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High Gas Flux and Chemically Resistant Membranes

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program and collaboration with major industrial gas companies and major diesel engine manufacturers, Compact Membrane Systems, Inc. (CMS), has developed high gas flux and chemically resistant membranes. Membrane module flux is sufficiently high that modules can be placed under the hood of diesel engines to produce nitrogen-enriched air (NEA) to reduce nitrogen oxide (NO_x) emissions by 50 percent. Environmental regulations are requiring major diesel engine NO_x reductions in the 2006-2007 time frame. CMS' membrane modules offer a timely alternative to existing hot and corrosive exhaust gas recirculation technologies.

CMS membranes are ideally suited in that they can simply be placed between the diesel turbo charger/after cooler and the engine. A small amount of oxygen-enriched air permeates the membrane, leaving highpressure NEA behind to be fed directly to the engine.

Using SBIR funds and, subsequently, collaborations with an industrial gas partner and major diesel manufacturer, CMS successfully has improved membrane performance towards meeting flux, size, ruggedness, and power-consumption needs. Multi-point operation on commercial large-size engines verified NO_x reduction levels. Membrane performance was not affected during lengthy truck tests. Simultaneous with 50 percent NO_x reduction, minimal changes in soot, particulate, hydrocarbons, or CO emissions were observed.

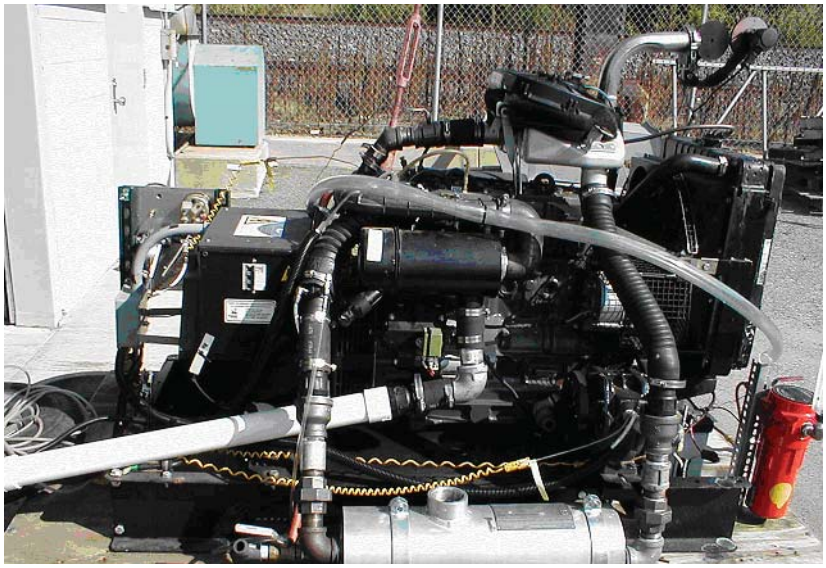
SIGNIFICANCE OF THE TECHNOLOGY

This NEA membrane technology is a broad new membrane platform. The CMS NEA membrane technology allows, for the first time, sufficient productivity for mobile applications and an ability to supply low-cost nitrogen up to 93 percent NEA in small- and large-volume applications. Costs are projected to be significantly less than for other conventional forms of nitrogen enrichment techniques (e.g., cryogenics, pressure swing absorption) for both large and small facilities.

Diesel engines, which run with excess oxygen (run lean), produce high levels of nitric oxide or NO_x and particulate matter (PM). This excess NO_x is a major limitation to broad utilization of diesel engines and the associated enhanced fuel economy of U.S. vehicles. The EPA has mandated that NO_x and PM emissions from diesel trucks be reduced by approximately 90 percent. Exhaust emissions consisting of nitrogen oxide(NO) and small amounts of nitrogen dioxide (NO_2) from internal combustion engines present a serious environmental problem. Although the problem exists for both gasoline and diesel engines,

SBIR Impact

- **CMS' membrane system provides a clean, cool, high-productivity, low-cost system to supply NEA to reduce NO_x emissions by 50 percent.**
- **Compared to the existing NO_x reduction technology, exhaust gas recycle, CMS membranes are much cleaner, which should improve engine life, and they do not require cooling.**
- **In addition to diesel engines, the CMS system is ideally suited for retrofitting diesel generators for NO_x reduction.**
- **The NO_x reduction capability of CMS' membranes has been shown to be of value for engines (discussed above) and furnaces as well. This is timely with EPA regulations coming into force on electrical power plants and other large furnaces.**



This 1.9 L Lister Direct Injection engine, which operates at 8 psi turbo boost and has an output of 35 Hp at 1,800 rpm (55 Hp at 3,000 rpm), uses one 6" x 20" cylindrical membrane module to reduce NO_x emissions by 50 percent with no significant change in soot, particulate, hydrocarbon, or CO emissions.

one-third of all NO_x emissions in the Northeast United States come from heavy-duty diesel truck engines.

Consumption of diesel fuel and gasoline have led to significant dependence on foreign fuel and increased carbon dioxide emissions as well as the associated concern for global warming. Diesel engines are much more fuel efficient than spark/gasoline engines, but diesel engines produce high NO_x emissions. Exhaust gas recycle, while lowering NO_x emissions by 50 percent, reduces engine life and puts significant stress on the cooling system.

COMMERCIALIZATION SUCCESS

CMS, working with EPA SBIR funds and subsequently with a large industrial gas partner, is focusing its activity on two commercial areas. The first is on-road large-scale diesel engines that require large NO_x reductions as part of the 2007 Tier III specifications (several systems have been installed on commercial diesel trucks over an extended time frame and performance has been verified). The second area is retrofitting diesel generators to reduce NO_x emissions.

AWARDS AND COMPANY HISTORY

CMS received the Tibbetts Award for Outstanding Small Business in the State of Delaware in 1998 and 2000. The award is given by the Small Business Administration to firms judged to exemplify the best in small business innovation and research. Founded in 1993, CMS has a growing patent portfolio due to its successful track record of obtaining research grants. CMS is a membrane technology company engaged in research and development of fluoropolymer membranes and thin films with exceptional gas transport properties and chemical resistance.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit http://www.epa.gov/ncer/sbir.