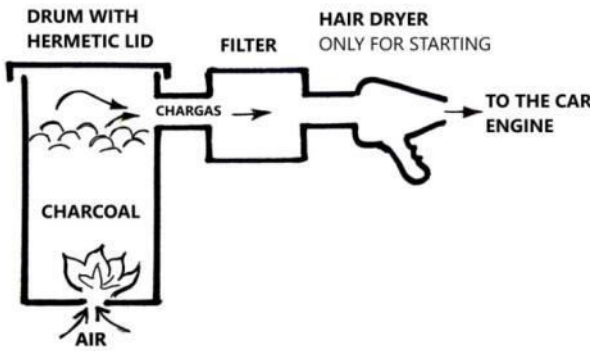
DRIVE ON WASTE

A GUIDE FOR DRIVING A VEHICLE ON CHARGAS & WATER.

Free guide that explains how to assemble a simple system that really works.

Patent pending: INPI 2019-0103426.

In short, the system works as follows:



Eddy Ramos.

Córdoba, Argentina.

"Soli Deo Gloria".

Version #4: (June 2022).

FOREWORD.

For the Glory of God.

This forth version guide has error corrections of the last guide and has more useful information. This is a guide for getting a vehicle to drive only on carbonized waste (or chargas) and water. It is not a theoretical note, as it has being tested for real and it really works, based on more than 10.000 km (6.400 miles) only on chargas. All information is free. It's based on my experience with a 1983 Ford Falcon "Ranchero" truck, **but it can be made for any gasoline** o propane motor vehicle (or electric motor-generator)**, without any changes on the engine.** Not good for diesel engines.

In the case of a car, it can be mounted inside the trunk or on a small trailer and the chargas feeds the car thru a hose.

I can drive up to 115 Km/h (72 Miles/h). The consumption or driving range depends on many factors: the type of carbonized waste, the size of the engine, the driving conditions, the addition of water, etc. but for my heavy car with a huge engine of 3,6 Lts (221 Cu inches) can be estimated between 15 to 20 kilos (33 to 44 Pounds) of waste per 100 km (62 Miles) driving at 80 Km/h (50 Miles/h).

In addition, this system not only cleans the planet of waste, but gases coming out of the exhaust pipe are less polluting than all currently used fuels and exhausts 20% of oxygen to the environment.

It is likely that you can drive only on chargas without spending a penny, but it takes a lot of labor. When time is money, then chargas will not be free.

Service:

"He who does not live to serve does not de-serve to live." I have been developing this for over twelve years, not with the goal of profiting but of providing a free service to the world community.

Will:

With will the impossible are easily achieved, but miracles cost a little more.

DEDICATED TO:

First I dedicate this work to my wife Fabiola, who had to put up with me filling our property with tons of waste, to try different designs.

Secondly, I dedicate it to Mr Marcelo Rava who trusted me before this worked, helped me at the most critical time and gave me many materials to manufacture the first and second gasification system.

Thirdly, I dedicate it to all those who, before this worked, "suggested" to me that I should never spend time and money "on something that was never going to work" and also to those who, after it started working, did not believe me when I said that my vehicle was running on waste.

Eddy Ramos,
January 2021.

Anyone, is PUBLIC, can download (and print) for FREE the "Guide for driving a vehicle only on chargas & water" from my Facebook: "Driveonwaste Driveonwaste"

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INDEX.

For the glory of God.

Chap. 1: Introduction, description and operation……..……1

Chap. 2: Construction ……..……5

Chap. 3: Starting, driving and shutdown. Possible problems……..……..12

Chap. 4: Maintenance ……16

Chap. 5: Cyclone or coarse particle separator ……..17

Chap. 6: Filter in oil bath. ……..19

Chap. 7: Towel filter ……..……..20

Chap. 8: Carbonization ……..……..21

Chap. 9: How to measure density ……..……26

Chap. 10: Evaluation of some types of residues/waste.……27

Chap. 11: Checklist ……..……29

Chap. 12: Diffuser disk……..……30

Chap. 13: Trailer gasifier……..……31

GUIDE TO MAKING A CAR WORK WITH CARBONIZED WASTE & WATER.

For the Glory of God.

Patent pending: INPI 2019-0103426.

"Man does not only live on oil, but also on waste that exists all around the world."

Chapter 1: INTRODUCTION, DESCRIPTION and OPERATION.

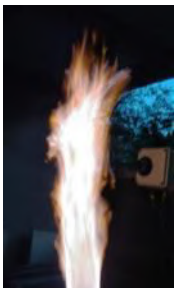
1. INTRODUCTION.

Yes, it is true, a simple system can be built that easily and quickly converts carbonized waste/residues into a chargas to run any internal combustion engine (electric motor-generator, vehicle, etc.) without modifying the engine. This system was mounted in the bed of my truck**.** In my 1983 Ford Falcon "Ranchero" truck, with a 3.6 Liter (221ci) engine, the consumption is aprox 15 Kilos (33 Pounds) of carbonized waste/residues per 100 km (62 miles) of travel at 80 km/h (50 Miles/h) using ONLY chargas & water, without gasoline nor Liquid Petroleum Gas (LPG). In a car with a smaller engine the consumption will be lower. I can also start and accelerate up to 115 Km/h (72 Miles/h) **only on chargas** without gasoline, as shown in one of the videos: *115 Km-h only on chargas without gasoline nor LPG*. I started driving on chargas in October 2019. The basic information for this is FREE on this site.

It is suggested that ALL information be downloaded, saved and spread **BEFORE IT MAY BE DELETED FROM THIS WEBSITE** by others who may be interested in this **NOT** being disseminated (example: oil industry). You have total permission to manufacture and disclose it by mentioning this source.

There are more and more vehicles that run on fossil fuel (gasoline) but there is less and less oil. When the oil runs out (and it will) there will not be many options left. The electric car that is talked about so much today needs to recharge its batteries with electricity, but again, in Argentina up to 80% of electricity generation is made with fossil fuel. Carbonized waste/residues is a good option, as there is more and more and it is usually free. In addition, this vehicle by consuming waste helps to clean the planet. Even in autumn, nature gets rid of a lot of things that it produced in the summer, such as seeds, pits, husks, etc. Pruning wastes are also useful. Another advantage of this system is that since everything works with aspiration, there is no container under pressure as with LPG tanks, nor does it have a tank with something explosive, such as gasoline. Plus exhaust 20% oxygen at the tail pipe while driving.

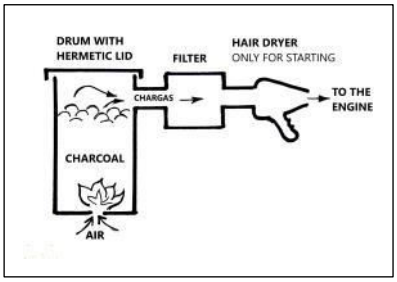
VERY IMPORTANT WARNING: "Chargas gas" is CARBON MONOXIDE, which is a combustible gas and VERY TOXIC. It is a CRIMINAL gas as it has no color nor odor and can kill. NEVER operate this system in enclosed spaces such as garage, etc. Only operate outside or in very well ventilated spaces. It is VERY POISONOUS. You simply MUST NOT breathe it.
USE EXTREME PRECAUTIONS! Thousands of people die inside their bedroom when they fall asleep with a faulty heater that emits carbon monoxide.
Chargas can be used for cooking and/or heating, but it is so toxic, that is better to be used only in an engine right after its generation.



Chargas

2) DESCRIPTION OF WASTE GASIFIER FOR VEHICLES.

System Summary: A simple metallic drum with an airtight lid, is filled with carbonized waste. Air enters the drum through a hole underneath and the chargas exits above, and after some filtering enters to the engine. The hair dryer/blower is for starting only.



Note: All reading is intended to be straightforward. For those who wish to go deeper technical information is expanded at the end of each chapter as indicated with a call (see below * x). It is also intended that the system is simple to build with the minimum of complications and as far **as possible without any type of electrical welding** (everything is clamps, silicone caulk and Teflon tape).

Description of my vehicle: (see drawing and photo on page 11) The 1983 Ford Falcon "Ranchero" truck has a model 3.6 Liter (221ci) engine. It can start and run with only chargas (see below *1). My first gasifier is a test one with a small 75 Liter (19 Gal) drum, the load capacity is 65 Liters (15 Gal), whose range depends on the type of carbonized waste/residues and the driving conditions but is between 30 and 40 km (19 to 25 Miles). The higher & bigger the drum, the greater the driving range of the vehicle. The upper cover for loading the carbonized waste is metallic and hermetic. The nature and the consistency of the carbonized load is explained below. At the base of the drum there is a hole, with a spout, nipple or nozzle, for the entry of air, water and firing the system. The entire system works with the suction of the engine intake manifold. The chargas comes out of the upper part of the gasifier and goes through some filtering system (cyclone, oil bath filter and towel filter) before it gets to the engine. Note: the oil bath filter is not shown in the diagram at the end of this chapter, but is shown at the end of chapter 2. In this way the chargas enters clean into the engine. To start this gasifier, some type of blower is necessary, such as a hair dryer or a Bildge blower or a car HVAC blower. Once the gasifier has been ignited and the engine of the vehicle (or electric motor-generator) powered by the chargas is started, the blower is no longer necessary.

3) OPERATION:

● Starting: First load the gasifier drum with carbonized waste (=pure charcoal), close de airtight lid. Fill the water bottle. Then the starter blower is turned on. The gasifier is then ignited with a flame introduced through the nipple/nozzle inlet at the base of the drum. When the charcoal is ignited inside the drum, the chargas is immediately produced and drawn by the blower to flush the entire system in a few minutes. Start dripping the water drops system. When all of the air in the system is thus purged and replaced by pure chargas, it can be lit with a match. At this time, the chargas can be introduced into the vehicle's engine and it can be started. The vacuum of the intake manifold on the running engine now produces the suction in the gasifier. So from this moment on, the starter blower is no longer necessary.

● Driving: It can be driven until the charcoal load descends to half the level of the gasifier. It is recommended to install a thermometer at the gasifier outlet that indicates the gas outlet temperature. With this indication, the level of charcoal inside the gasifier can be determined. It's like the fuel gauge. The temperature of the chargas raises as the top of the load approaches the fire in the bottom of the gasifier. When the temperature reaches 110 ºC (230ºF) it is time to reload: Turn off the vehicle's engine, remove the gasifier lid, reload with charcoal, and closed the lid. The engine is started normally without the blower. If while you are driving the chargas runs out, you can continue by changing to gasoline/LPG, without stopping or getting out of the vehicle.

● Shutdown: If the engine is stopped for a short time, the gasifier continues hot for a while and can be restarted normally without the blower. This restart time window (1 to 4 hours) depends on many factors. If the engine is stopped for a prolonged period, the gasifier should be turned off by plugging the inlet of the nipple/nozzle and plugging the gas outlet. This keeps the remaining charcoal from burning to ash and stops the exit of poisonous chargas.

4) POLLUTION: This system is "Decontaminating" because by consuming carbonized waste/residues it cleans the planet. Furthermore, chargas is less polluting than currently used fuels and contributes a 20% of oxygen to the environment while driving. (see below *2).

5) DEFINITION OF CARBONIZED WASTE: Not all types of carbonized waste are appropriate for gasifier fuel. For example, the incomplete combustion of plastic waste or wood laminated inside the gasifier can generate toxic and/or corrosive gases for the engine.

Carbonizing waste means that before using it in the gasification, the humidity and the tar have been eliminated leaving only dry and pure charcoal. Carbonizing waste is a simple art that can be learned; see Chapter 8 “Carbonizing”. Improperly carbonized waste will have volatiles/tar that may cause problems (see below *3).

The heavier the better. For example, hard wood charcoal is heavier than peanut shell charcoal. The carbonized waste can be from a wide variety of vegetable sources, both industrial and natural. Wood: branches, logs, wooden boxes, wooden pallets, manufacturing scraps, etc. Other tree products: Pits of peaches, apricots, etc. Shells: walnuts, peanuts, almonds, hazelnuts, chestnuts, etc. Seeds: oak acorns, black cedar nuts, pine cones, etc. Vegetables and carbohydrates: pasta, potatoes, dry bread, etc. Even animal bones can be carbonized for gasifier fuel. Mineral coal has to be re-carbonized to eliminate the tar. Never use olive pits, they are very corrosive because contains salt.

Waste can be “natural or industrial”. These “natural” or “renewable” wastes are those that nature leaves behind in the fall, what it produces in spring and summer. For example seeds such as oak acorns, black cedar nuts, pine cones, dry branches and logs, also pruning remains. The "industrial" waste is what the industries leave behind. For example walnut shells, peanut shells, peach or apricot pits, etc.

6) GRANULOMETRY: The last stage is obtaining the appropriate grain size of the charcoal (granulometry). It should be between 3mm (1/8”) (like a grain of rice) and 20mm (3/4”) (like an olive), is better if the max size is 12mm (1/2”). Two screens must be used to achieve that size. If it is very large it must be crushed. Of course it is not necessary to screen carbonized waste that lies between these two measures, as for example occurs with seeds (ie: oak acorns, black cedar nuts, etc.). This range in size of the pieces of charcoal helps the proper functioning of the gasifier, and also increases the density of the load. The higher the density, the greater the energy for the same volume. For example, UNSIEVED walnut shell has a density of 100 Kg/m3, but SCREENED between these two values (3 to 20 mm) its density doubles, that is, 200 Kg/m3 thus doubling the driving range for the same gasifier size.

NOTES:

* 1) The chargas is not methane: Chargas is carbon monoxide (CO) that is very combustible and is produced inside a gasifier by the incomplete combustion of dry charcoal a few minutes after ignition. Chargas is not the methane gas that forms in a “digester” that runs on wet waste and that decomposes after several weeks.

* 2) Pollution: Chargas & water = carbon monoxide + hydrogen + oxygen is less polluting than gasoline (which pollutes with lead, sulfuric acid, etc.). Also chargas engines contributes 20.76% oxygen to the environment unlike all vehicles that pollute and consume oxygen from the environment. The following analyzes of September 21, 2021 are of the exhaust gases combusting gasoline, LPG, Chargas without water and Chargas with water, always engine at 1,200 rpm.

Analysis **Gasoline**
CO: 3,48%

On **LPG.**
CO: 3.63%

Chargas no water
CO: 0.19%

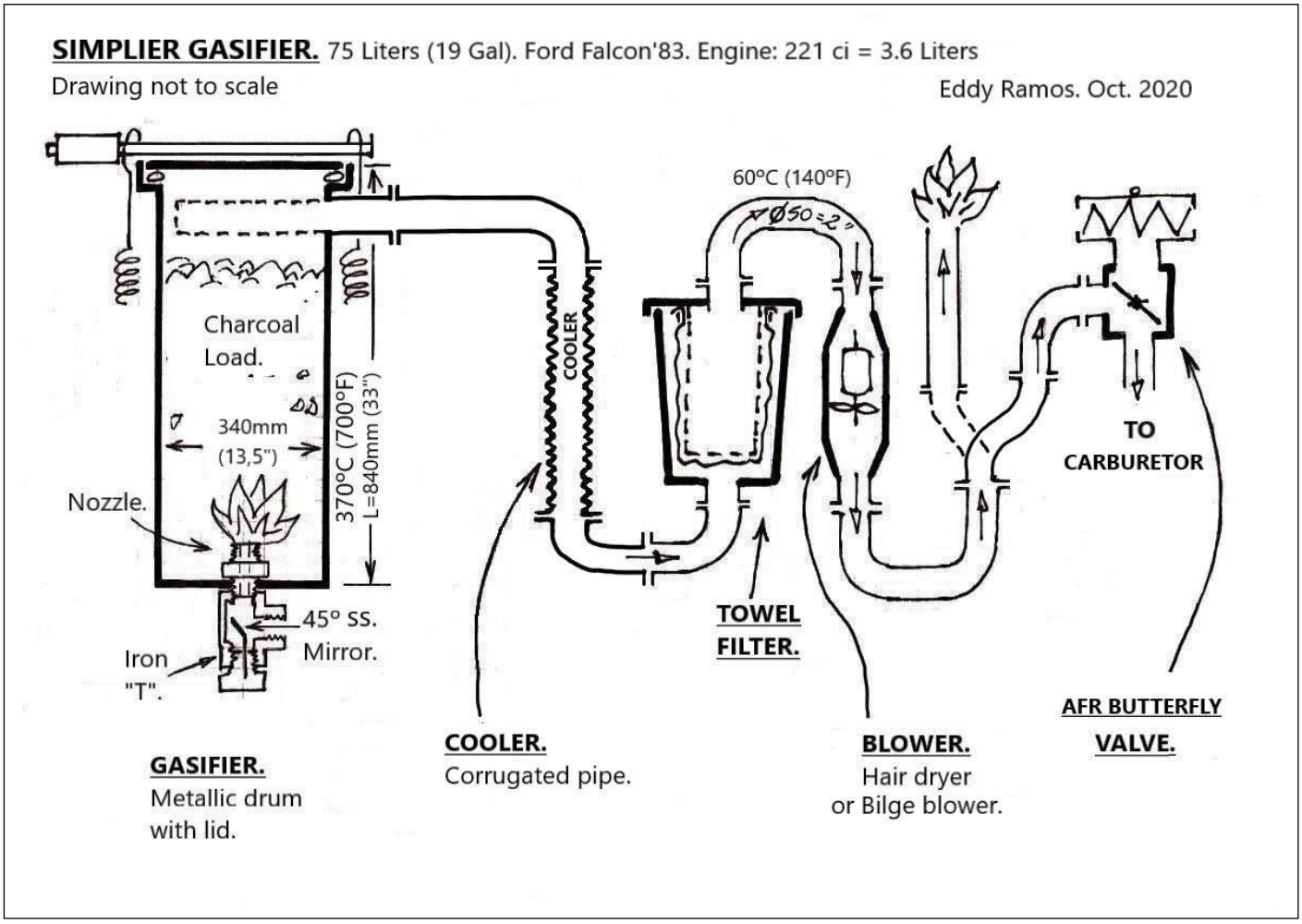
Chargas with water.
CO: 0.00% O2: 20.76%

The carbon monoxide vehicle is even less polluting than the electric car that is talked about so much today. Although the electric car does not generate combustion gases, it needs to recharge its batteries with electricity. Where I live in Argentina most of the electricity generation it is made with fossil fuel.

In other words, the electric car does not pollute the neighborhood where it circulates, but it pollutes the country.

* 3) These volatiles together forms a type of tar that has some caloric value, but when it cools it turns into a kind of glue. While the system is hot, this tar circulates in a gaseous form thru all the filtering system. But when the engine cools down this tar can stick the intake valves. Then when cold starting is attempted, the stuck valves are twisted by the force of the camshaft that tries to move them but are stuck to their seats by the cold solidified tar.

Another problem is that the volatiles pass in gaseous form through all the filters and then as they cool down, it condense in the system and dirtys everything: the filter, the hoses, the carburetor, the intake manifold and also increase the slag in the nozzle. This can happen in very few kilometers. To top it off, some volatiles are very corrosive and can corrode everything in a very short time.



Chapter 2: SYSTEM CONSTRUCTION.

For the Glory of God.

This is not a detailed construction description; these are just basic ideas for making a prototype that obviously accepts modifications. The collaboration of an auto mechanic would help a lot. This construction is focused to have the least difficulty and, without welding.

NECESSARY MODIFICATIONS OR NOT OF THE ENGINE FOR USE WITH CHARGAS:

A) If the vehicle runs on gasoline only, the distributor is normally 6 to 10 degrees ahead of TDC (Top Dead Center). As the gas combustion rate is slower then it is necessary to advance the distributor to 8 to 13º with respect to the TDC. If the vehicle was already running on LPG, the distributor should already be in advance for gas and it is not necessary to modify it. This is only for starting the engine, as once in operation there is little difference. An advance between 8 to 10º of the TDC serves for both: gasoline and gas.

B) It is important that the ignition coil is of the highest voltage available on the market, since gas is more dielectric (insulating) than gasoline. If the vehicle was already running on LPG, it should already have it installed.

C) If the engine, in addition to the chargas, is going to work with another fuel (such as gasoline or LPG) then it is very convenient, although not necessary, to place a simple butterfly valve on the carburetor mouth as explained below in the next page.

CONSTRUCTION OF THE SYSTEM:

As the whole system works with negative pressure, that is to say with suction, then it is very important that there are no air leaks throughout the system. To do this, see about "Air tightness" in Chapter 4: "Maintenance".

To better understand the system, refer to the drawing and the photo at the end of this chapter.

1) THE GASIFIER:

The gasifier, made from a metal drum and a lid with a rubber gasket. The higher & bigger this drum is, the better driving range can be done with a single load. My first test gasifier was 75 Liters (19 Gal) (Diameter: 340mm =13.4"X Length: 840mm=33") it had a driving range of approximately 30 Km (18 Miles) to 50 km (30 Miles) depending on the speed and the type of waste. This first gasifier had the drum supported by a pivot in the middle that allowed it to be overturned. In other words, it could be turned half a turn to easily unload it. My second gasifier was a 200 Liters (50 Gal) capacity drum, not tipping and a lid with a silicon gasket. It must have a well-sealed, air tight metal lid with a gasket to prevent leaks (like the 50 Gal honey drums). At the base of the drum is the secret of this system, a pipe or nozzle is installed as described below. The chargas outlet is through the upper part of the drum through an outlet pipe.

Grille before gas outlet from the gasifier:

To avoid pieces of charcoal that fly inside the gasifier from plugging the outlet of the chargas it is advisable to place a metal mesh whose holes are equal to or smaller than the outlet at the base of the cyclone.

2) THE FILTERING:

The main idea with the filtering is that the chargas reaches the engine as clean as possible. The dirtiness of the chargas depends on the type of initial waste, the quality of the carbonization and the speed of the vehicle. The higher the speed of the car, the greater the amount of dirt that comes out with the chargas or drags out from the gasifier. The following filtering scheme is very complete as it is for all types of charcoals. If you use a cleaner type of chargas, you do not need as much filtering.

The chargas that comes out through the gasifier outlet pipe can first pass through a cyclone or coarse particle separator, then it can be cooled before passing through an oil bath filter and finally through a towel filter.

2) THE FILTERING SYSTEM:

● **The Cyclone**: Its function is to filter the thickest particles and some water when the load is a little humid. This reduces the number of times the next filter needs to be cleaned. Some soldering may be needed to build it. In this design an inverted fire extinguisher was used. See Chapter 5: “Cyclone”.

● **The Cooler**: The chargas then goes through a cooler that is a corrugated metal pipe (see below in NOTES *1). This spout can be made of 76mm (3”) diameter aluminum or 50mm (2”) diameter stainless steel. See below paragraph “B: Adding drops of water”. The longer the cooler, the better it will cool the chargas, but as it always accumulates dust, then it must be disassembled to clean it. I am using a 4.5 meter (15 feet) S.S long cooler.

● **Oil bath filter**: Then it enters an old air oil bath filter similar to those installed in very old large engines (tractor or truck) that have tubular inlet and outlet. You can also use a Renault Torino or Rambler car oil bath air filter but it must be modified as the air inlet is not tubular. For more details see Chapter 6: "Oil bath filter".

● **The cloth filter**: Then it goes through a last filter which is a 20 liter plastic bucket, with a black microfiber towel. For more details see Chapter 7: "Towel Filter".

3) THE BLOWER: Then it goes through a blower that is only used for the cold start of the gasifier. In this design is used a “Bilge blower” (see below in NOTES *2), which is a 12Vdc fan used in RV or boat, but you can use a hair dryer without the heat or a car HVAC 12 Vdc blower.

4) THE MULTIVALVE: In this design there is a 38 mm (1½”) two-way plastic multivalve, which has one inlet and two outlets (see NOTES *3 below). Such as the one used in swimming pool equipment. This multivalve is not essential; in my following constructions I did not use it at all.

5) FLAME ARREST: Before the engine, some type of flame arrestor is suggested, to prevent the flame from going backwards, that is, towards the filtering system, which can cause an explosion. I've never used one, but it's a good idea.

6) AFR BUTTERFLY VALVE on the carburetor mouth (See below in NOTES *9): Finally the chargas goes to the engine carburetor where there is a butterfly valve. This valve should be operated by the driver from the cab. The valve is not essential but it facilitates two things: (A) On the one hand, it allows you to change fuel while you are driving. In this way, when the vehicle is operated with chargas this valve is almost closed, but lets in a little air to achieve the Air/Chargas mixture. As the gasifier delivers chargas with some air, sometimes the butterfly will go completely closed. When the vehicle runs on LPG or gasoline, this butterfly valve will be fully open. And (B) on the other hand it can regulated the AFR mixture. This design has the problem that tar gets into the carburetor. A better design will have the AFR butterfly and the chargas inlet between the carburetor body on top and the throttle butterfly at the bottom, this way avoids tar getting into de carburetor body.

AFR Valve completly open

AFR Valve almost closed

7) THE CONNECTIONS WITH CAMS: All the connections of the hoses are of the type to levers or cams (see below in NOTES *4). They are not essential either, but they facilitate connections.

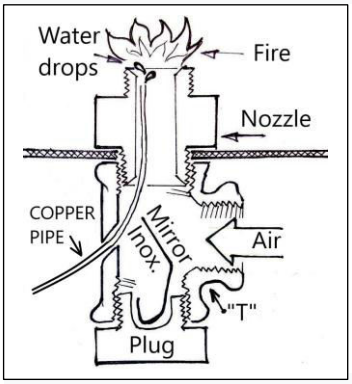
NOW LET'S GO TO THE DETAILS:

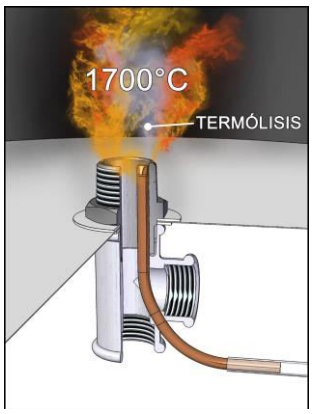
A) THE NOZZLE: Also see below NOTE *5:
It is the secret of this system. The first thing to do is calculate the diameter of the INNER hole of the nozzle as it is critical for the correct operation of the system. This is calculated based on the engine displacement expressed in LITERS and the engine RPM when the vehicle circulates at 80 km/h and the result is the size of the inside hole of the nozzle in MILLIMETERS.
Let's take for example a Ford Falcon from 1983, with a model 221 engine that is 3.6 liters. At 80 km/h in fourth gear ("direct") the engine turns at 2500 RPM.
We will call "**A**" **(RPM)** = 2500 rpm, which are the engine revolutions circulating at 80 km/h direct gear.
We will call "**B**" **(LITERS**) = 3.6 liters which is the size of the engine = volume of all the engine cylinders.
The internal diameter (in millimeters) of the nozzle will be equal to: "**A**" times 0.0046 and the square root of "**B**".
Let's see how it looks:
Nozzle int diameter: **A** X 0.0046 X √**B** = 2500rpm X 0.0046 X √3.6 Lts = 2500 X 0.0046 X 1.897 = 21.81mm.
This result can vary between a minus and a plus 10% =
That is, 21.81mm (0.85”) MINUS 10% = 19.62mm (0.77”) and PLUS 10% = 23.99mm (0.95”).
Result: For this motor the nozzle will have a hole between 19.62mm (0.77”) and 23.99mm (0.95”)
A nozzle with a 20mm (3/4”) hole was used and it worked very well (See NOTES *5 below).
Large nozzle: Then I tried to use a larger nozzle whose hole was 23.4mm (0.92”) but it did not work well, especially at low rpm.
Conclusion: A bigger hole does not mean more power. The nozzle hole should be just right for it to work well at low and high rpm. The formula gives an approximate measurement, then different diameters must be tested starting with the smallest size until the optimum is found. When this air passes so quickly through the incandescent embers of the appropriate size (granulometry), incomplete combustion occurs, that is, carbon monoxide (CO) or chargas is generated, which is a combustible gas. If the air speed is slower, a complete combustion of the embers will occur, that is, carbon dioxide (CO_2) is generated, which is a non-combustible gas. **Approximate inner nozzle diameter hole: For a 2.6 liter engine it would be 17.3mm and for smaller 0.9 to 2.0 liter engines it would be between 14.3 and 14.6mm.**

B) ADDING 2 DROPS OF WATER (See below in NOTES *6):
The humidity in the gasifier load detracts from the power of the chargas since calories are wasted to evaporate this humidity. In addition, this moisture leaves the gasifier in the form of water vapor together with the chargas, then this water vapor condenses and smears everything. That is why it is convenient that the load inside the gasifier has the lowest possible humidity. On the other hand, when a few drops of water are injected into the mouth of the nozzle, these drops impact against the incandescent carbon generating hydrogen and oxygen, gases that are much more combustible than carbon monoxide. In other words, with the addition of drops of water, the chargas will have carbon monoxide PLUS hydrogen and oxygen gases. The water vapor comes out of the moisture that evaporates from the wet charge and is different from the hydrogen and oxygen gases that are generated by the water drops when it hits the glowing carbon in the nozzle. This is why the addition of water drops inside the nozzle increases the power to the engine, facilitates cold engine starting, contributes of oxygen to the environment and cools the chargas at the gasifier outlet, therefore increasing the driving range. In other words, you can travel almost twice the distance without reloading.

If too much water is added, it does not increase the power any more, it simply continues as water vapor mixed with the chargas and this excess of water vapor condenses on the way which is not good and makes everything messy. The addition of water makes the chargas more powerful but also makes it contain nitric and carbonic acid particles at the gasifier outlet. If a corrugated aluminum pipe is used as a cooler, these acids can pierce it in a short time. If adding water is to be used then it is advisable to use corrugated stainless steel pipe (See below in NOTES *1).

The water injection must be a few millimeters below the nozzle outlet. A copper pipe from a disassembled thermocouple can be used to allow the heat of combustion within the nozzle to vaporize the water without melting the pipe. The copper pipe needs to be as straight as possible so it can be cleaned inside with a wire.





C) THERMOMETER AT THE GASIFIER GAS OUTLET (See below in NOTES *7):

It is convenient to install a thermometer that indicates the temperature of the chargas at the gasifier outlet. It is like the fuel gauge that indicates the level of charcoal inside the gasifier. As the level of charcoal decreases, the temperature of the chargas increases. When the temperature reaches 110ºC it is time to reload or change fuel.

D) AFR (Air-Fuel-Ratio) sensor/gage: (See below in NOTES *8)

It is necessary to have a AFR sensor installed at the outlet of the exhaust manifold to regulate the best AFR. It must be installed in the exhaust pipe about 100 mm (4") from the outlet of the exhaust manifold. The AFR gage installed on the dashboard near the car instruments.

E) CARBON MONOXIDE DETECTOR IN THE CAB:

It is highly recommended to have a battery-powered or 12 VDC carbon monoxide detector in the vehicle cabin, as this gas is VERY toxic. Carbon monoxide should be detected immediately in case there is any leakage of this gas inside the vehicle cabin.

NOTES:

Places to get each piece: In principle, they can be obtained for free, for little money or buy online:

*1) The 3"corrugated aluminum pipe: It is used as a gas outlet for a water heater. Available at any hardware store, it comes up to 2 meters (6 feet) long. The corrugated stainless steel pipe of 50 mm (2") diameter: It is bought in exhaust pipe houses.

*2) The starting Blower: It can be a 220 Vac hair dryer. A "Bilge blower" is an axial fan of plastic fitting a 76 mm (3") diameter tube that operates at 12 VDC. It is used to ventilate the bathroom of a RV or In a boat. In my second design I used a car HVAC 12 Vdc blower.

Bilge blower

*3) The Two-way multivalve: It is a valve with one inlet and two outlets. They are 39mm plastic (1 ½ ") in diameter and are used in pool equipment. It is not indispensable.

Valve in "Caburetor"

Valve in "Off"

Valve in "Exterior"

*4) Connection of cams: It is to facilitate the arming and disarming of the system. Double junction type connections are slightly cheaper.

*5) Nozzle Material: A common galvanized or a natural gas epoxy nipple can be used as a nozzle but they are very thin-walled and melt in a short time. On the other hand, the high pressure hydraulic oil hose Hex-nipple is a thicker wall nipple that is used in the connections of agricultural equipment and withstands high temperature very well. For the Ford Falcon 221, 3.6 liter engine, a high pressure hose Hex-nipple with an external diameter 25.4mm (1") NPT thread was used as a nozzle whose inner hole is 20mm and it worked very well.

25.4mm NPT hydraulic hose Hex-Nipple
Inner diameter: 20mm.

*6) Regulation of the drops of water: To regulate the drip, you can use an IV, which is the plastic tube with transparent drip sight glass for injecting serum into hospital patients. **This injection of the water drops into the gasifier nozzle is by gravity**. The regulation of the drip by "wheel" is better than the regulation by a twisted valve.

*7) The Thermometer: Used to measure engine water temperature. It is obtained at auto parts house.

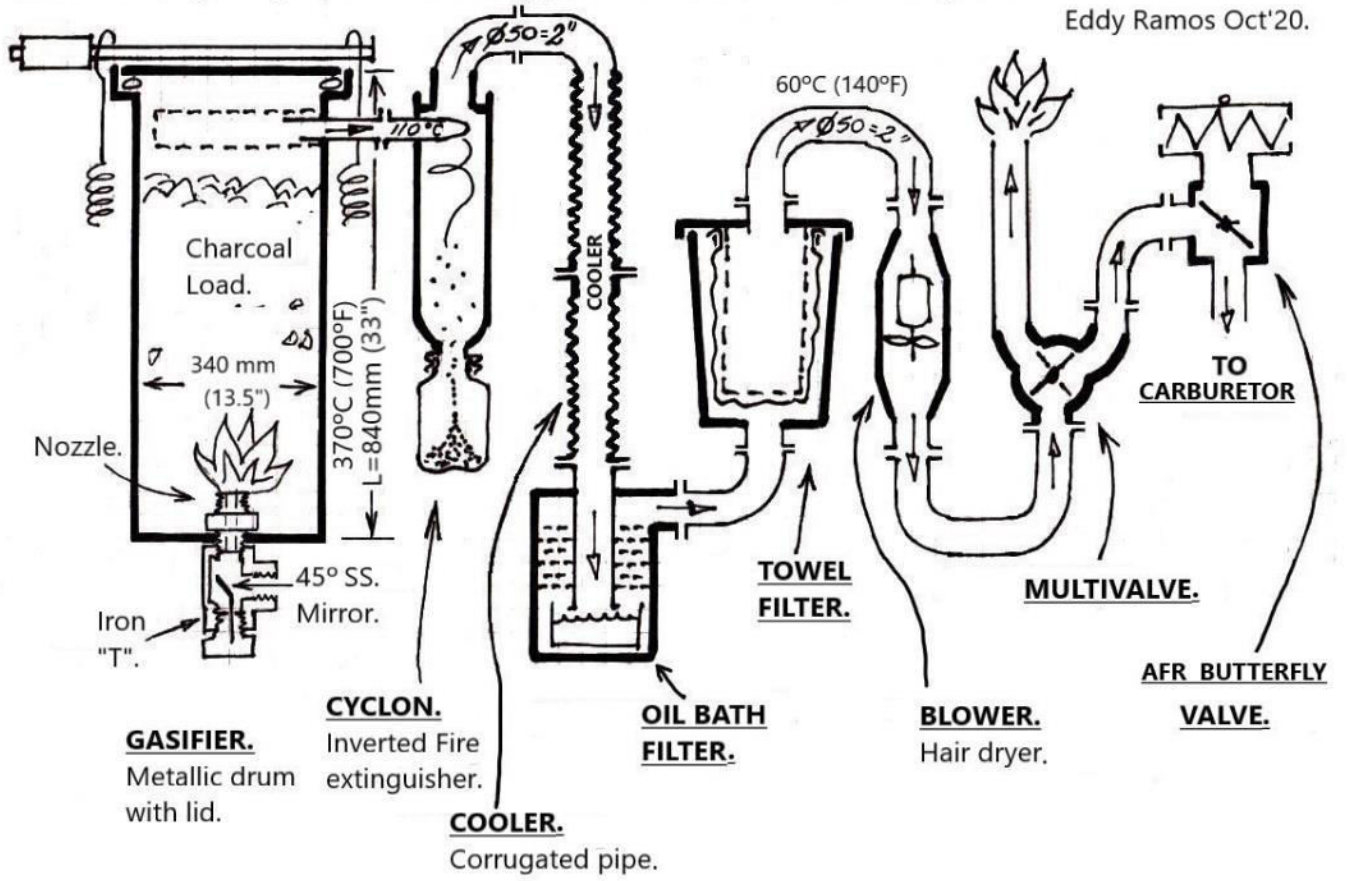
*8) ARF sensor: It is used in modern cars. New is expensive. But in tailpipe shops when they override a vehicle's catalyst they sometimes remove this sensor. This is available for free used or for little money in the same workshop when you request to place one in your vehicle. It is necessary to obtain the gage indicator of the AFR mixture that is connected to the sensor. This gauge I got used cheaply in a modern auto repair shop.

*9) AFR Butterfly valve: I made it myself because it is very simple. Surely there may be some autopart similar to it, ie a carburetor choke valve.

TECHNICAL SPECIFICATIONS OF THE VIDEO At 115 km/h without LPG nor gasoline:

Place: On highway 36 from Rio Cuarto to Córdoba, June 24, 2020, approx. 6.30 pm.
Outside temperature: 7ºC (44ºF).
Wind speed: Calm.
Vehicle: 1983 Ford Falcon "Ranchero" Truck. Weight 1.400 Kgs (3100 pounds).
Engine: Ford brand, model 3.6 liter (221cubic inches) displacement, power = 132 Hp @ 4000rpm.
Fuel: Only charcoal of walnut shells (Junglans Regia), density approx = 176 Kg/m3 + Water = 2 drops/sec.
Small gasifier, diameter = 340mm (13.4"), height = 840mm (33"), 75 Lts (19 Gal).
Nozzle: 25mm (1") NPT hydraulic Hex-nipple with 20mm (¾") inner hole.
Gasifier chargas outlet: Diameter = 38mm (1 ½").
Cyclone: 12-liter inverted fire extinguisher, with 38mm (1½") inlet and 50mm (2") outlet and a transparent glass bottle at the base.
Cooler: 50mm (2") corrugated stainless spout, length = 4.5 meters (15 Feet).
Oil bath filter: From modified Renault Torino, with inlet and outlet diameter = 50mm (2").
Oil bath filter to the cloth filter: 50mm (2") corrugated stainless steel pipe, length = 1.5 meters (5 Feet)
Cloth filter: Cloth inner unit only: From VW truck 17280, it was Tecfil ASR839. Since this commercial cloth filter collapsed, then I later exchanged it for a wire cage covered with a black microfiber towel.
From the Cloth Filter to the Blower: Flexible plastic hose diameter: 57mm = (2¼"), length: 1 meter (3 Ft)
Blower: Type "Bilge blower" 12 VDC.
Plastic Multi-valve: 38mm (1½").
Connection from the Multivalve to the butterfly valve on the engine carburetor: Flexible plastic hose diameter = 57mm (2¼ "), length = 4.7 meters (14 Ft).
Direct connection to the motor, without blower or multivalve. This was achieved through the following procedure: First I turned on the gasifier and the vehicle's engine to chargas with the Blower and Multivalve connected. Then I turned off the vehicle's engine, disconnected the Multi-Valve and the Blower. I connected the chargas from the Cloth Filter directly to the hose that goes to the butterfly valve on the engine carburetor without going through the Blower or the Multivalve. Then I started the engine again and began to circulate with the gasifier almost cold. It took about 4 km (aprox 3 minutes) until the gasifier came into operation and reached the maximum speed of 115 km/h (72 miles/h). At that moment I started filming and went off the road to open the hood of the vehicle and show that the LPG and gasoline were disconnected. That is, I started and reached that speed ONLY with chargas.

BASIC SCHEME and EXPLANATORY PHOTO OF THE SYSTEM.



VERY IMPORTANT WARNING: "Chargas gas" is CARBON MONOXIDE, which is a combustible gas and VERY TOXIC. It is a CRIMINAL gas as it has no color or odor and can kill. NEVER operate this system in enclosed spaces such as garage, etc. Only operate outside or in very well ventilated spaces. It is VERY POISONOUS. You simply MUST NOT breathe it.

USE EXTREME PRECAUTIONS! Thousands of people die inside their bedroom when they fall asleep with a faulty heater that emits carbon monoxide.

For the Glory of God.

In winter it would be advisable first to start and preheat the engine with LPG or Gasoline.

Starting procedure:

1) Check the levels of oil, coolant, and brake fluid of the vehicle.
2) With the engine off, make sure that the LPG and/or gasoline fuels are cut off and that the carburetor bowl is empty. Verify that the distributor advance is for CHARGAS.
3) Check the condition of the batteries of the carbon monoxide detector in the cabin.
4) Check all connections and possible air leaks.
5) Remove the caps from the gasifier air inlet. Clean the inlet of the nozzle with a "nozzle cleaner" rod (see photo below) if necessary to remove any slag that has remained and may be blocking the nozzle outlet. Place the lower plug with the stainless steel mirror (see photo below).

Nozzle-cleaning rod with a groove for the water drops

Plug with SS. mirror.

6) Remove the gasifier lid. Cover the chargas outlet screen to prevent charcoal from falling into this outlet. Load the gasifier with charcoal.

7) Measure the level of the charge. Uncover the gasifier outlet. With a brush, clean the edges where the gasifier lid sits.

8) Place the gasifier lid.
9) Position the multivalve with outlet to flare "Exterior".

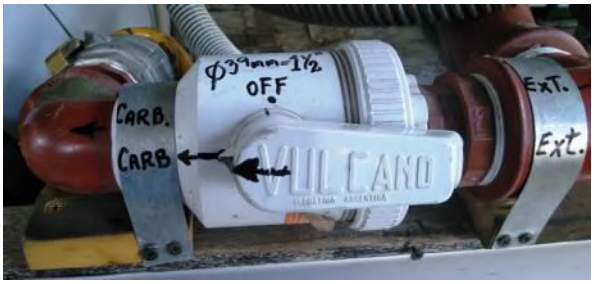
10) Turn on the starter blower. Add alcohol to the inlet of the nozzle and light with a match, lighter or torch until the gasifier ignition is verified by the red color reflected in the stainless steel mirror. Install the flame arrestor in the air inlet/ignition port. Place the tray under the gasifier.

Ignition.

The glowing ember reflects at the mirror of the plug.

Flame arrestor at the port.
Tray placed under the nozzle.

11) Continue with the blower on until the system is completely flushed (2 to 5 min) and the chargas comes out **continuously WITHOUT water vapor or SMOKE**. (If the smoke does not disappear there may be too many volatiles or water in the load. It is advisable to change the load, unloading it into metal buckets with a NON-HERMETIC lid). Then light the chargas and flare the system in a safe direction. The flare must be continuous, solid and WITHOUT SMOKE. If the flame is weak, there is a dirty filter, clogged nozzle or air leak.
12) Adjust the water drip between one to two drops per second, no more. Remove the engine air filter.
13) Position the multivalve towards the "Carburetor" (see photo below). If you have an AFR butterfly valve on the carburetor, then open it fully to help flush the hose that goes to the engine.



14) After 30 sec. start the engine: Completely closing or slightly opening the AFR butterfly valve and turning on/off the starting blower.
15) Once the engine is started, replace the engine air filter, adjust the AFR mixture with this AFR butterfly valve. Let it regulate for 60 seconds, and then adjust little by little for smooth running.
16) When the engine can be idled and accelerate without dying, the journey can begin.
17) If desired, you can turn off the engine and connect the "Chargas" directly to the hose that goes from the last filter directly to the engine, without the blower and the multivalve and then start the engine.

Driving on "Chargas":
It can be handled normally as if it were with LPG.

Operation of the AFR butterfly valve on the carburetor inlet:
When the engine is started on chargas, the AFR butterfly valve should be almost closed. As soon as the engine starts, regulate the opening of this butterfly valve until you notice that the engine works better and keep it in that position throughout the entire trip, unless the AFR gage indicator sais otherwise. Then, while driving, together with the indications of the AFR gage, this AFR butterfly valve can be closed or opened to obtain always the best combustion.

If the AFR butterfly valve is completely closed, it may be due to the following reasons:
A) There are air leaks between the gasifier and the carburetor (hoses, filters, etc.) making it unnecessary for more air to enter the carburetor mouth.
B) Dirty chargas filters, so when closing the AFR butterfly valve, the greater suction compensates for the dirt in the filters, until the filters are completely dirty.
C) Nozzle plugged by excess slag.

Towel filter change:

While driving, if it is necessary to completely close the AFR butterfly valve or when the AFR gage indicates a very lean mixture, it means that the towel filter is dirty (or that are air leaks). Turn off the engine, remove the cover of the towel filter, put on gloves. Change the dirty towel for a clean towel, replace the filter cover and start. Wash the dirty towel with soap and water.

Fuel reload:

If the gas temperature at the outlet of the gasifier reaches 110ºC (230ºF), it means that it is time to recharge (or change fuel, see below).
1) Turn off the engine and turn off the water drops.
2) Wear gloves because the lid is hot.
3) Remove the gasifier lid. **BEWARE!! When the hot gasifier lid is removed there may be a "Puff", a small explosion.** Open the lid away from your face and hold your breath to avoid breathing the carbon monoxide that emanates from the gasifier. Measure the level of the charcoal load.

It can be seen how the lighter shells that fly into the gasifier end up deposited on the mesh.

4) Use the “Nozzle Cleaner” bar if necessary.
5) Cover the screened gas outlet of the gasifier to prevent the charcoal from falling through the screen and plugging this suction outlet (see photo above #6 in “Starting procedure”). Refill the gasifier. Measure the level of the full charge. Uncover the gas outlet screen of the gasifier. With a brush, clean the edges where the lid sits (see photo above # 7 in “Starting procedure”). Replace the gasifier lid, open/adjust the water to one to two drops per second, no more than that.
6) Start the engine. If the engine is turned off for a short time, then it can be started without difficulty. It may be necessary to use the “Nozzle cleaner” bar (see photo above #5 in “Starting procedure”) with the engine running. If the engine is switched off for a long time, it is necessary to follow the indications for permanent shutdown described below in “Final shutdown”.

Fuel change:

When the gas temperature at the outlet of the gasifier reaches 110 ºC (230 ºF), it means that it is time to reload or change fuel. If there is no more charcoal for reloading, the other fuel (LPG or gasoline) can be enabled. For this, the AFR butterfly valve at the carburetor inlet must be COMPLETELY OPENED. You can continue driving like this until you can park safely. Beware as there is no suction in the nozzle, so burning embers may fall through the flame arrestor at the nozzle and fly out, potentially causing a fire. It is advisable to stop as soon as possible to completely turn off the gasifier, turn off the water and extinguish the burning embers that may remain in the tray with water. I solved this at the gasifier trailer by screwing a metal embers holder at the nozzle.

If you are going to use gasoline, remember to retard the distributor (6 to 10º) for gasoline. This is to facilitate starting, because at high rpm if the distributor is not adjusted it only increases fuel consumption.

Final shutdown:

1) Cut off the water.
2) If you are driving on gasoline, cut off the gasoline and continue with the engine running until the carburetor bowl is empty. If the carburetor bowl is left with gasoline and then you try to start with LPG or "Chargas" the engine will not start because it will have two fuels at the same time.
3) Turn off the engine.
4) Close the gasifier completely, that is place the plugs at the air inlet and at the gasifier outlet. The gasifier will cool off in a couple of hours due to lack of air. Extinguish any embers that may remain in the tray under the gasifier.
5) If you are going to start with gasoline, move the distributor back to (6 to 10º).

Nozzle with plugs

Problems: If it does not start on "Chargas".

Let's assume that the engine runs well on LPG and/or gasoline.

1) Check if there are two fuels at the same time, which will "flood" the engine.
2) If the blower is being used to push the "Chargas" into the engine, it may have flooded the entire air filter. The air filter should be removed until it starts and then replaced.
3) As the whole system works with negative pressure (that is to say suction) then you must make sure that there are no air leaks in the whole system.
4) It may be that the AFR mixture is not correct. You should try to close or open the AFR butterfly valve that is on the carburetor until you find the appropriate mixture with the AFR indicator.
5) It may be that the nozzle at the base of the gasifier is clogged with slag. Then clean it with a "nozzle-cleaner" bar (see photo above # 5 in "Starting procedures").
6) There may be a dirty filter. This is verified with the speed of the "Chargas" when flaring.
7) The addition of about two drops of water per second greatly facilitates cold starting.
8) Check if the carburetor is very dirty, especially if poorly charred waste was used. To clear this, it is convenient to finish traveling the last 50 kilometers with gasoline (not with LPG) so that it can dilute deposits in the carburetor. Blowing compressed air into the carburetor mouth also helps to clean ashes but not tar.
9) The waste is not good. Before sending the "Chargas" to the engine, make sure that it ignites well when it goes to the flare. In other words, it is constant and does not blow out. Ideally, it should be blue, but it can be a little transparent yellow (not solid yellow), and preferably smokeless.

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USE EXTREME PRECAUTIONS! Thousands of people die inside their bedroom when they fall asleep with a faulty heater that emits carbon monoxide.

For the Glory of God.

SLAG: Slag or ash is the small part of the waste that is not combustible.

The type and amount of slag depends on the type of waste. The photo on the right side is the walnut shell slag that gathered arround the nozzle after traveling 100 km (60 miles) at 80 km/h (50 miles/h). From time to time the gasifier charge must be completely emptied and the slag that collects around the nozzle must be cleaned.

TEMPERATURE SENSOR: From time to time check and clean this sensor or bulb that is at the outlet of the gasifier, as it gets dirty with carbon dust that acts like an insulator. When it is dirty, it takes longer to set the temperature, that is, when it indicates 110ºC (230ºF), it could actually be much higher.

HOSES: The carbon powder that comes out of the gasifier can dirty and close the interior of the pipe that connects the gasifier with the cyclone and also the cooling hose that goes from the cyclone to the first filter. They should be cleaned with a wire brush or stiff bristle “pipe cleaner”.

AIR TIGHTNESS OF THE WHOLE SYSTEM: From time to time it is advisable to check the tightness of all the elements. Each thing is lung-inflated and submerged in a pool of water, just like flat tires are done. The gasifier it can be lung inflated and checked with soap and water.

FILTERS: The filters must be cleaned regularly, because when they are too dirty it take away power from the engine. One way to roughly guess about the dirt on the filters is to see the force of the output of the chargas when it is turned on to “Exterior” the flare. Also when the butterfly valve at the carburetor must be very closed for a good AFR mixture, it may indicate dirty filters or air leaks. The oil bath filter element is first cleaned with gasoline or better with 50% ammonia degreaser with water for a while and then with a pressure washer. If necessary repeat again. Let it dry under the sun. The dirty microfiber towel filter is washed with soap and water. A dirty and moisten towel filters better than a clean and dry towel, so replace only when necessary. Also two, or better three towels (one on top of each other), filters better than only one.

CARBURETOR: From time to time remove the air filter from the engine and check the carburetor mouth to see if it is clean. If the load has not been well charred, the volatiles can clog the hoses and the carburetor. For this reason, every time you use chargas from poorly carbonized waste, it is advisable to finish the last 50 km (30 miles) of the journey with gasoline (not with LPG) so that possible deposits in the carburetor are diluted. Blowing compressed air into the carburetor mouth also helps to clean ashes but not tar.

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Chapter 5: CYCLONE.

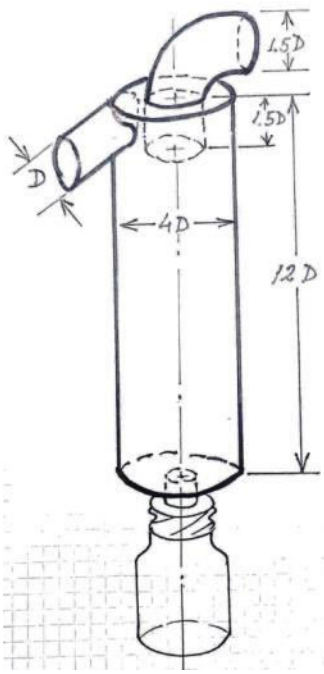
For the Glory of God.

A cyclone or coarse particle separator is a cylindrical container where the chargas enters tangentially; the coarse particles hit against the cylinder wall and settle to the bottom. Below is a clear glass jar where you can see the decanted particles. Here an inverted fire extinguisher was used. A cone=shaped container is NOT needed for the gas to spin into a cyclone and drop particles.

The cyclone is not essential. It only serves to reduce the amount of larger dirt that enters the next filter, which is the oil bath filter. The size of a cyclone depends on the gas flow that is going to circulate through it.

To make a cyclone you need some welding (high temperature sealants and epoxies may possible be used instead).

On the Internet there are many ways to calculate a cyclone. Only a basic way of doing it is shown here.



MEASURES OF A CYCLONE FOR GASIFIER.

The best cyclone for a gasifier is based on a gas inlet velocity of 10 m/sec.

First the approximate flow of the gas entering the cyclone must be calculated (in Liter/sec).

According to the formula:

The approximate flow of gas entering the cyclone (in Liters/sec) = **A** (Liters) X **B** (RPM) X 0.00175

Where **A** is the size of the engine **in liters.**

Where **B** is the **RPM** of the engine running at 80 km/h.

Example: For a 3.6 liter engine and with the engine running at 2500 rpm when driving at 80 km/h.

The approximate flow would be = 3.6 Liters X 2500 rpm X 0.00175 = 15.75 liters/sec.

The calculation is approximate because in my case at 80 km/h in direct gear, I measured: 13.17 liters/sec.

With the gas flow value, enter the following table that gives the cyclone measurements:

Flow of gas to entry of the cyclone	Diameter of entrance of commercial tube		Real diameter royal interior of the tube input **= D**	Real section of the tube entry	Diameter of the tube exit **= 1.5D**	Depth of the tube exit inside of the cyclone **=1.5D**	Diameter of the cyclone **= 4D**	Height of the cyclone **=12D**
Litros/seg	Pulgada	MM	MM	MM	Decímetros2	MM	MM	MM
3.46	3/4	19	21	0.0346	31.5	31.5	84	252
5.55	1	25.4	26.6	0.0555	40	40	106	320
9.6	1.25	32	35	0.096	52.5	52.5	140	420
(*) 13.2	1.5	39	41	0.132	61.5	61.5	164	500
(*) 21.6	2	50	53	0.216	79	79	210	636
31	2.5	63	63	0.31	95	95	252	756
48	3	76	78	0.48	117	117	312	936

For the 3.6-liter (221ci) engine turning at 2500 rpm (at 80 km/h), according to a theoretical flow of 15.75 m/s, the cyclone measurements would be between the lines (*)13. 2 and (*)21.6 Liters/sec, giving us an inlet tube I.D. between 1.5” and 2”.
If the size of the cyclone is very large, you can go up one line and make it smaller; always using the same proportions, but the efficiency of the cyclone will be lower.

I used a 13 liter fire extinguisher upside down. The tangential inlet pipe is 38mm (=1½ ”) in diameter and the outlet is from the center up of 50mm (2”) in diameter.

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Chapter 6: Oil Bath filter.

For the Glory of God.

Filtering the chargas is essential to avoid dirt in the system and ensure that the chargas reaches the engine as clean as possible. Oil bath air filters were very popular in older cars, trucks, and tractors. They are very effective. Newer paper cartridges, are very easy to change but some types of chargas could be very dirty, and it is very expensive to change the paper cartridges so often. Also when paper filter gets dirty may collapse. The oil bath filter of tractors and trucks can be used directly without modifying since the air inlet and outlet is in the form of a tube. On the other hand, the air filter in oil bath of the Renault Tornado car engine in Torino must be modified, see below:

Original oil bath filter of Torino

Same as left outside view.

Same inside view.

Mark to be cut.

Cut

Tangential inlet pipe

Original air inlet holes plugged and the new tangential inlet pipe welded.

View from the bottom.

Finished.

Chapter 7: TOWEL FLITER.

For the Glory of God.

For the final filtering, after the oil bath filter, a towel filter can be used. A 20 Liter (5 Gal) plastic bucket was used here. Instead of using a paper filter, it is advisable to use a towel filter as it is much cheaper than paper filters. It can be washed with soap and water. It is recommended that the cloth be a microfiber towel (easy to wash) and black in color because as the ashes are white it is easy to see how dirty the black towel is.

The cloth filter can be a simple towel lined cylindrical on a cage like the photos above.

To have a greater filtering surface within the same bucket, it can be a double cage, that is, two concentric metal mesh cylinders lined outside the large cylinder and inside the small cylinder with the same towel as can be seen in the photos below. Two, or better three towels, one on top of the other one will filter better than only one towel.

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For the Glory of God.

"Raw" or non-carbonized combustible waste/residues are made up of moisture, volatiles, slag, and carbon. Moisture or water is a great disadvantage during gasification as it consumes calories from the gasification process. The burnable volatiles add calories but when cold they are a glue and dirty everything from the nozzle to the engine. Slag is inevitable but minimal. The most useful fuel for a simple gasifier is pure and dry charcoal. When "raw" waste is carbonized (pyrolyzed) with heat, water and volatiles are removed, leaving only almost pure and dry coal with a little slag.

Carbonizing the waste is essential to reduce the volatiles of chargas. If waste that has been inadequately carbonized is gasified in the gasifier, its high volatile content, can dirty the whole system. If the filters gets dirty quickly then it will happen that the driving range of the vehicle will not depend on the consumption of charcoal but on how far it can last till the system gets clogged. Example: If I have a system that would allow me to travel 500 Km (300 Miles) non-stop, consuming only well-carbonized waste, but it is badly carbonized, perhaps the system gets clogged far before.

When "raw" waste is well carbonized, it results in a pure, dry charcoal between a third and a quarter of its original weight, and half of its original (raw) volume. But this carbonized waste (that is now dry coal) has almost twice the calories per pound compared to raw waste. In other words, for the same driving range, twice the weight of waste to be "carbonized" is needed compared to the unprocessed waste. But this avoids many cleaning and maintenance problems. Example: To do 100 Km (60 Miles) at 80 km/h (50 Miles/h) **30 Kgs. (66 Pounds) of non-carbonized waste** are needed against the 15 Kgs (33 Pounds) of carbonized waste **that results from baking 60/45 Kgs (132/100 Pounds) of raw waste.**

LET'S SEE SOME POINTS:

Humidity: The humidity in the gasifier load consumes power from the gasifying process, that is, calories are wasted to evaporate it. Furthermore, the chargas or carbon monoxide leaves the gasifier with water vapor that will then condense and muddy everything. Therefore carbonized waste should have as little moisture as possible. Freshly carbonized waste is without moisture. Therefore it must be stored in airtight containers to keep it dry, since charcoal is very eager to absorb moisture from the environment.

Volatiles: Volatiles are the oils and tar in raw waste. The different volatiles evaporate at different temperatures. The lighter volatiles evaporate at a lower temperature and the heavier volatiles need a higher temperature. Some volatiles are combustible.

Slag: It is the small part of the waste that is not volatile, neither carbon nor combustible. During gasification it will remain around the nozzle. Cold slag left in the nozzle is generally easy to clean. Some wastes have little slag like hardwood but others have a lot of slag like peanut shells. Some examples can be seen in Chapter 10: "Evaluation of some types of waste".

Hull/shell: As the shells have a greater surface area by volume than the seeds/pits, the shells can carbonize better, that is, it is easier to eliminate the greater amount of volatiles and obtain more pure carbon. They also deliver more calories (heat energy) and faster by weight during the gasification. It also deliver a cleaner chargas. Since the seeds are more difficult to dry, they may appear dry on the outside but inside they can still be damp or wet. When carbonizing moist seeds, the evaporation of water inside the seed lowers the temperature of the process and the seeds are left with many volatiles (that is, badly carbonized).

Density: A well-carbonized waste has a lower density than the same type of badly carbonized waste. This means that pure coal weighs less than volatile. Therefore it is VERY IMPORTANT to measure the density of freshly carbonized waste (i.e. with no moisture) and save this density value of THAT TYPE of carbonized waste for future reference. Then to evaluate the correct carbonization, the density of

that type of charcoal is compared to this reference value. To see how the density of a load is measured see Chapter 9: “How to measure density”. In Chapter 10: “Evaluation of some types of waste” there are some reference density values. The higher the density of a type of well-carbonized waste, the greater the driving range per load. Example: The well carbonized and sieved hardwood has a density of approx. 290/350 Kg/m3, whereas the well carbonized and sieved peanut shell has a density of approximately 70 Kg/m3. In other words, it takes four to five times more volume of peanut shell to make the same route as with hard wood.

Carbonization Summary:

In the process of **CARBONIZING** waste in a kiln, it is ignited on top and burns to the bottom as the intense heat drives off combustibles volatiles. This refining process (pyrolysis) turns complex wastes into pure and dry carbon. During **GASIFYING,** this charcoal, is ignited from below and becomes chargas.

Each waste is charred differently; therefore you have to find the best way to do it. To achieve a good carbonization of any raw waste it is essential that it is as dry as possible. Drying it at the sun is free. Moist waste may also be dried by using the excess heat that is released from the carbonization process.

In carbonization processes where the fire goes from top to bottom, the upper half of the carbonized waste has less **volatiles** than the lower half of the load, because the upper half of the charcoal was exposed to the high temperature for a longer time. The density of the top half of the carbonized waste should be taken as a future reference value. It is advisable to measure the density of the lower half of carbonized waste as it is emptied **in layers**. If badly carbonized waste remains after the process, it can be mixed with the next batch of raw waste in a ratio of 3 parts of dry raw waste to 1 part of badly carbonized waste. Always, after each carbonization, measure the densities.

All waste has volatiles that must be removed with heat. When the volatiles are combustible, they can be used to generate enough heat to sustain the carbonization/pyrolysis process. For example: wood, hard shells and seeds. On the other hand, when the volatiles are not combustible, an external heat is needed, as happens, for example, with banana peel.

Below are a number of ways to carbonize wastes whose volatiles are combustible.

A classic and simple way to carbonize is with two 200 liter (50 Gal) metal drums. See on the next page: "Carbonization with two drums"

This and others examples may be found on Youtube:

“Gary Gilmore Making Charcoal” are three videos of 4 to 6 min each:
https://youtu.be/XiFHXg9o2wo, https://youtu.be/LyzY9D_rgeg and https://youtu.be/tyJO8mKvKsM.

Another 7 minute video: Producing Charcoal with a Barrel Kiln: https://youtu.be/tR6MslcJayk

Another 2 min: Homestead Charcoal making the best way, English: https://youtu.be/OHlCEyWMEkY

Raw **Charred and Sieved**
Walnut shell (Juglans Regia)

Raw **Charred**
Oak acorns (Quercus robur)

Never use olive pits because are very corrosive since it has salt. During the gasification process, with water, the salt converts in caustic soda and chlorine acid. Both are VERY corrosive.

CARBONIZATION WITH TWO DRUMS.

Materials: You need two or three metal drums of 200 Liters (50 Gal) each and two iron bars of 6mm(1/4”) to 12mm (1/2”). Both covers are removed from the first (upper) drum, which is the chimney. The second (lower) drum is where the load is to be charred. It must have a bottom, a round lid that can be closed with a ring, and several holes must be drilled or punched near the base. The third drum is the interior, or insulator. It is not essential, but it helps to improve carbonization; it is inserted inside the lower perforated drum, see next photo. Also, you will need some sand.

Interior insulation drum: The lid and the base are removed from this third drum that will go inside the perforated drum. It is cut lengthwise to be able to roll it inside the lower drum. And it is cut out with legs so that the holes in the lower drum are free.

Installation of the insulation drum: The third drum is wound into the lower drum, with the "legs" down. The holes in the lower drum must be clear between the legs of the inner drum.

Loading: The lower drum is filled to the top with dry combustible waste to be charred.

Ignition: The load is ignited at the top, the fire will go from top to bottom. The ignition depends on the type of load: If it is a walnut shell, it can be ignited with a little alcohol. If they are oak acorns, a few dry sticks are added to the top of the whole load of acorns and they are lit with alcohol. If they are pieces of wood, medium sticks are added above the load with finer ones on top and it is lit with alcohol. Once the fire is lit evenly across the load, the two iron bars are laid across and the chimney is placed on top.

Closing the bottom holes with sand: The fire will go from top to bottom, but not everything is even. This time depends on the load. The woods char in 2.5 hours and the acorns in 8 hours. When the hot embers begin to be seen at the holes below, only those holes are covered with sand. When all the holes are covered with sand, remove the chimney, and the two iron bars. Close the lower drum at the top with the lid and the ring. Let cool overnight.

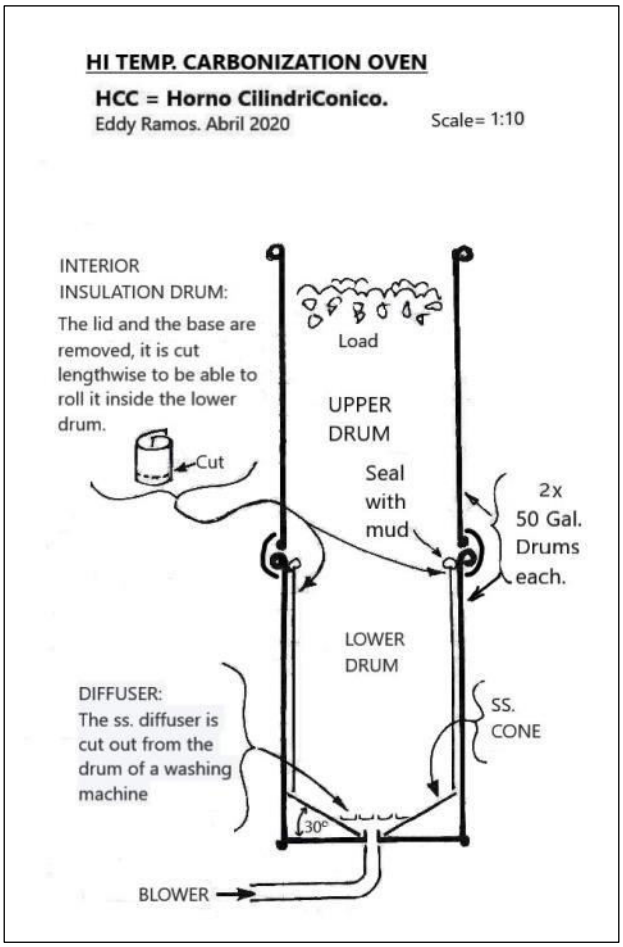
The next day, remove the ring and the top cover. The charred charge occupies less volume than the initial "raw" charge. The charred load will be 1/3 to ¼ of the original load. The upper layer has been well charred, so it is **very important** to measure the density of this upper half. Take it as a reference for that type of a well carbonized waste and compare it with the density of the successive lower layers. If the density increases, it means that it has been badly charred (volatiles remain). This badly charred waste can be mixed with the next load in a ratio of 3 parts raw filler to 1 part badly charred filler.

Crushed and sieved: If the charred charge is between 3mm (1/8”) and 20mm (3/4”) in size -better if up to 10mm (1/2”)-, it is ready to load in the gasifier, for example oak acorns or most pits. But if the load is larger than 20mm, it should be crushed at the top of a mesh that has 20mm (3/4”) openings and sift down with another mesh that has 3mm (1/8”) openings. In the middle will be the appropriate size to gasify.

VERY IMPORTANT WARNING: “Chargas gas” is CARBON MONOXIDE, which is a combustible gas and VERY TOXIC. It is a CRIMINAL gas as it has no color or odor and can kill. NEVER operate this system in enclosed spaces such as garage, etc. Only operate outside or in very well ventilated spaces. It is VERY POISONOUS. You simply MUST NOT breathe it.
USE EXTREME PRECAUTIONS! Thousands of people die inside their bedroom when they fall asleep with a faulty heater that emits carbon monoxide.

Hi temp carbonizer (sample carbonizing wallnut shells):

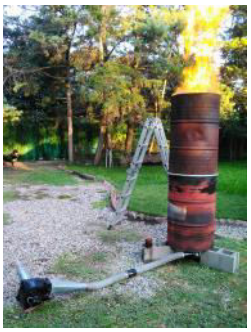
The following carbonizer is based on Bruce Southerland idea. The HCC (**H**orno**C**ylindri**C**onical). **Procedure** in photos: (1): The diffuser is cut out from the drum of a washing machine. (2): Interior view with the diffuser. (3): The oven is filled to 2/3 of the top drum with approx. 320 Lts. (80 Gal.) of walnut shells. (4): Connect the blower (a speed controller is helpful). The load is ignited from the top with enough alcohol to startup, the oven is on with yellow/red flame (tar is burning). (5): After approx. 120 min. the lid ring (connecting the barrels) is removed. Between the two drums it can be seen that the flame stops being yellow/red and becomes blue. (6): The upper drum is removed and the blue flame is seen. It is ready to seal everything. The blower is switched off and the lower air inlet is plugged. A solid top cap with clamping rings is attached. Let cool 24 hrs. In the case of acorns it needs 48 hrs to cool down. (7): Carbonization finished, it is approx 80 Lts (20 Gal.) of coal. (8): **The result**: Blue Charcoal, "crystal sound", no tar.



Ph.1: Diffuser.

Ph.2: Interior

Ph.3: Full of load.



Ph.4: Burning.

Ph.5: Blue flame between drums.

Ph.6: No superior drum

Ph.7: Carbonized.

Ph.8: **The result**: Blue Charcoal, crystal sounding, no tar.

CHAPTER 9: HOW TO MEASURE DENSITY.

Well-carbonized waste weighs less than bad charcoal because the volatiles left in badly carbonized waste are heavier than pure charcoal. Therefore, by measuring the density of freshly carbonized and dried waste, it can be seen how good, fair or badly it is carbonized.

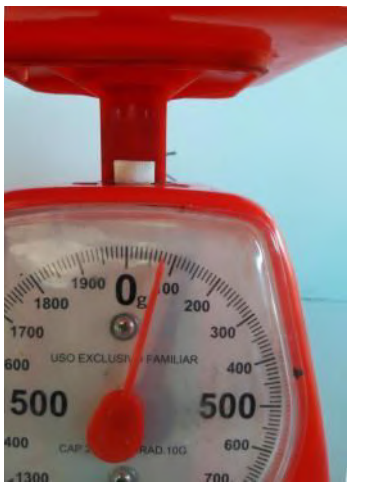
Density is the weight in grams within a liter, (= Kilos in a cubic Meter).

To measure density you need:

A scale

One liter jar

Place the jar on the scale



The weight of the empty jar

Adjust the scale to zero with the empty jar on it.

Fill the jar with one liter of load to get the weigh.

When the container is full to the liter you can see the weight in grams for a liter. In this case it is seen that it weighs 175 grams in one liter. So the density is 175 grams per liter, which is the same as saying that the density is 175 Kilograms per a cubic Meter.

When measuring density it is important that the load is **completely dry**, because if the load is wet then the weight of the moisture/water will be added. In other words, the measurement of the density of a wet load will not be reliable.

For the Glory of God.

Quebracho (Schinopsis balansae):

Advantages: As it is a hard wood it is very difficult to crush "raw" but it is easy to crush when charred. Carbonized, crushed and sieved, it has a very high density (approx. 350-400 Kgs./m3), which makes it ideal for gassing as it has great driving range. It has almost no solid residues and the little it does forms a light, white "Styrofoam" type slag that is broken with the fingers. Disadvantage: It is difficult to obtain and is sometimes expensive. In 100 km at 80 km/h, a slag of almost 100 grams (0.1 Kilogram) is accumulated.

Walnut Nutshell (Juglans Regia):

Advantages: It is usually obtained clean and bagged. It can be carbonized moderately well. The charred walnut is very easy to crush. Once crushed and sieved, it has an acceptable density (165-185 Kgs./m3) for its gasification. Generates little amount of sand-like slag caked with something like dirty glass. The attached photo is of the slag that accumulated on top of the nozzle after traveling 100 Km at 80 Km/h and is almost 120 grams (= 0.12 Kilograms).

Acorns or oak seeds (Quercus Robur):

Advantages: Once carbonized, it has a good density (150-200 Kgs./m3), is good for gasification. It does not need to be crushed; it has the right granulometry for its gasification. It has some slag residues that settle like dirty glass on the nozzle, but very easy to clean.

Disadvantages: It is usually cumbersome to gather it, and then you have to clean the leaves, twigs and pebbles. It can be cleaned by ventilating it with a blower. It is not easy to carbonize. With the two-drum method (it take 6/8 hours), only the upper half of the load is charred well, so the lower half has to be re-charred with another load of “raw” acorns in a ratio. 3 parts crude to 1 part char and then only the top half of the load is charred well.

The attached photo is of the slag that accumulated on top of the nozzle after traveling 100 km at 80 km/h and is almost half a kilogram (= 0.5 Kilograms).

Peanut shells (Arachis hypogaea)**:**

Advantages: You can remove all the volatiles so it can be very well carbonized. Low density 80 Kgs/m3.

Disadvantages: It has very low density, a LOT of volume is needed to achieve the same driving range as other types of waste. It is very dirty when you receive it, although for an additional cost you can get it clean.

It has very dirty soil and during the gasification process it clogs the oil bath filter very quickly: in just 30 km of travel at 80 km/h I clogged the Renault Torino filter. Finally, in the nozzle, it was deposited a lot of caked sand-like slag above the nozzle: in just 30 km at 80 km/h it accumulated a 19 cm high "volcano", that is, I raised the base of the fire by 19 cm decreasing the autonomy of the gasifier as can be seen in the attached photo. The weight of this slag was almost 1.2 kilograms, so after traveling 100km at 80km/h, almost 4 kilograms of slag would accumulate on top of the nozzle.

LIST of how much raw waste I need to do 100 km at 80 km/h in my 3.6 Lt (221 ci) engine:

The following values are very approximate and for very dry & crispy non-carbonized waste.
15 Kg of powder carbonized hardwood residues from charcoal industry.
65 Kg (143 Pounds) of walnut shell. (Juglans Regia).
75 Kg (165 Pounds) of oak acorns. (Quercus Robur).
75 Kg (165 Pounds) of conifer cones. (Pinus Sylvestris).
40 units of disposable wooden drawers for vegetables. (approx weight of each one: 1.7 kilos (3.74 Pounds).
50 Kg (110 Pounds) of banana peel. (Muse paradisiaca).
93 Kg. (200 Pounds) of hard bread.
56 Kg (123 Pounds) of grapefruit peel.
70 Kg (154 Pounds) of orange peel.
107 Kg (235 Pounds) of peanut shell. (Arachis hypogaea).
14 m2 of carpet (* 1).

WASTE THAT SHOULD NOT BE USED:

Olive pits because they contain salt. Salt is not only corrosive as itself, but when gasified with water it turns into caustic soda and hydrochloric acid which are VERY corrosive.

Mineral or coking coal: This coal has a large amount of asphaltite which evaporates before being gasified and passes through all the filters in gaseous form, then condenses the rest of the way dirtying everything, including the carburetor and the intake manifold. One way to remove the asphaltite from this type of coal would be to mix it with walnut shells and char everything together, removing the volatiles from the shells along with the asphaltite from the coal.

VERY IMPORTANT WARNING: "Chargas gas" is CARBON MONOXIDE, which is a combustible gas and VERY TOXIC. It is a CRIMINAL gas as it has no color or odor and can kill. NEVER operate this system in enclosed spaces such as garage, etc. Only operate outside or in very well ventilated spaces. It is VERY POISONOUS. You simply MUST NOT breathe it.
USE EXTREME PRECAUTIONS! Thousands of people die inside their bedroom when they fall asleep with a faulty heater that emits carbon monoxide.

Chapter 11: CHECKLIST FOR BEFORE LEAVING.

THE PREVIOUS DAY:

1) Start the engine so that the next day it is easier to start, and measure the air flows in the filters with an air speedometer: * Oil Bath + Cloth = 2,8m/s, * Oil Bath= 7,2m/s, * Cloth = 3m/s. Clean them if necessary.
2) Cell phone with battery charge, credit.
3) Check oil level, coolant, brake fluid, frog water, tire pressure, clean oil and cloth filter, etc.
4) Install AA batteries in the cabin carbon monoxide detector.

PREVIOUS STARTING:

1) Permits to drive: driver's license, green card, insurance, ID, money.
2) Are the car tools in the tool box? Also tape measure, fiber marker?
3) Fill drinking water bottle.
4) Empty the gasifier water bottle (1 ¼ ltrs) and fill the spare bottles with water.
5) Remove the gasifier lid, load with charcoal and view/measure the charge level. Then clean with a brush the edges where the lid sits. Replace the gasifier lid. Load the spare bags full of charcoal.
6) Tool box with gasifier accessories and see level of alcohol in bottle and the torch load.
7) Place the tray under the gasifier and empty the cyclone glass bottle.
9) Check the system hose & electric connections and that there is no air filtration.
8) Spare parts: Starter blower, hoses, bags of extra charcoal load.
10) Turn on the gasifier according to the instructions below to see that the gas comes out without smoke, then turn off. If it continues to come out with smoke, you have to wait for it to stop smoking or this hot load will have to be changed, unloading it in metal buckets with a non-hermetic lid.

JUST BEFORE STARTING:

1) Put to zero the odometer and GPS.
2) Verify that the distributor advance is for GAS.
3) Energize the carbon monoxide detector in the cabin.
4) Change the multivalve to the “Exterior”.
5) Pass the "Nozzle Cleaner" bar.

STARTING:

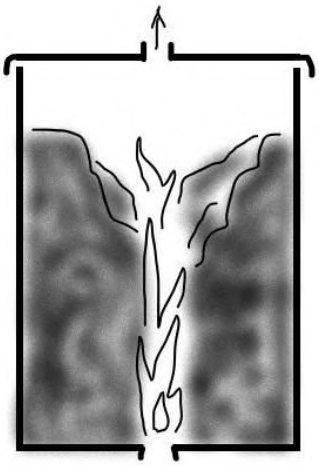
7) Cut off all other fuels. Prepare the alcohol and the torch, turn on the starting blower.
8) Light the gasifier by introducing alcohol and fire to the inlet of the nozzle.
9) Adjust the water drip between 1 or 2 drops per second, no more than that.
10) Wait until the gas that comes out to the “Exterior” stops coming out with vapor/smoke and light the gas. Note: Do not breathe the gas that comes out as it is poisonous.
11) Verify that the flame is blue or transparent yellow and not "solid" yellow and/or without smoke.
12) Full open the AFR Butterfly valve on the carburetor and change the Multivalve to “Carburetor”.
13) Wait 30 seconds for it to purges the air out from the hose that goes to the carburetor.
14) Close the AFR Butterfly valve on the carburetor almost completely.
15) Start the engine and let it regulate for a few seconds. Adjust the AFR Butterfly valve.
16) Accelerate the engine slowly until it can idle smoothly and can be well accelerated.
17) Close the hood and the tailgate. !!

BY THE END:

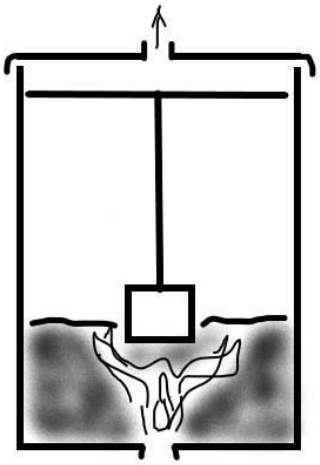
1) Close the gasifier hermetically. Turn the Multivalve to “Close”.
2) Quench the embers in the tray under the gasifier with water.
3) De-energize the monoxide detector at the cabin.

Chapter 12: REFRACTORY DIFFUSER DISK.

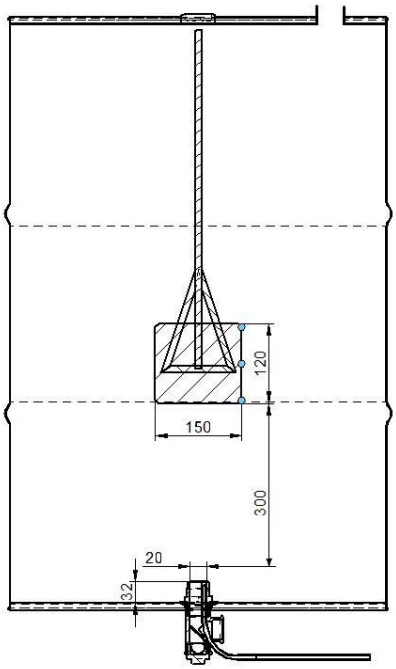
The refractory diffuser disk is a useful accessory as it increases up to DOUBLE the autonomy of a gasifier. When the diffuser disk is not present, as the load inside the gasifier is consumed, the nozzle produces a kind of column or fire tube that crosses the load vertically, causing the chargas to come out at a very high temperature, being that there is still a lot of load available. To increase the autonomy of the gasifier, it is very useful to install a refractory diffuser disk several centimeters above the nozzle. This measurement depends on the size of the engine, for the 3.6 liter engine the base of this disc is 30 cm (12") above the mouth of the nozzle. This means that there will be no longer a column of fire, but rather the fire works like a circular burner. The size of the disk depends on the diameter of the drum. The diameter of my gasifier is 50 cm (20") and the diameter of my refractory disk is 15 cm (6") so the diameter of my disk is 30% of the diameter of the gasifier. My disk is 5.5 cm (2.2") thick. The disk must resist about 1700 ºC (3100 ºF), that is, it must have a refractory material with 96% alumina. My disk is supported by an AISI 310 stainless steel iron.

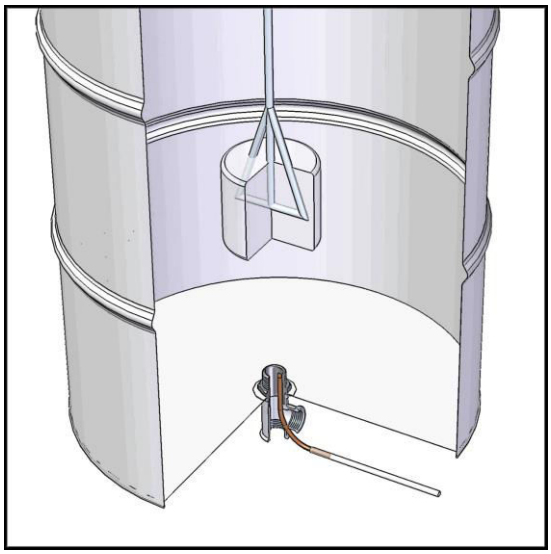


No disk: Fire column across the load



With disc: Fire as circular burner.





CHAPTER 13. TRAILER GASIFIER.

For traveling long distances, a multi-drum gasifier trailer can be used.

The following gasifier trailer was used very satisfactorily to travel 4,800 Km (3,000 Miles) only with chargas from end to end of Argentina from Nov'21 to March'22 in a 1983 Ford Falcon Ranchero vehicle with a 3.6 liter engine. The autonomy of this gasifier trailer is around 500 km (300 Miles) at 80 Km/h (50 Miles/h) on average, depending on the type of waste to be used. The weight of the entire trailer, loaded with waste and ready to use is approx. 400 Kgs. (180 Pounds). This same vehicle, WITHOUT the trailer, but with a small gasifier installed on the truck bed, needs 15 Kgs. (33 Pounds) of coal to travel 100 Km (62 Miles) at 80 Km/h (50 Miles/h), but with the trailer gasifier towed, it needs 20 Kgs. (44 Pounds) of the same waste to make the same distance at the same speed.

The construction principle is similar to that of the 75 liters gasifier in the truck bed. (See drawings below).

(1) Three metal drums of 200 liters each, with a hermetic upper lid through which the waste is loaded, a lower nozzle with a 20 mm orifice with the water inlet and a 50 mm chargas outlet on top. The original gasket (100ºC) was replaced for each lid with a silicone gasket (180ºC). Each nozzle has a "T" below it with a metal threaded bushing that contains the burning embers (ember holders) that could fall to the floor, especially when the suction of the engine or the starting fan does not reach the nozzle. That is, when the engine is turned off, when the filters are clogged or when there is a big air leak in the system. Each nozzle has a globe valve, and the three valves are mechanically linked by a lever bar that can open or close them at the same time, or manipulate them independently.

(2) A three-step filtration system. (A) A cyclone with a glass jar. (B) An oil bath air filter from an old Fiat 900 tractor with 76 mm inlet and outlet and (C) Three 20 liters plastic buckets with a cage and three microfiber towels in **each** bucket. The buckets are connected in parallel.

(3) The gasifier starting blower is a 12 Vdc HVAC fan of a car.

(4) All connections from the drums to the plastic buckets are 76mm, the buckets with 63m connections and from then on to the motor are 50mm connections.

(5) The drums have two thermostats of 90ºC and 150ºC each connected to an indicator LED in the cabin.
At the entrance of the cyclone a 12V thermometer bulb with an analog clock in the cabin.

(6) It has an individual water drip system for each gasifier nozzle with a general cut-off valve.

Power-up procedure.

The three metallic ember holders of the nozzles are removed.

Connect the starting fan inlet hose to the outlet of the plastic bucket filters. The outlet hose of the fan is placed upwards to begin the venting of the system and a metal adapter is placed at the outlet to prevent the fire from melting the plastic connector.

Once the fan is turned on, each gasifier is lit from below with a butane torch, a handheld mirror is used to view the embers inside each nozzle. Turn on all three gasifier. After a few minutes, open the water drip (2 drops per second) in each of the three gasifiers. As long as the drop of water falls down the nozzle, it means that there is still no vaporization of the water. When it stops dripping down, then wait a few minutes and lit the chargas that comes out of the fan outlet hose. When the chargas at the outlet of the fan hose can be lit and the flame does not blow off, it means that the entire system is already completely purged of all the air and also that the chargas has hydrogen. The lever opens the three globe valves at the same time. The ember holders are screwed into each nozzle. Turns off the fan and remove the metal accessory at the outlet of the fan hose and attach it to the pipe that connects to the engine. Remove the engine air filter. The engine is started with/without the starting fan on, and slightly opening/complete closing the throttle valve on the carburetor. Once the engine is started, replace the

engine air filter. Begin to accelerate very slowly. When it can be kept throttled to about 2000/2500rpm, the engine can be shut off, the gasifier starting fan connection removed and jumper it with a tubing. The engine is restarted.

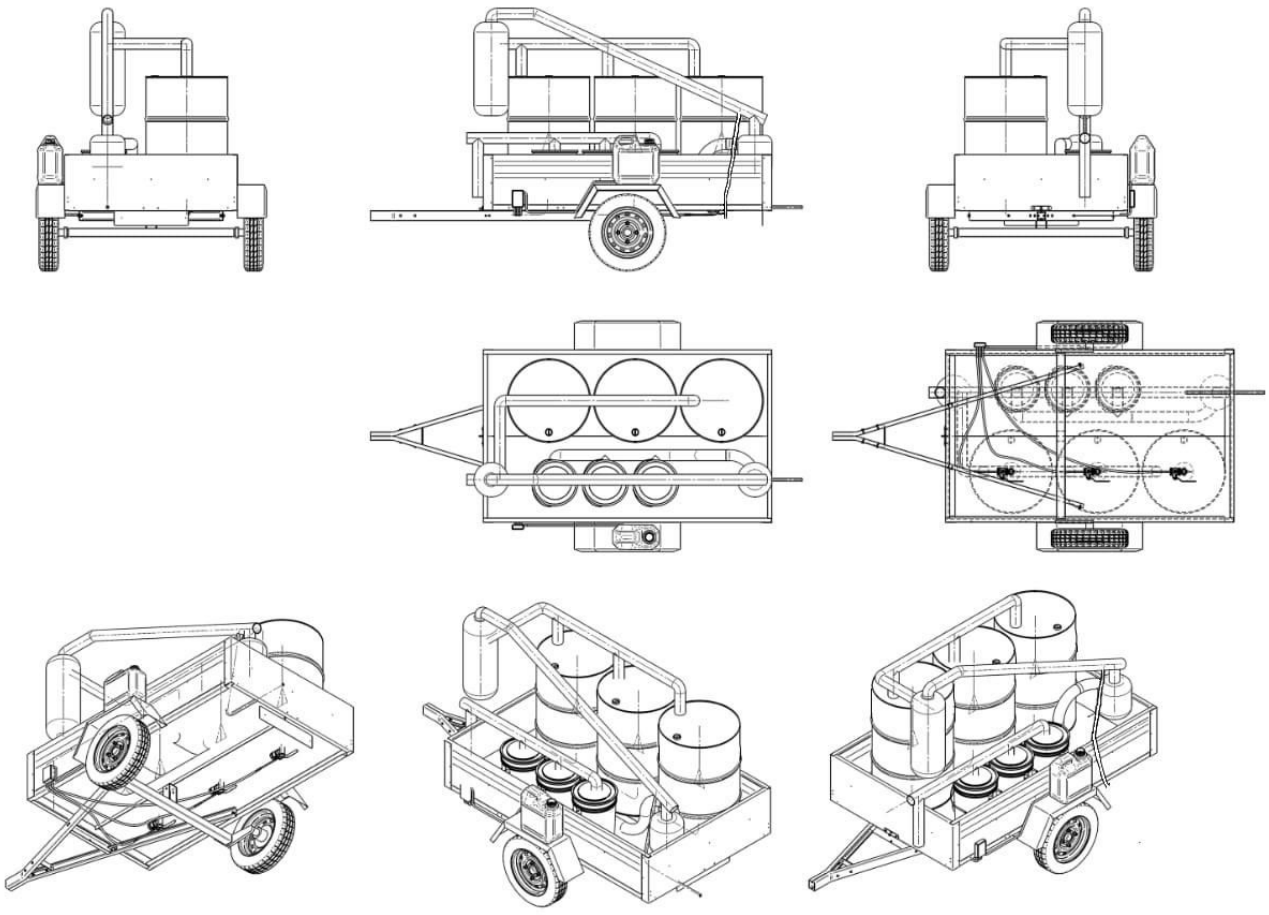
Notes:

* This gasifier trailer was not designed for gravel roads, so during these journeys, due to the severe vibration, it suffered serious damage, especially to the lids (plastic buckets and glass bottle of the cyclone). It had to continue on LPG or gasoline to the next town for repairs.

*As the load is consumed, an ash cushion forms above the nozzle, that is, between the nozzle and the load. While the gasifier is on, you can reload the drum and continue your journey. But once the gasifier has cooled down, the thicker this ash cushion, the more difficult it will be to ignite and the longer it will take to vaporize the water entering the nozzle. In this case, the use of the nozzle cleaning bar may help, but eventually the gasifiers must be completely unloaded and clean the slag/ashes on top of the nozzle.

*The load of the three drums should be as even as possible in every way: type and size of waste, load levels, amount of water dripping, etc. This is so that the three gasifiers are consumed equally.

*The gasket on the lid of each drum is made of silicone that supports up to 180ºC. For them there is a 150ºC thermostat near each joint that alerts the cabin when a drum is heating up to turn it off and continue with the other two drums.




VIPAL
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3


AUTO A BASURA
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AUTO A BASURA
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40
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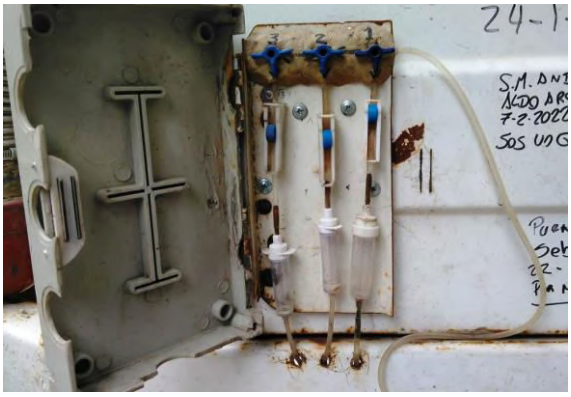
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Map of the route along the **"Garbage Route",** La Quiaca (Jujuy) to Cabo Vírgenes (Sta. Cruz), a total of **4,756 km only with chargas** = "Gasura".

We did the return only with gasoline because we were committed to return in a few days.