4.4 NITROUS OXIDE EMISSIONS FROM COMBUSTION AND INDUSTRIAL SOURCES

4.4.1 NITROUS OXIDE ABATEMENT TECHNOLOGIES FOR NITRIC ACID PRODUCTION

Technology Description

Nitric acid (HNO_3) is an inorganic compound used primarily to make synthetic commercial fertilizer. As a raw material, it also is used for the production of adipic acid and explosives, metal etching, and in the processing of ferrous metals. Plants making adipic acid used to be high emitters of nitrous oxide (N_2O), but now that adipic acid plants in the United States have implemented nitrous oxide abatement technologies, nitric acid production itself is the largest industrial source of N_2O emissions. The nitric acid industry currently controls NO_x emissions using both nonselective catalytic reduction (nonselective catalytic reduction) and selective catalytic reduction (selective catalytic reduction) technologies to reduce N_2O to elemental nitrogen. While nonselective catalytic reduction is more effective than selective catalytic reduction at controlling N_2O, nonselective catalytic reduction units are not generally preferred in today's plants because of high-energy costs and associated high gas temperatures. Only 20% of nitric acid plants use nonselective catalytic reduction today. Additional research is needed to develop new catalysts that reduce N_2O with greater efficiency, and to improve nonselective catalytic reduction technology to make it a preferable alternative to selective catalytic reduction and other control options.

Nitric-acid plant controls for NO_x using both nonselective catalytic reduction and selective catalytic reduction technologies. Nonselective catalytic reduction is very effective at controlling N_2O.

System Concepts

- Nonselective catalytic reduction uses a fuel and a catalyst to consume free oxygen in the tail gas and convert NO_x to elemental nitrogen (Chartier, 1999). Nonselective catalytic reduction can reduce N_2O emissions by 80%-90%. (IPCC, 2000)

Representative Technologies

- The gas from the NO_x abatement is passed through a gas expander for energy recovery. Nonselective catalytic reduction units produce stack gases in the 1,000°F to 1,100°F range that require more exotic materials for constructing the expander and have higher maintenance costs.

Technology Status/Applications

- Virtually all of the nitric acid produced in the United States is manufactured by the catalytic oxidation of ammonia (EPA, 1991). During this reaction, N_2O is formed as a byproduct and is released from reactor vents to the atmosphere. While the waste gas stream may be cleaned of other pollutants – such as nitrogen dioxide – there are currently no control measures aimed at specifically eliminating N_2O emissions.

Current Research, Development, and Demonstration

RD&D Goals

- RD&D goals are focused on the catalysts used to convert NO_x into elemental nitrogen.

RD&D Challenges

- The use of a catalyst that can reduce a higher percentage of N_2O emissions is not the focus of the current research. The technology is primarily implemented in order to reduce NO_x emissions, not as an N_2O emission-reduction technology.
- Develop catalysts that reduce N_2O to elemental nitrogen with greater efficiency.

- Promote the use of nonselective catalytic reduction over other NO_x control options such as selective catalytic reduction and extended absorption.

RD&D Activities

- Information on R&D activities to develop new catalysts for nonselective catalytic reduction technologies is unavailable. To date, RD&D expenditures have been made by the industry. Estimates of future expenditures by the industry are not available.

Recent Progress

- Currently, the nitric acid industry controls for NO_x using both nonselective catalytic reduction and selective catalytic reduction technologies. Nonselective catalytic reduction is very effective at controlling N_2O, while selective catalytic reduction can actually increase N_2O emissions. Nonselective catalytic reduction units are generally not preferred in modern plants because of high energy costs and associated high gas temperatures. Only 20% of nitric acid plants use nonselective catalytic reduction.

Commercialization and Deployment Activities

- Nonselective catalytic reduction units were widely installed in nitric acid plants built between 1971 and 1977. It is estimated that approximately 20% of nitric acid plants use nonselective catalytic reduction (Choe, et al., 1993). Information on the status of the commercial development of nonselective catalytic reduction catalysts is not currently available, however.

Market Context

- Approximately 80% of current plants do not employ nonselective catalytic reduction, but instead use selective catalytic reduction or extended absorption units, neither of which are known to reduce N_2O emissions. Research is underway into materials for catalysts that are applicable for N_2O control in nitric acid plants that do not employ nonselective catalytic reduction. Nitrous oxide emissions from nitric acid production will be influenced by the degree and type of NO_x emission control efforts that are applied in both new and existing nitric acid plants.