

ERRORS OF EMISSION

Troubleshooting and Preventing Wood Dryer RTO Failures

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Since the Environmental Protection Agency (EPA) began widespread enforcement of press and dryer emissions controls, the regenerative thermal oxidizer (RTO) has seen growing acceptance as *the* technology of choice for controlling volatile organic compound (VOC) emissions from wood dryers. Presently, most OSB dryers, many plywood dryers and a few MDF and particleboard dryers are equipped with these devices.

Unfortunately, many mills have experienced serious operational problems and some complete failures. The cause of these difficulties can be attributed to a general lack of understanding of how the unique properties of wood dryer gas streams may affect RTO operation. In order to avoid problems it is important to pinpoint their specific causes.

RTO/Wood Dryer Applications

Understanding wood dryer RTO failures begins with understanding the source of the key constituents in wood dryer emissions. The fundamentals are simple: wood dryers need heat to evaporate water from raw wood. Normally, this heat is provided in one of three ways:

1. Indirectly with steam or hot oil
2. Directly by burning natural gas, propane or oil
3. Directly by burning waste wood

In each situation the dryer emissions contain abundant quantities of water vapor and substantial quantities of particulate matter. These emissions components require special treatment for optimal RTO operation.

Emission Categories

We must begin by recognizing and understanding the distinction between constituents that are gases and those that are particles. With the exception of water vapor (to be discussed later), gas phase constituents do not normally have much impact on RTO operation. Gases that enter an RTO are either oxidized in the combustion chamber or they are not. In either case, constituents that remain as gases throughout treatment in the RTO should have no effect on the machine.

Particles, however, can have a significant impact. Because the essence of RTO operation involves passing the gas stream back and forth through beds of heat exchange media where intimate contact and mixing is required, plugging and degradation of media are common problems.

There are three principal ways that particles are created in wood dryers. The first is mechanical. Mechanically created particles may come from the preparation of the wood prior to drying (peeling, waferizing, refining, etc.) or from the mechanical action inside the dryer itself. These particles are mostly wood fiber. Additionally, mechanical particles tend to range from furnish particles from the product cyclone of an MDF dryer to visible particles such as the "tooth

picks” coming from a veneer dryer. As a general rule these particles are greater than two microns in diameter and, as such, are generally considered large.

The second principal way that particles are created is through the condensation of vapor. Particles created by this mechanism typically form in the size range of 0.2 to 0.5 microns and are distinctly different than particles of a mechanical origin. The vapor that gives rise to these condensation particles may come from compounds with low boiling points, such as the organic resins and fatty acids present in wood. Alternatively, the vapor may come from compounds and elements not normally associated with boiling points at all. Such compounds and elements are those found in wood ash (the inorganic portion of wood) such as sodium and potassium.

In wood dryers the former type of condensation particles come from the evaporation of organic resins and fatty acids in the hot dryer environment and the subsequent cooling of the vapor after the gas exits the dryer.

The last mechanism by which particles are created is a bit less obvious. In this case the constituents of the wood ash evaporate in the extreme-temperature environment of the flame (up to 2700°F) and condense into sub-micron particles just down stream of the flame front.

Thus, a direct wood-fired dryer will have sub-micron particles consisting of high-molecular-weight organic and inorganic compounds. Both appear as the familiar “blue haze” frequently seen at dryer exhaust stacks.

In summary, the wood drying process may produce three distinctly different categories of particles: 1) large, mechanically formed particles consisting of wood fiber, 2) sub-micron, condensation particles consisting of wood resins and fatty acids, and 3) sub-micron condensation particles consisting of oxides of light metals from wood ash.

Wood Dryer Particles

Particle Type	Source	Size	Composition
Mechanical	Abrasion in dryer	> 2 microns	Fiber
Organic condensation	Evaporation from wood	0.2-0.5 microns	Resins and fatty acids
Inorganic condensation	Wood-fired flame	0.2-0.5 microns	Ash

RTO Failure Modes

Most RTO failures can be attributed to particulate matter. The simplest example is overt plugging of the inlet area of the RTO due to an excessive amount of mechanical particles in the gas stream. This type of failure has happened from time to time on MDF dryer applications because too much fiber has escaped the product cyclones. The failure mechanism can be chronic or acute but always results in unacceptable loss of flow and the requirement to either wash out or bake out the RTO. Either of these “fixes” costs time and money. Additionally, wash outs result in large quantities of waste water.

The second, and most common, failure mode results from the build-up of sub-micron inorganic particles on the hot, top surface of the heat exchange media bed. As they deposit, these materials tend to melt and fuse to the media surface. Because these particles are chiefly sodium and potassium oxide, upon melting, they react with the silica compounds of the media and tend to destroy its structural integrity. The result is that the media bed begins to crumble and compact with the consequence of unacceptable RTO pressure drop.

Once again the “fix” to this problem is regular wash outs of the RTO to remove the soluble sodium and potassium compounds from the media beds. Such wash outs must be performed regularly to prevent the ultimate failure of the entire media bed and very costly media replacement.

A less frequent failure mode results from the build-up of condensed organic particles on the cold inlet surfaces of the RTO. Build-ups in these areas can result in performance failures due to poor valve sealing or more extreme failure due to uncontrolled fires. The only practical way to deal with this problem is manual cleaning of the affected surfaces. Once again, this costs time and money because dryer production must be stopped.

The final type of failure does not involve particulate matter at all. Rather, it is the high water vapor content of the gas stream that is the cause. In this scenario the moist dryer gases (e.g. >20% water vapor) may form condensed water on the inner surface of the carbon steel outer shell of the RTO. This area, between the internal refractory layer and the steel outer shell, can have a surface temperature much lower than the dew point of the dryer gases. The resultant wet area is a prime target for corrosion of the vulnerable carbon steel. Such corrosion will accelerate significantly if there are even trace amounts (e.g. 1 ppm) of HCl or SO₂ in the gas stream. This failure mode is perhaps the most troubling of all in that it is hard to detect until the ultimate failure of the RTO housing and then the only “fix” is replacement of the affected areas.

Culprits and Victims

Culprit	Victim	Result	Fix
Wood fiber	Media bed	Plugging	Bake outs and wash outs
Condensed organics	Inlet ducting and valves	Build-up	Manual cleaning
Wood ash	Media bed	Media degradation and disintegration	Wash outs with media replacement
Liquid condensation	RTO housing	Corrosion	Replace corroded areas

Prevention

None of the “fixes” discussed above are appealing to plant operators who need the maximum on-line availability of their dryers. The right way to fight these culprits is to eliminate them beforehand. Following are some preventative measures that will allow plant operators to make product rather than fixing their RTOs.

1. Mechanical plugging—improve product cyclones or add a low energy scrubber
2. Media attack—change dryer fuel to natural gas or install a wet ESP
3. Organic build-up on cold surfaces—insulate inlet ducting or raise inlet gas temperature.
4. Corrosion—line the RTO inner surface with corrosion barrier.

Before doing anything, however, it is imperative to understand the process and the types of problems that can affect RTOs. Only after gaining a full understanding of the process should the RTO design begin. Know what the potential culprits are and you will understand how best to fight them.

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