Fire Management TechTips

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THE USE OF AIR CURTAIN DESTRUCTORS FOR FUEL REDUCTION AND DISPOSAL

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All emissions evaluations and supporting data was provided by Ron Babbitt and the staff from U.S. Department of Agriculture (USDA) Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT

SUMMARY

The San Dimas Technology and Development Center (SDTDC) evaluated the use of air curtain destructors (ACDs) as an efficient, environmentally friendly, technically feasible alternative in fuel reduction and disposal. SDTDC's industry research found two companies, Air Burners LLC, of Palm City, FL, and McPherson Systems, Inc., of Tifton, GA, that manufacture the self-contained box-styled ACDs. These ACDs are air curtain incineration systems with a refractory-lined firebox. An engine supports the attached fan, which creates an air curtain across the top of the unit. During SDTDC's evaluation, both manufacturers' ACDs efficiently disposed of large quantities of forest vegetation (fuels) at very high temperatures, while releasing very little emission particulate matter. This safer alternative to open burning is viable throughout the year except when fire danger is too high.

BACKGROUND

This tech tip provides the latest information on air curtain destructors for fuel reduction and disposal. This information will be of interest to anyone concerned with fuels management issues.

Because vegetation reduction for wildfire mitigation and forest health is critical to fire and fuels management, researching alternative methods has become a top priority. Prescribed fire and pile burning have been the traditional methods of removing unwanted fuel and vegetation for many years. But weather conditions, air quality rules and regulations, and safety concerns (especially adjacent to wildland-urban-interface areas) have restricted the use of these methods. Although leaving vegetation onsite to decompose naturally is sometimes an alternative, decomposition can take many years and vegetation onsite does not alleviate fire risk. Decomposition can also increase the risk of outbreaks of unwanted insects. Chipping, grinding, and mulching are other alternatives, but their necessary removal and disposal may prove costly.

ACDs have been used throughout the world for several applications:

- In forest fuel management and wildfire mitigation efforts.
- In the construction industry (to reduce debris from land clearing and demolition operations).
- At landfill sites (to maximize costly space by reducing wood waste and similar burnable waste).
- In disaster recovery (for clearing debris from storms or floods).

ACDs can operate safely and year round for vegetation disposal with few operating limitations. These limitations include fire conditions, required clearance from trees (or other fuel hazards), maximum allowable wind conditions, and the proper use of heavy equipment (figure 1).

Figure 1—ACD in full operation (no visible smoke).

DESCRIPTION

The main operating principle of the ACD is blowing high-velocity air (curtain) across and into the upper portion of the combustion chamber (see figure 2). As the high-velocity air blows across the top, a rotational air current develops within the firebox. This powerful curtain of air has two effects: First, the high volume of air causes high oxygenation of the fire. Second, the high-velocity airflow over the combustion chamber entraps particulates (smoke). The high oxygenation helps to raise the burning temperature inside the unit, contributes to a more complete combustion process, and assists in reducing emissions and smoke. In addition, the high temperatures and oxygen-rich environment help combust ﬠgreen,ﬠ high-moisture vegetation.

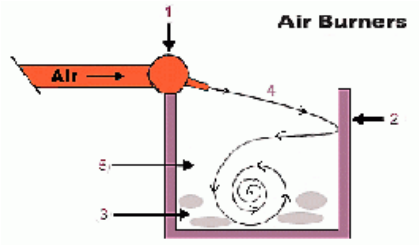

Figure 2—Air burner.

1. Air-curtain burner manifold and nozzles direct high-velocity airflow downward along refractory-lined walls.

2. Self-contained unit allows for fire containment and easy ash cleanup.

3. Vegetation to be burned.

4. Airflow forms an air curtain over the burning vegetation.

5. Continuous airflow overoxygenates the burning vegetation, allowing for higher burning temperatures and a more complete burn.

EQUIPMENT

Air Burners LLC manufactures several ACD models available through the General Services Administration. McPherson Systems, Inc., also offers various models and sizes of burners for permanent or portable use. Both manufacturers offer diesel or electric power with burn rates averaging from 1 to 15 tons per hour. The larger units are more difficult to transport onsite and require special permits for transport over roads. Some systems can be customized (check with manufacturer).

Figure 3—Skid-mounted ACD.

As figure 3 shows, the skid-mounted ACD is a self-contained system with a refractory-walled firebox, diesel engine powerplant, mechanical drive system, blower fan, and fuel tank. Both manufacturers engineered ACDs for transport by a lowboy or similar drop-deck trailer. This ease of transport increases flexibility, because operators can bring the ACD to the project site and avoid transporting vegetation elsewhere for processing. These ACDs are ready for use on arrival with minimal setup time. The refractory-lined firebox allows contained burning. The unit supports the diesel engine, fuel tank, and direct-drive system to operate the fan. An air-nozzle manifold is mounted on the backside of the firebox. The vegetation is loaded over the top of the ACD on the side opposite the manifold.

Both manufacturers created vertical refractory walls to aid combustion by retaining and reflecting the high temperatures that the firebox generates. The manufacturers state that the combustion process reduces the wood waste by about 98 percent, leaving only 2 percent in volume as residual ash. Twin refractory-lined panel doors at the rear of the firebox allow for ash removal. Both units are designed without bottom panels and sit directly above ground.

Because of the skids and durability of the Air Burners LLC unit, users can reposition it onsite or transport it from site to site, depending upon the terrain and distance. During transport the rear door panels can open for dumping ash. Users can empty the McPherson of ash by using a loader with a bucket. After the unit has cooled, the panels are disassembled. With both units, ash may be left in place, disposed of, or mixed with soil onsite or elsewhere.

OPERATION

Air curtain destructors are easy to operate and both units are almost identical. ACD operations follow three stages: startup, full operation, and burndown. For startup, operators partially load the firebox with layers of fine flammable forest vegetation, apply an accelerant (typically drip torch mix) over the layers, and cover it with heavier logs to just under the manifold. Ignition is via a fusee (similar to a road flare). Once the unit reaches its desired burning temperature and the heavier material starts to combust, the fan starts up and its speed gradually increases to full capacity. Although startup produces smoke, it decreases as the fan speed increases and the air curtain process approaches full operation. Depending on vegetation type and moisture content, startup burning takes about 1 hour and is complete when true combustion is observed (figure 4).

Figure 4— Approximately 5 tones of vegetation combusting.

During full operation, operators use mechanized equipment to feed vegetation into the burner at a steady rate. The best results were obtained by using an excavator with a grappler arm. An excavator with a bucket and thumb worked best for cleaning ash from the burner.

The last stage, known as burndown, typically takes about 2 to 3 hours, depending on the type and size of the vegetation. The unit is allowed to burn with no interruption to the air curtain. See figure 5. Once the materials inside burn down to under one half the height of the burner, operators slowly decrease the amount of air. After burndown, hot coals may remain for several days under an insulating blanket of ash. In the right conditions, operators may leave the ash in place to reignite new vegetation added the next day. Use caution when watering to cool the embers, cooler water may inadvertently splash water on the hot panels, possibly causing them to crack.

ACDs are designed to run for about 24 hours before ash removal, but running time depends on the vegetation's type and size. Long burns generally are more efficient (having lower emissions) than shorter burns. Efficiency starts to drop once the ash pile reaches about one-quarter to one-third of the firebox depth. For safe operation, have at least a 100-foot cleared space around the ACD. Barring extremely high winds, large embers are unlikely to escape the firebox and burn beyond the cleared area. Although small embers commonly are released from the burner during operation, they generally completely burn out before they hit the ground.

Safety should always be the number one consideration. Personnel must use all protective equipment, including personal protective clothing, and ensure that all mechanized equipment is clean and running efficiently. Operators should have a water source or fire engine and crew onsite to reduce the risk of possible fire spread. No one should operate an ACD if the fire danger is too high or if people or animals are likely to have unsupervised access around the burner site. Should conditions require shutdown, operators can extinguish the fire by using onsite soil to smother the combustion process in the unit.

SDTDC EVALUATION

SDTDC entered into a partnership with the Wallowa-Whitman National Forest (Region 6), the San Bernardino National Forest (Region 5), and San Bernardino County Solid Waste Management to evaluate two commercially available air curtain units. SDTDC evaluated the Air Burners LLC model 217 in November 2002 on the Burnt Powder Fire Zone, Baker City, OR, and the McPherson Systems model M30 in June 2003 on the San Bernardino National Forest, Mountain Top Ranger District, Lake Arrowhead, CA.

The vegetation used during the evaluation was a combination of Jeffery Pine and Douglas Fir. Each evaluation surveyed combustion rates, ember release (from the units), and emissions. Evaluation results for both units were very positive. Combustion rates were within range of the manufacturers' parameters. Emission evaluation results were favorable for both units. Table 1 shows the emissions of both units compared to broadcast and pile burning.

Figure 5— Photo shows results when the airflow is broken; a log smolders above the air curtain.

Table 1— Average emission factors for different management tools (pounds per ton).

	CO_2	CO	CH_4	NMHC	PM 2.5	CE (%)
Broadcast burning—Ponderosa Pine	3,286	179.8	6.6	5.4	36.0	90
Pile burning—Ponderosa Pine	3,268	178.5	13.9	9.9	25.5	89
LLC Air Curtain	3,616	26.3	1.4	1.1	1.1	99
McPherson Air Curtain	3,613	30	1.1	0.6	1.4	99

Explanation of Data

CO_2 = emission factor for carbon dioxide.
CO = carbon monoxide.
CH_4 = methane based gases, such as propane and butane.
NMHC = nonmethane gases, such as benzene.
CE = combustion efficiency.

PM 2.5 = particulate matter expressed in pounds per ton. U.S. Environmental Protection Agency regulates particulate matter 2.5 and below.

CONCLUSIONS

ACDs offer a useful alternative to current fuel reduction and disposal methods.

ACDs:

- Produce lower smoke emissions compared to pile or broadcast burning.
- Burn a greater variety, amount, and size of materials from dead to green vegetation.
- Reduce fire risk and outbreak of insect problems.
- Operate with fewer restrictions in weather and burn conditions.
- Contain burn area to a specific site.

INFORMATION

For further information regarding ACDs manufactured by Air Burners LLC, contact:

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Air Burners LLC
4390 Cargo Way
Palm City, FL 34990
Phone: 888&#65533;566&#65533;3900 or 772&#65533;220&#65533;7303
Web site: http://www.airburners.com

For further information regarding ACDs manufactured by McPherson Systems, Inc., contact:

McPherson Systems, Inc.
Don McPherson
Hwy. 82W
100 Springhill Church Rd.
Tifton, GA 31794
Phone: 229&#65533;386&#65533;2367
Web site: http://www.mcphersys.com

Additional information regarding the air curtain burner may be found on the San Dimas Technology and Development Center Intranet Web site at: http://fsweb.sdtdc.wo.fs.fed.us/. The SDTDC staff thanks Sally Haase, Research Forester, USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA, and Keith Windell, Mechanical Engineer, USDA Forest Service, Missoula Technology and Development Center, Missoula, MT, for reviewing this document.

ABOUT THE AUTHOR...

Susan Zahn has almost 20 years of employment with the USDA Forest Service on each of the southern California forests. Sue has worked in areas of fire suppression, prevention, fire rehabilitation, fuels, wilderness and trails management, and as a volunteer coordinator. Sue started working at SDTDC in 2002 as the fuels management specialist. Sue has been assigned to a Wildland Interagency Incident Management Team for 10 years. She also serves on many regional and interregional training cadres. She is a graduate of the University of La Verne, with a bachelor of science degree in public administration.

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