



VAULT TOILET VENT GAS ODOR CONTROL

Brenda Land—Sanitary Engineer

Vault toilet odor was the number one forest recreational visitor complaint in 1990. Extensive work went into the development of passive vault toilet ventilation principles to reduce odor in the toilet user compartment. Passive ventilation of toilet buildings (nicknamed SST toilets) is very effective in most applications at removing odors from the toilet user compartment. The vault odor is not destroyed, but removed to the outside of the building through the vent stack, sometimes having an adverse effect on the surrounding area. San Dimas Technology and Development Center, (SDTDC) examined ways to minimize the odor, or the adverse effect of the odor of the vented toilet.

The Tennessee Valley Authority (TVA) analyzed vault toilet vent gases with a chromatic gas spectrometer. The only gas present in a detectable quantity was ammonia. There was no detectable methane or any other identifiable gas present. Removing or destroying the ammonia present in the vent gas substantially reduces the odor.

The odor, or adverse effect of the odor, may be minimized in several ways.

1. Activated carbon will adsorb the odor.
2. A flame in the vent stack will burn the volatile gas, minimizing the odor.
3. The odor can be transported by pipe to an area away from the main use, minimizing the adverse effect of the odor.
4. A biologically active filter will convert the ammonia to odorless nitrogen gas, minimizing the odor.

Carbon Filter

Activated carbon will adsorb (attach) to most of the objectionable odors in vault gas, removing it from the exhausted air. Activated carbon is available in granular or powdered form. The carbon has a finite surface area to adsorb contaminants. The carbon then must be replaced. Powdered activated carbon has more surface area than a granular carbon, so a smaller amount is needed to remove the same amount of contaminants.

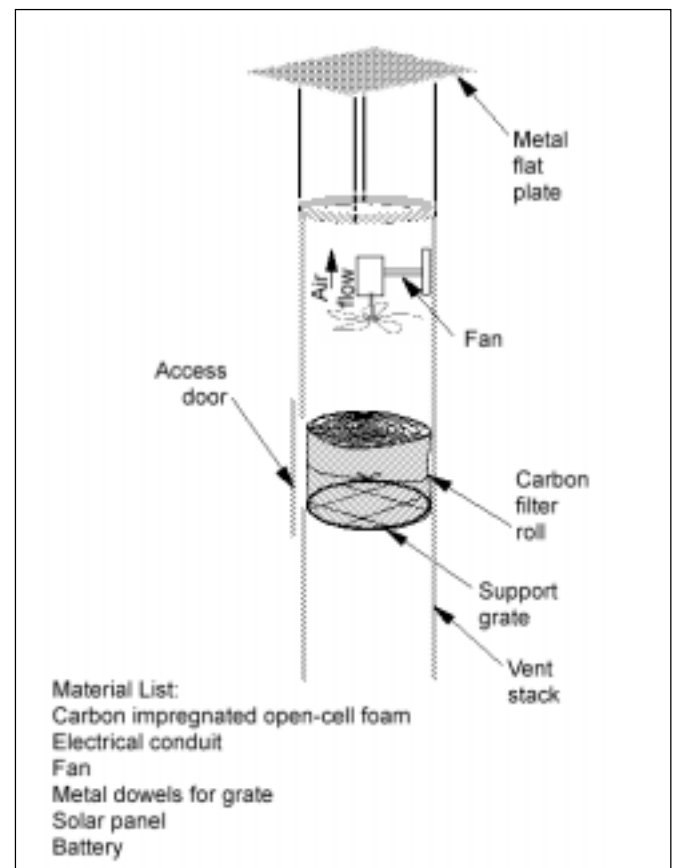


Figure 1—Carbon filter.

Carbon filters made of activated powdered carbon impregnated open cell foam are smaller and more efficient than granular carbon filters. Most of the objectionable odor will be adsorbed (attached) on the carbon as the vault gases pass through the foam. The carbon-impregnated foam was effective at reducing odor for 30 days in pilot testing. The filter must be replaced when it is no longer able to remove the odor.

Premade foam filters are not available to fit vault vent pipes. The carbon-impregnated foam must be cut and rolled to fit the vent pipe. The foam is available in bulk rolls or sheets of various thicknesses. Cut the foam to about 12 inches (0.3 meters) wide strips, long enough to form a roll that fits snugly in the vent pipe. Roll and tie the foam, as shown in figure 1. A door must be cut in the vent pipe to allow for easy installation and replacement of the filter. Placing a filter in the vent restricts the airflow. Forced ventilation is required to prevent the vault gas from finding another exit (the toilet riser, into the building). The carbon's adsorptive capacity is exhausted in about 30 days and must be replaced.

A fan is required to pull the air through the foam filter. Locations without electricity would need to install a solar system consisting of a solar panel, controller, battery, and dc fan. A rain cap should be installed over the vent pipe to protect the fan. The odor inside the building is substantially increased if the fan is not working. The restriction of the filter stops passive venting of the building. Remove the foam roll from the vent pipe when the fan is not operating.

The cost of the solar package is less than \$500. The annual material cost of replacing the filter is about \$100 for a 3-month season (about \$30 per filter per month of operation). A short list of supply sources is included at the end of this document.

Flame

A kerosene flame was first used in 1962 by the Northeastern Forest Experiment Station to neutralize vault odor. It works well, and is an inexpensive, low maintenance way to neutralize the vent odor. A propane flame in the vent stack will minimize the odor, as well as disperse any remaining odor better, because the hot air rises higher in the atmosphere. The gas flame

can also be used to provide a night light for the building, by installing a translucent window in the vent. A propane tank, regulator, safety valve, burner, and thermocouple are the necessary components. The only maintenance required is changing or filling the propane tank. The material cost is less than \$150, plus the propane tank. The pilot light sized flame uses about a gallon of propane gas a day.

The Northeastern Forest Experimental Station was concerned about the possibility of gasoline or other volatile material being poured into the vault and creating a fire hazard. For this reason, they suggested a flash suppressor consisting of several layers of steel mesh be installed. However, the only known vent fire was caused by leaves accumulating on the flash suppressor. The decision to install a flash suppressor should be made at the local level, based on the likelihood of volatile, flammable material being disposed of in the vault toilet.

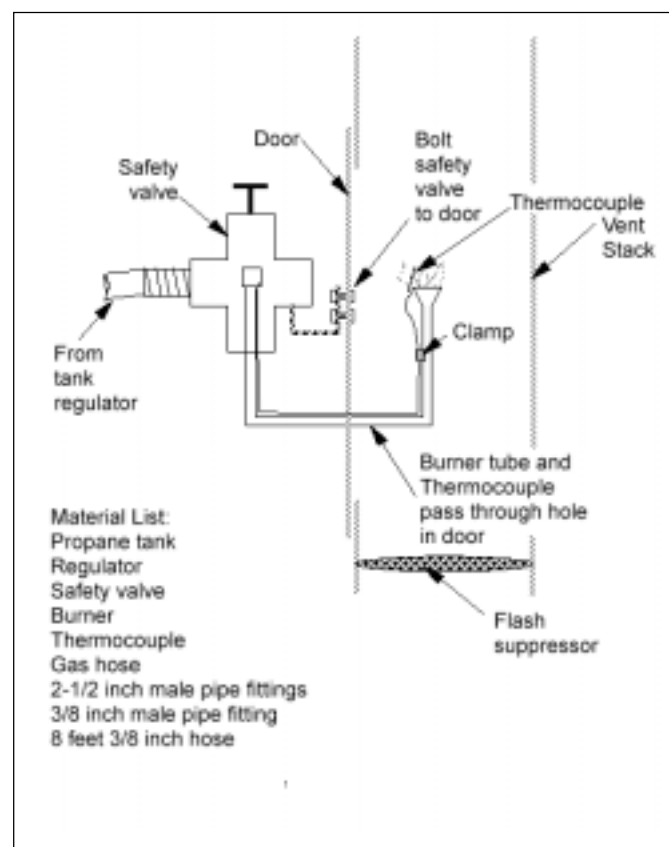


Figure 2—Flame in vent.

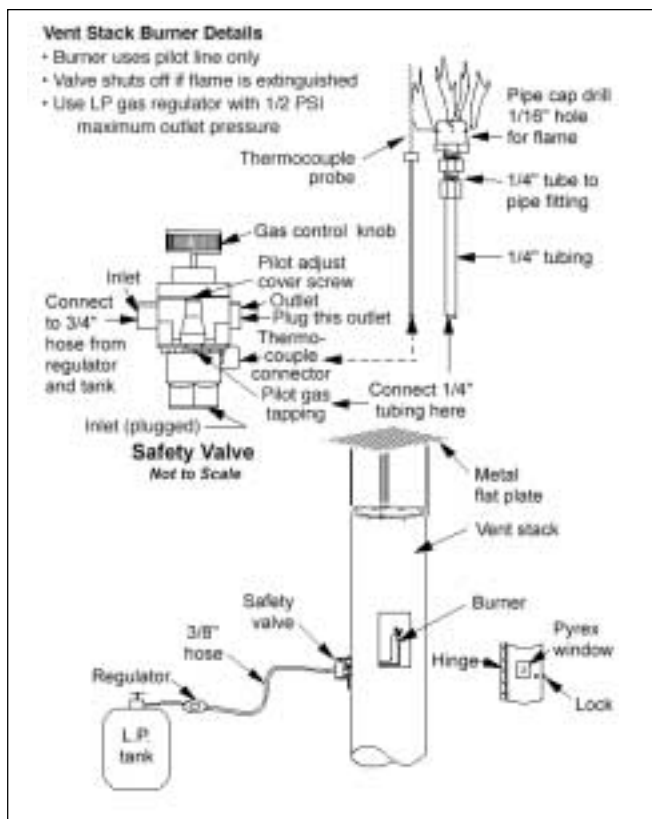


Figure 3—Vent flame details.

Relocation

The odor can be transported away from the toilet building and visitor use areas by extending an underground pipe to a remote or downwind area. The toilet can be vented a few hundred feet away from the building. This option depends on local terrain and visitor use patterns.

In existing toilet structures, a splice may be made into the vent where it penetrates the concrete slab. A fan is usually required to move the air through the extended pipe. A solar package can be used in areas without electricity. The fan and solar panels can either be mounted at the toilet building or at the vent termination point. The cost of the solar package is less than \$500. The cost for extending the pipe is dependent on location.

Biological Filter

The biological vent filter was developed in a cooperative agreement with the Tennessee Valley Authority (TVA). A biological filter uses bacteria to convert ammonia into odorless nitrogen gas. The only odor that remains after the biofilter is a damp earth smell.

The biological filter consists of a sleeve that fits inside the existing vent stack. The sleeve is filled with bark nuggets as a support medium for the bacteria. The biological filter also requires a water storage tank, water pump, timer, and fan. The support medium must remain damp for the bacteria to survive. Water is sprayed over the bark twice a day by means of a water pump and timer. The biofilter creates enough resistance to natural convection that a fan is required to move air through the filter. Electricity is required to operate the system. Solar panels, charge control, and battery may be used in areas without electricity. If the fan is not working the odor in the building will be substantially increased because of the restriction in the vent. Water must be kept in the water tank for the biological filter to function properly.

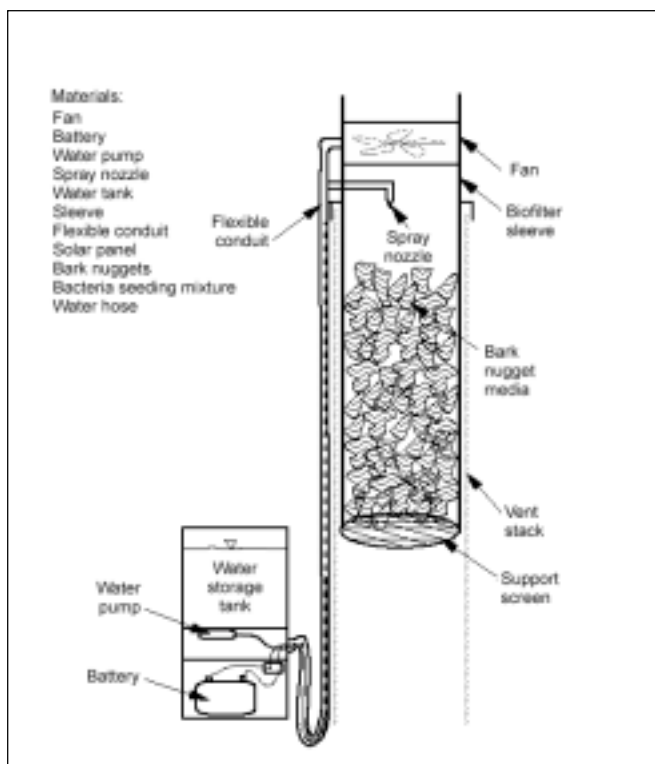


Figure 4—Biological filter.

The cost of fabricating and assembling the biological filter components is variable, depending on availability of in-house assembly, use of off-the shelf/fabricated components, and local metal work cost. The solar and electrical components cost about \$300. Fabrication drawings and operational directions are available on the intranet at <http://fsweb.sdtcd.wo.fs.fed.us>. The filter can be built by a local fabricator or at SDTDC. The bacteria to seed the filter is available from TVA. In cold climates, the filter will need reseeded with bacteria in the spring.

The following supply sources are for reference only, and not an endorsement.

Carbon Filter Material

Polysorb carbon impregnated open cell foam is available from Columbus Industries, Inc., phone (614) 983-2552. Other brands are available from local HVAC suppliers.

Solar Supplies

Solar modules, batteries, fans, and controls are available under GSA contract from Applied Power Corporation, phone 1-800-777-7075. Several other solar-electric companies are also available.

Biofilter Bacteria

The TVA contact is Tim Holt at (256) 386-3799.