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GE POSITION PAPER

Feasibility of Methanol as Gas Turbine Fuel

GE perspective on the technical feasibility of firing methanol in gas turbines is drawn from actual experience and published data. The review below is a composite summary of our position.

Overview

Methanol is an attractive future fuel for stationary gas turbine engines. Tests have shown that, with minor system modifications, methanol is a readily fired and is fully feasible as a gas turbine fuel. Relative to natural gas and distillate, methanol can achieve an improved heat rate, higher power output due to the higher mass flow, and lower NOx emissions due to the lower flame temperature. Since methanol contains no sulfur, there are no SO_2 emissions. The clean burning characteristics of methanol are expected to lead to clean turbine components and lower maintenance than with distillate fuel.

Technical Issues

Relative to natural gas and distillate, methanol has three main characteristics that make turbine modifications necessary: low heating value, low lubricity, and low flash point. The low heating value means higher fuel flow rate, and therefore modification of the fuel system components. The low lubricity of methanol requires changes in the main fuel pump/flow divider system (when firing liquid methanol), and use of a pressure flow divider or optional addition of a lubricity agent. The low flash point necessitates precautions to eliminate possible sources of ignition. Explosion proof components are required. In addition, startup is performed on distillate or natural gas.

The question of firing liquid or vaporized methanol has been considered. Either is feasible.

History

Methanol has been tested as a gas turbine fuel in the U.S.

In 1974, a 12-hour test was conducted by Turbo Power and Marine in a 20 MW gas turbine at the Bayboro Station of Florida Power Corporation. The methanol was fired as a liquid. NOx emissions were 74% less than those from No. 2 distillate, and CO emissions were comparable (Reference 1).

In 1978 and 1979, EPRI and Southern California Edison Company sponsored a 523-hour test at SCE's Ellwood Energy Support Facility, using one half of 52

MW, twin engine, gas turbine generator unit supplied by Turbo Power and Marine Systems, Inc. (Reference 2). The methanol was fired as a liquid. Some fuel system modifications were performed to permit the higher mass and volumetric flow of methanol to achieve baseload output. Some elastomers in the fuel system were replaced with materials impervious to methanol attack. The tests showed: "Operations on methanol are as flexible as on natural gas or distillate fuel. The ability to start, stop, accelerate, decelerate, perform automatic synchronization, and respond to control signals is equal to operations on either natural gas or distillate fuel. Turbine performance on methanol is improved over other fuels due to higher mass flow and the lower combustion temperatures resulting from methanol operations. Oxides of nitrogen emissions on the methanol-fueled turbine, without water injection, were approximately 80% of the emissions of the distillate-fueled turbine with water injection. There was a significant reduction in particulate emissions during methanol operation. An additional reduction in oxides of nitrogen emission was obtained during operations of the methanol-fueled turbine with water injection. No significant problems occurred during the test that could be attributed to methanol. The hot end inspection indicated cleaner components within the methanol-fueled turbine."

During 1984-1985, GE conducted methanol combustion tests of heavy-duty gas turbine combustors in a private study for Celanese Chemical Company, Inc. This work is unpublished. The tests were conducted at GE's Gas Turbine Development Laboratory in Schenectady, NY. Tests were performed with an MS6001B full-scale combustor representative of GE heavy-duty gas turbine combustors, and an MS7001 developmental dry low NOx combustor. The methanol was fired as a liquid, "dry" and also with water addition. A high-pressure centrifugal pump was used to supply the methanol to the combustor. The tests demonstrated that methanol fuel can be successfully burned in GE heavy-duty combustors without requiring major modifications to the combustor. NOx emissions were approximately 20% of those for the same combustor firing NO. 2 distillate at the same firing temperature. With water addition, NOx levels of 9 ppmv could be achieved. Liner metal temperatures, exit pattern factors, and dynamic pressures were not significantly affected by methanol combustion and met GE criteria for acceptable performance. The results are valid for 2000 F firing temperature machines (E-class). Additional work would be required to confirm performance with methanol fuel, elevated firing temperatures of the F series of machines. Vaporized methanol will reduce NOx 5% to 10% (relative to CH4 emissions) where as liquid methanol will reduce NOx 30% relative to CH4 emissions. Water content in the methanol provides further NOx reduction.

In 1984, a field test demonstration was performed at the University of California at Davis (Reference 3). Methanol was fired in a 3.25 MW Allison 501-KB gas turbine for 1,036 hours. Low NOx emissions were observed and were further reduced by mixing water with the methanol. Problems encountered with the traditional gas turbine fuel pump were bypassed by using an off-board centrifugal pump.

It has been reported that a demonstration test was performed by Tokyo Electric Power at Yokosuka in 1993, involving methanol power generation in a 30 MW gas turbine generator (Reference 4).

GE Commercial Position

Methanol is considered a superior turbine fuel, with the promise of low emissions, excellent heat rate, and high power output. The gas turbine fuel system must be modified to accommodate the higher mass and volumetric flow of methanol (relative to natural gas or distillate). The low flash point of methanol necessitates explosion proofing. The low flash point also dictates that startup be performed with a secondary fuel such as distillate or natural gas.

Testing to date has been with methanol as a liquid. GE is comfortable with methanol as a liquid or vapor.

GE is prepared to make commercial offers for new or modified gas turbines utilizing methanol fuel in liquid or vapor form based on the earlier experience. Some combustion testing may be required for modern machines applying for very low NOx permits.

REFERENCES

(1). "A Special Report: Burning Tomorrow's Fuels," *Power*, S14-S15, February 1979.

(2). "Test and Evaluation of Methanol in a Gas Turbine System," Southern California Edison Company, EPRI Report AP-1712, February 1981.

(3). "Methanol. Clean Coal Stationary Engine Demonstration Project. Executive Summary," California Energy Commission, Report P500-86-004, February 1986.

(4). "Methanol Power Generation – Demonstration Test Starts for a Power Source at Peak Demand," *Japanese High-Technology Monitor*, 5 April 1993.