Composting toilet

(with optionally Black Soldier Fly Larvae or Compost worms)

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Para este manual en español, por favor sigue este link

Please leave comments and questions either by email or directly in this document through Google docs.

If you are reading this, we don't have to convince you any more about composting toilets. Here are our instructions:

We strive to have aerobic composting conditions to eliminate the chance of odours. Hot, or thermophilic, composting would be difficult to achieve due to the small volume and high rate of ventilation, extracting heat while it is providing aeration. Due to these factors we recommend the use of the resulting compost to be limited to trees or ornamental gardens. If you want to use it in your vegetable garden, then let the compost rest for a minimum of one year. Alternatively, add the contents to a hot compost for second stage processing. After either of these two options your compost will be free of pathogens and safe to use.

A composting toilet has many benefits:

1. Save water
2. Does not contaminate
3. Low cost
4. Odourless

5. Low maintenance
6. Ultimately provides liquid fertilizer and safe compost

We have been using our composting toilets for several years now and feel like we have come to some conclusions on the design and the cover materials to use for our tropical climate here on the Caribbean coast of Colombia. It is a variation on the clivus multrum toilet but in our case designed for easy and cheap construction while still superbly durable, effective, odourless and simple.

Some of the key points of this toilet design are:

1. No separating urine from faeces. The urine quickly drains down past the fresh faeces and thus avoids the production of smells associated with badly managed compost or dry toilets. Removing the urine 'funnel' found in dry toilets avoids the urine smells associated with urine separators
2. A constant air flow providing oxygen to the composting mass (aeration) and extracting undesired (compost) odors
3. Drainage of excess liquids
4. Adding of cover materials
    a. balancing carbon/nitrogen ratio,
    b. absorbing liquids,
    c. covering faeces for a more pleasant experience for the next user
    d. Minimizing the chance of attracting unwanted flies
5. Low temperature (under 60C)
6. Perfect environment to host Black Soldier Fly Larvae (BSFL) or compost worms. Their compost processing ability will significantly extend the time between drum changes and keep unwanted flies at bay

Design:

The composting toilet consists of a minimum of two 200 liter drums. A family of four typically fills one drum in about 6 months. When full, the current drum #1 is pulled out and replaced with a new drum #2. Drum #1 is then allowed to rest until the new drum #2 has been filled. At this point drum #1 can be used as compost or be emptied out onto an active hot compost for second stage processing before being put in place in the composting toilet again. We also write the date on the drum that has been removed for future reference.

Construction:

(All PVC mentioned is sanitary grade)

The drum: (multiply by two for second drum - recommended identical in size!)

- 50 gallon or 200 liter plastic drum with a more or less right-angle intersection between the walls and the base. Drums that narrow towards the bottom are hard to work with because of the angle and position of the chimney connection (see picture)

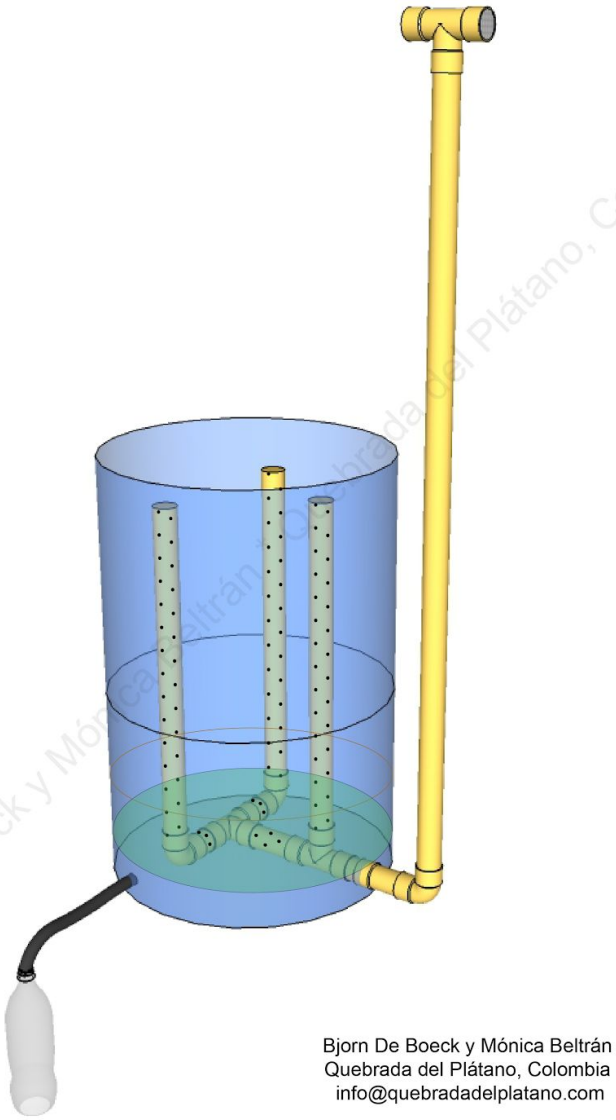
DIFFICULT

CORRECT

- 3 PVC tubes 2” of 70 cm
- 1 PVC tube 2” of 10 cm
- 2 PVC tubes 2” of 8 cm
- 1 PVC tube 2” of 5 cm
- 4 T pieces PVC 2”
- 1 ¾” male PVC adapter
- 1 empty gallon bottle (or larger) with cap
- One piece of non transparent, non translucent garden hose for drain. Recommended diameter ¾” or 18mm
- PVC adaptor male & female 2”

Chimney:

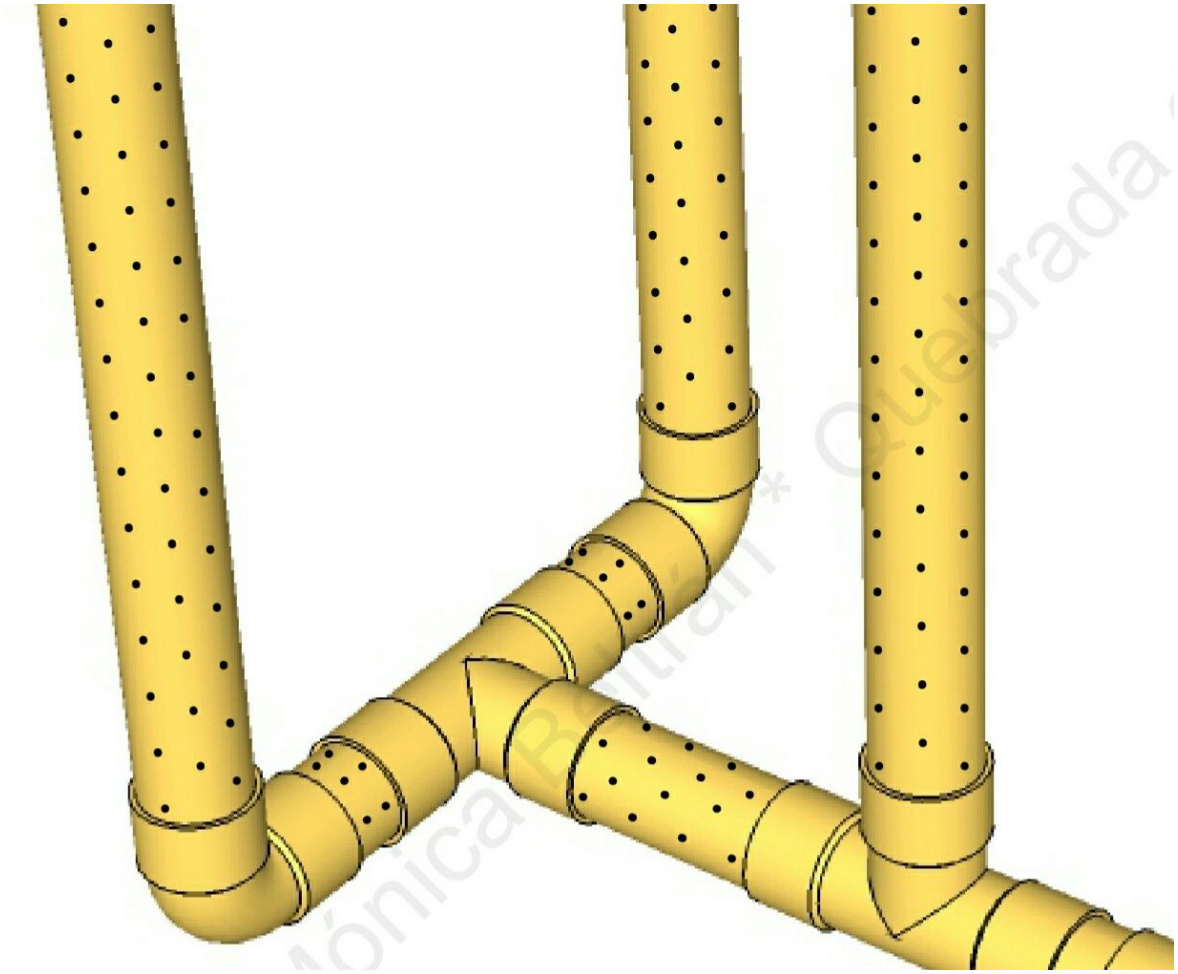
- 1 L piece PVC 2”
- 1 T piece PVC 2”
- 4 meters of PVC tube 2” (or 6m of PVC tube 4”, see note on solar heat ventilation)
- Matt black paint spray
- 2” fan 12V with 110V to 12V adaptor (Fan is optional but highly recommended). A sewer vent whirlybird will work too if you have a constant breeze at your location of about 5 knots
- Mosquito netting



When installing the adaptor, allow a 3-4 cm distance from the bottom to make sure the liquids don't drain into the ventilation.

The holes in the tubes and all the bottom pieces are about 5 mm and spaced regularly every 5 cm more or less. They provide air to the mass but also liquids will seep into them so make sure you put holes in the bottom PVC manifold too to allow for liquids to drain. Glue internal part of the tubes together as in drawing. From the air penetration hole place first the 5 cm piece, then a T, then the 10cm piece, another T, the two 8cm pieces and finally the last two T pieces. Space vertical tubes so as not too much in the middle but not stuck to the sides either. Do not glue the PVC into the adaptor. This will just go pressed in and won't move as long as the drum doesn't move. Support this PVC manifold propping it up, floating horizontally. Anything will do from a

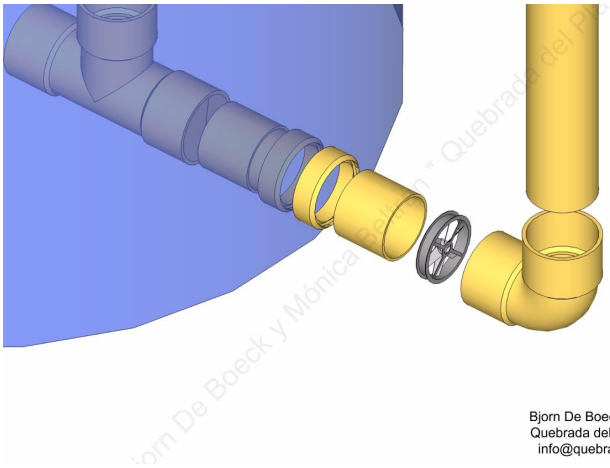
handful of concrete (that's what I do) to a piece of sturdy wood.



Probably the most important part of the toilet : Make a hole the EXACT size of the outside diameter ¾” male adapter in the lowest possible point of the drum. Screw in the male adaptor with a rubber washer to ensure a good seal. *It is very important to make sure you protect the drain hose from blockage* by placing coconut husks around it creating a small ‘chamber' where liquids can collect and proceed into the hose. Make sure the drain hose and liquids recipient are all at a lower level than the bottom of the drum to ensure proper drainage. Make another tight fitting perforation in the cap of the gallon jug for the hose to fit through. Leachate can be used diluted as fertilizer.
Note: undesirable smells could come from a leak in the drain system. Go through the extra effort to get this right. Do not allow for ANY leakage or blockage whatsoever. Work carefully and do a water test before putting your system to work.

The chimney tube needs to be scuffed with some fine sandpaper, wiped down with alcohol and painted with matt black paint, all the way down to the connection with the drum.This paint will heat up the air in the chimney when the sun hits it and provide passive ventilation through rising warm air. Install the PVC T on the top to prevent rain from entering the chimney. Install a piece of mosquito netting to prevent insects from entering. At the bottom glue the L with a piece of PVC tube to the chimney. Do not glue the chimney to the threaded adaptor as the chimney will be unplugged again when changing the drums.

Install the fan. Install mosquito netting between the drum and the fan. This will prevent the black soldier fly larvae from leaving the drum and blocking your fan. The black paint blacks out any light filtering through the PVC tube and so discourages larvae from exiting through this connection. A 5 cm computer fan fits nicely when you cut off the corners with a hacksaw (see photo). Install so it sucks air out of the drum and up, into the chimney. Drill a 1 mm hole in the bottom of the L to allow for possible water to drain from the chimney. When purchasing the fan, get yourself one or two spares. They are cheap and, depending on the quality you buy, prone to failure due to extended use, flooding or burning out.
A word of caution about excess ventilation: if you intend to have BSFL in your compost drum, excess ventilation can suck so much air through the system that the only way for black soldier fly to pick up to scent would be through the top of the chimney, where you have installed mosquito netting, thus preventing them from getting in to lay their eggs. A small fan will do just fine as long as you're not leaving too big a gap anywhere in the system.



The actual seat and house is up to you and your creative mind. You have the option to make it a squat toilet, if that is what you want. Make sure you seal everything as airtight as possible. This is more important for those who decide not to install the fan and rely on solar heated air extraction only. We use regular toilet seats but I have seen designs with seats with absolutely no gaps, added neoprene seals etc.

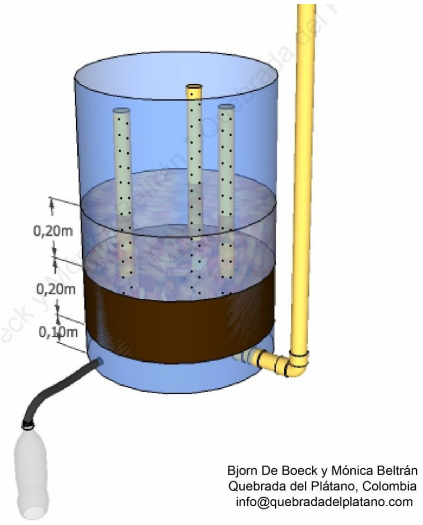
(*) A note for those who rely on *just* solar heat for ventilation: the larger the area painted black, the more hot air will be rising. Therefore, to optimize your ventilation, we recommend using a 4 inch diameter chimney that is painted black and exposed to direct sunlight for 6 vertical meters.

Note how the drum meets the board pretty flush. This is essential to prevent critters from getting in there and to prevent smells from rising up without going through the chimney.

If you want to attract Black Soldier Flies, you will need to leave a small gap or hole somewhere for them to find their way in. Additionally you can hang or glue a small piece of corrugated cardboard inside the drum, they like laying their eggs in that.

Start Up:

1. Line the bottom of the drum with sticks or pieces of coconut husk until you fill in the gaps between the horizontal PVC tubes. Protect the drain hose from blockage by covering it with coconut husk or pieces of rock or wood. Cover all this with a piece of shadecloth or fine plastic mesh. This ventilation layer allows liquids to drain to the bottom and towards the drain hose while providing oxygen to the bottom of the compost helping to avoid anaerobic digestion.
2. Add a 20 cm layer of finished compost (1 part) mixed with dry sawdust (2 parts). This layer absorbs urine while also inoculating your system with beneficial compost bacteria.
3. Add a 20 cm layer of dry shredded leaves. This layer allows some initial airflow for oxygen to get to your mass and additionally absorbs urine.



Cover material:

Always have a bucket ready with cover material. Also provide a small scoop (200cc) to indicate the quantity to deposit after every poo. After urinating it is not required to add cover material. The cover material's main task is to balance the ratio between nitrogen and carbon; *it is not to hide what's below*! Therefor: a single small scoop suffices for the purpose. Depositing excess amounts of cover material will result in your drum filling up faster than the composting process can reduce the volume and lower the necessary humidity.
The following materials can be used:

- Sawdust: not chainsaw wood chips (too rough) nor sawdust from sanding (too fine).
- Shredded dry leaves: Work best if composted first since leaves have a waxy surface that slows down composting
- Dried grass clippings: Must be dry and not too fine, otherwise it will "clump" and stop air movement through the mass
- Rice hulls

Information Sheet:
Post an information sheet to advise people on how to use your toilet. It can be as simple as

- Add one scoop of cover material after pooping
- No cover material added after peeing
- Toilet paper can be thrown in.
- ALWAYS close the lid after use.
- The list of what can't go in

Post the information facing the toilet seat to make it 'compulsory reading' whilst you sit down.

What CAN go in:

- Toilet paper. We recommend unbleached and without perfume
- Shredded cardboard (like the little roll inside the toilet paper)
- Mushrooms (they add additional help to the composting process!)
- Wood ashes (in small quantities can be mixed with your cover material if your cover material is too humid)

What CAN NOT go in:

- Wood
- Plastic, Metal, Glass
- Chemicals
- Lime
- Oil
- Antibiotics - or rather: people who use antibiotics should, preferably, not use your system consistently
- Tampons and sanitary pads
- "Wet wipes"
- Diapers
- Earth or sand
- Kitchen scraps; they will attract undesired fruit flies

Routine maintenance:

1. Once every month, with a stick, **distribute the cone**. You can also add a thin layer of compost or worm castings if they are available. If you have active BSFL, they will keep your mass nice and flat.

2. Every few days, depending on frequency of use, **check liquid discharge**. If very little is found, empty 1-2 liters of water on top of your compost. If bottle has a good quantity (2+ liters), dilute 5-1 with water and fertilize your plants.
3. Check if **ventilation** is working properly. If the toilet lid has condensation droplets the ventilation might be inadequate.(However, this is normal if using a solar chimney as only means of ventilation.)
4. **Drum replacement**. Try to hold off on replacing the drum as long as you possibly can without it being an inconvenience to anybody. The fuller the drum, the more composting is happening and the more the mass will reduce with time. When you need to change the drum, disconnect the chimney and the drain hose. If you have a level and smooth surface, the drum should slide out without too much effort, despite of its weight. Try to loop a piece of rope around the bottom of the drum and pull it out. Install the new drum as you did before and put the full drum aside and out of the way. Put a good quantity of kitchen scraps on top and close the lid. I have not seen the need to plug the vent and/or drain holes. When you eventually empty the drum that has been resting (a minimum of 6 months), what comes out will look just like compost and won't have anything remotely recognizable in it nor any bad smells. You can give it a quick rinse before using again.

It is normal that in the first couple of months you have more liquid discharge. After that, your bio-sponge should start to form and will absorb better. Your toilet is a living organism and no matter how low maintenance, it still needs to be looked after properly and its health checked regularly. If funky smells are noticeable, it could have one of three reasons:

1. Bad drainage: check if the liquids are draining properly and no liquids are stagnant inside the drum. A blocked drain can be cleared by *briefly* backflushing connecting a water hose to the discharge hose and pushing water into the system
2. Bad ventilation: without a constant oxygen supply your compost might start with anaerobic digestion
    a. Check the chimney for blockage,
    b. is the fan working and sucking air in the correct direction or, does the solar chimney have proper sun exposure
    c. Is the chimney connected
3. There can be too much urine in the early stages of use. Encourage users to pee somewhere else when possible for a while or be very vigilant of the drain bottle and empty more frequently

As long as you have good ventilation and drainage you should have a perfectly working odor-free compost toilet that is a pleasure to use!

Lastly, the resulting end-product of a compost toilet is a stable, soil-like material called "humus". In some American states, it is illegal to use this material in your gardens. Therefore, it must be either buried or removed by a licensed waste hauler. Please check your state and local regulations for details.

Any questions you can send directly to us bioreservaqdp@gmail.com. We will be more than happy to help out wherever possible. Allow some time for us to reply because we live off-grid and without cell phone coverage.

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