A Perfect Storm: Mulch Fire Dynamics and Prevention

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By Erika Jensen

An unusually large number of fires, occurring at commercial mulch and compost facilities over the past few years, have caused concern for the organics industry, as well as the communities affected by these fires.

About 75% of the reported fires to date were the result of spontaneous combustion. To better understand these events, we will first look at the biology and chemistry that leads to spontaneous combustion fires. Although much of this information is common knowledge within the industry, we'll use an understanding of the causes to frame a discussion on how to prevent such fires and avoid backlash from local residents and government officials.

Composting Dynamics and Risk Factors

Spontaneous combustion fires begin with pile heating caused by microbial activity. Heat is produced as microbes decompose the organic materials, made possible by the presence of moisture. When the pile size is too large, the pile cannot lose heat as fast as it is generated, and the temperature rises. If the decomposition continues under the right conditions, the pile can continue to heat to a dangerous level.

At around 180° F, microbial activity shuts down and direct chemical reactions (abiotic) processes take over. Pyrolysis is one such process, and can be defined as the decomposition of organic materials through the action of heat, which occurs in the absence of oxygen. The gasses and compounds that result from the process of pyrolysis are highly combustible, and when oxygen is introduced they can burst into flames. Smoldering can also occur in the absence of oxygen.

"During pyrolysis, the traditional "fire triangle" that we've all been taught about is changed somewhat. Usually we think about the fire triangle involving fuel, oxygen, and heat. But when pyrolysis comes into play, a smoldering fire can occur without oxygen," said Robert Rynk, of the State University of New York at Cobleskill (SUNY Cobleskill).

Risk factors for spontaneous combustion fires include piles that are over 20 feet tall, piles that are moderately dry, in the range of 20 to 40 percent moisture (or dry with some wet spots), and static piles that may sit for a month or more without being turned. These values are general estimates and vary based on weather conditions and pile composition. For example, oils and resins in the feedstock materials may also play a role, as some materials are more prone to combustion because they have a lower combustion temperature. However, this is a minor consideration compared to the other risk factors of pile size, moisture level, and stasis (no turning, no movement).

Methods of Prevention

Fortunately, the prevention of mulch fires is simpler than understanding exactly how they occur. Best management practices, such as careful monitoring of temperature and moisture; noticing and correlating weather events; restricting pile size; maintaining moisture levels; and turning piles to release heat are critical to the prevention of combustion fires in organic material piles. According to John Ferguson of Nature's Way Resources, careful monitoring of pile temperatures is part of his daily work, using a soil (temperature) probe to check for hot spots (A). "My workers monitor the temperature of the mulch piles at least twice a week, and log-in the information weekly. If it looks like we've got excessive heat building up, we flood the mulch pile first, then turn it or spread it out to release the heat," Ferguson said. Checking for signs of a smoldering pile is also part of the monitoring. He added, that keeping the pile at a consistent moisture level of 40-60 percent is important for fire prevention, and also happens to be about the right moisture level for composting. Water works as a "governor" and has an important role in moderating temperature and heat exchange within a mulch pile. "You don't get fires if you keep the mulch at around 50 percent moisture," said Ferguson.

Pile Size

Restricting pile size is an important part of fire prevention. Some facility owners, like John Ferguson, compost their mulch before offering it for sale. During this process, small piles will lose heat too fast for composting to initiate. When composting mulch, the ideal pile height is in the range of 3-10 feet tall. According to Jean Bonhotal, Director of the Cornell Waste Management Institute, piles over 10-12 feet in height are not recommended, due to the risk of overheating and spontaneous combustion. Piles should be long and narrow, no more than 12-15 feet wide. Piles that are over 20 feet tall have a tendency to overheat and sometimes spontaneously combust. In addition to smaller pile size, it's prudent to allow sufficient space between the piles for access. John Ferguson allows 8-10 feet between his piles, which is enough space for equipment to access the area, including fire trucks if needed. Larger mulch piles, in particular, benefit from turning because it lowers the pile temperature and prevents overheating. "Big piles are fine, as long as they don't sit idle for a long time. There are a lot of factors that contribute to spontaneous combustion fires, but time is an important one. If you wait long enough, you'll probably have a fire. One month seems to be a typical period for fires to show themselves in large static piles," said Bob Rynk.

Water

Water is a key component in both mulch and compost production, and it works in a number of different ways. Moisture contributes to pile heating by stimulating microbial activity. However, it can also absorb large amounts of heat, as well as cool the pile through evaporation. In this way it acts as a "governor". Providing enough water is a big job. John Ferguson uses a retention pond to supply water to his mulch piles, and the pond also serves as a water source for emergencies. Additionally, he accepts liquid byproducts from various businesses, such as cheese plants. He does this by offering businesses a lower rate for disposal of their liquid waste, which is then sprayed directly onto his mulch piles. Mark Mills, of Ace Supply/Precision Sharpening, uses a water wagon with a 2,500 gallon tank to pump water onto his mulch piles. He also sprays the mulch with water as he is stacking the material. He makes an effort to reclaim the water after it drains out of the piles by capturing it in a pit and then pumping it back onto the piles. He does not turn the piles, instead relying on water to keep the piles from getting too hot. While it is important to maintain about 50% moisture content within a pile, Ferguson warns that a combination (very

wet/very dry) pile can also be a fire hazard. "When we had mulch fires, every time it was connected with a particular weather event. Here in the Houston area it's not uncommon to get 3-6 inches of rain from a storm. The mulch materials that were soaked with rainwater swell and seal off the top of the pile. Then if we get dry, gusty winds, one end of the pile can dry out while the other side stays wet, the wind gusts increase the air pressure inside the pile. From chemistry and physics, we know that as the pressure increases so does the internal temperature, which can then provide the impetus to initiate the chemical processes that lead to spontaneous combustion."

Air Flow

Oxygen is a strong driver of microbial activity. However, trying to eliminate the air in a pile by compacting it with machinery is not a means of prevention. "Driving on piles is not a good idea," said Mark Mills. "It really doesn't help anything. It makes things worse."

This is due to a number of different factors. For example, compacted piles are denser and have a greater tendency to overheat, because the large mass retains heat and reduces vertical airflows. Also, not all of the processes that lead to spontaneous combustion, such as pyrolysis, are dependent on oxygen.

In a survey conducted by Robert Rynk of SUNY Cobleskill and Richard Buggeln, University of Tennesee, 70% of the facilities experiencing spontaneous combustion report that they intentionally compact the piles by driving over them with a wheel loader or bulldozer.

Fighting Fires

David Banwarth is a fire protection engineer, whose interest in mulch fires is primarily connected to community-wide planning for fire safety. Banwarth encourages commercial mulch facilities to do their planning ahead of time, because mulch fires are very common. Pre-planning with the fire department is essential.

There are a number of different strategies to effectively manage fires before they get out of control. A combination of applying water to the pile surface, along with opening up the pile, is one effective option for putting out the fire. In the Rynk and Buggeln survey, respondents endorsed fighting a spontaneous combustion fire with the assistance of a wheel loader, excavator, or bulldozer, in addition to a fire hose.

According to John Ferguson, it's important to wet the surface material before you open up the pile, since the introduction of fresh oxygen can cause the fire to flare up and spread along the surface. Additionally, Ferguson keeps large amounts of soil and dirt and other materials that could be applied to smother a fire.

Robert Rynk makes the point that smart use of water resources is the best way to get the fire under control.

"Large amounts of water are ineffective and unnecessary to fight a mulch or compost fire. Whatever water that is applied should be applied selectively and in concentrated locations. Fire departments tend to make the mistake of automatically turning on the hoses and flooding the piles with water. It is their instinct to do so. This approach is not only a waste of water, but also does nothing to extinguish the fire. Liberally spraying water does help to keep the fire from spreading to adjacent piles, equipment and buildings. However, it should be applied strategically and not to soak the piles, especially those on fire. Fire suppressing chemicals such as foam can be effective," said Rynk.

Crisis Communications

In addition to putting out the actual physical fire, mulch producers may have to contend with an emotional firestorm of community-wide panic over a fire incident. Search the internet for "mulch fires" and you invariably come up with images of huge fires, with flames shooting high into the air. Which is why such fires always make the headlines. Unfortunately, it's not always easy to interview a mulch facility owner while a fire is in progress, which means they don't necessarily get a fair representation in the media.

Preplanning for crisis communications is essential. Who needs to know about the fire? Key contacts could include your employees, homeowners in the immediate area, media contacts, fire/police departments, and of course your customers. Press releases to the media can be largely written ahead of time and revised as necessary during the event. Social media is a powerful tool that you can use to tell your story directly to the public. You might consider posting your own photos on a Facebook page, along with essential information about the crisis as it unfolds. If you don't have a Facebook page, consider ahead of time, how fast you can get information onto to the home page of your company website.

Community-wide Impact

As a fire protection engineer, David Banwarth's focus is to look at the impact on the community. In addition to careful prevention efforts, facilities should plan for an adequate and reliable water supply.

"Ideally, this should be a public water supply or a large supply of stored water, though the costs associated with this may be prohibitive," said Banwarth.

According to Banwarth, mulch facilities are best located in an industrial park setting, where there is access to a public water supply, road access for emergency vehicles, and limited exposure to homes and schools. In an industrial park setting, a typical mulch fire may be extinguished within hours; in a rural setting it may take several days and many more resources, in terms of personnel and emergency response vehicles. The longer time associated with a non-industrial setting is due to several factors: longer response times due to distances to rural areas; typically more difficult access; lengthy delays in establishing an adequate and continuous water supply; and advanced fire growth prior to extinguishment activities.

Banwarth points out that mulch fires can have a huge impact on the community at large:

"More developed and challenging mulch fires can severely strain or consume the fire and medical response resources of a community. The same firefighters, emergency medical responders and apparatus that would be available for other emergencies may be putting out a mulch fire. Engine companies or medic units may have to respond from more distant locations to handle regular calls for service. The adverse impact on community emergency services can be greatly reduced by locating commercial mulch manufacturing facilities in locations that best provide an ability to quickly respond and extinguish incipient fires."

In conclusion, understanding the chemical processes by which mulch piles ignite, brings a more informed understanding of how to effectively prevent fires. By thinking through a strategy for putting out fires, as well as managing communications during an emergency, mulch and compost producers can be prepared for the likely scenario of a fire at some point.