

Toilet biology

We often get asked about the biology of our toilets. How do they work and why do things sometimes go wrong?

NatSol has 3 different toilet systems and there are different answers to those questions in each case. The 3 different systems are: -

- the Full Access Composter, which is urine-separating and has two vaults in which to alternately batch-process solid wastes
- the Compact, which is also urine-separating but where solids are removed regularly for composting elsewhere
- the Zero Discharge, which neither separates urine nor composts

We'll start with our best seller: -

The Full Access Composter (FAC)

Composting takes place in an underground chamber and this process should last at least a year. There are two vaults and the pedestal is switched between them on an annual or longer cycle. The composting process is not radically different from a garden compost heap. If you are a gardener you will know that a compost pile which is too wet will stagnate and become smelly due to a lack of oxygen. You will probably also know that a pile which is too dry simply won't compost; either nothing happens or the process is very slow. So moisture content is crucial.

There is another, less obvious, factor. This concerns the balance of nutrients, particularly the Nitrogen [N] to Carbon [C] ratio which should be roughly 1:30. Both are present in living organisms and their waste matter. The main source of N in excrement is the urine. We excrete N from protein breakdown in the body in the form of urea. Urine is also a great source of other valuable nutrients: Potassium (K), and Phosphorous (P). It is, in fact, the best plant fertiliser you can't buy because it contains the three main plant nutrients, N, P & K, as well as a host of micronutrients. Needless to say, it is also wet, and sometimes that's just what composting needs – a bit more H₂O.

In composting toilets, it is common for N to be present in larger quantities than are needed. Faeces always contain some N and even in urine-separating toilets it is usual for some urine to get into the composting chamber. For this, and other, reasons we recommend the addition of some 'soak' material after each defecation. The soak is usually wood shavings, which are convenient and easily obtained, but chopped straw or Hemcore (from hemp) can also be used. The important qualities of soak are that it's dry and rich in C. The dryness helps to soak up unintended additions of urine and the C balances out any excess N in the composting vault. Soak is also great for covering up number twos which you don't want the next person to see.

It's not a disaster if N and C aren't present in the correct ratio but it helps.

So that's it? Not quite. Decomposition requires all sorts of micro critters which do the work. Some are microscopically small; some are visible to the naked eye. We don't usually introduce these, they just get in there, but we do suggest that when you empty a vault you leave a little bit of compost behind as a starter pack of organisms for the next cycle.

All done and dusted now? Almost. Amongst the organisms which get into the vault there will be some which you don't want. The most obvious of these are dung flies and, occasionally, if a toilet is not being properly used and appropriately managed, you could get an outbreak of these. There are a number of possible species, usually small flies such as members of the family *Spaeroceridae*.

We have rarely known a case of dung flies occurring in toilets where the composting pile has the right moisture content. They almost always seem to occur when the pile is too wet. You might reasonably assume from this that they like wet conditions but this might not be correct. There are predators for dung flies which also find their way into a toilet composting pile and the most useful, most successful, of these predators doesn't like a wet environment.



Trumpet fanfare (toot toot) introducing *Staphylinus philonthus politus*:



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We'll call her Staph for short. Staph is one member of the family of devil's coach horse beetles, also known as rove beetles, and there is nothing they like better than rummaging through a compost pile for fly eggs and larvae which are considered a very tasty main course. Providing the pile has an open, aerobic structure, Staph is highly efficient and it becomes most unlikely that flies will manage to breed.

If you are worried about having such a frightening looking creature wandering around just below your bum then fear not. She is generally less than one centimetre long and has no incentive to go on bum biting expeditions. But you may see her running around in the compost which you eventually remove.

It can take a few months with new toilets before Staph finds her way in – usually, we suspect, down a vent pipe. That happens easily with passively vented toilets but is harder if you have a fan. In that short period of time dung fly breeding can start but, in airy remote toilets where the building is not fully enclosed, it's highly unlikely you will notice that and, before it becomes an issue, Staph will spot the flies and move in for the kill.

Some toilets are in more indoor locations and have fans. The dung flies still seem to find their way in but Staph may be excluded and will need to be introduced. She doesn't mind being sent in the post and we have a local supply, so if necessary we can come to the rescue. A dozen or so normally includes at least one male and one female and that seems to do the job.

There are a couple of other insects which might be problematic. One is *Drosophila*, the fruit fly. Fruit flies feed and breed on decaying plant material. If somebody has a problem with any insect we usually ask them to send some dead flies to us in the post. This happened with a rather public facility in Scotland. We expected to see dung flies and to discover that significant urine had been getting into the vault. We were duly surprised to discover that the flies sent in the post were *Drosophila*. Given the nature of the site we asked if anybody had been chucking their unwanted sandwiches or other lunch box items down the toilet and, hey presto, that's what the managers discovered.

Then there was the case of the very wet toilet where a blockage had occurred in the pipe taking the urine away to a soakaway, resulting in considerable urine in the vault. A user reported bees coming out of the toilet but they were found to be drone flies which mimic bees in appearance in order to frighten off predators – “we look like we might sting you but we're really just having you on”

On one of our very early toilets the owners left a bale of soak material outside for months. The polythene wrapper got damaged and rain got in. Then meal moths laid eggs in the bale. These eventually hatched after some of the damp soak was used down the toilet and the toilet cubicle became, briefly, a lepidopterists' heaven, full of beautifully marked flutterers.

So what about the Compact toilet?

The Compact is a small urine-separating toilet which takes about 20 to 25 number twos before it needs emptying. The composting takes place in a dedicated bunker outside and we provide advice about how to construct that. The trug which receives the solid wastes is too small for a composting process to get going, but not too small for dung flies to be interested. It's unusual for the full range of predators to arrive in the time it takes for dung flies to breed, so the trug should be emptied at least every three weeks even if it isn't full. Three weeks is roughly the time taken for a dung fly breeding cycle to complete but it will be longer in cold weather.

Is that it? Yes.

And the Zero Discharge (ZD)?

This toilet came out of a request by The Royal Parks to design a system without urine discharge for the Isabella Plantation, a Site of Special Scientific Interest (SSSI) in Richmond Park, London. The ecology of SSSIs can be upset by all those nutrients in urine. In addition,

usage was expected to be very high, and we were not confident that management of composting toilets would be successful with that volume of waste.

The ZD does not separate urine, does not compost, and waste is removed by slurry tanker. There is no flushing.

So how does this work with regard to biological issues like flies? Well, er, to be honest we are not altogether certain, but we can report that flies have not been an issue with this model of toilet. Can they get in there, - you might ask? Yes, definitely. They can get in through the toilet pedestal or down the emptying hatch when the toilet is being emptied.

Our best shot at understanding why flies are not a problem is that it's quite a hostile environment in there. Most of the liquid is urine, with small additions of water from hand basins in the disabled access cubicles and from the cleaner's sink. Urine contains urea and an enzyme which causes the urea to convert to ammonia when outside the body. You know that acrid smell from public urinals which aren't cleaned often enough? That's ammonia.

We suspect that high concentrations of ammonia discourage flies from breeding. However, you might have remembered that we had a composting toilet with too much urine which ended up with drone flies. Why don't we get drone flies in ZDs? Drones are fairly large, and they may not be finding their way in. Or it may be that the conditions are not quite right in some other way.

Looking for a PhD topic and interested in entomology and human excrement? There you go, and we'll provide some assistance by putting you in touch with owners of toilets which you might investigate.

Andy Warren – Managing Director

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