DEMONSTRATION OF A NEW EMISSION CONTROL SYSTEM FOR STATIONARY DIESEL AND NAURAL GAS FIRED ENGINES

Final Report

Prepared for the
California Air Resources Board

by
Sorbent Technologies Corporation

March 2004

Innovative Clean Air Technologies Program

Grant No. ICAT00-3

NON-CONFIDENTIAL

ICAT FINAL REPORT EXECUTIVE SUMMARY

Date of Report:	March 31, 2004
Contract Number:	ICAT-00-3
Title:	**Demonstration of a New Emission Control System for Stationary Diesel and Natural Gas Engines**
Principal Investigator:	Brian W. Nelson, Ph.D.
Company:	**Sorbent Technologies Corporation**
ARB Contacts:	Kevin Cleary
Project Period:	March 1, 2001 -- January 31, 2004
Research Category:	Diesel Engine NOx After-Treatment Technology

Project Description:

Diesel engines are used extensively today as power sources for small- and medium-size applications. They will continue to be used extensively in the future because of their durability, low cost and high efficiency. The environmental benefits of using modern diesel engines for power generation include low carbon dioxide and hydrocarbon emissions. Unfortunately, diesel engines produce large amounts of nitrogen oxides (NOx) and particulate matter.

A new technology, Selective NOx Recirculation (SNR), was developed by Sorbent Technologies Corporation specifically for controlling diesel NOx emissions. It is the result of seven years of R&D. Originally, the technology was developed for controlling pollution from sources other than diesel engines. These applications were for larger installations, and ones that do not require constant, unmanned operation. The goal of this project was to improve and adapt the new technology to operate on stationary diesel engine exhaust gases.

This project successfully demonstrated SNR as an easily-retrofitable, cost-effective NOx-control technology for stationary heavy-duty diesel engines. The technology utilizes a special carbon-based sulfur-tolerant, high-capacity, NOx-selective sorbent material to adsorb the pollutants out of the exhaust gas stream, and then directs a concentrated NOx desorption stream to a NOx decomposition system that converts the pollutant into nitrogen and oxygen.

With SNR, the exhaust NOx is adsorbed at low-temperatures so the unit can be straightforwardly retrofitted at the very end of the diesel exhaust train. A catalytic particulate trap installed somewhere upstream of the NOx filter protects the adsorbent filter while significantly reducing the diesel particulate emissions. This simple, innovative scheme uses no consumables and little energy from outside. It can be applied generically to any new or retrofitted NOx-emission source and is capable of 80% NOx reductions.

The work in this project was performed by Sorbent Technologies Corporation, the technology developer, and The Pennsylvania State University's Energy Institute, as a subcontractor. Testing of the new technology was conducted at Sorbent Technologies' laboratory in Twinsburg, Ohio, at Pennsylvania State University's Diesel Combustion & Emission Laboratory, and at a field demonstration site at Hans Hilleby Farm in Woodland, California.

Summary of Findings:

The objectives of the ICAT program were met. Based on data from experiments conducted during the project, a system for reducing the NOx emissions from diesel-fired and natural gas-fired engines by up to 80% has been designed. Specifically:

- The carbon-based NOx filtration material was shown to be capable of being made into monolithic cartridges for space-efficient utilization with high NOx removal efficiency, reasonable pressure drops, and reasonable structural strength.

- These NOx filter cartridges were shown to effectively adsorb NOx from actual diesel exhaust gases when the gas temperature is below about 130ºF and desorb the NOx when the material temperature is elevated to above 230ºF. This phenomenon occurs no matter which chemical form the NOx is in when it is adsorbed, NO or NO_2.

- Components of the NOx filtration system were miniaturized to the extent that they can be packaged on a small skid for easy installation.

- Electric resistance (Joule) heating of the sorbent beds was found to be an effective method for directly heating the solid sorbent material when it is formed into a monolithic cartridge. The cartridges were found to effectively act as an electric resistor, converting electrical energy into heat energy. However, the cartridges with the chemical composition most effective in physical tests had a electrical resistance that was much lower than that of other cartridges. The potential for optimizing the electrical properties of the adsorbent cartridges should be examined further.

- Commercial ejector pumps were found to be effective at removing the NOx from the sorbent cartridges. Ejector pumps, which operate on the principle of aspiration using a high-velocity stream of compressed air, were able to draw up to a -6.5 psi vacuum on the sorber chamber. Leakage of air through the valves that closed off the chamber was the limiting factor in the amount of vacuum that could be applied. However, the vacuum that was achieved was found to be sufficient to regenerate the sorbent cartridges.

- Consistently greater than 80% NOx decomposition could be achieved under certain conditions. However, the decomposition process may need to be optimized in each individual application.

Conclusions:

The SNR technology was successfully demonstrated as an integrated system at a commercial scale for stationary diesel engines. Up to 80% NOx removal and decomposition and 95% particulate removal was achieved. The next step in commercializing the technology is to build several prototype systems and run them in different applications for certification and commercial demonstration.

Publications: No publications have yet been made, owing to the potential patentability of the discoveries made during the project.

Commercialization Keywords: smog; ozone; NOx; particulate emissions, diesel engines; stationary sources