

**ANNUAL PROJECT REPORT
AS OF DECEMBER 1999**

1. Project Sponsor:

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3. OCDO Grant No. OCRC/99-A4.9

4. Project Update X or
Final Report

5. Project Title: Mechanistic Studies during the SCR of NO_x over Novel Catalysts

6. Project Term: From: September 1, 1999 To: August 31, 2000

<u>Budget:</u>	<u>Name</u>	<u>Cost Share</u>
	OCDO	\$75,000
	University of Cincinnati	\$39,489
	TOTAL PROJECT COST	\$114,489

I. ABSTRACT

8. OVERVIEW OF PROJECT & OBJECTIVES:

Since Ohio coals have high sulfur contents, other options must be developed to burn high sulfur coal while economically meeting environmental regulations. Sulfur and nitrogen oxides, along with particulate matter and trace metals, are among the major pollutants that must be removed from flue gas. Moving the DeNO_x unit to the tail end of the treatment process is one economical solution that allows the particulate matter and SO₂ to be removed first, thereby increasing the lifetime of the DeNO_x catalyst. However, moving the DeNO_x unit downstream, where the reaction temperatures are cooler, would require reheating the gas stream using traditional catalysts. Developing a catalyst that operates at lower temperatures would solve this problem. Therefore, the objectives of the project are the identification of a promising catalyst for the selective catalytic reduction of NO at low temperatures using NH₃ as the reductant and the development of a catalyst preparation method that will improve the hydrothermal and SO₂ stability of the catalyst. In addition, mechanistic studies will help to better understand the DeNO_x process at low temperatures.

9. WORK DONE & CONCLUSIONS:

A large number of metals were deposited by a novel solution impregnation method on high BET surface area supports. After *in-situ* calcination in an oxidizing atmosphere, the catalysts were tested for low temperature DeNO_x reactions with NH₃ as reductant in the narrow temperature range of 100°C to 200°C and at a space velocity of 8000 cm³.g⁻¹(cat.).h⁻¹. Some of

the catalysts studied were found to be so active that quantitative performance was achieved at reaction temperatures $\leq 120^{\circ}\text{C}$ with 100% selectivity for N_2 .

From the work performed up to this point, we can make a number of conclusions. First, the choice of an appropriate support and metal oxide(s), in addition to the catalyst preparation method, is paramount to excellent catalytic activity at temperatures as low as 120°C . Second, the high dispersion of metal oxides on the support and its high surface area, coupled with balanced Brönsted/Lewis acidity, are possible reasons for the excellent performance of our catalysts. Finally, the catalyst systems developed perform better than commercial catalyst systems currently in use.

10. PLANS FOR COMING YEAR:

In the next year, a detailed study will be carried out on the role of the metal precursor; novel catalyst preparation methods will be tried over various supports, and the combination of metal oxides will be studied to achieve even better performance than reported here. A detailed characterization of the presently reported catalysts will also be performed simultaneously using techniques such as X-ray Diffraction, Chemisorption, X-ray Photoelectron Spectroscopy, Fourier Transform Infrared Spectroscopy, Raman Spectroscopy, etc. Determining the oxidation state of the active components, the nature of catalytic sites, and the acidity of the catalysts will be the emphasis of the work. All of this information will provide a solid foundation on which to elucidate the reaction mechanism.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. Catalysts were tested for low temperature De NO_x reactions with NH_3 as reductant in the narrow temperature range of 100°C to 200°C and at a space velocity of $8000 \text{ cm}^3 \cdot \text{g}^{-1}(\text{cat.}) \cdot \text{h}^{-1}$. Some of the catalysts studied were found to be so active that quantitative performance was achieved at reaction temperatures $\leq 120^{\circ}\text{C}$ with 100% selectivity for N_2 . The catalyst system that has been developed is so promising that an Invention Disclosure was filed on December 20, 1999.

III. ARTICLES/PRESENTATIONS