The Dow Chemical Company's Houston-Galveston Area NO_x Reduction Program

Case Study

Summary

The Dow Chemical Company (Dow) operates seven chemical and materials manufacturing sites in the Texas Houston-Galveston area. Texas Commission on Environmental Quality regulations specify that industrial facilities in the Houston-Galveston area must reduce NO_x emissions 80% by 2007 to be in compliance with federal regulations. Dow is presently implementing a list of prioritized, cost-effective abatement projects to meet these NO_x regulations.

Benefits

- NO_x reductions of 21,000 tons annually
- Estimated $60 million in savings
- Turbine NO_x emissions of 2.5 - 3.0 parts per million

What Is NO_x and Why Is It Regulated?

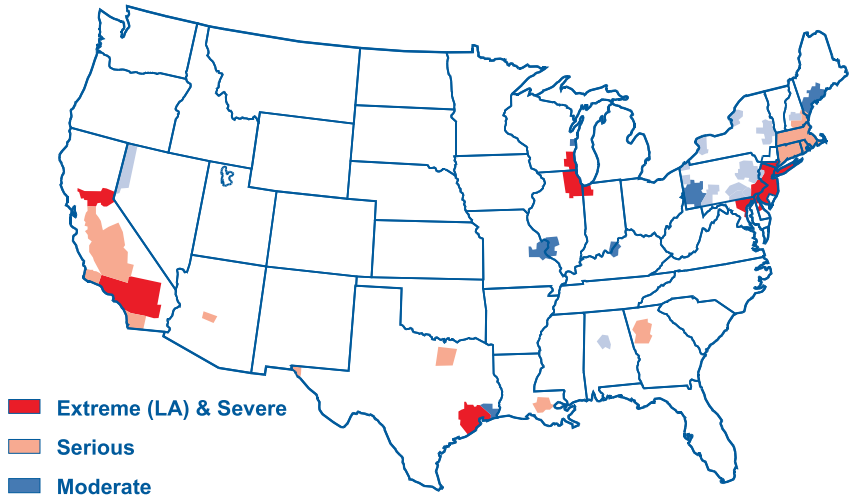
During combustion, nitrogen in the air and/or fuel is thermally oxidized into nitric oxide (NO) or nitrogen dioxide (NO_2). Combined, these products of reaction are referred to as nitrogen oxides (NO_x). Naturally occurring and man-made emissions of NO_x react in the air in the presence of sunlight to form ozone (O_3). Ozone, a pollutant regulated by the U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ), has been shown to cause damage to human health, vegetation, and many common materials such as rubber and paint. NO_x also contributes to acid rain and haze. Sources of these pollutants include automobiles, power plants, industrial furnaces, and boilers. Fundamentally, any hydrocarbon-combustion equipment is a potential source for ozone. In the Houston-Galveston area (HGA), industry contributes approximately 50% of the NO_x emitted into the atmosphere.

NO_x Regulations in Texas

The Federal Clean Air Act of 1990 established ambient air quality standards for six pollutants, including ozone. All states are required to be in "attainment" by staying below specific maximum threshold concentrations known as the National Ambient Air Quality Standards.

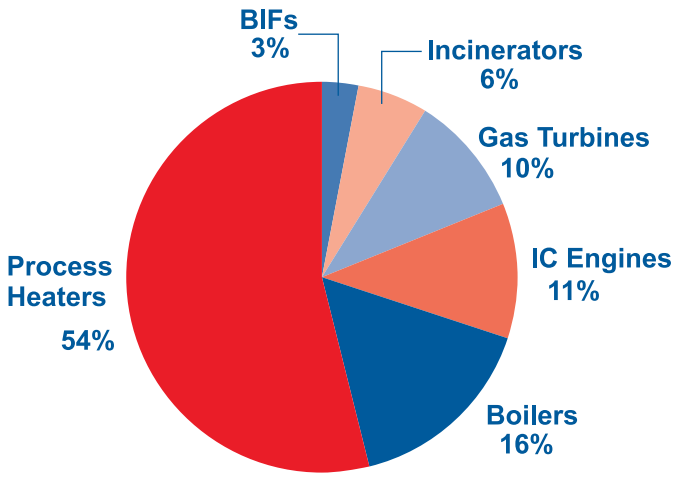
Numerous counties within the State of Texas are in nonattainment for ozone. The HGA, which consists of eight counties in the Houston metropolitan area, is designated "nonattainment-severe" for ozone and has until November 2007 to be in attainment. States having nonattainment areas are required to submit a State Implementation Plan (SIP) to the EPA detailing how attainment will be reached. Figure 1 shows all of the nonattainment areas for ozone in the country as of January 2001.

Figure 1: Ozone Nonattainment Areas in the United States as of January 2001



The TCEQ has made multiple revisions to the Texas SIP based on industry input. The most recent revision to the SIP, finalized in December 2002, incorporates the effect of volatile organic compounds (VOCs) on ozone levels in the HGA. This change specifies that average NO_x emissions from industrial point sources shall be reduced by 80% from 1997 levels, as compared to the previous requirement of 90% reduction, with an accompanying reduction in VOCs. The breakdown of Dow sources affected by the TCEQ NO_x regulations is reflected in Figure 2.

Figure 2: NO_x Point Sources at Dow By Equipment Type



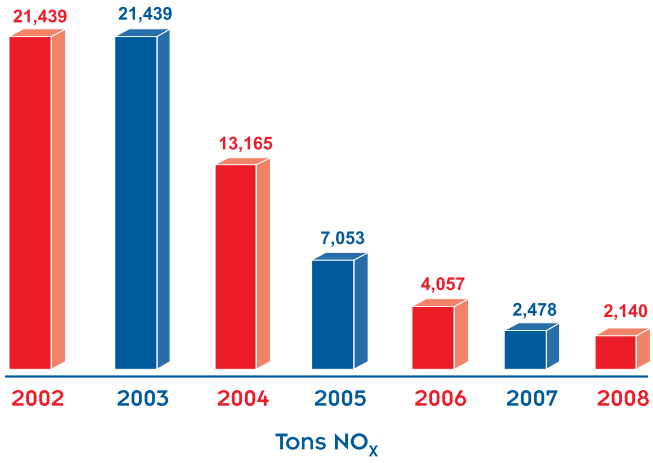
* BIF - Boiler & Industrial Furnace, IC Engine - Internal Combustion Engine

Project Overview

Dow, with the assistance of Technip-Coflexip (Technip), developed an economics-driven NO_x abatement program to meet TCEQ SIP requirements for 80% reduction of NO_x emissions in its HGA facilities. Dow operates seven sites in the area—Freeport, Oyster Creek Cogeneration, Laporte, Texas City, Deer Park, Jacintoport, and Sheldon—representing over 150 separate NO_x point sources. Gas turbine exhausts, primarily generated at the Freeport facility, are responsible for the majority of NO_x emitted from these sites. By evaluating the NO_x requirements for all of these sites simultaneously and prioritizing compliance efforts, Dow is taking a flexible approach to meeting the regulations cost effectively.

TCEQ cap and trade regulations, outlined in 30 Texas Administrative Code (TAC) Chapter 101, require operating companies to report NO_x emissions based on site-specific caps. A site cap is the limit for NO_x emissions for a site based on the combination of all point-source limits within the site. Site cap limits are derived using average fuel activity for each source from 1997 to 1999 multiplied by specified final emission limits, then summing the total for all point sources. The site cap limit is stepped down over time based on required reduction milestones to arrive at the 2007 final cap. As an example, Figure 3 shows the step down in the NO_x cap at Dow's Freeport facility between 2002 and 2008. (The projected 2008 cap is based on the 80% rule).

Figure 3: NO_x Cap Step Down at Dow Freeport



The 30 TAC Chapter 101 regulations allow Dow the flexibility to establish a combined cap for all of the company's facilities within the HGA, effectively enabling the trading of NO_x reduction credits between individual point sources and between plants. Therefore, where actual emissions from a point source (after NO_x abatement) are lower than the mandated emissions level, the difference between the two can be credited toward another point source or facility. Using this approach, Dow established one control plan for all seven sites in the HGA, moving NO_x credits (or allowances) between sites as regulations allow. NO_x control technologies, both combustion modification and post-combustion flue-gas control, can be very expensive. Preparing a control plan for all point sources and identifying individual allowances and abatement options helped Dow prioritize NO_x compliance efforts with the most cost-effective abatement alternatives.

Project Team

Dow has assembled a team of approximately 50 operations and design personnel to work on the NO_X compliance effort for its seven sites in the HGA. The Houston office of Technip, an engineering technology and construction company, was contracted by Dow to evaluate and propose NO_X reduction methodologies at these sites.

Other software solution providers involved in the project include Aspen Technology, Inc. (AspenTech) and Pavilion Technologies, Incorporated. Dow's AspenTech InfoPlus Explorer (IP.21) data historian software provides data acquisition, trending, and historical recordkeeping of raw and summarized data. Pavilion's Environmental Portfolio Manager will serve as the calculation engine to determine NO_X emissions in real-time and the platform to ascertain environmental market opportunities by comparing actual NO_X emissions to caps.

Project Implementation

Dow enlisted the services of Technip to develop the approach for NO_X compliance using the flexibility of the TCEQ cap and trade program. The first step toward successfully determining compliance priorities was to understand the sources of NO_X emissions and the options for NO_X abatement. To do this, Technip prepared feasibility studies for all of Dow's industrial point sources in the HGA, over 150 in all.

To prepare the feasibility studies, Technip gathered operating data to calculate current emissions, identified the best available control technology for the given application, and calculated abatement cost per ton of NO_X reduced (cost/ton) for each source. The list of all point sources was then prioritized based on cost effectiveness, or cost/ton. At this point, Dow was able to create a dividing line on this list and focus on only the most cost-effective abatement projects above this line. Dow selected approximately 20 point sources for NO_X abatement.

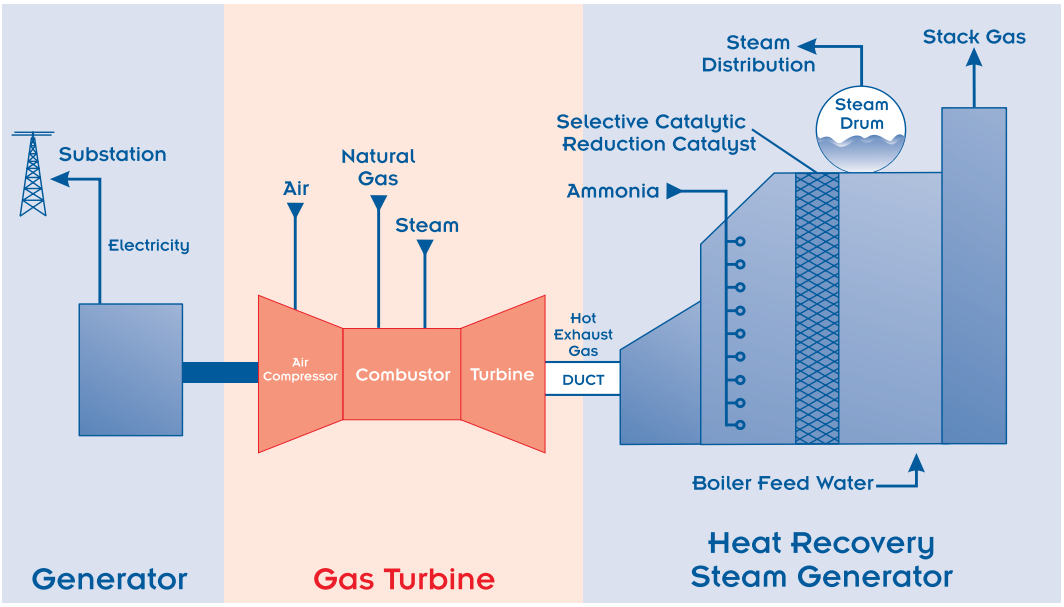
To date, Technip has completed the feasibility studies for all of Dow's industrial point sources in the HGA. Information from the individual feasibility studies has been compiled into an area-wide NO_X project control plan. Sources were grouped by site, and emission allowances were identified for each source. The abatement technology type (e.g., selective catalytic reduction, ultra low NO_X burners, etc.) and associated capital and operating costs were used to calculate cost effectiveness for each source. The control plan was also used to predict the annual difference between NO_X emissions and cap allocation.

A regional margin (i.e., a buffer) is needed to ensure that the established NO_X cap for the seven Dow sites does not run short of allowances during any calendar year. This margin is also needed to account for normal operating flexibility, including source variability, capacity creep, abatement device shortfalls, and shifts in turnaround schedules. The control plan margin size was validated via a Six Sigma project performing a comprehensive evaluation of system variability.

To date, one gas turbine with a heat-recovery steam generator has been retrofitted. The turbine was equipped with a steam-injection combustor and a new control system, and the heat-recovery steam generator equipped with selective catalytic reduction. Continuous emission monitoring systems were installed on the stack as well as an oxygen monitoring device. After these changes, stack NO_X emissions are currently controlled at 2.5 to 3.0 parts per million.

For Dow, a majority of the point-source emissions identified for abatement are gas-turbine emissions; 6 of the 20 point sources selected for abatement are gas turbines at the Freeport facility. Typical NO_X abatement technology for a retrofitted gas turbine is shown in Figure 4.

Figure 4: Typical Gas Turbine with NO_x Abatement Technology



Dow will be responsible for the ongoing, long-term management of this program. The company will continuously track emission data and make adjustments as necessary to meet its HGA site cap. The TCEQ requires thorough record keeping, including results of stack gas tests, fuel usage totals, and operating hours. Dow will use the Pavilion Environmental Portfolio Manager platform to provide the required annual reports to the TCEQ.

Savings

NO_x abatement efforts by Dow Chemical in the HGA are expected to reduce annual NO_x emissions by approximately 21,000 tons by 2007.

The reduction of 21,000 tons of NO_x breaks down as follows:

- Approximately 5,800 tons from retrofit projects (a significant majority of this reduction is from gas turbines in Freeport)
- Approximately 4,600 tons from currently planned permanent equipment shutdowns
- Approximately 10,600 tons from compliance efforts prior to the December 2002 TCEQ SIP revision

Dow estimates capital and operating cost savings of approximately $60 million by taking advantage of cap and trade flexibility and applying an economic approach to meeting the regulations.

The Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy conducts technology showcases to encourage industry adoption of energy efficiency technologies and practices. Replication throughout industry can boost productivity and help achieve National goals for energy, the economy, and the environment.

For more information, please visit our Web site: www.eere.energy.gov

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