SKILL GUIDE · SANITATION & HYGIENE

Composting Toilets: Humanure, Vermicomposting & Incineration

The Bathroom & Hygiene Without Running Water skill guide covers the short-term bucket toilet: a liner, cover material, and temporary sealed storage. This guide picks up where that stops, the Sanitation & Hygiene addendum's Stage 3 goal of a real, permanent, no-power sanitation system: the actual science behind safely composting human waste long-term, plus vermicomposting, incineration, and pyrolysis as real alternatives.

The real mechanism: heat or time, not just a pile of waste

Thermophilic (hot) composting works because sustained heat kills pathogens directly. In an active pile that reaches 131–150°F, E. coli and salmonella die within 1–4 hours. Roundworm eggs, the most heat-resistant pathogen commonly found in human waste, need far longer: 1–2 months of sustained heat at that same temperature.

WARNING

A pile that never gets hot isn't automatically unsafe, it just needs time instead of heat

Most backyard humanure setups never reach true, sustained thermophilic temperature, and that's fine as long as it's treated honestly: given enough time, roughly 12 months minimum for cold composting, pathogen load drops to safe levels on its own. If the finished compost will ever touch a food crop, that minimum doubles to 24 months, the WHO, EPA, and every credible composting-toilet guideline agree on this figure. Skipping the cure time because the pile "looks like dirt" is the single most common real mistake.

The actual chemistry: why sawdust cover material isn't just for odor

Composting needs a carbon-to-nitrogen ratio of roughly 25:1 to 30:1 to work efficiently. Raw human waste alone is far too nitrogen-rich, about 6–10:1, which is exactly why a cover material matters: fine hardwood sawdust runs 300–500:1, so a consistent layer after each use is doing real chemistry, correcting the ratio toward the range that actually composts, not just masking smell. A persistent odor problem is a real diagnostic signal that the ratio is off, or the pile is too wet with too little air, not a sign that composting toilets are inherently unpleasant.

Element	Spec	Why
Cover material amount	A handful to a cupful after each use, enough to fully bury what's underneath and leave no waste visible	About one 20-liter bucket of sawdust per week for two adults and a child; too little leaves odor and flies, too much just runs out the supply faster than necessary
Cover material	Fine hardwood sawdust, wood shavings, or chopped straw (under 3–4 inches)	High carbon content corrects raw waste's nitrogen-heavy ratio toward the 25:1–30:1 target
Bin design	Sealed, above-ground container, isolated from soil and water contact	Contains waste safely while decomposition happens, and keeps it inaccessible to children or animals
Cure period	12 months minimum; 24 months if output will touch food-crop soil	Matches WHO/EPA guidance for pathogen die-off without relying on sustained heat

A real system needs at least two bins in rotation, ideally three: one actively receiving material from the toilet bucket, one resting and curing untouched, and a third fully finished and ready to use, so a bin is never both being filled and being counted toward its cure clock at the same time. When a toilet bucket fills, its contents get dumped directly into the active compost bin and immediately covered with a layer of the same carbon material, not left exposed; this is the actual mechanical link between the short-term bucket system and the long-term pile, and it's worth practicing the transfer before relying on it.

Size matters more than most instructions mention: a pile smaller than roughly 3 feet on each side (about a cubic yard) simply can't hold enough of its own heat to reach or sustain thermophilic temperature, regardless of what's in it, so an undersized bin will default to the slower cold-composting timeline no matter how well the carbon ratio is managed. And "reaches 131–150°F" isn't a guess to make by touch: check it with a long-stem compost thermometer with an 18 to 24 inch probe, inserted to roughly the center of the pile's depth, left in place for a minute or two before reading, and checked in the morning before the sun's own heat can skew the number. If attempting the hot-composting route, turn the pile every 1 to 2 days, moving cooler material from the outer edges into the hot core; a pile left untouched develops cool pockets at its margins that never reach a pathogen-killing temperature even while the center does.

Vermicomposting: a real pretreatment step, not a standalone finish line

Eisenia fetida, commonly called red wigglers, are the species used for this specifically; they process waste quickly and tolerate the conditions involved better than other earthworm species. Real research backs a genuine pathogen-reduction effect, including eliminating up to 99% of fungal pathogens found in test material. The honest limit: vermicomposting is a pretreatment step that meaningfully reduces pathogen load, not a substitute for the same hot-composting or cure-time rules above, and the same food-crop caution still applies to its output.

A working bin needs real numbers too: roughly 1 to 2 pounds of worms per square foot of bin surface area, a bedding layer (shredded cardboard or coco coir works) a few inches deep kept damp but not soaked, like a wrung-out sponge, and a bin with drainage and airflow rather than a sealed, airtight container.

Incinerating toilets: the no-composting alternative

An incinerating toilet burns waste to sterile ash after each use rather than composting it at all, the most hands-off option in terms of ongoing management, at the cost of a real, continuous fuel or power dependency.

Type	Unit cost	Per-use operating cost
Electric	\$2,000–\$4,500	Electricity cost varies by local rate and unit
Propane	\$2,500–\$4,800	~0.25–0.35 gallons of propane per cycle, roughly \$0.63–\$1.23 at typical current prices

Weigh this against generator or solar/battery capacity if considering the electric version for a real Tier 3 plan; it's a real, continuous draw, not a one-time equipment cost.

These units aren't plug-and-use: every incinerating toilet needs dedicated exhaust venting, typically a 3 to 4 inch pipe routed to the roof or an exterior wall and terminating at least 24 inches above the roofline, never vented into an attic or crawlspace. Skipping proper venting causes indoor odor at best and a real fume or overheating hazard at worst. Ash left behind after each burn is sterile and can go into regular household trash or be used as a soil amendment in small amounts; let it cool fully before handling either way.

Pyrolysis and biochar: faster than composting, but only with real equipment

Pyrolysis heats waste in a sealed, oxygen-free chamber, a retort, to roughly 930–1,200°F (500–650°C), destroying pathogens in minutes rather than the months a cold-composting cure needs, while cutting the waste's volume by about 90% and leaving behind biochar, a stable, carbon-rich material with real, documented use as a soil amendment. This is genuine, actively studied sanitation technology, not a fringe idea, and the output is credibly described in the research as pathogen-free when the process actually runs at temperature.

The gap between that and a backyard burn barrel is the entire point: real pyrolysis depends on the chamber staying sealed against outside air and holding true temperature evenly throughout the load, exactly what a gasketed, refractory-lined retort is built to do and an open or improvised burn setup can't reliably guarantee. A cooler pocket in an uneven burn can leave hardy pathogens, roundworm eggs among them, alive in material that looks fully processed. Treat this as a real upgrade path once you own or build equipment that actually verifies sustained temperature throughout the chamber, not a shortcut around the aging method above with whatever's already on hand.

Check before installing anything permanent

Utah's onsite wastewater rules (Utah Admin. Code R317-4) explicitly cover composting toilets, but a permanent installation, as opposed to a temporary bucket-toilet setup, is the kind of thing worth a call to your local health department before building, not after. NSF/ANSI Standard 41 is the real, recognized certification standard for a manufactured composting toilet unit if buying one rather than building from scratch.

Sources

- Joseph Jenkins' Humanure Handbook, the original documented methodology: Humanure Handbook
- Pathogen die-off temperatures and times, and 12/24-month cure guidance: The Off-Grid Workshop
- Carbon-to-nitrogen ratio math and cover material specs: Coconino County; NSF/ANSI 41 requirements: NSF
- Vermicomposting species, bin stocking density, and pathogen-reduction research: Red Worm Composting; National Library of Medicine; Urban Worm Company
- Incinerating toilet costs, operating specs, and venting requirements: Septic Tank Hub; Cinderella Eco; Incinerator Toilet Venting Guide
- Minimum pile size for thermophilic heat, and measuring pile temperature: Permies; Grow Your Pantry
- Bin rotation, cover-material amount per use, and turning frequency: Humanure Handbook; Appropedia; Compost Check
- Pyrolysis temperature, retort design, and biochar output: University of Colorado (Sol-Char toilet research); Waste and Biomass Valorization
- Utah onsite wastewater regulations: Cornell Legal Information Institute