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Caterpillar Dual Fuel Engines for Bus and Truck

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ABSTRACT

Caterpillar Inc. has developed dual fuel versions of its venerable 3306 in-line six cylinder, 10.5 liter diesel engine for use in urban buses and heavy duty trucks. The engine retains its diesel performance by using its standard diesel injectors to ignite the clean burning natural gas. Both horizontal and vertical configurations are available.

For city delivery trucks and smaller urban buses Caterpillar is developing the 3126 in-line six cylinder, 7.2 liter diesel engine for dual fuel. This engine features complete electronic control of the diesel and gas fueling and timing, cylinder selection, and turbocharger air control to maximize natural gas substitution rates.

INTRODUCTION

Caterpillar views Russia as a large opportunity for its engines and other products. Many Caterpillar engines currently provide power for the oil and gas industry, in construction equipment, and many other applications. To support growing demand Caterpillar is positioning itself to be a local producer of engines for the Russian market.

Recognizing the needs for Russian urban bus and city delivery trucks, Caterpillar is developing diesel pilot ignition natural gas engines to serve those markets. With a team consisting of GazProm, Ikarus as the bus manufacturer, the Russian Federation Ministry of Transportation, the Government of Moscow Department of Transportation and support of the World Bank, Caterpillar intends to demonstrate dual fuel natural gas engines as the best alternative in an urban bus.

3306 DUAL FUEL ENGINE

Although the use of natural gas fuel for buses in Russia is not new, diesel pilot ignition offers remarkable improvements in economy, reliability, and durability over conventional spark ignited gas engines. Since dual fuel engines can operate with the diesel's high compression ratio and do not require a throttle to meter the gas, the engine produces diesel type performance. Features of the diesel pilot ignition natural gas engine include:

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- Power rating and torque back up equivalent to diesel
- Fuel consumption equal to diesel
- Heat rejection equal to diesel
- Lower NOx and particulate emissions than diesel
- Full diesel power back up
- Lower prices than diesel converted dedicated spark ignited engines

Caterpillar chose the 3306 engine to develop a dual fuel version for the Russian urban bus. It is a 10.5 liter in-line, six cylinder engine used for many years in Cat construction equipment, heavy duty trucks, electric power generators, and in a variety of other commercial applications. With no changes to the basic diesel engine, natural gas components applied to the fuel system enable it to operate as a diesel pilot ignition natural gas engine. DieselGas of New Zealand provided the components and developed the dual fuel version in cooperation with Caterpillar.

The natural gas components for the engine consist of a gas metering valve, an actuator to control the pilot diesel supply, and sensors all controlled by a computer to precisely meter and monitor the dual fuel system. If a problem occurs with the gas control system the engine immediately reverts to full diesel power to assure reliability of the vehicle. Demonstrated performance of the dual fuel version shows it exactly matches the full diesel performance while burning economical and clean burning natural gas. For urban bus applications an average of 50-60 percent of the energy consumed would be natural gas. For heavy duty regional trucks gas substitution can average over 80 percent.

To meet the installation requirements of the Ikarus bus, Caterpillar designed and developed a horizontal version of the 3306 engine. Principal modifications include a different oil pan, oil pump lines, and oil drain back system. This configuration allows mounting the engine mid chassis under the floor of the bus and gives easy access to the fuel system. The horizontal configuration successfully completed all of Caterpillar's stringent oil system tests.

Further testing of the 3306 dual fuel engine included a 1000 hour heavy duty cycle endurance test and a regional heavy duty truck field test. Results from the 1000 hour endurance test revealed no problems even with this test's high 75 percent average maximum fuel rate. A standard vertical configuration of the engine has been operating without engine problems for over 30,000 km in a Kenworth truck hauling asphalt. The vertical configuration can apply to some bus chassis and for other heavy duty truck regional applications.

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CONCLUSION

Caterpillar is developing dual fuel versions of its engines for the transportation industry since its advanced dual fuel technology offers the most economical, reliable, and durable means to burn natural gas. With the application of complete electronic control Caterpillar dual fuel engines can achieve very high gas substitution rates with diesel cycle benefits.

