Dimethyl Ether (97/98S8)

Dimethyl ether (DME) has shown interesting promise as a substitute for crude oil-derived diesel fuel for transportation vehicles. Its properties meet or exceed the most stringent current and proposed emissions regulations, while affording additional excellent diesel properties such as high cetane number. The market for transportation fuels has resisted efforts at making DME a viable alternative due mainly to its high cost relative to conventional diesel fuel; current commercial technologies use methanol as a raw material, making the price noncompetitive.

Recent developments in DME production technologies have resulted in improved economies of scale, while at the same time using inexpensive stranded natural gas as a raw material in a one step process. Using different reactor configurations and catalysts, Haldor Topsøe and Air Products have both developed one step processes that convert synthesis gas directly into DME without having to separate and purify methanol. These developments offer the hope of decoupling DME prices from methanol and making it cost competitive with crude oil based diesel fuel.

The only current commercial process in use for the production of DME is via fixed bed catalytic dehydration of methanol. Because the process is relatively simple, this method is commonly used because of the low capital investment required and the availability of feedstock. However, this results in a DME cost that is by default more expensive than the price of methanol.

Air Products and Chemicals, as part of its research program with the Department of Energy's Clean Coal Technology and Alternative Fuels programs, has developed a liquid phase methanol synthesis process, the LPMeOH™ process. The same basic technology has been used to develop a one step liquid phase DME from syngas synthesis process, the LPDME™ process.

In the LPDME™ process, syngas is combined with recycled syngas/methanol and fed to a liquid phase slurry reactor. The catalyst can be a combination of methanol synthesis and dehydration catalysts. Alternatively, Air Products has also discussed the use of Cu/ZnO/γ-Al_2O_3 as a single catalyst. Catalyst is present as a fine powder slurried in inert mineral oil. Sparging and bubble action provide agitation to the slurry. The reactor is operated isothermally at about 250°C and 750 psig.

Crude DME is then separated from the oil/catalyst slurry, and purified in a manner similar to the conventional methanol dehydration process.

This report presents capital cost and cost of production estimates for both the conventional and Air Products' LPDME™ processes. The basis for both plants is a capacity of 2.37 million metric tons (5,230 million pounds) per year of DME. Since natural gas price is the major cost element in the production of DME, it makes more economic sense to build these plants in areas with inexpensive natural gas resources. To illustrate the cost advantage of using cheap natural gas the economics for these processes are based on both USGC and Middle Eastern locations.

The conclusion is that the new DME production technologies can offer significant reductions in DME production costs. The lowest cost case presented in this report is a DME cost of production plus 10 percent ROI of $138 per ton, for the Middle East case. DME produced in the Middle East using new process technology could be competitive with diesel fuel should crude oil prices rise moderately from their current low levels.

DME has excellent diesel properties. Conventional diesel engines using DME exhibit tailpipe emissions low enough to meet California's 1998 Ultra Low Vehicle Emissions regulations and European Euro III Heavy Duty Emissions. Its vapor pressure is between propane and butane, meaning it can be handled like LPG. Engines running under DME exhibit lower running noise. It is also suitable for combined-cycle power generation applications. The cetane number, a measure of auto-ignition properties, for DME ranges from 55 to 60, which easily meets current and future requirements of 40 to 55.

No major engine modifications would be required, only minor fuel injection changes and an air cooler addition. While DME injection pressures would be similar to conventional diesel fuel, a pressurized fuel system would be required, due to DME's vapor pressure being similar to LPG.

As with any fuel alternative, a fuel infrastructure (e.g. transportation, storage, distribution, and marketing facilities) would have to be built for consumers to replace diesel fuel with DME. It would be difficult to justify building the infrastructure if consumer demand is not sufficient to guarantee market penetration. However, since DME shares many transport properties with LPG, there is an existing (if smaller) infrastructure that could be leveraged for use in promoting DME use, should the cost of DME become competitive with traditional diesel fuels.