Agricultural Outlook Forum
U.S. Department of Agriculture

Presented: February 21-22, 2008

Identifying Environmental Consequences of Conversion Plants: Options for Managing Tradeoffs

Annette Sharp
Executive Director
Central States Air Resources Agencies (CenSara)

ENVIRONMENTAL CONSEQUENCES OF CONVERSION PLANTS: OPTIONS FOR MANAGING TRADEOFFS

[FIRST SLIDE] As introduced, I work for the Central States Air Resource Agencies Association known as (CenSARA). The member states are the air quality regulatory agencies in the 9 central states as highlighted on this map. CenSARA provides training and air quality project management to these states. One such project was coordinating workshops in response to the permitting issues of biofuel conversion plants in the CenSARA region. CenSARA initially worked with state staff in both air and water quality.

[SECOND SLIDE] Of the 194 ethanol biorefineries (existing or under construction), 111 of those are located in CenSARA member states.

[SLIDE THREE] I listened carefully to the information presented yesterday by the Corn Growers Association stating that so much misinformation had been communicated in the press about ethanol production and the crops comprising the feedstock for ethanol production. One distinction I would make today is that this country has not planned for the volume of water that goes into the production of ethanol inside the conversion plant itself. A typical 120 million gallons a year ethanol conversion plant operating 353 days a year could expect to use 565 million gallons per year of raw production water, and 460,000 gallons per year of on-site Potable Water. Like many others, state environmental regulatory agencies are concerned with the long-term sustainability of ground and surface water near these facilities. The water quality coming into the conversion plant determines the amount and types of chemical treatment that must be applied so that the water can be used in the production process. The least amount of treatment is when there are low total dissolved solids (TDS) and low mineral concentrations of iron and manganese. Source waters with high levels of TDS and minerals require chemical treatment that results in brine wastewater. With the formation of brine, the conversion plant must meet additional water quality discharge standards. Generally, the least expensive option is to dilute and release to a nearby stream. That option requires yet more water use. This method is not full proof as the stream flow year round is not constant. The conversion plant must adjust pollutant concentration levels on a constant basis. Another brine disposal practice, pumping down a drilled and encased well shaft has unintended environmental consequences of possible migration into drinking water aquifers. A discharge to land is generally prohibited and a discharge to any area considered a wetland has to be mitigated. Discharges of any type from the conversion plant are regulated.

[SLIDE 4]

There are many air quality regulatory issues for conversion plants. There are differences in construction technology that pose unique air quality permitting challenges. I was particularly glad to hear from one of the largest ethanol producers yesterday that they believe they have perfected the ideal construction design that eliminates some of the air quality emissions from the conversion plant. Not only do states not permit equally, different types of construction design require separate engineering analysis before a permit can be written thereby increasing the amount of time before a permit is completed. Most conversion plants attempt to meet what is known as a “minor” source classification as there are less complicated rules and reporting requirements with that classification. One of your handouts speaks to a very small subset of acronyms. Follow along if you will on the various requirements that biofuel conversion plants must meet. The conversion plant must meet MACT, NSPS, and NESHAPS. Translated means that environmental regulatory agencies need an accurate accounting of the types and amounts of emissions produced in a facility. Not only do we need to know process emissions, but we also need to know projected excess emissions during plant shut downs, start ups, and plant malfunctions. Some states require a calculation for particulate emissions from haul roads leading into the plant. Stack tests from existing biofuel conversion plants show the formation of acetaldehyde and other Hazardous Air Pollutants which triggers other permitting considerations. Most ethanol plants have two shut downs every year where the scrubbers are turned off and uncontrolled emissions from the fermenter are vented to the atmosphere for about 50+ hours. Those emissions when added to the process emissions generally make the conversion plant a major source. Bad batches or upsets at the conversion plant also release pollutants to the atmosphere. Loading rail cars or semi-tankers releases pollutants to the atmosphere. Another component of air quality emissions at biofuel conversion plants involves the sulfur content in natural gas which generally has not been correctly identified and shown in permit applications.

Transportation of feedstock to a conversion plant that produces 125 million gallons per year takes approximately 40,000 semi truck loads generally down dirt roads and through small communities causing concern over road maintenance, traffic congestion, and esthetics.

Finally, permit engineering calculations show that ethanol conversion plants generate approximately 8 pounds of CO_2, a greenhouse gas, for every 1 gallon of ethanol produced.

[SLIDE FIVE]

An environmental regulatory concern from biodiesel conversion plants is the production of glycerin. Land application of glycerin has been used to dispose of this by-product but that practice is not acceptable in many states. It’s preferable for glycerin to be collected and then sold in a resale market. If that option is not available to the biodiesel conversion plant, alternative disposal remedies are required which might entail paying for disposal.

[SLIDE SIX]

On the back side of your handout, there is a brief discussion of thermal oxidizers and regenerative thermal oxidizers known as TOs and RTOs. RTOs currently provide the best emission reductions from conversion plants when followed by scrubbers in the stack. The destruction efficiency of RTOs is approximately 98% of all pollutants. This is particularly effective for removing hazardous air pollutants. Scrubbers virtually eliminate particulate matter. A closed loop system at a conversion plant would use proximity to a confined animal feeding operation to capitalize on methane recovery from a manure pit to provide power for all or most of the needs of the facility. And the mash left over from biofuel production would be added to the feed stream for the animals.

[SLIDE SEVEN]

Also on your handout there is a listing of most of the air quality environmental regulatory requirements for conversion plants. EPA regulations are promulgated under title 40 of the Code of Federal Regulations. One requirement is that facilities (all facilities) in an area that is designated as being in attainment for the National Ambient Air Quality Standards also known as NAAQS, must demonstrate that the emissions from a newly constructed facility will not be detrimental in maintaining the NAAQS. A PSD permit requires facilities to make that demonstration through air modeling.

[SLIDE EIGHT]

Where do we go from here? Understanding the total emissions from conversion plants requires stack testing across multiple process cycles which takes 3-6 days. It is expensive and time consuming. To date RTOs show good results for pollutant destruction. And RTOs followed by scrubbers show the best results for pollutant destruction. As we learned yesterday and today, there are several different designs for conversion plants each bringing different levels of environmental risks. State environmental regulatory agencies want to work with the agricultural community to ensure that biofuel production is a net benefit to the environment. The time to involve those agencies is when you are just thinking about constructing a biofuel conversion plant. Many agencies offer a one-stop shop appointment where staff from all media (air, water, land) discuss your plans and respond to your questions. We look forward to being part of the renewable fuels future. Thank you.

Handout 1 – Panelist, Annette Sharp

THERMAL OXIDIZERS (TOs)

What a TO does.

Thermal oxidizers are used to modify product and process gas emissions into environmentally safe gasses. Typical TOs process contaminants by first preheating the gasses, then passing the gasses through a burner at a controlled and optimal temperature and produce environmentally safe gasses such as water and carbon dioxide.

How the Thermal Oxidizer Works.

Thermal oxidizers are sometimes divided into non-flame oxidizers, which use slow heating to incinerate pollutants, and direct flame thermal oxidizers, which use plumes of flame. Thermal oxidizers may also include a process called catalytic oxidization. In catalytic oxidization, organic compounds pass over a support material coated with a catalyst, commonly a noble metal such as platinum or rhodium, that encourages the pollutants in the air to burn. Catalytic oxidizers can break down pollutants at much lower temperatures than thermal oxidizers lacking catalytic action.

The most significant distinction between types of thermal oxidizers is whether they are regenerative or recuperative. Regenerative thermal oxidizers use ceramic heat transfer beds to recover as much energy as possible from the oxidization process -- often as much as 90% to 95%.

REGENERATIVE THERMAL OXIDIZERS (RTOs)

What a RTO does.

Regenerative Thermal Oxidizers (RTOs) destroy air toxics and Volatile Organic Compounds (VOCs) that are discharged in industrial process exhausts. VOC destruction occurs through the process of high temperature thermal oxidation, converting the VOCs to carbon dioxide and water vapor, recycling released energy to reduce operating costs.

How the Regenerative Thermal Oxidizer Works.

Process gas with VOC contaminants enters the Twin Bed RTO through an inlet manifold. A flow control valve directs this gas into an energy recovery chamber which preheats the process stream. The process gas and contaminants are progressively heated in the stoneware bed as they move toward the combustion chamber.

The VOCs are then oxidized, releasing energy in the second stoneware bed, thereby reducing any auxiliary fuel requirement. The stoneware bed is heated and the gas is cooled so that the outlet gas temperature is only slightly higher than the inlet temperature. The flow control valve switches and alternates the stoneware beds so each is in inlet and outlet mode. If the process gas contains enough VOCs, the energy released from their combustion allows self-sustained operation. For example, at 95% thermal energy recovery, the outlet temperature may be only 77° (25°) higher than the inlet process gas temperature.

Handout 2 – Panelist, Annette Sharp

Acronyms

MACT – Maximum Achievable Control Technology
NESHAP – National Emissions Standards for Hazardous Air Pollutants
NSPS – New Source Performance Standard(s)
PSD – Prevention of Significant Deterioration

Environmental regulations in this country may be promulgated by the federal government, state government, or local government. State and local regulations may not be less stringent than federal regulations. They may be more stringent.

Federal environmental regulations are mostly promulgated by the U. S. Environmental Protection Agency (EPA). As such, federal regulations are provided a "Title" number and found in the Code of Federal Regulations. The Title number assigned to the U.S. EPA is Title 40.

Both NSPS and NESHAP regulations govern biofuel conversion plants. Under Title 40, Part 60, there are a number of specific New Source Performance Standards that conversion plants must meet such as the following:

- Subpart Db – Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units;
- Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units;
- Subpart Kb – Standards of Performance for Volatile Organic Liquid Storage Vessels (including Petroleum Liquid Storage Vessels) for which construction, reconstruction, or modification commenced after July 23, 1984;
- Subpart DD – Standards of Performance for Grain Elevators; and,
- Others.

Likewise, there are National Emission Standards for Hazardous Air Pollutants that conversion plants must meet under Title 40, Part 63 such as the following:

- Subpart O – Ethylene Oxide emissions standards for Sterilization Facilities;
- Subpart FFFF – National Emissions Standards for Miscellaneous Organic Chemical Manufacturing;
- Subpart ZZZZ – National Emissions Standards for Stationary Reciprocating Internal Combustion Engines;
- Subpart DDDDD – National Emission Standards for Industrial, Commercial, and Institutional Boilers and Process Heaters