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Review of Nitrogen Oxides (NOx) Removal Techniques in Industrial Flue Gas

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PURPOSE OF THE ABSTRACT

Review of Nitrogen Oxides (NOx) Removal Techniques in Large Flue Gas Flows
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Nitric oxide (NO) and nitrogen dioxide (NO2) are together referred to as nitrogen oxides (NOx). NOx contribute to acid deposition and eutrophication which, in turn, can lead to potential changes occurring in soil and water quality. The subsequent impacts of acid deposition can be significant, including adverse effects on aquatic ecosystems in rivers and lakes and damage to forests, crops and other vegetation. Such anthropogenic eutrophication with nitrogen as nutrient can lead to severe reductions in water quality with subsequent impacts including decreased biodiversity, changes in species composition and dominance, and toxicity effects.
NO2 is associated with adverse effects on human health, as it can cause inflammation of the airways at high concentrations. It also contributes to the formation of secondary particulate aerosols and plays the role of catalyzer between CO and O2 to form tropospheric ozone (O3) in the atmosphere. Both are important air pollutants due to their adverse impacts on human health. Therefore NOx discharge regulations are straitening globally.
Combustion is the dominant source of NOx generation. The emissions are dependent on the amount of nitrogen in the fuel and on the air-fuel mix ratio. High temperatures and oxidation-rich conditions generally favor NOx formation in combustion. But once the combustion is fine-tuned, the only solution to further reduce NOx emissions is to treat the flue gas.
Road transportation accounts for almost 50% of the NOx emissions. Other significant sources of NOx are electricity production, energy use in industry production, industrial processes and marine transport. The present article intends reviewing the different techniques for NOx elimination from these processes where large flue gas flows can be treated. These techniques are:

- Selective Non-Catalytic Reduction (SNCR) where ammonia is injected into the flue gas and converts NOx into nitrogen and water as per 4 NO + 4NH3 + O2 ? 4N2 + 6H2O and NO + NO2 +2NH3 ? 2N2 + 3H2O
- Selective Catalytic Reduction (SCR) involves the same reactions but a lower temperature thanks to the use of a catalyst (usually vanadium or tungsten oxide)
- Oxidation with ozone or chlorine dioxide where NO and NO2 are oxidized to dinitrogen pentoxide N2O5, as per NO + O3 ? NO2 + O2 and 2NO2 + O3 ? N2O5 + O2, which is soluble and removed in a wet scrubber as per N2O5 + H2O ? 2HNO3

The article highlights information on NOx removal efficiency, design and operating conditions including insights on economics aspects.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
NOx | ozone | air pollution | nitrogen oxides

BIBLIOGRAPHY