Control Measure: Aggregate Kilns-NOx, Measure # 68
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

Lightweight aggregate is a type of coarse aggregate that is used in the production of lightweight concrete products such as concrete block, structural concrete and pavement. The production of lightweight aggregate includes mining or quarrying the raw material (clay, shale or slate), crushing the material and then feeding the material to a rotary kiln. Most plants use rotary kilns although some use traveling grates that are also used to heat the raw material.

ANALYSIS

Control Technology or Method of Control

The NOx emitted from this industry is from the combustion in the rotary kilns. Emissions will depend on the method of firing. As with Cement and Lime Kilns, firing can be with coal, natural gas and sometimes material classified as hazardous waste.

Similar to Cement Kilns, there are several options for the control of NOx from Aggregate Kilns. These options include the use of Low NOx Burners (LNB), Mid-Kiln Firing (MKF), Selective Catalytic Reduction (SCR) and Selected Non-Catalytic Reduction (SNCR). Each of these methods has been demonstrated to significantly reduce NOx emissions.

Low NOx Burners (LNB) are designed to "stage" combustion so that two combustion zones are created, one fuel-rich combustion and one at a lower temperature. Staging techniques are usually used by LNB to supply excess air to cool the combustion process or to reduce available oxygen in the flame zone.

Mid-Kiln Firing (MKF) is another staged combustion technique. In this process, solid fuel is fed into the calcining zone of the rotating kiln using a specially designed feed injection system. MKF allows part of the fuel to be burned at a calcinating temperature that is much lower than the normal burning temperature.

Selective catalytic reduction (SCR) is the process of using ammonia in the presence of a catalyst to selectively reduce NOx emissions from exhausts gases. The SCR process has been used extensively for gas turbines, internal combustion engines and fossil fuel-fired utility boilers but has also been used in kilns. In this system, anhydrous ammonia, usually diluted with air or steam, is injected through a catalyst bed to carry out NOx reduction reactions. A number of catalyst materials have been used, such as titanium dioxide, vanadium pentoxide and zeolite-based materials. The catalyst is typically supported on ceramic materials, e.g., alumina in a honeycomb monolith form. The optimum temperature for the catalyst reactions depends upon the specific catalysts used, but occur in the range from 570 to 840 ^{o}F (300 to 450 ^{o}C). This can be higher than typical cement kiln flue gas temperatures especially in plants that use heat recovery systems, or use a bag house for particulate collection. Because catalysts can be fouled by particulates, the presence of alkalis, lime and sulfur dioxide in the exhaust gases are of concern.

SNCR technology relies on the reduction of NOx in exhaust gases by injecting ammonia or urea without the use of a catalyst. This approach avoids problems related to catalyst fouling, but requires injection of reagents in the kiln at a temperature "window" of 1600 to 2000 ^{o}F (870 to 1090 ^{o}C). At these temperatures, the urea decomposes to produce ammonia, which is responsible for NOx reductions. To achieve full effectiveness, SNCR systems must operate in a section of the kiln with the proper temperature and residence time. At lower temperatures, the NOx reduction reactions become too slow resulting in too much un-reacted ammonia, which is usually referred to as ammonia slip when discharged to the atmosphere. The effective temperature window range can be lowered to about 1300 ^{o}F (700 ^{o}C) by the addition of hydrogen along with the reducing agent. Several other reagents can also shift the temperature window.

Emissions Affected

The SIC code for this category is 3295. To our knowledge, there are currently no Source Classification Codes for this industry.

Emissions Reductions

Emissions reductions of 50 to 80 percent have been achieved in kilns using SCR technology and SNCR technology respectively. Based in the 2002 Emissions Inventory for Point Sources, we were unable to identify any Aggregate Kilns. However, in a personal conversation with Karen Hill of the TCEQ staff[1], we understand that there may be sources in this category. If this is the case, we will work with the TCEQ staff to determine the sources of emissions and evaluate the potential reductions from this category.

Cost-effectiveness

The cost-effectiveness numbers for this measure are from the Alternative Control Techniques (ACT) document by EPA for cement kilns.[2] Based on the EPA document plus information developed by Pechan[3] provides us with the cost-effectiveness of each technology as shown in Table 1 below.

[1] Personal conversation with Karen Hill of TCEQ on October 27, 2005.
[2] Alternative Control Techniques Document-NOx Emissions from Cement Manufacturing, US EPA, EPA-453/R-94-004, March 1994.
[3] AirControlNET, Documentation Report, v. 3.2, E.H. Pechan & Associates, Inc., September 2003.

Table 1. Cost-effectiveness of control technologies for aggregate kilns.

NOx Control Technology	Cost-Effectiveness (dollars per ton)
LNB	560
MKF	460
SCR	3,370
SNCR	850

COMMENTS

Most cement kiln owners and operators have chosen SNCR technology as the preferred method to reduce NOx emissions from kilns. This is due primarily to the lower capital cost of SNCR when compared to SCR. Accordingly, we expect aggregate kiln owners to use the same technology. It should also be noted that control efficiencies greater that 50 percent have been achieved using SNCR in cement kilns. For example, in one case of a precalciner kiln, over 80 per cent NOx reduction was achieved.[4]

In addition to aggregate kilns, there are several other categories where kilns are used in the process to manufacture products for market. These include Clay and Fly Ash and Ceramic Products manufacturing. It is suggested that these categories also be investigated to determine the potential for reducing NOx emissions.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%.	tpd	
68	Aggregate Kilns	Control of NOx from Aggregate Kilns	Unknown	Unknown	50	Unknown	850

REFERENCES

(See footnotes)

[4] Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines, Technologies & Cost Effectiveness, Northeast State for Coordinated Air Use Management (NESCAUM), December 2000.

DRAFT

Control Measure: Alternate Energy Sources to Reduce Emissions from Electricity Generation, Measure #73
Category: Area & Point
Author: Derin Warren, North Central Texas Council of Governments

DESCRIPTION

This measure would require or encourage the use of low or zero emissions technologies for generation of electric power. Locally generated electricity by a low emissions method for an individual building, facility or defined population will reduce the demand for power from local fossil fuel plants, and thus reduce fossil fuel plant emissions.

ANALYSIS

Emissions Affected

This measure would affect emissions from electricity generation.

Emissions Benefit

A difficulty with this measure may be the assurance and quantification of reduced fuel consumption by local power plants. Several projects around the country have demonstrated various low emissions alternate technologies that produce practical levels of energy, and the amount of power generated by these technologies is assumed to be directly subtracted from an existing fossil fuel supported power grid.

Emissions reductions gained by this method are dependent on the efficiency of the affected fossil fuel plants, measured as NOx produced per megawatt hour (MWh) of electricity produced. Texas ranks seventh lowest in the nation and lowest among coal-using states in NOX average emission rates for electric generating plants. To estimate potential emissions reduction specific to the DFW area, the average tons of NOx produced per MWh was calculated from a sampling of 13 power plants within an approximately 150 mile radius of the DFW area. The power produced by various alternate technologies in demonstration projects can then be related to potential emissions reductions in the DFW area.

Based on a sample of the fossil fuel power plants near the DFW area, approximately 0.00092 tons of NOx emissions are produced per MWh per year of power produced. Recent successful photovoltaic alternate energy installations are producing in the range of 50 to 600 kWh. The estimated maximum reduction in NOx from a 600 kWh facility is 0.000552 tons per year. This is based on average 2003 annual fossil fuel plant emissions and assumes the alternative power technology could replace existing power usage at a continuous rate. A 65 megawatt concentrating solar thermal installation was recently contracted to be built in Nevada. The same facility could replace NOx emissions from DFW power plants at a maximum of 0.05875 tons per year assuming it could maintain the 65 megawatt output in the DFW area solar environment.

Cost Effectiveness

Historic costs for alternate electric generation technologies have been very high. These costs have decreased over time, yet remain a significant hurdle to installation of low emission technologies.

The cost of solar power installations varies greatly based on the type of technology. Although the initial cost for an individual home or industry installation may be regained in a few years based on reduced cost for power from the grid, larger installations continue at a high cost.

Fuel cells were not considered due to cost. Those currently most in use are generally reported to cost about $4,500 per kilowatt.

COMMENTS

Likely Ozone Directional Effect
Limited ozone reduction through NOx reduction.

Responsible Agency for Implementation
TCEQ
Local governments

Political/Social/Public Acceptance
Not high because of increase in power cost and limited impact on reduced emissions.

Technical Implementation Feasibility and Ranking
Some technologies are available on a limited scale; however, creating the volume of installations necessary to produce a significant reduction in emissions in the near term is questionable.

DRAFT

SUMMARY OF RESULTS: NO_x

Measure ID	Name	Description	Affected Source	Affected Emissions	Expected Emission Reduction		Cost Effectiveness ($/ton)
					%	Tpd	
73	Alternate Energy Sources to Reduce Emissions from Electricity Generation	Use of renewable energy rather than fossil fuel energy for electricity generation.	Area & Point			.06	

REFERENCES

Developing Cost-Effective Solar Resources with Electricity System Benefits, Staff Paper In Support of the 2005 Integrated Energy Policy Report, George Simons, California Energy Commission, 2005

Pure Energy Systems News, “World's Largest Solar Installation to Use Stirling Engine Technology”, Sterling D. Allen, 2005

Why Nevada Should Develop Its Solar Energy Resource. Joint presentation by The Solar Energy Industries Assn. (SEIA), Solar Thermal Power Div., DOE Concentrating Solar Power (CSP) Program, SunLab group at Sandia National Laboratories and the National Renewable Energy Laboratory (NREL), Las Vegas Nevada August 20, 2003

Control Measure: Architectural and Industrial Maintenance (AIM) Coatings, Short List Measure # 21
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

Adopt more stringent VOC content limits for architectural and industrial maintenance (AIM) coatings than required by EPA (Federal Part 59 limits). Regulated coatings include common exterior and interior flats and enamels, and also many specialty coatings, including shellacs and varnishes. Several options are available based on rules in other states, including California, and the STAPPA/ALAPCO and Ozone Transport Commission (OTC) model rules. The measure would apply to anyone who supplies, sells, offers for sale, or manufacturers any architectural coating for use within the 9-county DFW ozone nonattainment area. Since applying stricter VOC limits on coatings in only one area of the state would impose a difficult compliance burden on manufacturers, distributors and retailers, it might be advisable to apply the measure statewide.

ANALYSIS

Control Technology or Method of Control

Manufacturers will need to reformulate some coatings to lower the VOC content to specified limits and still achieve appropriate applicability characteristics. In Option 1, Texas would apply the VOC content limits in the OTC and STAPPA/ALAPCO model rules. Option 2 would apply more stringent limits on some categories, based on South Coast Air Quality Management District (SCAQMD Rule 1113 as amended in 2004.

Emissions Affected

Texas ASC categories 2401001000 and 2401100000, with estimated 2009 VOC emissions of 31.8 and 0.9 tons per day respectively in the 9-county Dallas/Fort Worth ozone nonattainment area.

Emissions Reductions

The EPA rule is currently in effect. It applies to over 40 categories of coatings and was estimated to reduce VOC emissions about 20% from uncontrolled levels.[1] Option 1 would produce an additional 21%-31% reduction, or 37-45% from uncontrolled levels.[2] Option 2 has

[1] "Midwest Regional Planning Organization (RTO), Identification and Evaluation of Candidate Control Measures", Prepared for The Lake Michigan Air Directors Consortium, April 14, 2005, Table A.14, p. A-10.
[2] RTO as cited and "Control Measure Development Support Analysis of Ozone Transport Commission Model Rules", Prepared for the Ozone Transport Commission, March 31, 2001. p.15.

the potential of an additional 13% reduction beyond Option 1.[3] Assuming 100% of the coatings in the ASC categories listed above are in compliance with the current federal rule and would be subject to this measure, and using the conservative end of the reduction range, Option 1 would have a control factor of 0.21 and produce VOC reductions of 6.7 tons per day in 2009. Option 2 would have a control factor of .38 and has the potential to reduce 2009 VOC emissions by 12.5 tons per day.

Cost-effectiveness

The cost-effectiveness of Option 1 was reported to be $6,400 per ton of VOC reduced.[3] Since the limits in the model rule have been applicable in California since January of 2003, paint manufacturers have already made their investment in reformulation and testing. The actual cost-effectiveness in Texas should be lower than it was in California. Option 2 had an estimated control cost of $20,000 per ton when adopted by the SCAQMD.[3] As is the case with Option 1, research and investment has been made in a number of the categories in an effort to comply and therefore the actual cost-effectiveness in Texas could be lower.

COMMENTS

Despite being more stringent overall, the model rule (Option 1) regulates fewer categories than the existing national rule and contains fewer compliance options. The model rule was developed largely from California's data and regulatory experience. Since climatic conditions in Texas and California differ, some of the limits may have to be adjusted for Texas. Option 2, imposing the more stringent limits in the 2004 SCAQMD rule, is technology forcing in some cases. The SCAQMD is tracking the industry's progress and reporting to its governing board. It is possible that some coatings may not be able to achieve the technology forcing limits by 2009.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
41	Architectural & Industrial Coatings	Require low VOC coatings	Over 40 categories of coatings in 9-county area	32.7	21-38%	6.7-12.5	$6,400-$20,000

3 RTO as cited.

REFERENCES

(see footnotes)

DRAFT

Control Measure: Area Source Credit for Energy Conservation and Efficiency, Measure# 56
Category: Area & Point
Author: Derin Warren, North Central Texas Council of Governments

DESCRIPTION

This measure is consistent with a continuing program that is in place and supported by state legislation.

Senate Bill 5, passed by the 77th Texas Legislature, 2001, requires all municipalities and other political subdivisions in nonattainment and near nonattainment areas to reduce electricity consumption by five percent each year for five years, beginning January 1, 2002. The reductions are to come from energy efficiency measures implemented for existing buildings and facilities. The legislation was passed under the 1- hour ozone standard nonattainment designations and therefore does not include the additional five counties designated under the 8-hour ozone standard (Johnson, Ellis, Rockwall, Parker, and Kaufman).

Senate Bill 7, passed by the 76th Texas Legislature, 1999, requires electric utilities to acquire increased energy efficiency equivalent to at least 10 percent of the utility's annual growth in demand. The efficiency is gained through market-based offer programs or targeted market-transformation programs. The Bill applies to electric utilities in a designated geographic area that covers most of the state and includes all of the ozone nonattainment areas. The Public Utility Commission of Texas has issued regulations for this program at TAC §25.181 through 183.

Additional emissions reductions from a more comprehensive and expanded energy conservation program that offered credits or incentives to non-government facilities might be estimated based on the method used for Senate Bill 5 calculations. Current data relating energy conservation to emissions reductions outside of the Senate Bill 5 estimates is scant, and further research would be needed to discover existing data or to develop local estimates.

ANALYSIS

Emissions Affected

This measure would affect emissions from electricity generation.

Emissions Benefit

TCEQ has developed a method to calculate the emissions reduced by implementation of Senate Bills 5 and 7. The method is referenced below as Appendix A to the current DFW SIP.

DRAFT

Based on a 25 percent reduction in electricity use from 2001 to 2005, estimated NOx emissions reductions are 0.5072 tons per day.

Cost Effectiveness

Cost estimates were not reported as part of the method.

COMMENTS

Likely Ozone Directional Effect
Predicted NOx reductions should be attainable to some degree based on the regulatory commitment and assuming a 25 percent use reduction by political subdivisions is practical, therefore ozone reduction is likely.

Responsible Agency for Implementation
TCEQ
Local governments

Political/Social/Public Acceptance
Historical acceptance by communities has been mixed, but public acceptance of conservation has increased over time. Some resistance may occur due to limited local resources for implementation.

Technical Implementation Feasibility and Ranking
A key element to implementation is the 25 percent reduction in electricity use by the affected political subdivisions. This should be achievable based on similar successful reductions by various governmental agencies across the country.

SUMMARY OF RESULTS: NO_x

Measure ID	Name	Description	Affected Source	Affected Emissions	Expected Emission Reduction		Cost Effectiveness ($/ton)
					%	Tpd	
56	Area Source Credit for Energy Conservation and Efficiency	Implementation of Senate Bill 5 and 7.	Area & Point			0.51	

DRAFT

REFERENCES

Demonstration for the Dallas - Fort Worth Ozone Nonattainment Area. APPENDIX A, Description of the Methodology for Determining Credit for Energy Efficiency Attainment, March 5, 2003

Control Measure: Brick Kilns-NOx, Measure # 69
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

This category includes the brick and structural clay products industry and consists of facilities that manufacture structural brick from clay, shale, or a combination of the two. In addition to these products, other facilities that manufacture structural clay products, such as clay pipe, adobe brick, chimney pipe, flue liners, drain tiles, roofing tiles, and sewer tiles. The manufacture of brick and structural clay products involves mining, grinding, screening and blending of the raw materials followed by forming, cutting or shaping, drying, firing, cooling, storage and shipping of the final product.

Prior to firing the shaped and formed product in the kiln, the products are loaded into a dryer. Dryers are typically heated to about 400 ^{0}F using waste heat from the cooling zone of the kiln. Products from the Dryer enter the kiln. The most common type of kiln used for firing brick is the tunnel kiln, although other types of kilns are used such as an intermittent or periodic kiln. A periodic kiln consists of a single firing chamber and is capable of firing only one loading of bricks at a time. A typical tunnel kiln ranges from about 340 feet to 500 ft in length and includes a preheat zone, a firing zone, and a cooling zone. The firing zone typically is maintained at a maximum temperature of about 2000 ^{0}F[1]. The process also includes flashing where small amounts of fuel are sometimes introduced to create a color to the surface of the bricks. After firing, the bricks enter a cooling zone where they are cooled to near ambient temperatures before leaving the kiln.

Natural gas is the most common fuel used for firing, however some kilns are fired by coal or sawdust. Some plants use fuel oil as a backup fuel, however, most natural gas-fired plants that have backup fuels use vaporized propane. Overall, the entire drying, firing and cooling process takes between 20 and 50 hours.

ANALYSIS

Control Technology or Method of Control

Combustion products, including NOx are emitted from brick kilns and some brick dryers. Brick dryers that are heated with waste heat from the kiln cooling zone are not a source of emissions because combustions gases are not vented to the cooling zone, however some dryers have supplemental gas burners that produce a small amount of NOx. Gaseous emissions including NOx are typically not controlled using add-on control devices.

---

[1] Brick and Structural Clay Product Manufacturing, Final Report, Emission Factor Determination for AP-42, Section 11.3, EPA Contract 68-D2-0159, August 1997.

Although natural gas combustion is considered cleaner than coal, NOx emissions can be significant. According to the EPA Compilation of Air Pollutant Emission Factors, NOx emissions when firing natural gas are 0.35 lb/ton of fired bricks produced. This is contrasted by a factor of 0.51 lbs/ton of fired bricks produced when firing with coal.[2]

Gaseous emissions from brick dryers and kilns typically are not controlled using add-on control devices. The exception is the use of dry limestone scrubbers to control hydrogen fluoride (HF) as well as wet scrubbers, which also can control SO_2 emissions. For the control of NOx emissions, combustion modifications and process modifications are typically used. These modifications generally address changes in the burner and flame to reduce NOx emissions. While such modifications have been widely used on industrial boilers and utility boilers, the conditions of these boilers differ substantially from those found in brick kilns. The primary difference is in the higher temperatures in brick kilns (2000 ^{0}F vs. 500 to 1000 ^{0}F in boilers). Also, brick kilns have higher excess air levels and different combustion chambers. These all contribute to higher levels of NOx than boilers firing the same fuel at the same rate. Many typical techniques such as flue gas recirculation, reduced air preheat and derating have limitations due to the higher temperature required. Also, there are tradeoffs, with such techniques between NOx and overall energy efficiency. One technique used in the glass manufacturing industry is the use of modified burners or Low-NOx burners (LNB)[3]. Glass manufacturing is similar to brick manufacturing in that temperatures in the range of 2000 to 2500 ^{0}F are required in the manufacturing process. The LNB are used to stage the combustion process in distinct zones to minimize the peak flame temperature and corresponding oxygen concentration thus minimizing NOx formation. NOx reductions between 30 and 50 percent over older design burners are possible.[4]

Depending on the age and condition of the facility, NOx emissions can also be reduced by improving brick drying before firing thereby reducing fuel requirements, stopping air leaks and controlling the kiln opening size to allow better control of air flow and direction and of course, switching the natural gas fuel or propane if the facility is burning coal or sawdust. Finally, new kiln designs such as the vertical shaft brick kiln can significantly decrease emissions through improved combustion airflow efficiency.

Emissions Affected

These facilities are classified under SIC code 3251, brick and structural clay. Facilities that manufacture structural clay products, such as clay pipe, adobe brick, chimney pipe, flue liners, drain tiles, roofing tiles, and sewer tiles are classified under SIC code 3259, structural clay products, not classified elsewhere. The primary emissions from this category are the tunnel and periodic kilns which are classified as SCC codes 30500311 and 30500314, Mineral Products, Brick Manufacturing Tunnel Kilns Gas Fired and Periodic Kilns Gas Fired. Based on the 2002

[2] Compilation of Air Pollutant Emission Factors, US EPA, AP-42, January 1995, Revised August 1997.
[3,4, 5] Alternative Control Techniques Document, NOx Emissions from Glass Manufacturing, US EPA, Report No. EPA-453/R-94-037, June 1994.

Emissions Inventory, one tunnel kiln is located in Denton County and the other in Parker County. A Periodic Kiln is also located in Parker County.

Emissions Reductions

Based on the 2002 nine county emissions inventory, the total NOx emissions from brick kilns is 110 tons per year (0.3 tpd). The emission inventory for this category are from two tunnel kilns and one periodic kiln as well as dryers and associated materials storage. Based on an emissions reduction of 50 per cent, the potential NOx reductions from this category are 47.9 tons (0.13 tpd).

Cost-effectiveness

As indicated in the discussion above, data were not available for controlling NOx emissions from Brick Kilns, however, due to the similarity of combustion in the glass manufacturing industry, we have identified Low-NOx burners as a potential strategy for reducing NOx from Brick Kilns. The cost effectiveness for retrofitting LNB on glass melting furnaces ranges from $790 to $1,920 per ton of NOx removed[5]. The ranges reflect the plant size with a 250 tons/day of production resulting in the highest cost-effectiveness. Pechan reports the cost-effectiveness for glass container manufacturing to be $1,690 per ton of NOx removed.[6] We have not identified cost-effectiveness for other measures such as improvements in the process design and operation to reduce fuel requirements and improve combustion airflow efficiency.

COMMENTS

We were unable to find any brick manufacturing facilities in the U.S. that have used the control techniques identified in this control measure. In reviewing a few permits that have been granted throughout the country, we found one case where emissions of NOx were limited to less than 50 tons per year as enforceable permit condition. In this case, no specific NOx control requirements were imposed.[7] In this case, the facility permit (Title V, Facility Wide Permit) required the permittee to maintain records, including the number of bricks produced and the report this data to verify compliance with the permit conditions and limits.

---

[6] AirControlNET, Documentation Report, E.H. Pechan & Associates, Inc., September 2003.
[7] State of New York, ENB Region 4 Completed Applications, P & M Brick LLC, March 5, 2003.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
69	Brick Kilns	Control of NOx from Brick Kilns	1 kiln located in Denton and 2 Kilns located in Parker County	0.3	50	0.13	790 to 1,920

REFERENCES

(see footnotes)

Control Measure: Cold Cleaning Regulations, Short List Measure # 48
Category: Area & Point
Author: Darcy J. Anderson

DESCRIPTION

Require use of low-VOC solvent for batch cold cleaning degreasing machines to clean contaminants from parts, products, tools, machinery, and equipment. Degreasing uses a solvent to remove grease, oil, or dirt from the surface of a part prior to surface coating or welding. Adopt the Chicago/Metro East cold cleaning regulations in all counties.

ANALYSIS

Control Technology or Method of Control

Apply limits on the volatility of cleaning solvents that can be used – vapor pressure maximum of 1 mmHg at 68° F.

Emissions Affected

Texas ASC category and 2009 estimated VOC emissions (tons per day TPD): 2415300000 Solvent utilization, degreasing, all industries; cold cleaning total, all solvents. Total estimated 2009 VOC emissions of 1.88 TPD in the 9-county Dallas/Fort Worth ozone nonattainment area.

Emissions Reductions

The Federal Title III Maximum Achievable Control Technology (MACT) for Open Top Degreasing, which applies to individual batch vapor, in-line vapor, in-line cold, and batch cold solvent cleaning machines, promulgated in 1994, was estimated to reduce VOC emissions overall by 31% from uncontrolled levels.[1] The Chicago / Metro East requirements are estimated to reduce VOC emissions by 38% - 65% from 2002 levels by the Midwest RPO.[2] Assuming 100% of the industries in the ASC category listed above are in compliance with the current federal rule and would be subject to this measure, and using the conservative end of the reduction range (38%), adoption of this control measure would result in VOC emission reductions of 0.71 tons per day in 2009.

---

[1] "AirControlNET, Documentation Report, v. 3.2," E.H. Pechan & Associates, Inc., September 2003, p. III-1109.
[2] "Midwest Regional Planning Organization (RPO), Regional Air Quality Planning, Evaluation of Candidate Control Measures," Final Report prepared for The Lake Michigan Air Directors Consortium (LADCO), February 9, 2005, Table A.13, p. A-9.

Cost-effectiveness

The cost-effectiveness of the MACT requirements was reported to be a SAVINGS of $69 per ton of VOC reduced.[1] The control cost listed by the Midwest RPO is $1400 per ton of VOC reduced.[2] Since the Chicago/Metro East regulations have been adopted by other areas, manufacturers have already made their investment in reformulation and testing. The actual cost-effectiveness in Texas should be lower than the estimate by the Midwest RPO.

COMMENTS

The 5 LADCO states have adopted requirements with varying geographic and size applicability criteria.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources)	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
48	Cold Cleaning Regulations	Require low VOC solvent	Degreasing, cold cleaning (all industries; 9 county)	1.88	38%	0.71	< 1,400

REFERENCES

(see footnotes)

Control Measure: Commercial and Consumer Products Requirements, Short List Measure # 33 & 37
Category: Area & Point
Author: Ron Friesen and Darcy J. Anderson

DESCRIPTION

Adopt commercial and consumer products requirements, which are already in effect in California for Phase I and Phase 2 limits as well as Mid-Term I and Mid-Term II limits. Reductions in VOC emissions are achieved by reformulation of the products. "Consumer product" means a chemically formulated product used by household and institutional consumers. The SCC / ASC categories affected are under solvent utilization, consumer and commercial. The measure would apply to anyone who supplies, sells, offers for sale, or manufacturers any of the commercial and consumer products covered under the SCC / ASC categories for use within the 9-county DFW nonattainment area. Since applying stricter VOC limits in only one area of the state would impose a difficult compliance burden on manufacturers and sellers, it might be advisable to apply the measure statewide.

ANALYSIS

Control Technology or Method of Control

Manufacturers will only be allowed to sell reformulated commercial and consumer products that meet lower VOC emissions limits set by the California Air Resources Board (CARB).

Emissions Affected

Texas ASC categories and 2002 estimated VOC emissions (tons per day TPD):

2460100000	12.0 TPD	All Personal Care Products
2460200000	7.9 TPD	All Household Products
2460400000	5.1 TPD	All Automotive Aftermarket Products
2460500000	13.5 TPD	All Coatings and Related Products
2460600000	2.0 TPD	All Adhesives and Sealants
2460800000	3.7 TPD	All FIFRA Related Products
2460900000	4.3 TPD	Miscellaneous Products (Not Otherwise Covered)

Total estimated 2002 VOC emissions of 48.5 tons per day in the 9-county Dallas/Fort Worth ozone nonattainment area.

Emissions Reductions

The Federal Consumer and Commercial Products rule 40CFR Part 59, which applies to 40% of all products and is now in effect, was estimated to reduce VOC emissions overall by 8% from uncontrolled levels (20% reduction for products covered by rule, only 40% of all products are covered by the rule).[1] The CARB 2003 SIP requirements are estimated to reduce VOC emissions overall by a total of 30.9% from uncontrolled emissions by the Midwest RPO, and an overall total of 37% in the California SIP.[2] Assuming 100% of the products in the ASC categories listed above are in compliance with the current federal rule and would be subject to this measure, and using the conservative end of the reduction range (30.9% - 8% = 22.9%), adoption of this control measure would result in VOC emission reductions of 11.1 tons per day (based on 2002 emission inventory; a somewhat larger value would be expected for 2009 given current population growth trends in the DFW nonattainment area).

Cost Effectiveness

The cost-effectiveness of the CARB 2003 SIP requirements was reported to be $4,800 per ton of VOC reduced.[1] Since the SIP limits have been applicable in California since 2003, and have been adopted by other area; manufacturers have already made their investment in reformulation and testing. The actual cost-effectiveness in Texas should be lower than it was in California.

COMMENTS

The CARB has been regulating consumer and commercial products since 1989, when it adopted a regulation to reduce VOC emissions from antiperspirants and deodorants. In the early 1990s, amendments to the consumer products rule (referred to as the Phase I and Phase II amendments) required emission reductions for 26 additional consumer products. In 1995, CARB adopted an aerosol coatings regulation, which required emissions reductions from 35 categories of aerosol paints and related coatings products. In 1997 and 2000, the regulations were amended again to include the so-called “mid-term” measures, so that the current regulations contain nearly 200 emission limits affecting 82 categories of consumer products, plus limits for 35 categories of aerosol coatings.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
33 & 37	Commercial and Consumer Products Requirements	Reformulate coatings and related products; adhesives and sealants; and misc.	Manufacturers of commercial and consumer products (all manufacturers; 9 county)	48.5	22.9%	11.1	4800

[1] “Midwest Regional Planning Organization (RPO), Regional Air Quality Planning, Evaluation of Candidate Control Measures,” Final Report prepared for The Lake Michigan Air Directors Consortium, February 9, 2005, Table 1, p.2.
[2] “Proposed 2003 State and Federal Strategy of the California State Implementation Plan, Revised, Section3: Consumer Products, Vapor Recovery, and Pesticides” released August 25, 2003.

REFERENCES

(See footnotes.)

Control Measure: Gasoline Dispenser Hoses, Measure # 109
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure deals with reducing VOC emissions from permeation through gasoline refueling hoses. Permeation occurs from gasoline evaporative control systems on motor vehicles, from portable gasoline containers, small engine components, and from gasoline refueling systems. Emissions from permeation are expected to increase as the average ethanol content of gasoline increases fuel permeability.

Permeation is a diffusion process whereby fuel molecules migrate through the elastomeric materials (rubber and plastic parts) that make up the vehicle's fuel and fuel vapor systems. Stage 2 gasoline fuel hoses are currently required to meet the UL 330 standard. In order to protect water quality, marine fueling station hoses are required to meet a more stringent standard, SAE J1527. This control measure would require Stage 2 fueling hoses in DFW to meet the more stringent marine refueling standard. The California air Resources Board (CARB) initially estimated that the change would reduce permeation emissions by 57%.[1] Subsequently, CARB conducted tests on in-use gasoline refueling hoses and found that their rate of permeation was less than expected; that is the actual in-use hoses exceeded the performance expected based on the UL330 standard.[2] This finding means the rate of improvement when switching to marine standard hoses may be less than the 57% difference between the two standards.

ANALYSIS

Control Technology or Method of Control

Hoses would be manufactured to stricter standards to physically reduce the amount of fuel lost through permeation. Implementation and enforcement could occur through California's vapor recovery system certification program, which is used in many states with Stage 2 requirements. The new standard would be phased-in, starting with new installations and completed over a several year period.

Emissions Affected

We estimate that fuel hose permeation produces 0.11 tons per day of VOC in the 9-county DFW 8-hour ozone nonattainment area. This estimate is based on CARB's California-wide emissions calculations, extrapolated to the DFW area. Since gasoline specifications, oxygenate content and temperatures in DFW may differ from California, actual VOC emissions may be somewhat higher or lower.

---

[1] California Air Resources Board Presentation, November 13, 2003, http://www.arb.ca.gov/vapor/archive.htm#y04.
[2] Personal communication between William Sylte of Sierra Nevada Air and Jim Watson of CARB, November 2, 2005.

Emissions Reductions

As noted, a change to the new hose standard could reduce permeation emissions from vehicle refueling by 57%, though the actual result may be less. Applying this control factor to the VOC emissions estimate provided above, this measure would reduce VOC emissions by 0.063 tons per day.

Cost-effectiveness

The California Air Resources Board initially estimated the cost-effectiveness of the measure at $10,920 per ton of VOC reduced[3] however several manufacturers have recently reported that they could meet the marine standard at lower cost. Nevertheless, the reduced emissions reductions indicated by the hose test results leave the current estimate of cost-effectiveness in the $14,000-$16,000 range.[1]

COMMENTS

The potential benefits of this measure will increase if the average ethanol content of gasoline is increased in the ozone nonattainment area.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
109	Fuel Hose Permeation	Replace hoses with marine hoses	Gasoline refueling, Stage II; 9 county)	0.11	Up to 57%	.063	$14,000 to $16,000

REFERENCES

(see footnotes)

---

[3] California Air Resources Board Workshop Handout, November 13, 2003, http://www.arb.ca.gov/vapor/emred_nov03.xls.

Control Measure: Glycol Dehydrators, Measure # 141
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure addresses the control of VOC emissions from glycol dehydrators. Among the VOC emitted are Hazardous Air Pollutants (HAP), including benzene. In addition, these devices emit methane, a greenhouse gas. The function of the glycol dehydration system is to remove water vapor from a natural gas stream to prevent corrosion and hydrate formation (mineral deposit) in pipelines. A variant of the liquid desiccant, glycol is used to remove the water vapor from the natural gas. Glycol dehydration systems are typically steel towers, ranging from 12 to 48 inches in diameter, and range in height anywhere from 12 to 32 feet.

These units were first regulated nationally by the 1999 "Oil and Gas MACT, 40 CFR Part 63, National Emission Standards for Hazardous Air Pollutants: Oil and Natural Gas Production and Natural Gas Transmission and Storage; Final Rule. The final standards for oil and natural gas production facilities require that the owner or operator of a major source of HAP reduce HAP emissions from glycol dehydration units (among other sources) through the application of air emission control equipment. In July of 2005, EPA proposed a supplemental rule that would control glycol dehydrators at minor sources. In addition, glycol dehydrators have been controlled by several California air districts, including the Ventura County APCD (1992) and the San Joaquin Valley APCD (2002).

ANALYSIS

Control Technology or Method of Control

There are several emission control options that can reduce emissions by 90-95%: 1) the installation of a collection and control device, 2) piping the vented emissions to an incineration device and 3) collecting the vented emissions back to the system as additional fuel feed stock. Natural Gas STAR Program, a voluntary partnership between EPA and the oil and natural gas industry, reports that glycol dehydrators can be replaced altogether solid desiccant dehydrators that reduce methane, VOC, and HAP emissions by 99 percent and also reduce operating and maintenance costs. [1]

Emissions Affected

Ozone season emissions from SCC31000227are estimated to be 0.46 tons per day (930 lbs/day) in the 9-county, 8-hour ozone nonattainment area, according to the 2002 inventory. There also may be sources in the Area source inventory but emissions data specific to glycol dehydrators

[1] The Natural Gas STAR Program, http://www.epa.gov/gasstar/pdf/lessons/ll_desde.pdf.

were not available for 2009 for either inventory. We do not have sufficient information to know whether the 2002 estimate reflects compliance by major sources with the MACT.

Emissions Reductions

Potential emissions reductions cannot be quantified with existing information. To quantify emissions reductions, it would be necessary to have 2009 emissions in sufficient detail to identify existing equipment located at major sources and therefore would already be controlled under the 1999 "Oil & Gas" MACT, and also equipment located at minor sources that could be controlled by 90%+ by the proposed supplemental EPA rule or, by a Texas rule similar to those in effect in California.

Cost-effectiveness

The cost effectiveness of 90-95% control from uncontrolled levels is approximately $280 to $570/ton of VOC reduced.[2] The fact that both HAP and green house gases are also reduced, enhances the cost-benefit ratio. EPA sources claim that replacing the glycol dehydrators with desiccant dehydrators can save money, largely due to the value of recovered product and reduced maintenance costs.[1]

COMMENTS

There is substantial uncertainty associated with this measure at this time. We do not have sufficient information on specific sources and equipment to know how much benefit has been derived from the 1999 MACT, or how much additional benefit will be gained if EPA's proposed supplemental MACT is finalized as proposed and affected sources comply.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
41	Glycol Dehydrators	Control or recycle vented VOC	Natural gas production (all 9 counties)	0.47	Up to 95%	unknown	$280-$570

REFERENCES

(see footnotes)

---

2 San Joaquin Valley APCD Staff Report on Rule 4408, Appendix C, December 19, 2002, p.4.

Control Measure: Industrial, Commercial and Institutional (ICI) Boilers-NOx, Measure # 7
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

This measure addresses combustion of fuel (primarily natural gas) from boilers used to process steam and heat as well as heat for residential and commercial space. This measure addresses medium and large size boilers with capacities of medium size boilers ranging from 40 to 80 MMBtu/hr and large size boilers above 80 MMBtu/hr. Process heaters are direct-fired heaters used primarily in the petroleum refining and petrochemical industries.

ANALYSIS

Control Technology or Method of Control

The control methods described in this measure address the ability of the boilers to achieve an 80 per cent emissions reduction in the four County Dallas-Fort Worth (DFW) and the other five counties of Ellis, Johnson, Kaufman, Parker and Rockwell. It should be noted that the control techniques and corresponding NOx emission levels presented in this measure might not be applicable to every ICI boiler application. The furnace design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique.

While numerous techniques are available for the control of NOx from ICI boilers, we have focused on Selective Catalytic Reduction (SCR) techniques and Selective Non-Catalytic Reduction (SNCR) techniques due to the emission limits that are required by this measure.

The SNCR process reduces NOx through a reaction between urea or ammonia and NOx in the furnace region (at temperatures of about 1600 ^{0} F and 2200 ^{0} F) to produce nitrogen and water. SNCR technology has been used on hundreds of industrial boilers firing a wide range of fuels.[1] The SCR process employs a similar reaction to SNCR, except that the reaction occurs at a much lower temperature (around 650 ^{0} F to 700 ^{0} F) and requires a catalyst. At these temperatures, SCR is capable of achieving very high NOx reductions, sometimes in excess of 90 per cent.[1] Again, SCR has been used to control NOx emissions from hundreds of industrial boilers throughout the U.S. and other countries.

---

[1] Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines, Technologies & Cost Effectiveness, Northeast States for Coordinated Air Use Management (NESCAUM), December 2000.

Emissions Affected

These ICI boilers fall under the SIC codes 10200601 and 10200602 for Commercial and Institutional boilers in two different size ranges (>100 MMBtu/hr and 10 to 100 MMBtu/hr). ICI boilers that fall under SIC codes 10300601 and 10300602 fall into two different size ranges (>100 MMBtu/hr and 10 to 100 MMBtu/hr respectively). Total emissions from medium and large size boilers in the 9 County are 562.9 tons per year (1.5 tpd).

Emissions Reductions

To evaluate the potential emissions reductions we have determined the percent control required by the current regulations in the Dallas-Fort Worth area and what additional reductions would be required to reach an 80 per cent control level. We also determined the reductions that would be achieved by applying an 80 percent emission reduction in the other five counties. Table 1.[2] shows the percent reductions that could be achieved beyond those required by current regulations.

Table 1. Percent reductions required by measure.

Natural Gas-Fired Industrial Boilers	**Size Range MMBtu/hr**	**Emission Reduction Required in 5 County Area (per cent)**	**Emission Reduction-Expand Measure to DFW Area (per cent)**
Medium Size	>40 - 80	80	17
Large Size	>80	80	6
	>100	80	6

Based on the 2002 Emissions Inventory, the potential emissions reductions for medium and large boilers is shown in Table 2.

Table 2. Potential emissions reductions.

Natural Gas-Fired Industrial Boilers	**Size Range[1] MMBtu/hr**	**Emission Reduction-Expand Measure to 5 County Area (TPY)**	**Emission Reduction-Expand Measure to DFW Area (TPY)**
Medium Size	>40 - 80	51.76	68.62
Large Size	>100	14.39	4.38
Total		**66.15**	**73.00**

1 For purpose of calculating emissions reductions, the emissions limits for 40 to 80 MMBtu/hr were applied to 2002 EI emissions from 10 to 100 MMBtu/hr. were applied to 2002 EI.

---

[2] Emission Factors from Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources, Fifth Edition, January 1995, revised, July 1998.

Cost-effectiveness

The cost effectiveness is based on a simplified costing methodology use by the U.S.EPA and identified in the Alternative Control Technique Guideline document for ICI Boilers.[3] Based on our evaluation, the cost-effectiveness for the control techniques is shown in Table 3. It is important to note that we did not calculate the incremental cost effectiveness of applying additional reductions to meet the 80 per cent requirement to the four county DFW area for medium size boilers (>40 MMBtu/hr) and large boilers (40 to 80 MMBtu/hr and > 80 MMBtu/hr) due to the small additional reductions that would be achieved (see Table 1). In addition, it was assumed that with the exception of the small boilers, these sources are already controlled to meet the DFW emissions limits for these sources and it would be impractical to apply additional controls to meet the more stringent limits of the HGB area.

Table 3. Cost-effectiveness of control measures.

Industrial Boilers **(Natural gas)**	**Size Range MMBtu/hr**	**Available Control Technology**	**Emission Reduction Potential (per cent)**	**Cost-Effectitveness[1] ($/ton of NOx Reduced)**
Medium Size	>40 - 80	SCR	50 - 80[2]	$4,830 to $6,880[3]
(Large Size	>40 - 80	SNCR	50 - 70[2]	$960 to $1,450[3]
	>100	SCR	50 - 80[2]	$3,040 to $5,350[3]

1 Cost-effectiveness represented by ranges reflects the range of capacity factors for equipment, which is a factor of how much the unit is operated.
2 Emission reductions from Alternative control Techniques (ACT) Document, NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, March 1994 Table 5-12.
3 Emission Factor from Alternative control Techniques (ACT) Document, NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, March 1994 Table 6-6 and 6-7.
4 Cost-Effectiveness based on range of cost-effectiveness for size range of 10 to 50 MMBtu/hr.

COMMENTS

As discussed above, the control techniques and corresponding NOx emission levels presented in this measure may not be applicable to every ICI boiler application. The furnace design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique.

[3] Alternative Control Techniques Document-NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, EPA-453/R-94-022, March 1994.

SUMMARY OF RESUTLS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
7	ICI Boilers	Reduce NOx Emissions by 80 Percent		1.5	25	0.38	960 to 6,880

REFERENCES

(see footnotes)

Control Measure: Industrial, Commercial and Institutional (ICI) Boilers-NOx, Measure # 9
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

This measure addresses combustion of fuel (primarily natural gas) from boilers used to process steam and heat as well as heat for residential and commercial space. This measure addresses boilers with capacities from 0.4 to 1,500 MMBtu/hr. Although coal, oil and natural gas are all fuels used in these applications, this measure focuses on natural gas since nearly all the boilers in the 2002 Emissions inventory used for this measure are fired on natural gas.

ANALYSIS

Control Technology or Method of Control

The control methods described in this measure address the ability of the boilers to achieve emissions reductions that would be necessary by applying the levels required by the four County Dallas-Fort Worth (DFW) area to the other five counties of Ellis, Johnson, Kaufman, Parker and Rockwell where such boilers are not regulated. This measure also investigates the emissions reductions that would be achieved if the levels required by the Houston-Galveston area were applied to the entire nine county area. It should be noted that the control techniques and corresponding NOx emission levels presented in this measure may not be applicable to every ICI boiler application. The furnace design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique.

While numerous techniques are available for the control of NOx from ICI boilers, we have focused on Selective Catalytic Reduction (SCR) techniques and Selective Non-Catalytic Reduction (SNCR) techniques due to the emission limits required by this measure.

The SNCR process reduces NOx through a reaction between urea or ammonia and NOx in the furnace region (at temperatures of about 1600 ^{0} F and 2200 ^{0} F) to produce nitrogen and water. SNCR technology has been used on hundreds of industrial boilers firing a wide range of fuels.[1] The SCR process employs a similar reaction to SNCR, except that the reaction occurs at a much lower temperature (around 650 ^{0} F to 700 ^{0} F) and requires a catalyst. At these temperatures, SCR is capable of achieving very high NOx reductions, sometimes in excess of 90 per cent.[1] Again, SCR has been used to control NOx emissions from hundreds of industrial boilers throughout the U.S. and other countries.

---

[1] Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines, Technologies & Cost Effectiveness, Northeast States for Coordinated Air Use Management (NESCAUM), December 2000.

Emissions Affected

These ICI boilers fall under the SIC codes 10200601, 10200602 and 10200603 for Commercial and Institutional boilers in three different size ranges (>100 MMBtu/hr, 10 to 100 MMBtu/hr, and < 10 MMBtu/hr respectively) and SIC codes 10300601, 10300602 and 10300603 for Industrial boilers in three different size ranges (>100 MMBtu/hr, 10 to 100 MMBtu/hr, and < 10 MMBtu/hr respectively). The total NOx emissions from this category in the DFW area are 640 tons per year (1.8 tpd). In the 5 County are the total NOx emissions are 89 tons per year (0.24 tpd).

Emissions Reductions

To evaluate the potential emissions reductions we have determined the percent control required by the current regulations that are applicable in the Houston-Galveston Area as well as the Dallas-Fort Worth area. We also determined the reductions that would be achieved by extending these emission limits to the other counties. Table 1.[2] shows the percent reductions that could be achieved beyond those required by current regulations.

Table 1. Percent reductions required by measure.

Industrial Boilers (Natural Gas)[1]	**Size Range MMBtu/hr**	**Emission Reduction Required by DFW Regulation (per cent)**	**Emission Reduction Required by HGB Regulation (per cent)**	**Additional Emission Reduction if HGB Limits Applied to DFW Counties (per cent)**
Small Size	<40	0	63	63
Medium Size	>40 - 80	63	69	6
Medium to large Size	>80	74	78	4
Large Size	>100	74	85	12

[1] Boiler categories are identified by the size ranges contained in current regulations

Based on the 2002 Emissions Inventory, the emissions for each of the boiler categories is shown in Table 2.

[2] Emission Factors from Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources, Fifth Edition, January, 1995, revised, July 1998.

Table 2. Potential emissions reductions.

Natural Gas-Fired Industrial Boilers	**Size Range[1] MMBtu/hr**	**Emission Reductions-Expand DFW to 5 County Area (TPY)**	**Emission Reduction-Expand HGB to DFW Area (TPY)**	**Emission Reduction-Expand HGB to 5 County Area**
Small Size	<40	0.00	118.43	4.20
Medium Size	>40 - 80	40.76	17.30	44.64
Large Size	>100	13.36	8.75	15.29
Total		**54.12**	**144.48**	**64.13**

[1] For purpose of calculating emissions reductions, the emissions limits for <40 MMBtu/hr were applied to 2002 EI.

Cost-effectiveness

The cost effectiveness is based on a simplified costing methodology use by the U.S.EPA and identified in the Alternative Control Technique Guideline document for ICI Boilers.[3] Based on our evaluation, the cost-effectiveness for each of the control techniques is shown in Table 3. It is important to note that we did not calculate the incremental cost effectiveness of applying additional limits of the HGB to the four county DFW area for medium size boilers and large boilers due to the small additional reductions that would be achieved (see Table 1). In addition, it was assumed that with the exception of the small boilers, these sources are already controlled to meet the DFW emissions limits for these sources and it would be impractical to apply additional controls to meet the more stringent limits of the HGB area.

Table 3. Cost-effectiveness of control measures.

Natural Gas-Fired Industrial Boilers	**Size Range MMBtu/hr**	**Available Control Technology**	**Emission Reduction Potential (per cent)**	**Cost-Effectitveness[1] ($/ton of NOx Reduced)**
Small Size	<40	SCR	50 - 80[2]	$4,830 to $10,090[3,4]
Medium Size	>40 - 80	SCR	50 - 80[2]	$4,830 to $6,880[3]
Medium Size	>40 - 80	SNCR	50 - 70[2]	$960 to $1,450[3]
Large Size	>100	SCR	50 - 80[2]	$3,040 to $5,350[3]

1 Cost-effectiveness represented by ranges reflects the range of capacity factors for equipment, which is a factor of how much the unit is operated.
2 Emission reductions from Alternative control Techniques (ACT) Document, NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, March 1994 Table 5-12.
3 Emission Factor from Alternative control Techniques (ACT) Document, NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, March 1994 Table 6-6 and 6-7.
4 Cost-Effectiveness based on range of cost-effectiveness for size range of 10 to 50 MMBtu/hr.

[3] Alternative Control Techniques Document-NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers, EPA-453/R-94-022, March 1994.

COMMENTS

As discussed above, the control techniques and corresponding NOx emission levels presented in this measure may not be applicable to every ICI boiler application. The furnace design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique. In addition, boilers with heat input capacities less than 10 MMBtu/hr are generally classified as commercial/institutional units and are use in a wide variety of applications such as wholesale and retail trade, office buildings, airports etc. As a result these boilers are often pre-packaged boilers and may not amenable to retrofit of the types of controls discussed in this measure.

SUMMARY OF RESUTLS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
9	ICI Boilers	Control of NOx from Industrial, Commercial and Institutional (ICI) Boilers	Expand DFW to 5 County area	0.24	70-ave.	0.15	960 to 6,880
9	ICI Boilers	Control of NOx from Industrial, Commercial and Institutional (ICI) Boilers	Expand HGB Controls to 9 County area	2.0	70-ave.	0.40	960 to 10,090

REFERENCES

(see footnotes)

Control Measure: Lime Kilns-NOx, Measure # 70
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

Lime is a generic term that covers a class of calcium-based, manufactured, alkaline products. These products are derived from controlled heating of select, natural limestone to very high temperatures. The product lime is produced by the calcinations of limestone. Limestone deposits are prevalent throughout the country but only a small portion is pure enough for industrial lime manufacturing. Lime can also be produced from aragonite, chalk, coral, marble and seashells. Lime products are used in many applications including soil-stabilization, as a chemical in the iron and steel making process, to add bond strength to masonry mortar, water and wastewater treatment and as a product for flue gas desulfurization in power plants and other large SO_2 emitting facilities.

The basic processes in the production of lime are 1) quarrying raw limestone, 2) preparing limestone for the kilns by crushing and sizing, 3) calcining limestone, 4) processing the lime further by hydrating, and 5) miscellaneous transfer, storage and handling operations. The key part of the process is the kiln where the limestone is calcined. Most kilns are rotary kilns, which are long, cylindrical, slightly inclined refractory furnaces through which the limestone and hot combustion gases pass countercurrently. Rotary kilns can be fired with natural gas, oil and coal. A second type of kiln is the vertical or shaft kiln. This kiln is an upright heavy steel cylinder lined with refractory material. The lime is charged at the top and is calcined as it descends slowly to discharge at the bottom of the kiln.

Combustion products including NOx are produced in the kilns. Uncontrolled emissions from kilns range from 3.1 lb/ton of lime produced for a coal-fired rotary kiln to 3.5 lb/ton of lime produced from a gas-fired rotary kiln.[1]

ANALYSIS

Control Technology or Method of Control

Similar to Cement Kilns, there are several options for the control of NOx from Lime Kilns. These options include the use of Low NOx Burners (LNB), Mid-Kiln Firing (MKF), Selective Catalytic Reduction (SCR) and Selected Non-Catalytic Reduction (SNCR). Each of these methods have been demonstrated to significantly reduce NOx emissions.

Low NOx Burners (LNB) are designed to "stage" combustion so that two combustion zones are created, one fuel-rich combustion and one at a lower temperature. Staging techniques are usually used by LNB to supply excess air to cool the combustion process or to reduce available oxygen in the flame zone.

[1] Compilation of Air Pollutant Emission Factors, US EPA, AP-42, January 1995, Revised February 1998.

Mid-Kiln Firing (MKF) is another staged combustion technique. In this process, solid fuel is fed into the calcining zone of the rotating kiln using a specially designed feed injection system. MKF allows part of the fuel to be burned at a calcinating temperature that is much lower than the normal burning temperature.

Selective catalytic reduction (SCR) is the process of using ammonia in the presence of a catalyst to selectively reduce NOx emissions from exhausts gases. The SCR process has been used extensively for gas turbines, internal combustion engines and fossil fuel-fired utility boilers but has also been used in kilns. In this system, anhydrous ammonia, usually diluted with air or steam, is injected through a catalyst bed to carry out NOx reduction reactions. A number of catalyst materials have been used, such as titanium dioxide, vanadium pentoxide and zeolite-based materials. The catalyst is typically supported on ceramic materials, e.g., alumina in a honeycomb monolith form. The optimum temperature for the catalyst reactions depends upon the specific catalysts used, but occur in the range from 570 to 840 ^{o}F (300 to 450 ^{o}C). This can be higher than typical cement kiln flue gas temperatures especially in plants that use heat recovery systems, or use a bag house for particulate collection. Because catalysts can be fouled by particulates, the presence of alkalis, lime and sulfur dioxide in the exhaust gases are of concern.

SNCR technology relies on the reduction of NOx in exhaust gases by injecting ammonia or urea without the use of a catalyst. This approach avoids problems related to catalyst fouling, but requires injection of reagents in the kiln at a temperature “window” of 1600 to 2000 ^{o}F (870 to 1090 ^{o}C). At these temperatures, the urea decomposes to produce ammonia, which is responsible for NOx reductions. To achieve full effectiveness, SNCR systems must operate in a section of the kiln with the proper temperature and residence time. At lower temperatures, the NOx reduction reactions become too slow resulting in too much un-reacted ammonia, which is usually referred to as ammonia slip when discharged to the atmosphere. The effective temperature window range can be lowered to about 1300 ^{o}F (700 ^{o}C) by the addition of hydrogen along with the reducing agent. Several other reagents can also shift the temperature window.

Emissions Affected

The SIC Code for lime manufacturing is 3274. The SCC code is 3-05-016, Mineral Products, Lime Mfg, Calcining, Rotary Kiln. The NOx emissions from this rotary kiln are 1,018 tons per year (2.8 tpd).

Emissions Reductions

Based on the 2002 emissions inventory used for this project, there is only one lime kiln in the nine county Dallas Fort-Worth nonattainment area. The potential emissions reductions that can be achieved for each technology are shown in Table. 1 below. Note that all reductions represent the reductions from an uncontrolled level.

Table 1. Emissions reductions from lime kilns.

NOx Control Technology	Per Cent Emissions Reductions[1]	Annual Emissions Reductions (t/yr)
LNB	30	305
MKF	30	305
SCR	80	814
SNCR	50	510

[1] Per cent reductions from AirControlNET, Documentation Report, E.H. Pechan & Associates, Inc., September 2003.

Cost-effectiveness

The cost-effectiveness is from the Alternative Control Techniques (ACT) document by EPA for cement kilns.[2] Based on the EPA ACT document and information developed by Pechan[3], the cost-effectiveness of the different types of technology is shown in Table 2 below.

Table 2. Cost-effectiveness of control technologies for lime kilns.

NOx Control Technology	Annual Emissions Reductions (t/yr)	Cost-Effectiveness (dollars per ton)
LNB	305	560
MKF	305	460
SCR	814	3,370
SNCR	510	850

COMMENTS

It appears that most cement kiln owners and operators have chosen SNCR technology as the preferred method to reduce NOx emissions from kilns. This is due primarily to the lower capital cost of SNCR when compared to SCR. Accordingly, we expect Lime kiln owners to use the same technology. It should be noted that control efficiencies greater that 50 percent have been achieved using SNCR in cement kilns. For example, in one case of a precalciner kiln, over 80 per cent NOx reduction was achieved.[4]

[2] Alternative Control Techniques Document-NOx Emissions from Cement Manufacturing, US EPA, EPA-453/R-94-004, March 1994.
[3] AirControlNET, Documentation Report, v. 3.2, E.H. Pechan & Associates, Inc., September 2003.
[4] Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines, Technologies & Cost Effectiveness, Northeast State for Coordinated Air Use Management (NESCAUM), December 2000.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
70	Lime Kilns	Control of NOx from Rotary Kilns	One Large Source in Johnson County	2.8	80	2.2	3,370

REFERENCES

(see footnotes)

Control Measure: Utilize NOx and Energy Assessment tool ("NxEAT") Software, Measure # 143
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure envisioned the use of a free software product distributed as an energy efficiency tool by the U.S. Department of Energy (DOE) to help reduce NOx emissions in the petroleum refining and chemical industries. According to the DOE, "the NOx and Energy Assessment Tool (NxEAT) helps plants in the petroleum refining and chemical industries to assess and analyze NOx emissions and application of energy efficiency improvements. Users can inventory emissions from equipment that generates NOx and then compare how various technology applications and efficiency measure affect overall costs and reduction of NOx. By performing "what if" analyses, users can determine optimal and cost effective methods for reducing NOx from systems, such as fired heaters, boilers, gas turbines, and reciprocating engines."[1]

The TCEQ commented that they would not consider mandating a specific software or control technology product. As a result, the concept was downgraded from a stand-alone control measure to a compliance assistance tool that might be used to support other control measures. For example, if a facility was subject to a NOx emissions reduction requirement under a cap and trade rule, NxEAT would provide a tool the facility might use to design their control approach.

ANALYSIS

Control Technology or Method of Control

The concept is reducing NOx emissions through energy efficiency/ reduced fuel consumption.

Emissions Affected

The sources likely to use this software are point sources. The ozone season NOx emissions from refineries in the 2002 point source inventory are 140 lbs/day.

Emissions Reductions

Reductions would depend on facility-specific input.

---

[1] Text on DOE website. http://www.eere.doe.gov/industry/glass/news_detail.html/news_id=7986.

Cost-effectiveness

The literature on NxEAT claims that the tool will result in cost savings.[2] We were unable to locate any published case studies or other technical information that would corroborate DOE descriptions.

COMMENTS

More data needed on actual experience if tool is to be considered in designing control measures.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction	Est. Cost Effectiveness ($/ton)	
143	NOxEAT Software	Compliance assistance. install software to increase energy efficiency	Refineries & Chemical Plants, 9-counties	na	na	na	na

REFERENCES

(see footnotes)

---

[2] DOE website as cited.

Control Measure: Oil & Gas Production, Natural Gas Processing, Measure # 144
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure involves expanded and more stringent control of fugitive VOC emissions at Oil & Gas Production facilities. Crude oil and gas production facilities and natural gas processing facilities contain a large number of components such as pipes, flanges, valves, fittings, threaded connections, hatches, pressure relief valves, pumps, and compressors. Leakage of fluids or gases from these components can be expected to occur during process and transfer operations, causing fugitive VOC emissions.

Texas (Section 115.352) currently regulates some fugitive sources at natural gas processing facilities in part of the DFW 8-hour ozone nonattainment area. The regulation requires the repair of leaks at system components within 15 days after it is detected. A leak is a measured VOC concentration >500 ppm above background (as methane), or dripping or other discernable leaks. Pump and compressor seals have a leak threshold of 10,000 ppm. A number of conditions and exemptions apply.

EPA has published NESHAPS requirements for major sources of oil and natural gas production and natural gas transmission and storage (40 CFR 63, Subpart HH, June 17, 1999). It applies to equipment at major sources and addresses glycol dehydration units, tanks with flashing potential and certain fugitive sources at natural gas processing plants. This measure has some housekeeping provisions that apply to leaking components, but produces most of its reductions from the installation of control equipment on glycol dehydrators and tanks. Because most facilities in are not “major”, the NESHAP does not apply to most production and processing sources and components. EPA has also adopted a NSPS for Equipment Leaks of VOC from Onshore Natural Gas Processing Plants (40 CFR 60, Subpart KKK). This standard establishes control requirements similar to those in effect in Texas for new facilities.

Recently, the San Joaquin Valley APCD has adopted revised control requirements for oil and gas facilities in its jurisdiction. The revised requirements incorporate requirements and practices in other California air districts that have such facilities. Key features are more stringent definition of leaks than previously required, and shorter repair periods.

Option 1 would expand existing Texas Section 115,352 requirements to the other 5 counties in the 8-hour ozone attainment area, several of which have oil and gas production activities.

Option 2 would be a more stringent measure that expands coverage beyond natural gas processing facilities and uses some combination of the techniques described below to reduce emissions beyond the levels currently required.

ANALYSIS

Control technology or method of control

This measure is primarily a housekeeping measure that requires facilities to conduct periodic inspections of components that can leak volatile liquids or gases, identify leaks and repair them within specified time frames to minimize VOC emissions, and finally keeping records and reporting status to facilitate enforcement. Housekeeping rules can be made more effective by expanding the operations subject to the rule, reducing leak threshold s, eliminating exemptions, increasing the frequency of inspections, shortening the repair period for leaking components, and replacing frequently leaking components with Best Available Control Technology.

Emissions Affected

There is not sufficient information available to accurately estimate emissions that might be affected by this measure. The 2009 Area Source inventory provides an aggregate VOC emissions estimate for all onshore Oil & Gas Production activities, but no breakout by equipment or component. We note that the 2009 inventory shows 8.3 tons per day of VOC from ASC 2310001000, compared to 14.9 tons/day in the 2002 Area source inventory. We also examined the 2002 Point source inventory, which provides a more detailed break down using SCC categories. The categories affected by this measure (SCC 31000207, 31000224, and 31088801) are estimated to produce 0.21 tons/day of VOC.

Emissions Reductions

There is insufficient information available to estimate potential emission reductions from either of the options listed. For perspective, the NESHAP described above was estimated to reduce VOC at affected natural gas transmission and storage facilities by 19%. [1] The San Joaquin Valley APCD estimated that their more stringent rule would reduce VOC from affected Oil & Gas Production and Natural Gas Processing facilities by 82%, compared to previous requirements.[2]

Cost Effectiveness

The cost effectiveness depends on the specific requirements of the measure. As an example, the San Joaquin Valley APCD estimated that Rule 4409, which would reduce emissions from 16.4 tons per day to 2.9 tons per day, had an overall cost-effectiveness of $600 per ton of VOC reduced.[3]

---

[1] EPA Fact Sheet, May 14, 1999, p.2, http://www.epa.gov/ttn/oarpg/t3/fact_sheets/natgasfs.pdf.
[2] Staff Report on Rule 4409, Appendix B, July 28, 2004, San Joaquin Valley APCD, Table 1. http://www.valleyair.org/workshops/postings/8-31-04/fugitive_appb_w3.pdf.
[3] Staff Report on Rule 4409, Appendix C, July 28, 2004, San Joaquin Valley APCD, p.4. http://www.valleyair.org/workshops/postings/01-20-05/voc_appc_ph.pdf.

COMMENTS

Housekeeping rules are by nature a composite of numerous optional features and standards. An accurate evaluation of emissions reductions requires very specific information about existing conditions.

SUMMARY OF RESULTS: VOC

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
144	Oil & Gas Production	Better identify and repair leaking components	Oil & gas production and gas processing; 9 county)	unknown	Up to 82%	Unknown	$600 per ton

REFERENCES

(See footnotes.)

Control Measure: Refinery Boilers, Steam Generators and Process Heaters-NOx, Measure # 10
Category: Area & Point
Author: Ron Friesen

DESCRIPTION

This measure addresses large refinery boilers, steam generators and process heaters. Large boilers are defined as boilers with capacities of 80 MMBtu/hr or larger. Based on our evaluation of this category, we did not find any refinery boilers in this category. Therefore, this measure addresses process heaters which are direct fired heaters used primarily in and petrochemical and other chemical industries. Process heaters serve to process fluids which are heated to temperatures in excess of 400 ^{0}F in the radiative and convective sections of the heaters. Flue gas is usually in excess of 1500 ^{0}F for most process heaters.

ANALYSIS

Control Technology or Method of Control

The control methods described in this measure apply to process heaters. Control techniques and corresponding NOx emission levels presented in this measure may not be applicable to every process heater. The furnace design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique.

While numerous techniques are available for the control of NOx from process heaters, we have focused on Selective Catalytic Reduction (SCR) techniques and Selective Non-Catalytic Reduction (SNCR) techniques due to the emission limits that are required by the areas evaluated. Also, some combustion modifications such as low-NOx burners (LNB) can be used in combination with other control technologies such as flue gas recirculation, (FGR), SNCR and SCR.

The SNCR process reduces NOx through a reaction between urea or ammonia and NOx in the furnace region (at temperatures of about 1600 ^{0} F and 2200 ^{0} F) to produce nitrogen and water. SNCR technology has been used on hundreds of industrial boilers firing a wide range of fuels.[1] The SCR process employs a similar reaction to SNCR, except that the reaction occurs at a much lower temperature (around 650 ^{0} F to 700 ^{0} F) and requires a catalyst. At these temperatures, SCR is capable of achieving very high NOx reductions, sometimes in excess of 90 per cent.[1] Again, SCR has been used to control NOx emissions from hundreds of industrial boilers and process heaters throughout the U.S. and other countries.

[1] Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines, Technologies & Cost Effectiveness, Northeast States for Coordinated Air Use Management (NESCAUM), December 2000.

Emissions Affected

Process heaters fall under the SIC codes 10200601 and SIC codes 30600104 and 30600105.

Emissions Reductions

To evaluate the potential emissions reductions we evaluated the 2002 Emissions Inventory. Based on this evaluation, we were unable to find sources that fall into the category of Refinery Boilers. Therefore we focused on Process Heaters in our evaluation. Based on the percent control required by the current regulations in the Houston-Galveston area, we evaluated the emissions reductions that would be achieved at an 80 per cent control level. It should be noted that the emissions reduction potential for process heaters to achieve an 80 per cent reduction would require a combination of control technologies such as LNB and SNCR. Table 1 below identified several control technology options for process heaters.

Table 1. Reduction efficiencies for process heaters[1]

Control Techniques for Process Heaters	Total NOx Reduction, percent
LNB	50
SNCR	60
SCR	75
LNB + SNCR	80
LNB + SCR	88

1 Selected from Table 2-2, Alternative Control Techniques Document-NOx Emissions from Process Heaters (Revised) EPA-453/R-93-034, Sept 1993.

Based on the 2002 emissions inventory for process heaters, the total NOx emissions are 189 tons per year (0.52 tpd) and 1168 pounds per day during the ozone season. Based on the emissions inventory we were unable to determine the size range of the heaters and apply different factors unique to the different size ranges of the heaters. Therefore, we calculated the potential emissions reductions for process heaters to be a total of 151 tons per year (0.41 tpd) and 934 pounds per day during the ozone season. Please see the attached spreadsheet for the calculations.

Cost-effectiveness

The cost effectiveness is based on a simplified costing methodology use by the U.S.EPA and identified in the Alternative Control Technique Guideline document for Process Heaters.[2] This report evaluates a number of model heaters based on a refinery database, published literature and data. Table 2 presents the cost-effectiveness of a medium size (77 MMBtu/hr) heaters fired on natural gas that correspond to the control options identified in Table 1. Table 2 also identifies the capacity factor for the corresponding size of heater.

[2] Alternative Control Techniques Document-NOx Emissions from Process Heaters (Revised), EPA-453/R-93-034, September 1993.

Table 2. Cost-effectiveness of control measures.

Control Technique	Size MMBtu/hr	Emission Reduction Potential (per cent)	Cost-Effectitveness[1] ($/ton of NOx Reduced)	
			Capacity Factor- 0.5	Capacity Factor- 0.9
LNB	77	50	4,370	2,430
SNCR	77	60	5,450	3,170
SCR	77	75	16,400	9,370
LNB + SNCR	77	80	5,340	3,119
LNB + SCR	77	88	15,200	8,640

COMMENTS

As discussed above, the control techniques and corresponding NOx emission levels presented in this measure may not be applicable to every heater application. The heater design, method of fuel firing, condition of existing equipment, operating duty cycle, site conditions, and other site-specific factions must be taken into account to properly evaluate the applicability of each control technique.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
10	Refinery Boilers and Heaters	NOx reductions from refinery boilers, steam generators, and process heaters–NOx.	Process Heaters (all 9 counties)	0.52	80	0.41	2,430 to 16,400

REFERENCES

(see footnotes)

Control Measure: Small Boilers & Heaters, Measure # 170
Note: TCEQ has commented that they are already working on a measure that addresses these sources.
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure would apply NOx control requirements to new or existing small boilers and heaters with heat ratings < 5 MMBtu/hr. These units are usually found in manufacturing plants, government facilities, general merchandise stores, restaurants, hotels, rooming houses and camps, cleaning service facilities, hospitals, educational institutions, religious organizations, and refineries. Texas rules currently apply NOx emissions limits statewide on new boilers and heaters with heat ratings < 2 MMBtu/hr (Sections 117.460-469). As older units are retired, they must be replaced with new, lower-emitting units. In addition, NOx limits apply to boilers and heaters located at minor sources in the Houston-Galveston ozone nonattainment area (HGA) with heat ratings from 2-5 MMBtu/hr. (Sections 117.475(c)(1) and 117.534(2)(c)). Key NOx limits are 0.036 lbs/MMBtu (for gas-fired units and) 0.072 for liquid-fueled units. Texas' limits and requirements are consistent with those in the more severely polluted areas of the country, including California.

TCEQ is considering applying HGA requirements to the DFW 9-county, 8-hour ozone nonattainment area.

ANALYSIS

Control Technology or Method of Control

Manufacturers currently produce many complying limits, utilizing using several low-NOx burner designs and complementary management of excess air. For the larger category, compliance may be obtained by retrofitting existing units or installing new complying units. For smaller units < 2 MMBtu/hr, complying units are to be phased in as old units are replaced.

Emissions Affected

TCEQ is evaluating this measure.

Emissions Reductions

TCEQ is evaluating this measure.

Cost-effectiveness

According to the San Joaquin Valley APCD, the estimated cost effectiveness of controlling units < 2 MMBtu hour ranges from a cost savings of $1,108 to a cost of $5,385 per ton of NOx reduced.[1]

COMMENTS

Texas limits are consistent with the most stringent requirements on similar sized sources in California. TCEQ has indicated that it is considering applying the HGA requirements in DFW and will develop its own emissions reductions estimates.

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
170	Small boilers & heaters	Replace boilers & heaters with better controlled units	Commercial and institutional buildings; 9 county)	Deferred to TCEQ measure development			

REFERENCES

(see footnotes)

[1] Final Staff Report, San Joaquin Valley Air Pollution Control District Rule 4308, September 15, 2005, p.7.

Control Measure: Stationary IC Engines, Measure # 96A
Category: Area & Point
Author: W. Sylte, Sierra Nevada Air

DESCRIPTION

This measure would expand NOx control requirements for Stationary Internal Combustion (IC) Engines. Internal combustion engines are used by a large variety of private businesses and public agencies. Some examples are schools and universities, manufacturers, food processors, and sewer and water districts. These engines run pumps, compressors, electrical generators and other equipment. They vary by size, design and fuel type. Spark ignited IC engines burn gaseous and liquid fuels. Design characteristics include rich-burn and lean burn configurations, each of which has somewhat different emissions characteristics. Combustion ignited engines typically burn diesel fuel.

Texas currently controls NOx emissions from stationary IC engines located at minor sources in the Houston-Galveston ozone nonattainment area (HGA). Control requirements are contained in Section 117.471-481 and operate in conjunction with the Mass Emissions Cap & Trade program (30 TAC Chapter 101, Subchapter H, Division 3). Gas-fired, dual fired and diesel engines are addressed in the rule, but as we read the rule, only diesel engines have a NOx reduction requirement independent of the Cap & Trade program. Diesel engines that are installed after October of 2001, or are modified or relocated, must comply with a series of emission limits based on EPA Tier 1, Tier 2 and Tier 3 standards for non-road diesel engines. The emission limits vary by horsepower and the date of installation. Option 1 under this measure is to extend HGA level controls to the 9-county, DFW ozone nonattainment area, but without the Cap & Trade Program.

Some California air districts have recently updated their rules to apply more stringent, future-effective control requirements on stationary IC engines. For example, the San Joaquin Valley Air Pollution Control District has recently amended Rule 4702 to require emission limits on previously exempt agricultural engines, and also to add requirements based on EPA Tier 4 standards for non-road diesel engines. Like the Texas approach, the rule phases in cleaner engines over time. It gives owners of newer cleaner engines more time to meet prescribed limits, but ultimately requires all existing spark and compression ignited engines > 50 horsepower to meet specified requirements. Option 2, is to adopt control requirements in DFW that are similar to San Joaquin Rule 4702.

ANALYSIS

Control Technology or Method of Control

NOx emissions from spark ignited engine emissions can be reduced 70-90% from uncontrolled levels using control technologies such as pre-stratified charge (rich burn engines) and low emissions combustion controls.[1] Post-combustion controls, including SCR, are also feasible on

[1] Draft Staff Report, Rule 4702, March 24, 2005, San Joaquin Valley Air Pollution Control District., p. 12.

larger engines.[2] Diesel engine NOx can be reduced by 30% (Tier 1) to well over 90% (Tier 4). EGR provides more modest levels of control and, in the longer term and in conjunction with low sulfur diesel fuel, high efficiency catalyst technology of the type being developed for on-road diesel engines, sometimes referred to as NOx absorber technology, can be applied to most stationary diesel engines.[3]

Emissions Affected

A 2009 inventory was not available at the time this evaluation was conducted. Therefore, we have relied on the 2002 Point Source Inventory for DFW that was made available to the reviewing team. The categories and ozone season total is pounds per day were as follows:
Diesel engines * – 398 (0.199 tons per day)
Gas-fired lean burn engines –11,915 (5.96 tons per day)
Gas-fired rich burn engines – 2,235 (1.1 tons per day)
Dual Fuel – 590 (0.30 tons per day)
*This estimate is lower than expected in a large metro area.

Emissions Reductions

Option 1 – We have defined Option 1 as extending the IC engines requirements of the HGA rule to DFW, but without the complimentary Mass Emissions Cap & Trade Program. Therefore, benefits would be derived only from reduced emission limits on covered engines. Since our reading of the HGA rule is that other types of engines are not subject to control under the HGA rule (except those at facilities covered by Cap & Trade) emission benefits in DFW would be derived solely from diesel engines. Further assuming that all the IC engines in DFW are currently uncontrolled, and all diesel engines would eventually have to meet Tier 3 standards, a simplified control factor of 0.7 was calculated for diesels. Applying this control factor to the emission estimate presented above, Option 1 would produce a maximum reduction of 281 lbs/day from 2002 levels during the ozone season. Actual reductions for 2009 will probably be lower because 1) all existing engines may not be replaced by complying engines, and 2) some replacement engines will be Tier 2 rather than Tier 3 engines.

Option 2 – This option differs in that we assume that all IC engines would be subject to control requirements by 2009. Based on information from San Joaquin Rule 4702, we have assumed a control factor of 0.826 for lean burn engines, 0.865 for rich burn engines, and 0.90 for dual fuel engines. Applying these control factors to the emissions estimates described above yields a total NOx reduction from 2002 levels of 12,586 lbs/day (6.29 tons per day) during the ozone season.

Cost Effectiveness

There is insufficient information available to assess the overall cost-effectiveness of the measure options. Cost effectiveness varies by engine type, horsepower rating, operating hours and

[2] At a Glance Tables, Version 3.2, AircontrolNET, September 2003, on p.III-148 and 152.
[3] Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel, June 29, 2004, Federal Register, (Volume 69, Number 124).

baseline emissions. The following table shows a range of cost-effectiveness estimates for various engine replacement scenarios. The lower end of the range is typically a larger engine in the category with a 75% capacity factor ad the high end is a small engine with a 25%capacity.[4]

Scenario	C/E Range
Reduce uncontrolled rich burn engine by 80%	$187-$4,154
Reduce uncontrolled lean burn engine by 70%	$291-$3,899
Replace Tier 1 diesel engine with Tier 4 engine	$367-$3,106
Replace Tier 2 diesel engine with Tier 4 engine	$538-$5,029

COMMENTS

This control measure relies on the phase-in of newer cleaner engines as they become available, and as older engines are retired. This approach requires a number of years to implement and neither option would be fully effective in 2009. In July of 2005 EPA proposed a revised performance standard for stationary diesel engines that will result in the same type of phase in program as discussed above, though the implementation schedule will extend well beyond 2010.[5]

SUMMARY OF RESULTS: NOx

Measure #	Name	Description	Affected Sources	Affected Emissions (tpd)	Expected Emissions Reduction		Est. Cost Effectiveness ($/ton)
					%	tpd	
	Stationary IC Engines	Replace engines with lower emitting units	Manufacturing, schools, universities	7.6	70-90%	6.29tpd	$187-$5,100

REFERENCES

(See footnotes.)

[4] Appendix C, Preliminary Cost Effectiveness Analysis for Rule 4702, March 24, 2005, San Joaquin Valley Air Pollution Control District.

[5] 40 CFR Parts 60, 85, 89, 94, 1039, 1065 and 1068 [OAR–2005–0029, FRL–7934–4] RIN 2060–AM82, Standards of Performance for Stationary Compression Ignition
Internal Combustion Engines, July 11, 2005, Federal Register, Vol. 70, No. 131.