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DOE/PC/91343-T5Contract Numbers:

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Project Title:**IGR NO_x/SO_x
Control Technology**Reporting Period:

January 1, to March 31, 1994

Due Date:

April 30, 1994

Contractor Name:**IGR Enterprises**
11000 Cedar Avenue
Cleveland, Ohio 44106
(216) 721-5511Project Start:

September 25, 1992

Project Completion:

September 24, 1997

Approach Changes:

None

MASTER**IGR**

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Performance Variances,
Accomplishments, or Problems:

SUMMARY

During the first quarter of 1994, progress was made in several areas critical to the IGR NO_x/SO_x control technology. Work was conducted on an approach to the development of electrocatalyst materials that improve the electrical efficiency required for economical NO_x/SO_x destruction. Improved efficiencies are required for cost-effective NO_x/SO_x destruction. In conjunction with the above work, improved preparation methods were developed.

During this term NO_x destruction was quantified between 450°C and 550°C . NO_x destruction was obtained in *oxygen levels of up to 5.7%* at these temperatures.

Significant progress was additionally made in the field of SO₂ removal. Up to 75% SO₂ removal was achieved in 5.7% O₂ at 550°C. In accordance with IGR's planned research strategy IGR used the excellent prior experimental results achieved for NO_x removal as the technical basis to study SO₂ removal.

DISCUSSION

A. *ELECTROCATALYST PREPARATION*

Task 2 of the Statement of Work addresses the preparation of a suitable electrocatalytic surface for the stabilized ceramic electrolyte. The electrocatalytic surface is prepared by applying a electrocatalytic pre-mixture to the ceramic surface and heating until the electrocatalytic material is sintered to the ceramic surface.

This quarter IGR looked at a family of electrocatalyst systems in an attempt to lower the temperature of operation and to decrease both the voltage and amperage requirements for NO_x/SO_x reduction.

All electrocatalysts were applied via a sol gel. Approximate ranges and ratios for some of the mixed metal oxide components were determined. Ranges were determined by comparing oxygen tolerance, NO_x removal and power consumption. Multiple coats were applied for all electrocatalytic formulations. It is believed that by increasing the number of coats of the catalyst there will be an increased number of active sites available for the destruction of NO_x or SO_x which should lead to increased efficiency. A point raised by the above work is that small variations in composition can have a significant effect on performance.

B. *NITROGEN OXIDE (NO) DESTRUCTION*

Approximately 20 different samples were tested at various temperatures, oxygen levels and applied voltages over the last quarter. An additional 20 samples were prepared and discarded due to problems in processing. Test temperatures were varied from 425°C to 550°C. Oxygen levels were varied from 0.9% to 5.7%. Applied voltages were varied from 0.1v to 2.5v.

Initial testing involved a base electrocatalyst composition where the concentrations of the electrocatalyst components on the electrolyte surface were varied. As the concentration of the electrocatalysts increased the amount of NO_x removal in oxygen levels up to 5.7% increased to greater than 75% (removal). The applied voltage and the temperature where NO_x could be removed also decreased with increasing amounts of the electrocatalyst. Figure 1 is a plot of voltage reduction for this series of tests.

Based on these (excellent) results the formulation methods for the electrocatalysts were modified to expedite the manufacture and testing of samples. These samples were retested with oxygen levels up to 5.7% and temperatures as low as 425°C. Significant NO_x removal was noted.

During portions of this work there were some mechanical and electrical problems with the FT-IR gas analyzer. The instrument was overnight shipped to the manufacturer and

repaired (under warrantee). It is currently fully calibrated and operational on our test bench.

Additional testing involved varying the metal ion molar ratio of two of the components in the basic electrocatalyst. The first electrocatalyst of this series was able to effectively remove up to 70% of the NO_x with oxygen present but higher voltages were required as the oxygen level was increased. Changing the component ratio further increased the sensitivity of the electrocatalyst to oxygen and decreased its ability to efficiently remove NO_x. In addition this electrocatalyst appeared to be insensitivity to applied voltage, i.e. increasing voltage did not increase NO_x removal. These results show strong composition dependence of the electrocatalyst.

C. *SULFUR DIOXIDE (SO₂) DESTRUCTION*

Using the knowledge and experience gained from the NO_x work experiments were run determining SO₂ destruction as a function of oxygen level, temperature and power. *At 550°C up to 75% of the SO₂ was removed from gas streams containing 5.7% oxygen.*

Coal burning utility power plants typically contain 2-6% oxygen in their flue gas. During this contract IGR has, to date, been able to extend the "oxygen tolerance" of its Process from below the commercially acceptable range to fully include the

range of oxygen levels found in coal burning power plants. Using the same electrocatalyst system at 450°C SO_2 removal was decreased to 50% and at 425°C SO_2 removal was 40%. Power consumption was higher than is acceptable in all cases.

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Open Items: None

Status Assessment & Forecast:

Based on the above results work will continue on the electrocatalyst development and testing. In particular efforts will be directed towards lowering the electrical power requirements of the Process state-of-the-art.

FIGURES

Figure 1

NOTES

DATE

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7/27/94

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