judicious substitution or the use of scavenged parts is, therefore, quite acceptable. What h important is that ;

- The fire tube dimensions (inside diameter and length) must be correctly selected to match the rated horsepower of particular engine which is to be fueled,
- Air tightness of the gas generator unit and all connecting piping must he maintained at all times, and
- Unnecessary friction should be eliminated in all of the air and gas passages by avoiding Sharp bends in the piping and by using piping sacs which are not too small.

2.1 BUILDING THE GAS GENERATOR UNIT AND THE HOPPER:

Figure 2-2 shows an exploded view of the gas generator unit and the fuel hopper; the list of materials is given in Table 2-1 (all figures and tables mentioned in Sect. 2 are presented at the end of Sect. 2). Only the dimensions of the fire tube: (Item 1A) must be reasonably close; all other dimensions and materials can be substituted as long as complete air tightness is maintained. In the following instructions, all item numbers refer both to Fig. 2-2 and to Table 2-1.

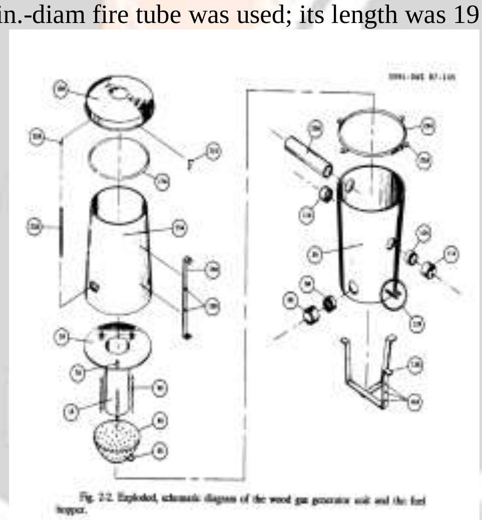
The prototype unit described in this report was constructed for use with a 35-hp gasoline engine; the unit has a fire tube diameter of 6 in. (as determined from Table 2-2). A gas generator unit containing a fire tube up to 9-in. diameter (Le. a gasify unit for fueling engines up to about 65 hp) can be constructed from the following instructions. If your engine requires a fire tube diameter of 10 in. or more, us drum for the gas unit and another 55-gal drum for the fuel hopper.

2.1 Prototype of the Hopper

The following fabrication procedure is very general and can be applied to the construction of gas generator units of any size; however, the specific dimensions which are given in the parts list and in the instructions below arc for this particular prototype unit. All accompanying photographs were taken during the actual assembly of the prototype unit.

The fabrication procedure is as follows:

- Using the displacement or horsepower rating of the engine to be fueled by the gasify unit, determine the dimensions (inside diameter and length) of the fire tube from Table 2-2, Fabricate a cylindrical tube OB cut a length of correctly sized pipe to match the dimensions from Table 2-2. (For the prototype gasify unit illustrated in this report, a 6-in.-diam fire tube was used; its length was 19 in.).



2.2 Exploded schematic diagram of the wood gas generator and Hopper

- The circular top plate) should be cut to a diameter equal to the outside diameter of the gasify housing drum at its top. A circular hole should then be cut in the center of the top plate; the diameter of this whole must he equal to the outside diameter of the fire tube. ‘Ifni fire tube should then be welded at a right angle to the top plate The grate should be meds from a stainless steel mixing bowl or colander. Approximately 125 holes with diameters of ll2 in. should be drilled in the bottom and up the sides of the mixing bowl; sac Fig. 2-4. A U-bolt should be welded horizontally to the side of the grate, 2 in. from its bottom. This 1J-bolt will be interlocked with the shaker mechanism in a later step.

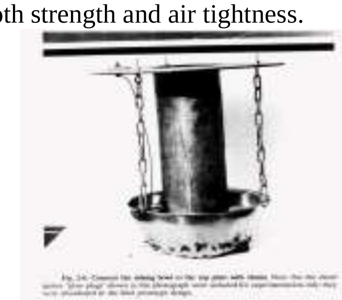
2.3 The fire tub

2.4 Dust collector

- The support chains are to be attached to the grate in three evenly spaced holes drilled under the lip of the tanking bowl or colander, one on each side of the top plate; so that the eyebolts can he adjusted to the proper length. When assembled, the bottom of the fire tube should be 1.25 in. above the bottom of the mixing bowl.

2.5 Fire tube with dust collector attached with chains

- A hole equal to the outside diameter of the ash cleanout port should be cut into the side of the gasify housing drum the bottom edge of this hole should be about 1/2 in. from the bottom of the drum. Because of the thin wall thickness of oil drums and garbage cans, welding is not recommended; brazing such pasts to the drums or cans will ensure both strength and air tightness.



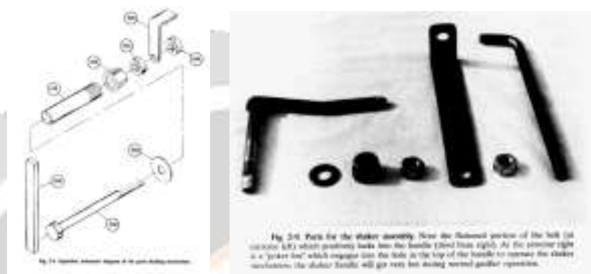
2.6 Prototype Fire tube attached to the dust collector

- Two holes, equal to the outside diameters cafe the ignition ports, are to be cut with their canters at a distance from the top of the housing drum equal to the t%-etude length less 7 in. 19 in. Bass 7 in equals 12 in. For this prototype nit); the holes shed he placed opposite each other as shown in Fig. 2-2. Shunned be attached to the wall of the housing drum by brazing.
- When the ash calcareous poor and the ignition port have been attached to the wall of the gasify housing drum , they should then he closed with pipe caps, respectively. The threads of the pipe caps should be Grist coated with high temperature silicone to censure air tightness. An optional steel crossbar welded to the pipe cap will reduce the effort required to open these caps later.
- The shaker assembly. The 1/2-in. pipe should be brazed into the side of the housing drum, 1.5 inches from the bottom of the drum; the length of this pipe which protrudes into the drum must be chosen SO that the upright bar is in line with the U-bolt OR the grate. Likewise, the length of the upright bar must be selected so as to connect into the U-bolt.
- Weld the upright bar to the head of the bolt. The threaded end of the bolt should be ground down or flattened on one side, to positively interlock with a slot to be drilled and filed in the handle. The handle can be formed or bent into any desired or convenient shape.
- A hole should be drilled in the pipe cap as that there is a close fit between this hole and the bolt the close fit will help to ensure air tightness.
- Before assembling the shaker, as shown in coat the bolt with a small amount of grease. Before kiering the bolt, fill the pipe with high temperature silicone to ensure air tightness. Tighten the nuts so that the position of the handle is maintains by friction, yet is capable of being turned and agitated during cleanout or stationary operation.

2.7 Brazing

- Fabricate the supports the gasify unit housing drum out of rectangular, iron bar stock. The shape and height of the support flanges must be determined by the frame of the vehicle to which gasify is to be mounted. The supports can either be bolted to the bottom and side with the 1J4-h. Bolts or can be hazed directly to the drum; . Remember to seal all bolt Holm for air tightness.
- Completely cover the bottom of the housing drum with 1/2 in. of hydraulic cement .The cement should also be applied to the inside of the drum for about 5 in. up the inside walls near the bottom. All edges should be rounded T o r easy ash removal.
- The fuel hopper is to be made form a second container with its hot torn up. Remove the Bolton, leaving a U 4 - h lip around the circumference.
- A garden hose should be cut to a length q u a l to the circumference of the fuel hopper and should then be slit along its entire length. It should be placed over the edge of the fuel hopper from which the bottom was removed. T h i s will prevent injury to the operator where adding wood fuel to the unit. To insure close fit of the garbage can lid, a piece of wealthier stripping should be attached under the lid where it makes contact with the fuel hopper.
- Cut four support bars to lengths 2.5 in. longer than the height of the fuel hopper. Drill a 3/8-in. hole in each end of all four support bars; these holds should be centered 3/4 in. from the ends. Bend 2 in. of each end of this support bars over at a right angle; then, mount them evenly spaced around the fuel hopper with U4-h bolts. One of the bends on each support bar should be as close to the lower edge of the fuel hopper as possible,
- Cut four metal triangular standoffs and braze, weld, or rivet them flat against the edge of the garbage can lid they must be aligned with the four support bars attached to the fuel hopper. During operation, the garbage can lid must have a minimum 3/4-in. opening for air passage; the standoffs should provide this clearance when they are engaged into the holes in the top edges of the support bars

- Two eye hooks should be attached to opposite sides of the garbage can lid Two screen door springs should be attached to the garbage can handles and used under tension to keep the top lid
- Cut the oil drum lock ring
- Cut four 2 by 2 by 1/4-in. tabs then, braze these tabs to the lock ring evenly spaced and in alignment with the support bars on the fuel hopper. Drill a 3/8-in. hole in each tab to align with the holes in the fuel hopper support bars.
- The connecting pipe between the gasified unit and the filter unit should be attached to the gasified housing drum at a point 6 in. below the top of the drum. This pipe must be a minim in of 2-in. in diameter and should be at least 6 f t long for cooling purposes. A device is available and can be used if they are suitable for operation at 400°F and above. The pipe can also be welded or brazed directly to the housing drum.
- When assembling the gasifies unit, the upright bar on the shaker assembly must be placed inside the U-bolt on the grate.



2.8 & 2.9 Schematic diagram of shaking mechanism and parts for shake assembly

- The lock ring will then clamp the gasifies unit housing drum and the top plate together. The fuel hopper sup ort bars (Item 1 9 4 must be attached to the tabs on the lock ring with bolts. High temperature silicone should be applied to all daces to make an air light connection. The lock ring connections are shown in the lower portion

2.2 BUILDING THE PRIMARY FILTER UNIT:

Figures 2-15 and 2-16 show exploded Views of the primary fitter unit; the list of materials is given in Table 2-3 (all figures and tables mentioned in Sect, 2 are presented at the end of Sect. 2). In the following instructions, all intern numbers refer to either Fig. 2-15 or 2-16

2.10 Filter

The prototype primary filter unit was made from a 5-gal paint can. That size seems to be sufficient for gasifies with fire tubes up to 10 in. in diameter. If a fire tube diameter of more than 10 in. is required, then a 20-gal garbage can or a 30-gal oil drum should be used, the filter unit could be fabricated in any shape or form as long as air tightness and unobstructed flow of gas are provided. If a 5-gal container is used, it must be clean and free of any chemical residue. Laic top edge must be straight and without any indentations. If an alternate container can be found or fabricated, a larger diameter will print longer operation between cleanings.

2.11 Filter with hopper

The piping (Item 29A in Figs. 2-2 and 2-15) which connects the gas generator unit to the primary filter should be considered to be a necessary part of the cooling system and should never have ala inside diameter less than 2 in. A flexible automotive exhaust pipe was used on the prototype filter unit described below; it was shaped into a semicircular arc so that increased length would achieve a greater cooling effect.

The fabrication procedure fur the filter unit follows:

- A hole q u a l to the outside diameter of the drain tube (Item 13B in Fig. 2-15] should be cut into the side of the filter container (Item 1s); the bottom edge of this hole should be about 1/2 in. loom the inside bottom of the container.
- The drain tube (Item 13B) should be inserted into the previously cut hole in the filter container and should be positioned so that its non threaded end is near the center of the container and k about 1/2 in. off the bottom.. Once this position has been ensured, braze (do not weld) the drain pipe into the side of t e filter container. Satchel threaded, exterior end of the drain pipe with the pipe cap

2.12 Cover of the hopper

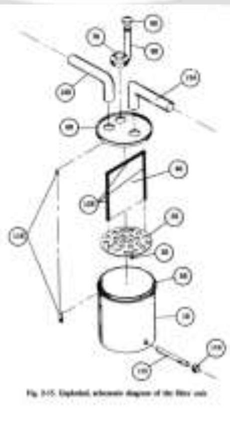
- Coat the bottom of the filter container (Item IN) with a ld-in. layer of hydraulic cement (Item 28A), taking care not to plug or obstruct the end of the drain tube (Item 13B) with cement (i.e., fill the drain tube with a paper, Styrofoam, or other easily removable, but rigid material). The cement should also be applied for about 1.5 in. up the inside walls of the container near its bottom. Round the edges slightly; the cement; is to provide a pathway for any liquid condensate to drain out through the drain tube. The cement. Must be allowed to harden before proceeding with the fabrication steps below. Remove the filler material from the drain tube when the cement has hardened
- A circular bottom plate (Item 2B) should be cut to a diameter i/2 in. smaller than the inside diameter of the filter container (Item 1s).l his will allow for heat expansion and easy removal for cleaning. This bottom plate should be drilled with as many 3/4-.-in. holes as are practical for the size of the plate. Three evenly spaced 3/8-in. holes should also be drilled around the edge of the bottom plate for the spacer bolts (Item 3B).
- Fig. 2-16 shows the detail of using three bolts (Item 3 8) as spacers for the bottom plate (Item 23). The length of the bolts should be adjusted to provide a clearance of about 2-in. between the layer of cement in the bottom of the container (Item IS) and the bottom plate

2.13 Operating configuration

- A rectangular divider plate (Item 4s) should be cut to a width 1/4 in. less than the inside diameter of the filter container (Item 1B) and to a height 2.5 in. less than the inside height of the container. The divider plate should then be welded at a right angle to the centerline of the bottom plate (Item 2B) as shown in Fig. 2-17.
- Cut a piece of high-temperature hydraulic host (Item 5B) to a length equal to the circumference of the filter container. It should he slit along its entire length and then placed over the top edge of the filter container (Item 1B) to censure air tightness.

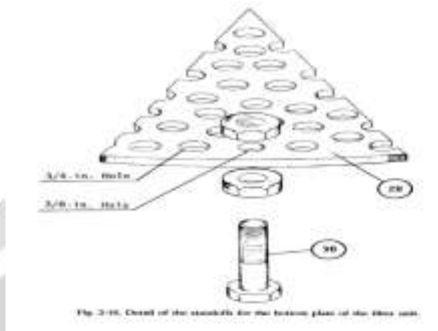
2.14 Lock ring of fuel hopper

- A circular lid (Item 6B) should be cut equal to the outside diameter of the filter container (Item 1B). Three holes should be cut into this :id for the exhaust pipe (Item 29A) from the gasify unit, the blower (Item 7B), and the filter exhaust pipe (Item lOI3) to the engine manifold. Note the arrangement of these holes: the pipe (Item 29A) from the gasify unit must enter the lid on one side of the divider plate (Item 413); the blower (Item 7B) and the filter exhaust pipe (Item IOB) to the engine manifold must be located on the other side of the divider plate. This arrangement can be seen in Fig. 2-18.
- The connecting pipe (Item 29A) between the gasify unit and the filter unit should be attached to the lid (Item 5R) of the filter container. At least one of the ends of the connecting pipe (Item 29A) must be removable for cleaning and maintenance. On this prototype unit, an airtight electrical conduit connector was used. Many similar plumbing devices are available and can be used if they are suitable for operation at 400°F and abos7e, The pipe can also be welded or brae& directly to the lid.



2.15 Schematic diagram of the filter unit

- Attach the blower (Item 7%) to the filter container lid . On the prototype gasify illustrated in this report, a heater blower from a Volkswagen automobile: was used.. A plumbing cap of stele or plastic with a close fit can be used or fabricated to fit. The vertical extension 2nd the closing cap arc visibly in Fig. 2-1.
- The gas outlet (Item 1OB) to the carbureting unit on the engine should be 1.25 in. minimum diameter. In fabricating this connection, all abrupt bends should be avoided to ensure free flow of gas. Using plumbing elbows is one solution. The gas outlet (Item 10B) can either be welded or brazed lo the lid (Item 6B) of the filter container or an airtight, electrical conduit connector can be used.



2.16 Detail of the standoff's for the bottom plate of the filter unit

- Latching devices (Item 11B) should be welded or brazed to the lid (see Fig. 2-20) and to the sides (see Fig. 2-21) of the filter container. An air-tight connection between the lid and the filter container must be maintained.
- Cut two lengths of high-temperature hydraulic hose (Item 12B) equal to the height of the divider plate (item 4B); cut a third length of hose equal to the width of the divider plate. . Place the first two hoses on each side of the divider plate, and place thru third hose along the top edge of the divider plate as shown in Fig. 2-17.
- Insert the divider plate (Item 4B) into the filter container (Item IB), making sure that the spacer bolls (Item 3B), adjust the height of the divider plate so that it is exactly flush with the top of the filter container. Make sure that the lid (Item 5B) will scat flatly and tightly against the top edge of the divider plate. the hoses (Item 12) create an airtight seal along all sides.

2.17 Divider plate (# off's(#4),

- Fill the filter container (Item 1B) on both sides of the divider plate with wood chips, the same kind as would be used for fuel in the gasify unit. After carefully packing and leveling these wood chips, place the lid (Item 6B) on the filter container, and close the latches tightly.

2.3 BUILDING THE CARBURETING UNIT WITH THE AIR AND TROTTLE CONTROLS

Figures 2-22 and 2-23 show exploded views of the carbureting unit; the list of materials is given in Table 2-4 (all figures and tables mentioned in Sect. 2 are presented at the end of Sect. 2). In the following instructions, all item numbers refer both to Figs. 2-22 and 2- 23 and to Table 2 4. The following a simple and easy way to assemble a carburetor to achieve both air mixture and throttle valve. It can be mounted to either updraft or downdraft manifolds by simply turning the unit over. Most o f the fabrication procedure below is devoted to the assembly of two butterfly valves: one for the throttle valve and one for the air mixture valve. e remainder of the carburetor unit can be assembled from ordinary, threaded plumbing parts.

The inside diameter of the piping used in the carburetor unit must be related to the side of the engine and should never be smaller than the intake opening on the engine manifold. If in doubt on the inside diameter for the pipe and/or hose sizes, always go with a larger diameter. This will reduce friction losses and will give longer operating hours between cleanings. Item unit it should normally be below 180°F. About 2 ft from the filter container, a river water hose can be connected to the pipe on the carbureting unit. This rubber hose will keep engine vibration from creating air leaks in the filter unit or in the connecting piping. The hose must be a fairly new item; such hoses have a steel spring inside to keep them from collapsing when negative pressure is applied. The spring will soon rust if it has first belie subjected to water and the the both wood gas enriched with hydrogen.

Fabrication procedure for the assembly of two butterfly valves follows:

- The manifold adapter (Item I@ in Fig. 2-22) must be fitted with bolts and/or holes for mounting onto the engine's existing intake manifold. Because gasoline engines are produced with so many different types of intake manifolds, ingenuity and common sense must be used to modify the manifold adapter (Item 1 C) for each different engine to be operated on wood gas. A gasket (Item 7C) should he cut to match the shape of the engine intake fitting.
- The butterfly valve (Item 3C) is shown in Figs. 2-24 and 2-25; two such valves are required. A 3/8-in. hole should be drilled through the diameter of each valve body (Item 1CC) at the midpoint of its length.
- The valve plate (Item 2CC) must be oval in shape with the dimensions given in table
- 2-4. An oval valve plate must be used so that, in the closed position, the valve will be about 100 off center. This will ensure that the valve will come to a complete stop in the closed position.
- The edges of the valve plate (Item 2CC), around the longer diameter of the oval, should be beveled to provide a positive, airtight closure. Two evenly spaced, 1/4-in. holes should be drilled along the shorter diameter of the oval plate.
- The valve support rod (Item 3CC) should be filed or ground flat on one side as shown in Fig. 2-24; the flat area must begin 1/4 in. from one end and must continue for a distance equal to the inside diameter of the valve body (Item 1CC).
- Two 3/16-in. holes should be drilled into the flat area of the valve support rod (Item
- 3CC); these holes must align with the holes in the valve plate (Item 2CC). They must also be tapped (with threads) to accept the valve plate screws (Item 4CC).
- The butterfly valve (Item 3C) should be assembled by first placing the valve support rod (Item 3CC) through the hole in the valve M y (Item ICC). The valve plate (Item
- 2CC) should be dropped into one end of the valve body and t k i l inserted into the flat area of the valve support rod. The two screws (Item 4C'G) should be used to attach the valve plate to the support rod. Check to see that the assembled valve plate rotates freely and seats completely in the closed position.
- A nut (Item 6CC) should be welded flat against one side of the throttle arm (Item SCC) near its end. A 1/8-in. hole should be drilled into the side of the nut and must be threaded to accept the sat screw (Item 7CC). At least one hole should be drilled into the throttle arm for attachment of the engine throttle control or air control linkages.
- Place the nut (Item 6CC) on the throttle arm over the edge of the valve support rod (Item 3CC) and use the set screw (Item 7CG) to secure the assembly .The throttle arm can be placed in any convenient orientation. Assembled butterfly valves are show in Fig. 2-26.
- The remaining parts of the carburetor assembly should he screwed together as shown in Fig. 2-27. Pipe thread compound should be used to make airtight connections. The led carburetor unit should be attached to the engine's intake manifold as shown in Fig. 2-28.
- This prototype gasify was designed to operate if gasoline were unavailable; but, if dual operation on wood and gasoline is desired, the elbow (item 2C) awed be replaced with a tee, allowing a gasoline carburetor to also be mounted.
- The arm on the butterfly valve (Item 3C) which is closest to the elbow (Item 2C) is to be connected to the foot- (or, on tractors, hand-) operated accelerator. The other butterfly valve is to be used as the air mixture control valve and can be operated with a manual choke cable. If the engine has an automatic choking device, then a hand operated choke cable should be installed. Both butterfly valves and their connecting control linkages must operate smoothly with the ability to adjust the valve yet keep it stationary in the selected position during operation. The linkages must close the valves airtight when the engine is off.
- The air inlet (Item 6C) should be connected by an extension hose or pipe, either iron or plastic, to the existing engine's air filter in order to prevent road dust or agricultural residue from entering the engine.

- The wood gas inlet (Item SC) is to be connected to the outlet piping (Item 1OB as shown in Fig. 2-15) from the wood gas filter unit. Part of this connection should be a high-temperature rubber or neoprene hose to absorb engine vibration.

3. CONCLUSIONS

- Fuel from wood is a futuristic concept that can be an alternative for the individual fuel generators.
- But if a process of distillation is required to make the oil usable.
- So when a low budget distillation process is made then this becomes a revolutionary invention.
- It can be used in a engine which can harness power from a crude oil, So that there will be no need for the process of distillation.

4. REFERENCES:

1.Anonymous, "Coast to Coast on Homemade Fuel," The Mother Earth (Nu. 73) pp. 178-179,January-February 1982.

2.Anonymous, "Wood Gas Update," The Mother Earth News (No. 71) pp. 164-165 September-1 October 1981.

3. Anonymous, "Mother's Wood burning Truck," The Mother Earth News (No. 69) pp. 126-229,May/June 1981.

4. Chatterjee, AK., State of the Art Report on Paralysis of Wood and Agricultural Biomass, PNAAK- 818, U.S. Department of Agriculture, Newark, NJ, March 1981.

5. Cruz, I.E., Producer-Gas Technology for Rural Applications, published by the Food and Agriculture Organization of the United Nations, New York, NY, 1985.

6. Donath, E.E., "Vehicle Gas Producers," Processing Technology (3) pp. 141-153 (1980). EM€, K.M., and D.M. Post, "How to Power a Gasoline Engine with Wood," Technical Reprint No. 1, The Mother Earth News, Hendersonville, NC, 1981.

7. Kaupp, A, and J.R. Goss, State of the Art Report for Small Scale (to 50kw) Gas Producer- Engine Systems, USDA Contract No. 53-319R-0-141, University of California, Davis,CA, March 1981.