

SELECTIVE CATALYTIC REDUCTION OF NITRIC OXIDE AT LOW TEMPERATURES FROM STATIONARY SOURCE EMISSIONS

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In developing higher efficiency catalysts for NO_x abatement from stationary emission sources utilizing selective catalytic reduction (SCR) under lower temperature conditions than currently employed, protocol test conditions have been established that approximate *real* operating conditions. Removal of NO_x from flue gas at low temperatures (<200°C) has advantages over high temperature operation, including placement of the catalyst after the electrostatic precipitator (ESP) unit so that the partially cleaned gas needs less soot blowing and catalyst cleaning and provides for longer catalyst lifetime. New low temperature catalysts would also be capable of retrofitting large utility boilers, especially hybrid systems that utilize high temperature SNCR as the first stage of the NO removal process, and would be applicable to many other industries in which NO removal from exhaust gases is required.

The catalysts for SCR must be active and stable in the presence of water and sulfur dioxide. It is noted that operating conditions will be fuel-dependent since the concentrations of NO, O₂, CO₂, H₂O, and SO₂ in the flue gas are different when coal is used as compared with the use of natural gas or oil as the fuel. In developing low temperature catalysts, protocol test conditions have been established. For example, a standard test for a catalyst to be used with flue gas from a coal-fired electric utility plants consists of using a gas mixture of 400 ppm NO, 5% O₂, 13% CO₂, 8% H₂O, and 400 ppm SO₂ (and balance of N₂ with overall gas flow (GHSV) of 10,000 hr⁻¹), while flue gas from a plant burning natural gas would contain appreciably more O₂, less NO, and very low SO₂. The laboratory reaction system used for catalyst testing allows for systematic variation of the SO₂ concentration, e.g. in the 0-1600 ppm range, as well as the moisture content, and for testing for periods of days or weeks.

Ammonia is the typical reducing agent employed, but comparisons of NO removal efficiencies using a variety of alternative reductants have been made. While many of the alternative reductants tested do not match the conversion level achieved with NH₃ (at a given constant temperature), all of them alleviate the problems encountered by ammonium bisulfate and ammonium sulfate formation. However, at least one reductant exceeds the performance of the NH₃-based system at low reaction temperatures. At the same time of achieving high NO conversions at low reaction temperatures, the formation of NO₂ in the oxygen-rich environment must not occur and the selectivity toward N₂O formation relative to N₂ should be minimized. Successful catalysts for this SCR process using natural gas and coal as fuels and the reaction engineering needed to achieve optimization have been delineated.