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Low-temperature nitrous oxide removal in the nitric acid industry

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The fertilizer industry is a major industrial source for nitrous oxide (N_2O). The global N_2O emission from the nitric acid industry is approx. 35 MMTCE. The emission is concentrated in a relatively small number of plants (compared to the very diffuse N_2O emission from agriculture), which makes treatment a promising option for reduction of greenhouse gas emissions.

Several techniques are being developed for N_2O abatement in nitric acid plants. A market analysis has been carried out and cost efficiencies of several techniques have been compared. Two techniques have been identified as very promising. The first, decomposition at 800 - 1000°C inside the ammonia burner, is currently being tested on full scale. This paper focuses on the second technique: N_2O abatement in the tail gases of nitric acid plants. The main advantage of placing the N_2O abatement system downstream the NO_x absorption unit is that the risks of production losses and contamination of the end product (ammonium nitrate based fertilizers) are eliminated.

The temperature of the tail gases of a nitric acid plant varies between 250 and 500 °C. For high-temperature plants direct decomposition catalysts are currently being tested on commercial scale. Direct decomposition is potentially a very cost effective N_2O abatement technique: costs are 0.5 - 2 € per ton CO_2-equivalents removed. It is however only possible in plants with a temperature of 400 °C and higher. ECN and Delft University developed a catalyst that decomposes N_2O at temperatures between 350 °C and 500 °C. This not only broadens the number of plants in which N_2O decomposition can be applied, but also improves cost efficiency for high-temperature plants.

For plants with a lower temperature, ECN developed a catalyst for the reduction of N_2O with hydrocarbons (propane/LPG or natural gas). The costs of the reducing agent result in somewhat higher costs: 1.5 - 4 € per ton CO_2-equivalents removed. A means to improve the overall cost efficiency is the combination of the reduction of N_2O with NO_x abatement in a single reactor. Especially the use of methane as a reducing agent for both NO_x and N_2O is a promising option.