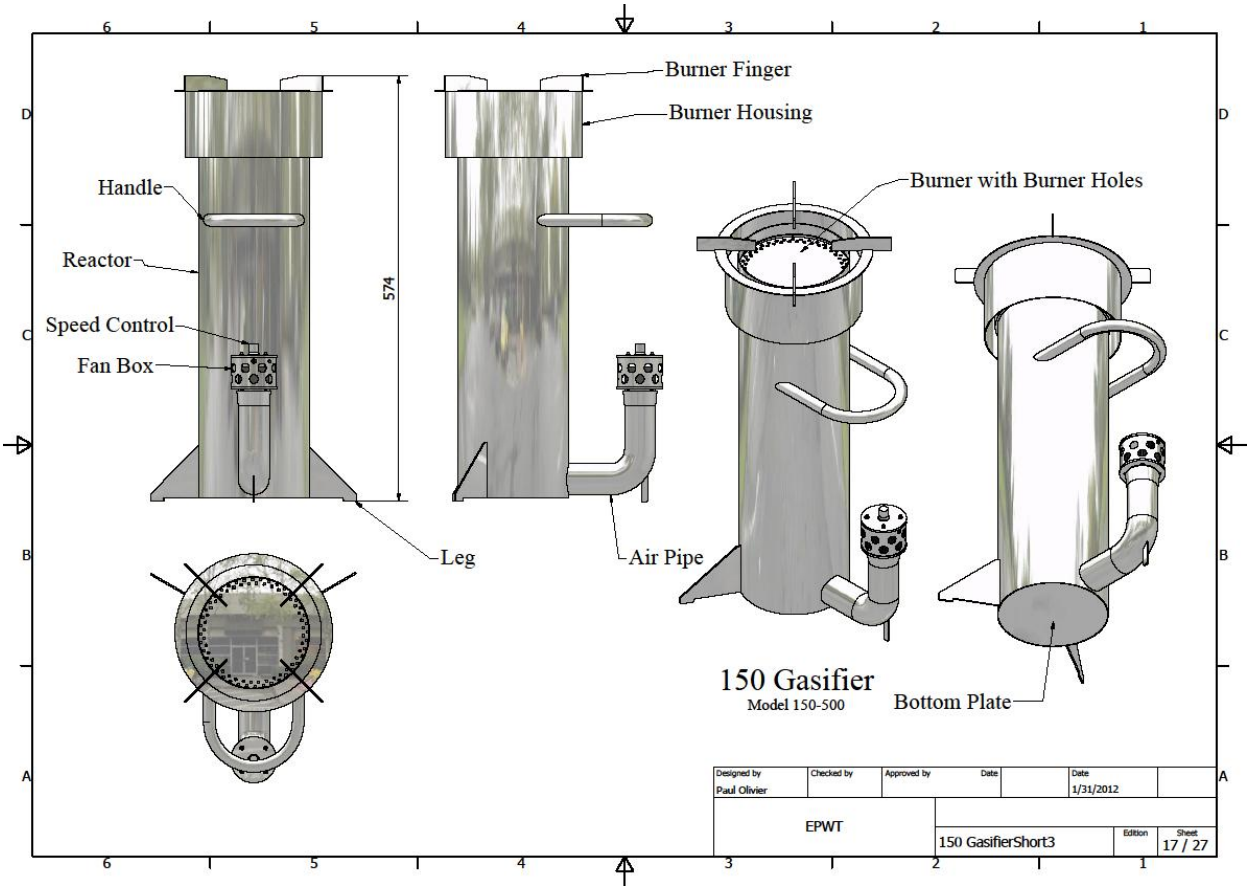
How to Operate the 150 Gasifier

Gasifier Parts



Biomass Fuel

Make sure that the moisture content of the biomass that you use in this gasifier does not exceed 12%. Most freshly milled rice hulls and coffee husks have an ideal moisture content. Biomass that has been stored outdoors should not be used as gasifier fuel. Coffee husks should be mixed half-half by volume with rice hulls.

Make sure that the biomass is uniform in grain size. Biomass such as rice hulls, coffee husks or screened palm kernel shells is sufficiently uniform in grain size. But biomass such as sawdust, wood shavings or coconut dust is not uniform and should not be used. Such biomass has to be pelleted before it can be gasified.

Filling the Reactor

In filling the reactor with biomass, you should use a metal or plastic scoop. If you scoop the biomass into a funnel, there is less chance of spillage. You can make a funnel quite cheaply by

cutting a hole at the top of a Vietnamese hat. Turn the hat upside down and place it on top of the reactor. You can fill the reactor with biomass to within one centimeter of the top.

About the Fan

Before attempting to light the biomass, you should insert the fan box into the curved air pipe at the bottom of the reactor. You should then insert the AC/DC adapter plug into the jack at the side of the fan box. Make sure that the adapter wire does not touch or come near the reactor. Rotate the fan box so that the adapter wire is not facing the reactor. Otherwise the adapter wire might burn due to the intense heat from the reactor.

When the adapter is plugged into the wall, a small red light should turn on indicating that an electrical connection has been made. The knob on top of the fan box controls the speed of the fan and consequently the flow of air and gas. Turn this knob in a clockwise direction to increase the speed of the fan and in an anti-clockwise direction to decrease the speed of the fan.

Before attempting to light the biomass, you should set the fan to a relatively high speed. Biomass such as rice hulls and coffee husks will not light if the fan is turned off or if the fan speed is too low. But the fan speed should never be so high as to fluidize or displace biomass, or create a channel or void within the biomass.

Lighting the Biomass

Since this is a top-lit gasifier, biomass is lit at the top of the reactor. Do not attempt to light biomass at the bottom of the reactor.

Corn shucks that have been thoroughly dried in the sun are ideal for lighting the biomass within the reactor. Light the corn shucks with a match or cigarette lighter. Never use newspaper and cardboard to light the biomass. They might contain chemicals that could contaminate the char. Never use ordinary white writing paper. The white ash from ordinary writing paper is incredibly messy. Paper and cardboard continually emit particulate matter throughout burn, and they can block the flow of gas through burner holes.

As corn shucks burn, they leave behind a char that glows red hot. It is mainly the radiant energy from this char that causes the biomass to ignite. The red-hot embers of the corn shucks should be moved around with metal tongs or metal chop sticks until the entire surface of the biomass is lit. It is very important that the entire surface of the biomass is uniformly lit.

Do not bury any part of the corn shucks in the biomass. They should remain entirely on the surface of the biomass. It is not necessary to remove burnt corn shucks after the biomass is lit.

If you cannot find corn shucks, then look for any type of natural fiber that is dry and thin. It should ignite quickly and emit radiant energy.

Never use gasoline, kerosene or any other type of liquid fuel. Never use commercial fire-starter materials. Never use solids impregnated with wax or any other combustible material. Never use

the white blocks commonly used in restaurants to fuel a hot-pot or keep food warm. Never try to light the biomass with a torch or open flame.

When the biomass begins to burn, do not allow flames to rise more than about 6 cm's above the top of the reactor.

Placing the Burner on the Reactor

Once the surface of the biomass is fully lit, you should lower the speed of the fan so that the height of the flames rising above the reactor is no more than about two cm's. Then shake the reactor a bit to make sure that the biomass has uniformly settled.

Before placing the burner on the reactor, check the reactor rim that supports the burner to make sure that no biomass has spilled onto the rim. The burner should fit snugly onto the reactor rim in a perfectly horizontal position. Use the u-shaped handle that comes with this gasifier to put the burner on the reactor.

This handle attaches to any two of the four fingers of the burner. Make sure that both ends of the handle are securely hooked and attached to the burner fingers before manipulating the burner. Once the burner is correctly situated on the reactor, you should detach and remove the handle from the burner.

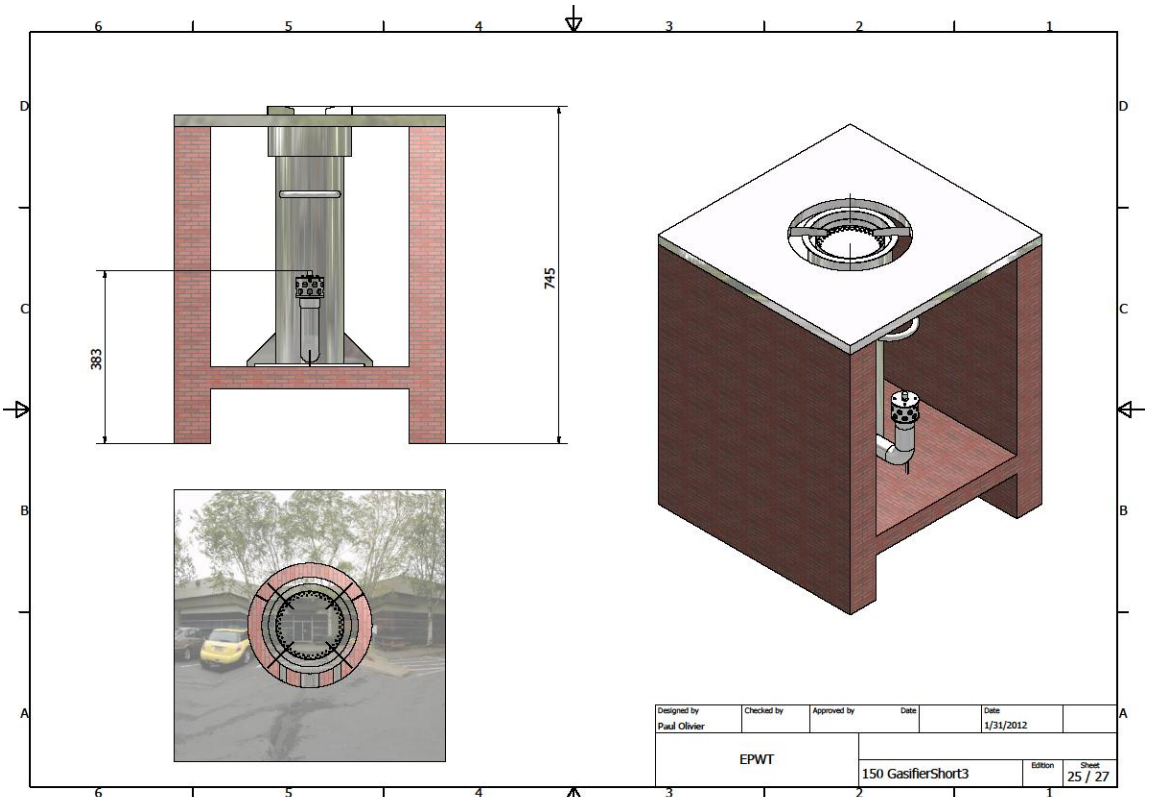
Not a Stand-Alone Device

You should never operate this gasifier as a stand-alone device. You should always situate it under a tabletop with a hole in the middle. The diameter of this hole should be at least 280 mm. Position the gasifier right in the middle of this hole. If the enclosure that supports the tabletop is correctly constructed, the bottom of the burner fingers should lie about 2 mm's above the surface of the tabletop.

When the gasifier is situated within the tabletop, the gasifier cannot tip over. Never let anyone reach under the tabletop to touch any part of the gasifier.

Do not make a tabletop out of wood or any other material that can burn. Tabletops can be made out of granite, terrazzo, or concrete. It is even possible to make a tabletop simply by cutting a round hole in a large floor tile.

The design of the enclosure that supports the tabletop might vary from simple and inexpensive, to very ornate and expensive. Please see your village retailer for ideas on how to build an enclosure. Situate the enclosure in a well ventilated area so that all fumes are safely evacuated from your kitchen or living space.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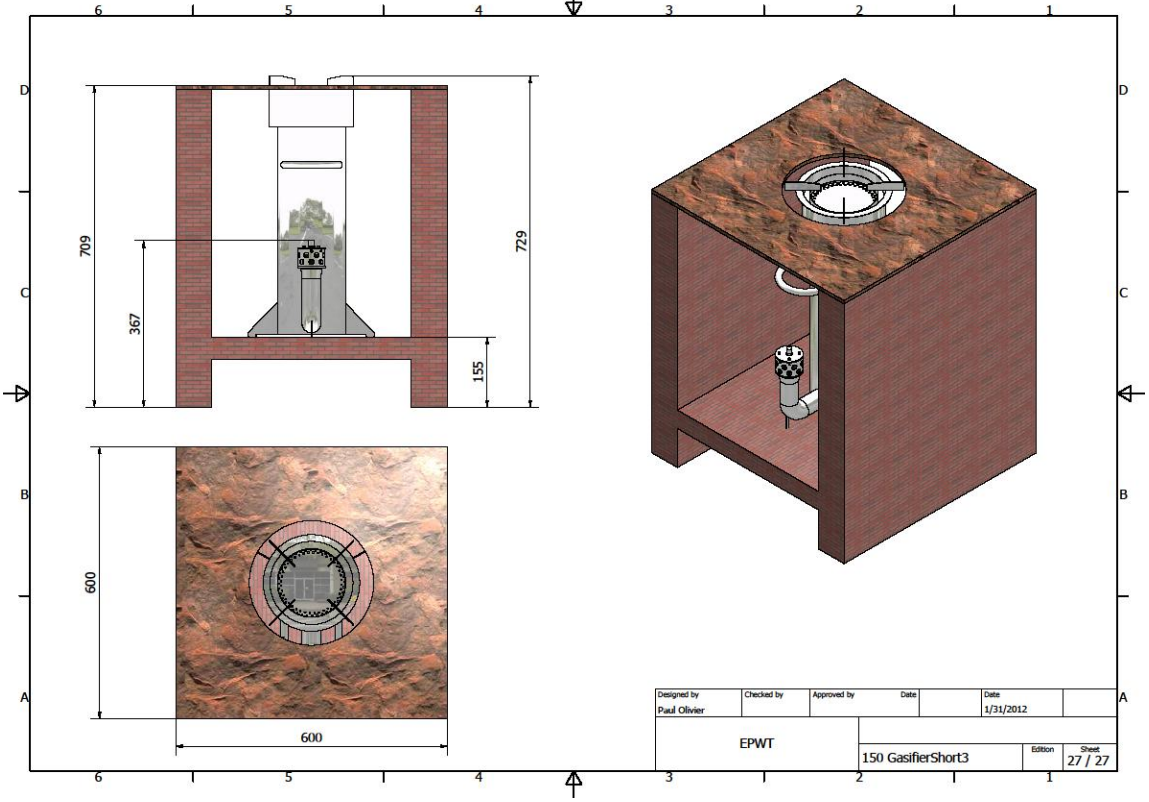
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Lighting the Gas

The next step is to light the gas. If the fan speed is too high or too low, the gas will not light. The gas from this gasifier cannot be lit with an electric spark, as is the case with a propane or butane stove. A flame is needed to light the gas.

A small strip of burning corn shuck can be placed near some of the burner holes to ignite the gas. This strip can be moved around with metal tongs or metal chop sticks until all burner holes support a flame. This procedure is quite delicate and takes time to master. You might have to adjust the fan speed quite often to get full ignition of all burner holes.

The lighting of the gas has to take place quickly, since during this critical time, carbon monoxide, an extremely deadly gas, is being emitted. Do not let the ash from the corn shucks block any of the burner holes.

When all burner holes support a flame, the flames will begin to pulsate. This is quite normal. Wait a short while until the gasification process has stabilized, and this pulsation will stop.

Gasification Mode

When the burner is placed on the reactor, the burning of biomass within the reactor should stop, and gasification should begin. All open flames within the reactor must go out. If there are open flames within the reactor, this means that carbon dioxide is being emitted.

Usually the burner holes right above open flames within the reactor will not support a flame. Since gas is being burned within the reactor, this is highly inefficient and dangerous. Open flames within the reactor should normally go out in less than 30 seconds after the burner is placed on the reactor.

If open flames within the reactor do not go out within less than 30 seconds, you should shut off the fan completely. When the fan is shut off, the flow of gas stops, and all flames above the burner and all flames within the reactor go out. You should then turn the fan back on and relight the gas. If the fan speed is not too high, open flames within the reactor will not reappear.

When burner holes do not support a flame, carbon dioxide is present in the gas exiting the burner. When this happens, there will always be a certain amount of carbon monoxide commingled with this carbon dioxide. Therefore under no conditions should you operate the gasifier unless all burner holes support a flame. Please see this video where all burner holes correctly support a flame: http://www.youtube.com/watch?v=84qDsbBO9p8

Placing the Pot or Pan on the Burner

When all burner holes support a flame, then it is time to put the pot or pan on the burner. This substantially changes the flow of gas. Often at this point you have to adjust once again the speed of the fan. All burner holes should continue to support a flame, and all flames should be positioned well under the pot or pan. The pot or pan should have a diameter of no less than 20 cm's.

A Hot Reactor

The temperature within the reactor during the gasification process can reach as high as 800 C. Some of this high heat is transferred to the stainless steel wall of the reactor, and consequently it gets quite hot – far too hot to touch, even for a fraction of a second.

It's impossible to see how far down the reactor the gasification process has descended. If you need to know this, carefully place your finger at the very bottom of the reactor below the reactor grate and very slowly proceed upwards to a point where the reactor starts to get warm. This will give you a rough idea of how much time remains until the burn is complete. Be very careful in doing this, otherwise you might get badly burned.

Channeling

When primary air does not flow up through the column of biomass in a uniform manner, channeling takes place. With channeling there is too much air in certain areas of the biomass, and not enough air in other areas. When channeling occurs, carbon dioxide is emitted, and you generally will see burner holes that do not support a flame.

Also, the reactor in some places might turn red hot as a result of the excessive heat caused by the total combustion of biomass or char within the reactor. Temperatures can rise well above 1,200 C. Such high heat can severely damage the reactor.

Of course channeling will always occur if the biomass is not uniform. But generally rice hulls and coffee husks are sufficiently uniform and do not give rise to channeling. With a uniform biomass, channeling only occurs as a result of a fan speed that at one point was too high. An excessive fan speed displaces a small amount of biomass and causes the formation of an easy pathway for air to flow up through the biomass.

A slight tap or shake of the reactor is generally all that is needed to collapse a channel. Since the reactor is quite hot, the best way to tap or shake it is to do so indirectly. Hold the grab handle of the reactor and tap the air pipe. But before doing this, take the pot or pan off the burner and set it safely on the table top. It is not necessary to turn off the fan.

Turn-Down Ratio

To a limited extent, you can turn up and down the speed of the fan according to the amount of heat required for cooking. In turning down the speed of the fan, you must make sure that all burner holes support a flame. If the speed is turned down too low, the burner might completely go out. If the burner goes out, you have to turn up the fan speed and relight the gas.

Since the gas is quite hot, it generally relights in an instant without removing the pot or pan from the burner. Since carbon monoxide is being emitted during this relighting process, you have to be prepared to relight the gas quickly. If you are not prepared to relight quickly, you should turn the fan completely off.

The fan should not be operated at a speed at which flames rise up the sides of the pot or pan. Also you should not turn up the gas so high that the flames are no longer situated right above the

burner holes. It can happen that, if the fan speed is too high, you might lose flame completely. You must then lower the fan speed and relight the gas.

You should expect to have a turn-down ratio of about 3 to 1 on loose rice hulls: low, medium and high. With a mixture of rice hulls and coffee husks, the turn-down ratio is a bit better: roughly 5 to 1.

Adjusting Fan Speed during a Burn

As the burn proceeds from top to bottom of the reactor, char accumulates above the gasification zone. If this char is derived from loose biomass, it offers more resistance to the flow of air or gas than the loose biomass from which it was derived. So if you want to maintain a consistent flow of gas and heat throughout the burn, you might have to increase from time to time the speed of the fan. Any increase in fan speed should be made in very small increments.

As the Process Draws to a Close

As the process draws to a close, burner holes begin to lose their flames, and the bottom of the gasifier gets hot. If you want to produce a char free from biomass, you should wait until all burner flames go out.

Once all flames go out, you should immediately turn off the fan. If the fan is left running, the char within the reactor will begin to burn. This gives rise to incredibly high heat that can severely damage and even deform the reactor and the reactor grate.

Next you should remove the pot from the burner. When the pot has been safely removed from the burner, turn off the fan and detach the fan box from the air pipe. Place the fan box at a safe distance from the hot reactor.

Emptying the Reactor

Before emptying the reactor, you must remove the burner from the reactor. Since the burner is extremely hot, you should never attempt to remove it by hand. You should always use the u-shaped metal handle provided with your gasifier. You should make sure that both ends of the handle are securely attached to the metal fingers of the burner before trying to lift the burner off the reactor.

To empty the reactor you should grab the reactor handle and the air pipe. Under normal operating conditions, both should be cool enough to manipulate with bare hands and without gloves. Remove the reactor from out under the tabletop and away from the enclosure. It is best to empty the reactor outdoors. The emptying of the reactor should be done in two steps.

In the first step, the reactor should be angled so that only the char flows out. In a second step, the reactor should be turned completely upside down to allow any biomass or char that has dropped below the reactor grate to flow out into a tiny pile separate from the char. If hot char and raw biomass are mixed, the raw biomass will burn. This gives rise to a lot of smoke that is dangerous,

if inhaled. Also, by angling the reactor in a certain position, you can remove biomass through the air pipe at the bottom of the reactor.

When the reactor is turned upside down, hot air will rise and exit through the air pipe. If the reactor is held too long in this position, air pipe will get quite hot. So both steps in emptying the reactor have to be done fairly quickly. It's easy to understand why the fan box has to be detached from the air pipe before turning the reactor upside down: the fan and the speed regulator above the fan would be severely damaged by rising heat.

Never let biomass accumulate below the reactor grate. Never light your gasifier with biomass from a previous run still in the reactor. Make sure that in carrying out step two, you have completely emptied the reactor of biomass.

Cooling Down Char

After the char is emptied, you should immediately cool it down. If the char was made from loose biomass, you should pour it onto a clean metal tray and spread it out as thinly as possible. This causes the char to cool down quickly and prevents it from burning up. Do not pour the char on the floor of your kitchen. This might contaminate the char and lower its value. It might also be a fire hazard.

If the char was made from pellets, you should soak the charred pellets in water. When hot charred pellets are initially placed in water, you should be very careful: a cloud of hot steam rises up in an instant and is quite dangerous. You should slowly pour water onto the hot pellets at full arms length with your face turned away from the rising steam.

Also there is another important health issue at stake. When rice hull char is allowed to burn and turn to ash, a highly dangerous substance called cristobalite is formed. If inhaled, cristobalite can cause silicosis, a serious lung disease. See http://en.wikipedia.org/wiki/Silicosis. If ever rice hull char is not properly quenched and a white ash becomes visible, you should only handle and dispose of this material while wearing a face mask.

Burner Maintenance

The diameter of the burner holes is 4.5 mm. After a month or two of constant operation, soot might build up on burner holes and reduce their diameter. When this happens, the gasifier does not function properly. At least once a month, run a wooden chopstick through each burner hole to remove soot and restore burner holes to their original diameter.

From Char to Biochar

The char from this gasifier is, in fact, a highly uniform charcoal. Even though it burns like charcoal, it should not be used as fuel in a charcoal stove. It should always be utilized as biochar, a marvelous soil amendment and feed ingredient that has a much greater value than the biomass from which it was derived.

Talk to your village retailer about the many benefits of biochar. If you are not in a position to use the biochar you make, your village retailer will assist you in selling it.

Conclusion

Do not take this gasifier out of its box and try to operate it for the first time all by yourself. In the hands of an inexperienced person, this gasifier is dangerous. Your village retailer should first demonstrate for you every step of the entire gasification process. When you have seen this demonstration and feel confident you can operate the gasifier correctly, you should operate it for the first time under the supervision of your village retailer. She is there to make sure that you have mastered every aspect of its safe operation.