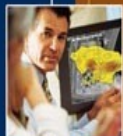


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Controlling NOx Emissions

REGFORM Air Seminar

October 9, 2008

Meredith Springs, PE



Introduction

- Why NO_x control is needed
- How NO_x is controlled
- Regulatory requirements for NO_x

Regulatory Drivers

- Ozone & PM2.5 NAAQS Standards
 - ◆ 0.08 ppm ozone standard
 - Currently working on RACT
 - No major changes to NOx control
 - ◆ 0.075 ppm ozone standard
 - Draft nonattainment areas in MO
 - RACT around 2013
 - Likely require NOx control
 - ◆ Draft nonattainment areas for 24 hour PM2.5 standards issued by EPA



Keys to Control

- Time
- Temperature
- Oxygen

Methods of Control (1/3)

- Reducing peak temperature
 - ◆ Lower combustion temperature = less NO_x formation
 - ◆ Techniques
 - Fuel rich or lean mixture
 - Injection of flue gas/water/steam
 - ◆ Controls
 - Flue gas recirculation (FGR)
 - Off-stoichiometric combustion
 - Low NO_x burners
 - Water/steam injection
 - Catalytic combustion

Methods of Control (2/3)

- Reducing residence time at peak temperature
 - ◆ Reduced residence time = less NO_x formation
 - ◆ Air/fuel/steam injection
- Chemical reduction of NO_x
 - ◆ Remove oxygen from NO_x
 - ◆ Controls
 - Low NO_x burners
 - Selective catalytic reduction (SCR)
 - Selective noncatalytic reduction (SNCR)

Methods of Control (3/3)

- Oxidation of NO_x with adsorption
- Removal of nitrogen
 - ◆ Remove nitrogen from reaction
 - ◆ Controls
 - Use of oxygen instead of air
 - Ultra-low nitrogen fuel
- Use of sorbent
- Combination

NOx Control Requirements from Other Agencies (1/4)

- South Coast Air Quality Management District (Southern California)
 - ◆ Rule 1146 – Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters
 - Boilers, steam generators, and process heaters ≥ 5 MMBTU/hr
 - Original limits
 - ◆ > 40 MMBtu/hr w/ $> 25\%$ annual capacity burning gaseous and/or non-gaseous fuels = 0.036 lb/MMBtu
 - ◆ ≥ 5 MMBtu/hr but < 40 MMBtu/hr burning gaseous and/or non-gaseous fuels = 0.052 lb/MMBtu
 - After 1/1/02
 - ◆ ≥ 5 MMBtu/hr but < 10 MMBtu/hr = 0.036 lb/MMBtu

NOx Control Requirements from Other Agencies (2/4)

- Texas Commission on Environmental Quality (TCEQ)
 - ◆ 30 TAC 117.410 – Emission Specifications for Eight-Hour Attainment Demonstration
 - Gas-fired stationary, RICE 300 hp or greater
 - ◆ Lean-burn engines = 2.0 g/hp-hr
 - ◆ Rich-burn engines = 2.0 g/hp-hr (if installed prior to 1/1/00) or 0.5 g/hp-hr (if installed or modified after 1/1/00)
 - Gas-fired boilers
 - ◆ ≥ 100 MMBtu/hr = 0.020 lb/MMBtu
 - ◆ > 40 MMBtu/hr but < 100 MMBtu/hr = 0.030 lb/MMBtu
 - ◆ < 40 MMBtu/hr = 0.036 lb/MMBtu
 - Liquid-fired boilers
 - ◆ 2.0 lb/mgal
 - Process heaters
 - ◆ ≥ 40 MMBtu/hr = 0.025 lb/MMBtu
 - ◆ < 40 MMBtu/hr = 0.036 lb/MMBtu

NOx Control Requirements from Other Agencies (3/4)

- Illinois Environmental Protection Agency (IEPA)

SUMMARY OF NO_x RULE EMISSION LIMITS FOR PROCESS HEATERS

FUEL	TYPE	PROPOSED EMISSION LIMIT (lbs/mmBtu)		
		7/30/07	12/18/07	Before IPCB
Natural Gas or Other Gaseous Fuels	>100 mmBtu/hr (had been \geq 100 mmBtu/hr)	0.07	0.07	0.07
	\leq 100 mmBtu/hr (had been \geq 50 but < 100 mmBtu/hr)	Combustion tuning for \geq 50 mmBtu/hr	Combustion tuning	Combustion tuning
Residual Fuel Oil	>100 mmBtu/hr, natural draft (had been \geq 100 mmBtu/hr)	0.10	0.10	0.10
	>100 mmBtu/hr, mechanical draft, (had been \geq 50 but < 100 mmBtu/hr)	0.15	0.15	0.15
	\leq 100 mmBtu/hr (had been \geq 50 but < 100 mmBtu/hr)	Combustion tuning for \geq 50 mmBtu/hr	Combustion tuning	Combustion tuning
Other Liquid Fuels	>100 mmBtu/hr, natural draft (had been \geq 100 mmBtu/hr)	0.05	0.05	0.05
	>100 mmBtu/hr, mechanical draft, (had been \geq 50 but < 100 mmBtu/hr)	0.08	0.08	0.08
	\leq 100 mmBtu/hr (had been \geq 50 but < 100 mmBtu/hr)	Combustion tuning for \geq 50 mmBtu/hr	Combustion tuning	Combustion tuning

NOx Control Requirements from Other Agencies (4/4)

SUMMARY OF NO_x RULE EMISSION LIMITS FOR INDUSTRIAL BOILERS

FUEL	TYPE	PROPOSED EMISSION LIMIT (lbs/mmBtu)		
		7/30/07	12/18/07	Before IPCB
Natural Gas or Other Gaseous Fuels	>100 mmBtu/hr (had been ≥ 100 mmBtu/hr)	0.06	0.08	0.08
	≤100 mmBtu/hr (had been ≥ 50 but < 100 mmBtu/hr)	Combustion tuning for ≥ 50 mmBtu/hr	Combustion tuning	Combustion tuning
	Auxiliary boiler at EGU, oil or natural gas, ≤250 mmBtu/hr, ≤20% capacity factor	0.06	Combustion tuning	Same as other boilers
Distillate Fuel Oil (had originally been mislabeled as residual oil)	>100 mmBtu/hr (had been ≥100 mmBtu/hr)	0.06	0.10	0.10
	≤100 mmBtu/hr (had been ≥50 but < 100 mmBtu/hr)	Combustion tuning for ≥ 50 mmBtu/hr	Combustion tuning	Combustion tuning
	Auxiliary boiler at EGU, oil or natural gas, ≤250 mmBtu/hr, ≤20% capacity factor	0.06	Combustion tuning	Same as other boilers
Other Liquid Fuels	>100 mmBtu/hr (had been ≥ 100 mmBtu/hr)	0.10	0.15	0.15
	≤100 mmBtu/hr (had been ≥50 but < 100 mmBtu/hr)	Combustion tuning for ≥50 mmBtu/hr	Combustion tuning	Combustion tuning
	Auxiliary boiler at EGU, oil or natural gas, ≤250 mmBtu/hr, ≤20% capacity factor	0.10	0.15	Same as other boilers
Solid Fuel	>100 mmBtu/hr (circulating fluidized bed)	0.08	0.10	0.10
	>250 mmBtu/hr	0.14 (wall)	0.18	0.18
		0.12 (tangential)		
		0.22 (stoker)		
	>100 mmBtu/hr, ≤250 mmBtu/hr	0.14 (wall)	0.25	0.25
0.12 (tangential) 0.22 (stoker)				
≤100 mmBtu/hr (had been ≥50 but < 100 mmBtu/hr)	Combustion tuning for ≥50 mmBtu/hr	Combustion tuning	Combustion tuning	

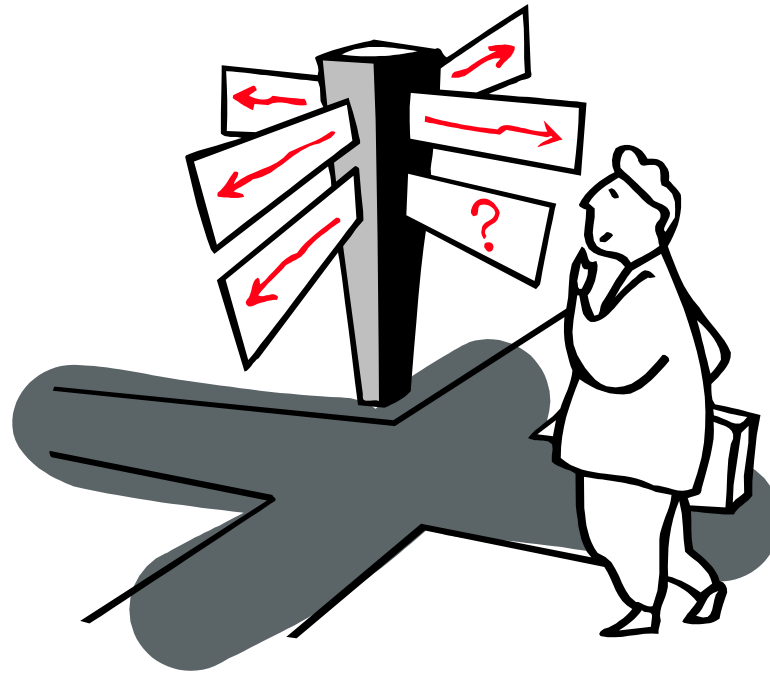
Missouri's Requirements (1/2)

- DRAFT – 10 CSR 10-6.390 Control of NO_x Emissions from Large Stationary Internal Combustion Engines
 - ◆ Currently in comment until 11/7/08
 - ◆ Potentially applicable to units greater than 1300 hp that emitted > 1 tpy NO_x during 1995-1997 ozone season or began operation after 9/30/97

Missouri's Requirements (2/2)

- Units beginning operation after 9/30/97
 - ◆ Rich-burn SI units = 3.0 g/hp-hr
 - ◆ Lean-burn SI units = 3.0 g/hp-hr
 - ◆ Diesel engines = 2.3 g/hp-hr
 - ◆ Dual fuel engines = 1.5 g/hp-hr

Questions?



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