Fire Management Tech Tips

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SHEEPHERDER STOVE

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INTRODUCTION

This study investigated the fire-start potential of a sheepherder stove and determined which spark arrester mesh size minimizes the stove's fire-start risk. This U.S. Department of Agriculture (USDA) Forest Service San Dimas Technology and Development Center (SDTDC) technical services project was proposed by Ken Wortring, wilderness coordinator, USDA Forest Service Intermountain Region, Salmon-Challis National Forest, Frank Church Wilderness.

Hunters, outfitters, and other outdoor enthusiasts use sheepherder stoves to warm their wall tents or heat their food. These stoves are popular during colder months or in colder regions of the country. Most are box-shaped and constructed from lightweight sheet metal for easy packing and transport. The stove is fueled by wood, pressed logs, or charcoal. Flammable liquid fuels are not suitable for these stoves.

SCOPE

SDTDC staff (we) used the Sheepherder Packer Stove from Cabela's for this study. It measured 10 inches wide, 8½ inches high, and 23 inches deep. It weighed 15 pounds without the exhaust flue. We used two exhaust flues in this test. The first was from a local hardware store. It measured 4 inches by 65 inches. The second was a Sheepherder's Stove Pipe from Cabala's. It measured 5 inches by 77 inches. Both were galvanized sheet metal.

For this study, staff measured surface temperatures along the stack and the floor. The variables we used to determine the flue's effect on the stove's surface temperature were fuel type, bottom insulation material, flue size, and spark arrester screen size.

TEST SETUP

We used a level concrete surface at SDTDC for the stove's burn testing (figure 1).

Figure 1. Sheepherder stove.

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To determine the stove and flue's surface temperature differences, staff used natural firewood and Duraflame pressed logs as fuels.

To test the stove's steel floor, staff covered the floor with a layer of sand or dirt applied evenly to a depth of ½ to 1 inch. This test determined if sand or dirt affected the stove's bottom temperature and the temperature of the concrete floor directly beneath the stove. SDTDC staff conducted several tests without any floor insulation to obtain maximum temperature readings for the stove floor and concrete area.

To determine the flue's effects on stove temperatures, we tested a 4-inch diameter flue with double-wall construction and Cabela's 5-inch diameter flue with single-wall construction. Staff also tested three spark arrester screen sizes: ½ inch, ¼ inch, and ⅛ inch. This test measured the changes in surface temperatures with the three screen sizes.

Staff took surface and center exhaust-flue temperatures at 12-inch increments, beginning at the flue's base. We measured spark arrester screen temperatures at the bottom of the stove's steel floor and on the concrete directly beneath the stove. The staff gathered data on ember emissions, screen clogging, and discolorations along the flue.

TESTING

Table 1 shows four sets of test results.

We calculated the minimum cross-wind speed required to overturn the stove and flue assembly.

FINDINGS

The test results concluded that the stove's temperature was not affected by fuel or exhaust flue diameter. The spark arrester screen size was directly affected by temperature (see figure 2). The smaller screen sizes consistently yielded lower

Table 1. Sheepherder Stove Test Matrix

	Flue Size (in)	Screen Size (in)	Fuel Type	Bottom Insulation
Set #1				
Test #1	4	1/2	Wood	Sand
Test #2	4	1/4	Wood	Sand
Test #3	4	1/8	Wood	Sand
Test #4	4	1/2, 1/4, 1/8	Wood	None
Set #2				
Test #1	4	1/2	Duraflame	Sand
Test #2	4	1/4	Duraflame	Sand
Test #3	4	1/8	Duraflame	Sand
Test #4	4	1/2, 1/4, 1/8	Duraflame	None
Set #3				
Test #1	5	1/2	Wood	Dirt
Test #2	5	1/4	Wood	Dirt
Test #3	5	1/8	Wood	Dirt
Test #4	5	1/2, 1/4, 1/8	Wood	None
Set #4				
Test #1	5	1/2	Duraflame	Dirt
Test #2	5	1/4	Duraflame	Dirt
Test #3	5	1/8	Duraflame	Dirt

stove temperatures. Smaller-size screen mesh caused reduced airflow and soot buildup on the screen. This led to lower temperatures.

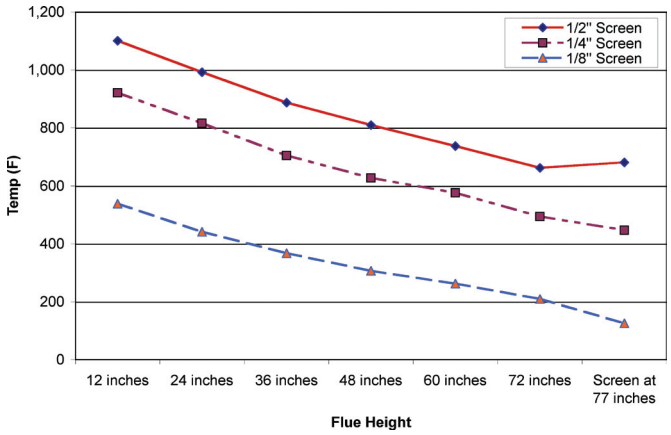

Figure 2. Flue height versus average flue center temperature.

Insulation affected the radiant heat from the bottom of the stove. Dirt insulated the bottom better than sand (see figure 3). Sand or dirt used as an insulator reduced the ground temperature by 40 degrees Fahrenheit when compared to using no insulation.

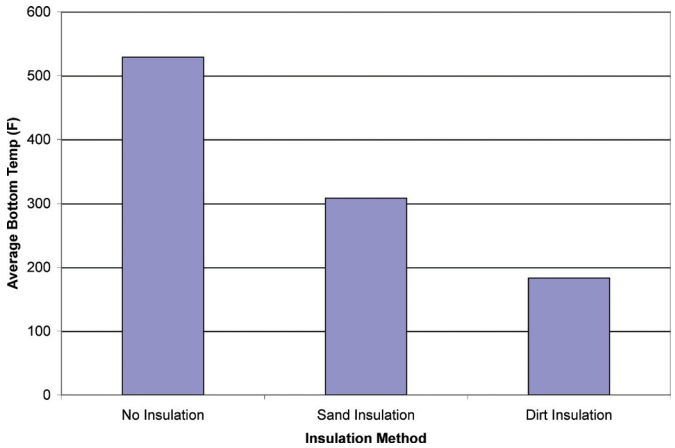

Figure 3. Average stove bottom temperature versus insulation method.

The calculated minimum wind speed required to overturn the stove was 15.9 miles per hour.

Table 2 and figures 2 and 3 summarize the test results.

Table 2. Sheepherder stove test results summary.

	1/2-inch Screen (°F)	1/4-inch Screen (°F)	1/8-inch Screen (°F)
Set #1 (woodlog, sand, and 4-inch flue)			
Floor Temperature	69	77	77
Floor Temperature, no sand	99	100	81
Stove Bottom	378	209	111
Stove Bottom, no sand	425	525	531
Center Pipe Temperature Range	401 - 664	170 - 235	135 - 242
Surface Pipe Temperature Range	106 - 164	88 - 104	97 - 113
Set #2 (Duraflame Log, sand, and 4-inch flue)			
Floor Temperature	91	91	70
Floor Temperature, no sand	96	100	91
Stove Bottom	289	378	273
Stove Bottom, no sand	233	453	605
Center Pipe Temperature Range	681 - 1,325	504 - 1,040	352 - 713
Surface Pipe Temperature Range	217 - 482	144 - 264	118 - 223
Set #3 (woodlog, sand, 5-inch flue)			
Floor Temperature	116	105	86
Floor Temperature, no sand	142	126	101
Stove Bottom	448	350	340
Stove Bottom, no sand	736	751	501
Center Pipe Temperature Range	676 - 1,236	671 - 1,406	135 - 638
Surface Pipe Temperature Range	122 - 342	245 - 602	79 - 209
Set #4 (Duraflame Log, Dirt, 5-inch flue)			
Floor Temperature	64	71	80
Stove Bottom	138	215	197
Center Pipe Temperature Range	686 - 1,177	222 - 1,003	114 - 557
Surface Pipe Temperature Range	222 - 360	144 - 230	81 - 150

RECOMMENDATIONS

A ¼-inch spark arrester screen size provides the best balance between ember reduction and optimal stove performance. A ½-inch screen size releases larger ember bits into the air and increases the potential to start a wildfire. A ⅛-inch screen size causes the soot to buildup too heavily on the mesh, choking the exhaust in less than an hour, and smothering the fire in the stove.

SDTDC staff recommends placing dirt on the steel floor of the stove to reduce the heat being radiated to the ground. This decreases the chances of a fire starting near the stove's base.

Caution: Do not use galvanized steel pipe as a chimney exhaust flue. Do not use these flues indoors or in an enclosed area without proper ventilation. Both exhaust flues tested were galvanized steel tubes. Temperatures in parts of the flue reached over 1,400 degrees Fahrenheit and vaporized the galvanized coating releasing toxic gases and fumes. These fumes can cause flu-like symptoms—headaches, muscle aches, weakness, nausea, and dizziness.

All testing conducted at SDTDC was in an open area outdoors.

For further information on the Sheepherder Stove, contact Ron Tam at SDTDC by phone at: 909–599–1267, ext. 274, or e-mail at: rtam@fs.fed.us.

SDTDC's national publications are available on the Internet at:

http://www.fs.fed.us/eng/pubs/.

Forest Service and U.S. Department of the Interior Bureau of Land Management employees also can view SDTDC's videos, CDs, and individual project pages on their internal computer network at:

http://fsweb.sdtdc.wo.fs.fed.us/.

About the Author

Ron Tam graduated from California Polytechnic University, Pomona, with a bachelor's degree in mechanical engineering. He joined San Dimas Technology and Development Center in 2002 as a mechanical engineering technician working on recreation, fire, and aviation programs.