# Fuel for Thought: How to Keep Ethanol Production Green

**An ethanol developer's speed to market, permitting expenses, material logistics, energy source, and selected co-products all relate to the dryer type and air pollution control technology decisions**

By Scott W. Golla and Richard Grzanka

In an effort to protect our environment and reduce the world's dependence on oil, there has been a major push towards alternative fuels. Ethanol has been at the forefront of this movement because it reduces greenhouse gas emissions from automobiles and its production has a positive net energy balance. This homegrown fuel also reduces the need for imported oil from sometimes unfriendly and unreliable supplier nations. The Energy Policy Act of 2005 requires the use of 7.5 billion gallons per year (BGY) of biofuels by 2012. According to the Renewable Fuels Association, that threshold should be met sometime this summer &#151 on a capacity basis. As a result, ethanol plants are expanding and being developed at a significant rate in North America and throughout the world. There are more than 70 ethanol production plants currently under construction in the U.S. alone. Washington is talking about a goal of 25 percent of our transportation fuel supply from renewable biofuels by 2025. This ethanol development has expanded to nearly all regions of the country, and suffice it to say, there is a boom going on in the ethanol industry that is expected to continue for some time.

Ethanol is produced by fermenting and distilling starch (currently from corn), creating a 200-proof alcohol suitable for combustion in a vehicle. Only 70 percent of the kernel is made into ethanol; the remaining fats, proteins, fiber, oils, and minerals are referred to as distiller's grain (DG). If a production plant is not very proximate to dairy operations or other significant livestock feeding needs, it will have to dry the DG in order to prevent spoilage during transport to more distant regional markets. Operating restrictions, penalties, and fines, as well as community pressures, are forcing many plants to strive for the lowest possible emission levels from their dryers, enabling future capacity expansions.

When developing, designing, and permitting ethanol production facilities, selecting the most appropriate process equipment, as well as air pollution control equipment, is critical since air permits are granted on a facility-wide basis. Some unique DG dryer designs are steam-heated or compressed-air based, but the vast majority of installed dryers are natural gas heated. Regardless of the dryer type, volatile organic compounds (VOCs), odors, and aerosols are emitted from the drying activity. By far the most commonly installed technology for this critical emissions source is some form of efficient thermal oxidation. Most of the major ethanol design firms incorporate thermal oxidation of this exhaust stream into their plant designs, and most state air permitting agencies require it.

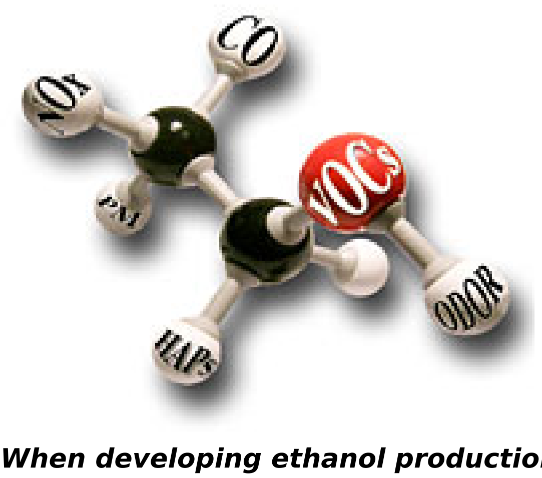
**Air Permit Implications**

Selecting the dryer technology, such as rotary or ring dryers and corresponding pollution control equipment including regenerative thermal oxidizers (RTOs) or direct fired oxidizers with waste steam generation, is often the underlying decision for determining air permitting major source status. Prevention of significant deterioration (PSD) thresholds are generally 250 tons per year (tpy) per pollutant facility-wide at least until the EPA changes its interpretation of the PSD rules for ethanol plants, which was proposed in 71 FR 12240 in March 2006.

In some non-corn-belt areas of the country where ethanol plants are now being proposed, such as in ozone non-attainment areas or transport regions, major source thresholds are as low as 50 tpy or even 25 tpy of VOCs to trigger non-attainment new source review (NNSR) permitting. When combustion emissions from boilers, emergency generators, fire water pump engines, and load-out flares are added to those from the dryer and thermal oxidizer, one can envision how these decisions are so critical.

NNSR permitting involves determining and installing lowest achievable emissions rate (LAER) control technology, obtaining emissions offsets, and analysis of alternatives for the entire development project. PSD permitting involves dispersion modeling, best available control technology (BACT) determination and commitment, and other impact analyses. Both NNSR and PSD permitting involve additional expense and longer permitting timelines, neither of which finds fondness with ethanol developers. Efficient, properly tuned thermal oxidizers are generally considered BACT and LAER, but there is surprisingly little history in the EPA’s RBLC database since most ethanol developers to date have sought to avoid NNSR and PSD permitting by keeping emission below the threshold levels.

**Equipment Selection**




***When developing ethanol production facilities, selecting proper air pollution control equipment is critical since air permits are granted on a facility-wide basis.***

Historically, a number of ethanol facilities in the upper Midwest were originally constructed without thermal oxidizers. However odor complaints and EPA consent orders forced the installation of oxidizers, and hence some form of thermal oxidation is now a part of any new ethanol plant design that involves a dryer. Certain plants with solid fuel boilers (usually major sources) may vent the dryer exhaust into the boiler for thermal destruction. Others may recover some energy from direct fired thermal oxidizers by generating steam.

In general, the following two technology solutions have been considered preferred for the ethanol plant DG dryer emission control:

1. Regenerative thermal oxidizer or RTO

&#149 Destruction efficiencies of 98 percent to 99 percent for VOCs, hazardous air pollutants (HAPs), and carbon monoxide (CO)
&#149 Designed to handle a wet air stream with some particulate
&#149 Pre-filters available for higher levels of particulate
&#149 Thermal energy recovery of 95 percent ensures low fuel usage and low nitrogen oxides ($NO_x$) production
&#149 Fuel injection system further lowers $NO_x$
2. Direct fired thermal oxidizer / waste heat boiler
&#149 Designed to oxidize 99+ percent of VOCs, HAPS, CO, and organic particulate without obstructions and eliminates the potential for plugging
&#149 Generates steam for use in the process
&#149 Can reduce overall capital cost of plant and air emissions
&#149 Optional turbine produces power for driving electric motors or for distribution within the plant
A natural gas RTO will most likely have the highest efficiency, the lowest emissions, and a lower total installation cost versus the various other options available. A natural gas RTO may allow for a larger capacity plant to be constructed (greater than 100 MMGY) while remaining a minor source, but most other options will trigger major source permitting. The trade-offs are between capital expenditures and operating expenses, as well as a shorter timeline to construction, versus potential future competitive advantages. A good natural gas supply deal is a must with some portion of the net input reserved for hedging on the spot market.
An ethanol developer’s speed to market, permitting timeline and expenses, material logistics, feedstock, energy source, and selected co-products all relate to the dryer type and air pollution control technology decisions.

**Equipment Design**

New plants and plant expansions need to review compliance for HAPs, VOCs, CO, $NO_x$, and particulate matter (PM), all regulated by the EPA. In addition, the fuel and electrical usage, as well as the selection of the materials of construction, need to be considered. And finally, ease of maintenance of the system to ensure long life needs to be taken into account.
The following parameters need to be considered to evaluate the selection and design of a fully integrated air abatement system:
1. Regulatory requirements and emission characteristics for VOCs, HAPs, $NO_x$, PM, and CO
2. Process characteristics for the new or existing plant, airflow requiring treatment, steam requirements and cost to produce, and power availability and cost to distribute
These considerations were taken into account when an upcoming expansion at a Nebraska ethanol production plant was certain to put the dry mill out of emission compliance. A multi-million dollar emission control system was selected to achieve greater than 99 percent destruction rate efficiency for air pollutants and odorous emissions. Known for its low operating cost and high destruction rate efficiency, a RTO was chosen as the best available control technology. The system will consist of two side-by-side Anguil RTOs to handle 120,000 SCFM of toxic-laden emissions. Advantages of the system include 99 percent efficiency for destroying VOCs and HAPS as well as 95 percent thermal energy recovery that will ensure lower fuel usage. Portions of the equipment are constructed of 304 stainless steel to protect

against corrosion from the ethanol process stream. The advanced design utilizes supplemental fuel injection and low $NO_x$ burners to minimize CO emissions.

**Environmental Impact**

According to the Department of Energy’s Argonne National Laboratory, ethanol-blended fuels reduced carbon dioxide equivalent greenhouse gas emissions by 7.8 million tons in 2005, which had the effect of removing the annual greenhouse gas emissions of more than 1 million automobiles from the road. There is no doubt that ethanol is a much cleaner burning fuel than gasoline. With state-of-the-art control technology in place at ethanol plants, we can ensure that its production does not counteract the positive impact of this alternative fuel.

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