Forest Research Note

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THE CONVECTION STACK — A DEVICE FOR RIDDING PIT TOILETS OF BAD ODOR

One of the common problems on outdoor recreation areas is that pit toilets smell bad. Flush plumbing is one answer to the problem. But pit toilets are needed in many places where modern sewage systems are economically or physically impractical. To reduce the smell of the pit toilet, one simple, safe, and inexpensive device that can be used is the convection stack.

Development and Testing

Ventilating stacks have been tried for some time in outdoor toilets. But by itself, a stack is only partly effective in reducing bad smells because the air in the toilet pit is apt to be cooler than the air above; so the cool air tends to stay in the pit, smell and all, rather than rise up the stack.

An obvious way to start the air circulating is to heat it and create convection currents. This principle was applied by installing a small kerosene burner in the stack.

This convection stack was tested in a full-size model of a pit toilet with a plastic side to allow observation and photography. The convection stack consisted of 6-inch stovepipe leading from the toilet pit up and out through the roof. When the burner was lighted, the flame created a convection current that effectively drew air down through the toilet stool and up and out through the stack (fig. 1).

Smoke was used to trace the air currents. Even when a fiercely burning smoke bomb was placed in the pit, no smoke escaped through the stool: it all went up the stack.

Besides creating a convection current, the burner has a desirable secondary effect: the flame oxidizes and modifies some of the malodorous gases as they pass up the stack.

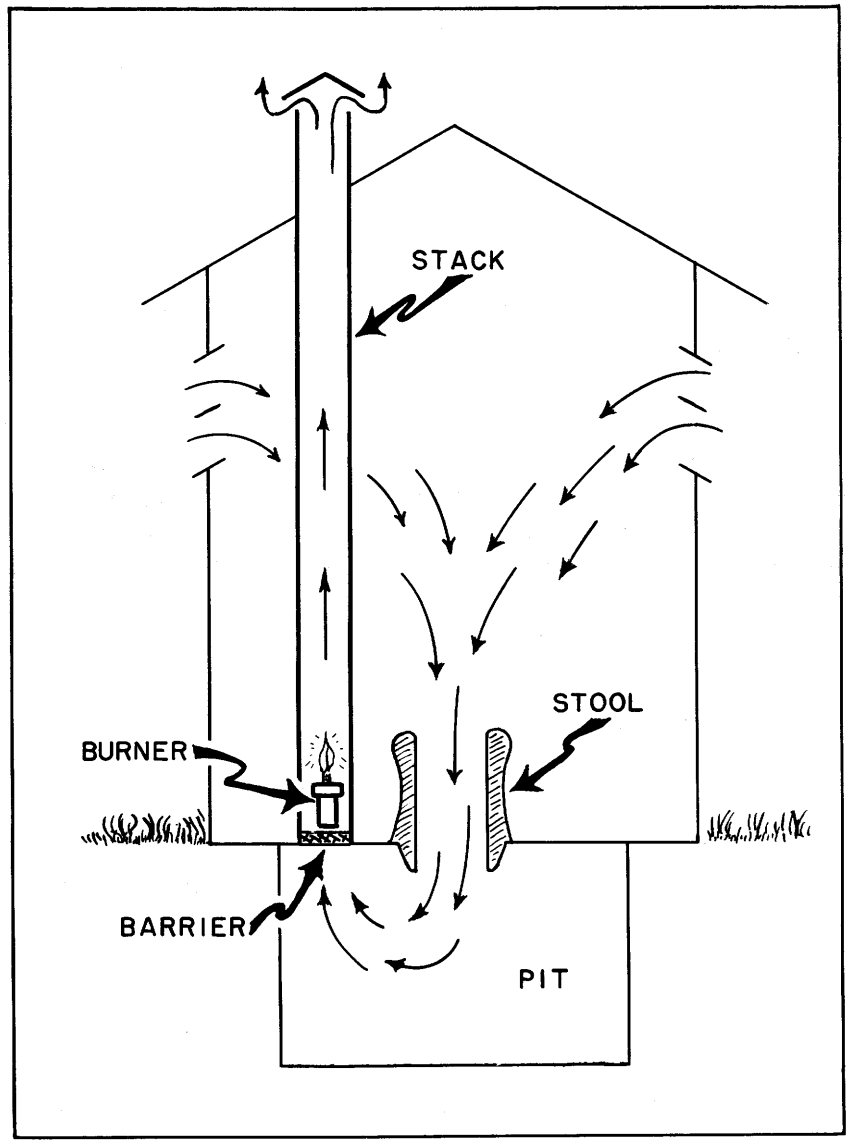

Figure 1. — Diagram of a pit toilet showing the pattern of air circulation created by a convection stack.

Convection stacks were tested at two pit toilets in use on the Buckaloons Recreation Area of the Allegheny National Forest in Pennsylvania. These toilets were very smelly while the stacks were being installed — the fumes were strong enough to irritate the eyes. But once the installations were completed and the burners were lighted, the smells were reduced to very low levels within 5 minutes. The campground custodian reported that many campers commented on the odor-free condition of these toilets.

Anti-Explosion Barrier

The convection stack moves so much air that gases from decomposing wastes would never reach explosive concentrations in the toilet pit. However, many recreationists now carry such volatile fuels as gasoline. Because such fuels might occasionally be thrown into toilet pits, special precautions should be taken to insure that the flame in the stack cannot ignite an explosive mixture in the pit. This can be done by separating the flame and the pit with a barrier that allows air to flow upward without allowing ignition temperatures to pass downward.

In tests to develop anti-explosion barriers, single thicknesses of screen or perforated metal were found to be inadequate. But copper netting of the type used in scouring pads made a completely effective barrier when pressed into a dense wad approximately 1 inch thick and the diameter of the stack. This copper netting was placed between two circular pieces of screen, bound together with copper wire, and inserted into the lower end of the stack (fig. 2).

In repeated tests an explosive mixture was introduced below this barrier. As the mixture was drawn into the stack, it ignited at the burner. But all fire was confined to the stack and never reached the explosive mixture below the barrier.

Before gases from an explosion in the stack can reach the pit, they must pass the many strands of copper wire that make up the barrier. The wire absorbs heat and cools these gases below ignition temperatures.

The barrier must be tight. When examined against a strong light, it must have no holes through or around it that appear larger than pinpoint size. Larger openings could provide routes for gases above ignition temperatures.

Fabrication and Servicing

The burner assembly used for convection stacks installed at the Buckaloons Recreation Area is shown in figure 3. The reservoir under the burner is made from a 1¼ by 5-inch pipe nipple. This allows the

wick to stay immersed and prevents an overflow of fuel regardless of the level of kerosene in the 1-gallon tank. The curved plate that holds the burner is fastened to the stack by the coil springs.

Convection stacks are inexpensive to build. Each of those installed on existing toilets cost $12.21 for materials and required approximately 1 man-day to assemble and install. Costs of materials might be reduced by quantity purchasing, and installation would take less time if it were done when the toilet was built.

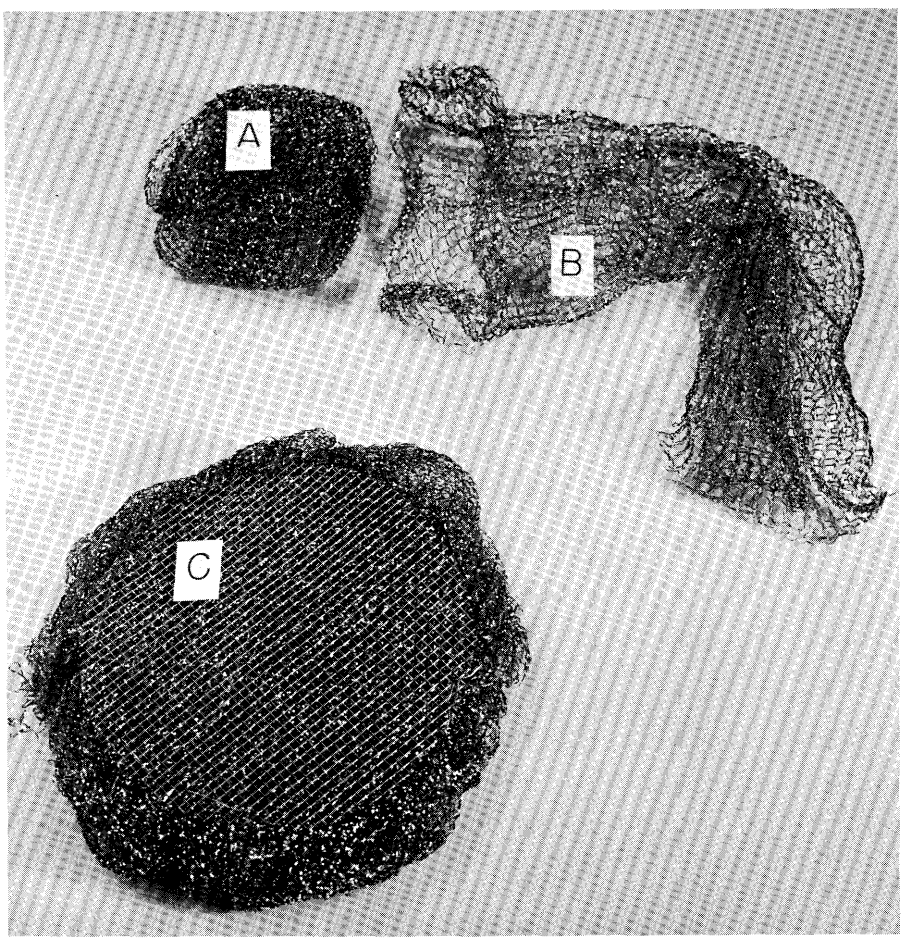

Figure 2. — The anti-explosion barrier incorporated in the convection stack in case gasoline or some other volatile fuel might be dumped in the toilet pit. Copper scouring pads (A) were unfolded (B), and nine of these were packed into a dense wad and bound between pieces of heavy screen 6 inches in diameter (C). The completed barrier is fastened into the lower end of the stack.

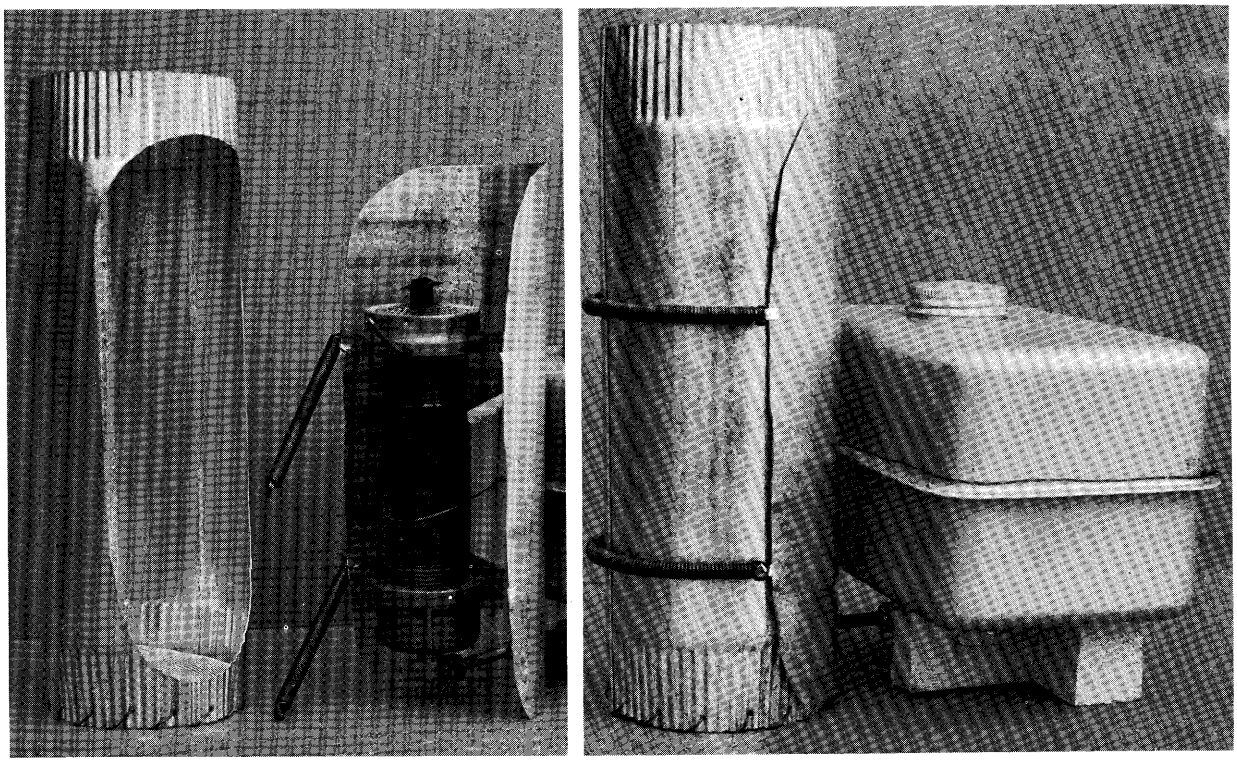

Figure 3. — Left: the burner assembly and section of stack into which it is inserted; note the anti-explosion barrier at the lower end of the stack section. Right: the burner assembly fastened to the stack.

Costs of operation and servicing are also low. Fuel consumption is approximately 3 gallons per month, and the 1-gallon tanks hold enough kerosene to last more than a week. Wicks made of cotton fabric should be trimmed twice a week, but will last longer if the upper ½ inch is made of several folds of fiberglass cloth. Burner servicing can be combined with routine cleaning operations and does not require more than a few minutes even when the wick needs trimming and the tank needs refilling.

Recommendations

Some recommendations for installations of convection stacks:

- The toilet pit should be tightly sealed.
- The stack should rise straight, without bends or offsets.
- Six-inch stacks are preferable to smaller sizes.

- A dense but porous barrier of copper netting is desirable to prevent combustion from reaching the pit if explosive fuels happen to be thrown into the toilet.
- A screen at the top of the stack is desirable to prevent insects from entering the stack and accumulating on the explosion barrier.
- The stack should extend above the peak of the roof and should have a protective top to shed rain.
- The burner assembly and fuel supply should be covered with a locked box to discourage tampering.
- The flame should be kept low to reduce fuel consumption and to minimize charring if a wick type of burner is used.

In addition to these specific recommendations, two additional ideas should be considered: use of the flame for illumination as well as convection, and use of gas as fuel.

Burner assemblies have been placed at floor level in the convection stacks installed thus far. However, with the stack placed inside the toilet building, the burner could be mounted several feet above the floor in a clear plastic section of pipe. This would make the flame visible for quick inspection and would provide nighttime illumination for the interior of the building.

During development of the convection stack, kerosene was chosen as a suitable fuel. However, gas burners are available that automatically shut off if the flame goes out. With these burners, bottled or natural gas would also be a safe fuel and might offer such advantages as: (1) no wicks to maintain, (2) no soot, (3) simple burners that are compact and easily mounted, and (4) long-lasting fuel supplies. In Pennsylvania, the Allegheny County Department of Regional Parks has become interested in our convection-stack experiments, and based on our work, is installing a multiple-unit convection-stack toilet using bottled gas as a fuel supply.

Whether kerosene or gas is used, the convection stack can provide a simple, safe, and inexpensive means of eliminating foul smells from pit toilets.

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[1]The research that led to development of the convection stack was performed by Mr. Wagar while serving as research forester at the Northeastern Forest Experiment Station's recreation research center at Warren, Pa. Recently Mr. Wagar left the Northeastern Station to take an assignment at the Intermountain Forest and Range Experiment Station's cooperative recreation research unit at Utah State University, Logan, Utah.