Alternative FUELS IN TRUCKING

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CAN ETHANOL PLAY A ROLE IN HEAVY-DUTY APPLICATIONS ?

by Todd C. Sneller, Administrator, Nebraska Ethanol Board

The Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992 present fleet managers with both an opportunity and a challenge. The challenge is to meet new fleet requirements with evolving heavy-duty technology based on alternative fuels. The opportunity is to play an active role in demonstrating new engine technology that can help reduce mobile source pollution. Fleet managers, constantly under pressure to control costs and maximize efficiency, face many options as they evaluate means of complying with new fleet regulations. One such option is the use of ethanol in heavy-duty applications.

Why ethanol ?

During evaluations of available alternatives for heavy-duty applications, fleet managers have raised cost and efficiency issues. New data being published by the Alternative Fuels Data Center show that heavy-duty vehicles using E-95 (95% ethanol/ 5% gasoline) have virtually the same fuel economy on an energy-equivalent basis as control vehicles using diesel. As part of the Alternative Motor Fuels Act demonstration program, analysts have collected data on fuel economy, including data on in-use testing of alternative fuels against a diesel control fleet. They have gathered the initial E-95 data from four line-haul trucks that had had an average fuel economy of 5.3 miles per equivalent gallon. The fuel economy was averaged over 10 consecutive refuelings. The trucks were powered by the Detroit Diesel Corporation's 6V92 compression ignition engine and have been in continuous service since 1992.

Fleet managers interested in the ethanol option will be pleased to note that heavy-duty application experience is being gained in Nebraska, Wisconsin and Illinois. Heavy-duty applications in Nebraska, conducted in cooperation with the ATA Foundation's Trucking Research Institute, will include snow removal and road construction assignments. The Trucking Research Institute is also gathering additional in-use data in Hennepin County, Minnesota. As these data are accumulated, confidence about maintenance, reliability, and safety issues will likely enhance the ethanol option among fleet managers.

Current examination of fueling infrastructure shows that ethanol may also provide a competitive advantage, because conventional fuel dispensers can be used for the storage and dispensing of E-95 at fleet terminals. The widespread availability of ethanol at terminals and bulk plants will assure a ready supply. Refueling with ethanol is done in the same manner as refueling with diesel fuel. No additional safety precautions or time requirements are needed. And, in many locations, the current cost of E-95 is comparable to diesel fuel. Fleet managers are familiar with these elements of the ethanol option, so potential implementation problems should be minimized.

As fleet managers evaluate options for complying with new fleet regulations, analysts are gathering additional information to supplement the initial performance of E-95-fueled heavy-duty equipment. Emissions evaluation is an important component of the Department of Energy's Commercial Truck Program's study of alternative fuels. And the issue of heavy-duty vehicle emissions

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METHANOL FOCUS

METHANOL: A CATALYST FOR EMERGING TRANSPORTATION TECHNOLOGIES

by Raymond A. Lewis, President, American Methanol Institute

Methanol is a widely available alternative fuel that has been used on a large scale for a long time. Many associate methanol with the Indianapolis 500, since it has been the fuel of choice for professional auto racers for the last 30 years because of its safety and performance advantages. These benefits will soon be available to the general public as methanol gains acceptance across the country as M-85 (85% methanol/15% gasoline), used in flexible fuel vehicles (FFVs). FFVs are cars that can operate on either M-85 or gasoline, or any combination of the two.

Still another highly promising avenue for methanol use is in powering heavy-duty vehicles such as buses and trucks. Methanol is a clear, liquid fuel made primarily from domestically produced natural gas. In the national effort to improve air quality in the smoggiest cities by reducing toxic emissions, analysts have found methanol to be a leading clean-burning alternative to the more common fuels. And methanol has distinct environmental and practical benefits.

Studies by the Environmental Protection Agency(EPA) and the Department of Energy indicate that methanol-powered vehicles create much less ozone, fewer nitrogen oxides, fewer particulates, and fewer toxic compounds than either gasoline or diesel fuel. At the same time, methanol has been shown to increase engine performance by about 10%.

Because of these advantages, methanol use in government and commercial fleets is increasing. Methanol has a simple molecular structure and contains oxygen; therefore, it is extremely clean-burning when used in diesel engines. In fact, the first clean fuel engine to be certified by the EPA for public use — Detroit Diesel 6V92 — achieves reductions in both particulate and NOx emissions at a level three times greater than the EPA standard. As a result, a growing number of communities are operating methanol-fueled transit school buses and other fleets to meet clean air requirements.

Another edge that methanol has over other fuels is that, as a liquid fuel, its infrastructure requirements are similar to those of gasoline and can be installed more cheaply than those of other options.

In addition to being a factor in converted diesel engines, methanol will be a prominent factor in the development of fuel-cell technology — seen as a solution to the inadequacy of battery power in electric vehicles. Fuel cells make electric current by combining hydrogen with oxygen —with the hydrogen coming from methanol. This next generation of fuel cells will be able to be used in a wide variety of vehicles, providing a driving range similar to conventional vehicles but using about half the energy.

Finally, methanol's potential use in fire trucks, street sweepers, loading equipment, and locomotives, as well as fuel-cell electric buses, illustrates the fuel's diverse heavy-duty applications. With changes in transportation being driven by a multitude of environmental and economic needs, methanol continues to be a catalyst for new technologies that will help define cost-effective, energy-efficient, and environmentally safe vehicles in the future.

***Raymond A. Lewis,** President of the American Methanol Institute since its inception in 1989, spent nearly 25 years in the chemical industry with Hoechst Celanese, managing a broad range of manufacturing, technical, and marketing functions. He served on the California Advisory Board on Air Quality and Fuels, the U.S. Alternative Fuels Council, the Clean Air Act Advisory Committee, and the U.S. Environmental Protection Agency's Clean Fuels Regulatory Negotiation Committee.*

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The aim of **Alternative Fuels in Trucking** is to inform fleet owners and operators, equipment suppliers, government officials, and other interested parties about important developments in the use of alternative fuels in heavy-duty trucks. Suggestions and comments are welcome. Views expressed by guest authors are their own, and not necessarily those of ATAF.

PROJECT PROFILE

DEMONSTRATION OF CATERPILLAR G3406LE NATURAL GAS ENGINE

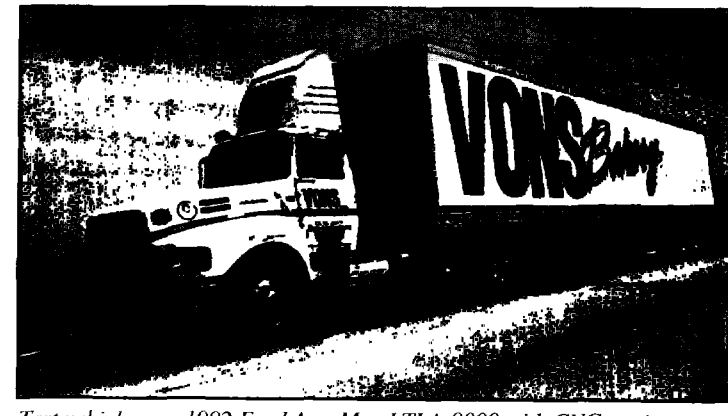
by Henry J. Modetz, Project Manager, Acurex Environmental Corporation

In 1990, the Acurex Environmental Corporation launched a developmental program to introduce engines fueled by compressed natural gas (CNG) in heavy-duty trucks. The project was sponsored by the Southern California Gas Company (SoCalGas); the South Coast Air Quality Management District (SCAQMD); the California Energy Commission (CEC); and the U.S. Department of Energy (DOE), through the National Renewable Energy Laboratory (NREL).

The project objectives were to develop a low-emission CNG-fueled Caterpillar 3406 engine for heavy-duty trucking applications; to integrate the engine into a Class 8 tractor; and to assess the performance, the emissions, and the durability of the engine and test vehicle during a one-year demonstration period.

When the project was started, most natural-gas-engine development efforts focused on transit applications. In fact, only one engine manufacturer, Caterpillar, could provide an engine suitable for demonstration in a heavy-duty truck, a 350-hp Caterpillar 3406B. In modifying the engine for CNG operation, Caterpillar installed new pistons, a new camshaft, a new cylinder head, and special components designed for lean-burn mobile applications. In addition to configuring the engine for a heavy-duty truck, Caterpillar added or replaced several external components and accessories, including a front sump oil pan, an oil-level gauge, an air compressor, a front crank pulley, an electric starter motor, and coolant hoses.

The modified engine, designated as the Caterpillar G3406LE Natural Gas Engine, was then installed in a test vehicle, a 1992 Ford AeroMax LTLA-9000 tractor, operated by The Vons Companies, Inc., a major grocery chain serving California and Nevada.



Test vehicle — a 1992 Ford AeroMax LTLA-9000 with CNG engine.

During the demonstration, the vehicle operated on a route from El Monte to Bakersfield and back again, via the Los Angeles freeway system, a roundtrip of about 260 to 280 miles. This route afforded a wide variety of operating conditions: city stop-and-go driving, level highway driving, and hill climbing and descent of Tejon Pass (elevation, 4,144 feet). The route also encompassed extremes in climatic conditions. Winter weather in Tejon Pass can include rain, fog, and freezing temperatures; while the ambient summer temperatures in Bakersfield often exceed 100 degrees Fahrenheit.

During the one-year demonstration period, performance and cost data for both the CNG tractor and the control vehicle were collected and compiled. The CNG tractor accumulated 32,022 in-service miles and 815 engine hours, with a fuel economy 30% below that of the diesel control vehicle. The CNG tractor had an overall uptime of 49% and a CNG-specific uptime of 63%. Its performance in hill-climb and acceleration tests showed it to be comparable to that of the diesel control vehicle.

All operating costs were monitored and reported to NREL's Alternative Fuels Data Center. Specifically, fuel usage, service labor, and parts required by both the CNG tractor and the control vehicle were compiled, permitting the cost effectiveness of CNG use to be evaluated.

CNG and diesel per-mile fuel costs were roughly equivalent, with the CNG tractor's lesser efficiency being offset by its lower energy costs. Maintenance costs for the CNG engine and test vehicle were higher than those for the diesel control vehicle due to the experimental nature of the G3406LE engine. The inherent extra efforts associated with engine and vehicle conversion and modification, and with diagnoses and troubleshooting of new and unfamiliar problems, and with procurement of CNG-specific parts

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will become increasingly more important, particularly in urban areas. Initial data from ethanol fuel emission test analyses are promising. Testing of E-95 fuel equipment at many different geographic test sites will provide information about performance in diverse applications. Data on a variety of users and types of industries will help fleet managers better understand transitional issues of concern. Most important, because of the availability of information about the E-95 option, managers who face new fleet challenges and opportunities will become more aware of the advantages of this alternative fuel.

***Todd C. Sneller** currently serves as Administrator of the Nebraska Ethanol Board. He has been involved with state and national development efforts in the ethanol industry since 1976. Sneller is a Nebraska representative to the national Governors' Ethanol Coalition. He also serves on the Executive Committee of the Clean Fuels Development Coalition.*

CATERPILLAR

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would naturally cause these costs to be higher.

In addition to collecting data about the test vehicle, analysts conducted a survey of project personnel, which revealed that fuel economy, range, and downtime were issues of concern. Personnel had positive comments about safety, vehicle performance, and fuel system simplicity. Mechanics who were interviewed expressed the desire for more documentation on the CNG systems and increased guidance in troubleshooting those systems. In general, those surveyed favored the future purchase of natural gas vehicles by their companies.

It is worth noting that the project generated much favorable publicity. The CNG tractor was featured in seven trade and trucking shows and two media events and was covered in numerous trade magazine and newspaper articles. Moreover, a technical paper detailing the project has been accepted for presentation at NGV '94, the 4th Biennial International Conference & Exhibition on Natural Vehicles, to be held in Toronto, Canada, October 3-6, 1994.

In summary, because of the project's limited size and duration and the experimental nature the G3406LE, the project results cannot be considered a definitive statement of CNG's suitability for all heavy-duty trucking applications. Nevertheless, in the application evaluated, the project successfully demonstrated that CNG is technically feasible in Class 8 engines. Furthermore, the results and experience gained in this project should serve as excellent bases for larger and more comprehensive evaluations of CNG in the heavy-duty truck sector.

***Henry J. Modetz** is in charge of the Engine Development and Demonstration Department of the Acurex Environmental Corporation. He is currently the Project Manager for the Compressed Natural Gas (CNG) Program, which features the development and demonstration of the Caterpillar 3406 and Detroit Diesel (DDC) Series 60 engines. In addition, he is the Project Manager for the Liquefied Natural Gas (LNG) Program, a multiengine development and demonstration just underway.*

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