

## **XII. DIESEL FUEL EMULSIONS**

### **A. Product Overview and Description**

Diesel fuel emulsions are blended mixtures of diesel fuel, water, emulsifying agents and other additives, that reduce PM and NO<sub>x</sub> emissions, as a result of the added water. Addition of water to the emulsified fuel also reduces the energy content of the fuel, with corresponding reductions in fuel economy and engine power.



Courtesy of Lubrizol

### **B. Emission Reduction**

Depending on the specific engine application and duty cycle, use of emulsions can result in NO<sub>x</sub> reductions of 5% to 30%, and PM reductions of 20% to 50%. These ranges of results have been demonstrated in several projects.

Use of an EPA-verified emulsified diesel fuel has been the subject of several studies, and for comparative purposes in several others. This emulsified diesel fuel is a combination of diesel fuel with 20% water by weight, and an "additive package" for stabilizing the fuel-water emulsion. A 2001 report prepared by Air Improvement Resource, Inc. under contract to the diesel fuel emulsion manufacturer undertook a comparative analysis of vehicle emissions using the emulsified diesel fuel and other diesel fuels. An eleven-engine database was developed to evaluate emissions from a baseline diesel fuel and the emulsified diesel fuel. The report's conclusions show that generally, the emulsified diesel fuel provided consistent reductions for NO<sub>x</sub> and PM. HC emissions were typically found to increase slightly. NO<sub>x</sub> reductions ranged from 3% to 30%, and for most of the test cases, PM reductions ranged between 24% and 83%. This study also evaluated the emulsified fuel's performance in Sacramento and Los Angeles, where the selected fleet engines represented 25% of the centrally fueled highway vehicle fleets in both locations.

### **C. Status and Availability**

Currently, there is one technology provider of an EPA- and CARB-verified emulsified fuel ([www.epa.gov/otaq/retrofit/retroverifiedlist.htm](http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm), and [www.arb.ca.gov/diesel/verdev/verdev.htm](http://www.arb.ca.gov/diesel/verdev/verdev.htm)). The fuel product has been available from fuel suppliers in the general areas of the

West Coast, East Coast, Great Lakes area, and Gulf Coast. Emulsified fuels have been developed by other technology providers as well, but to date, have not been verified by EPA or CARB.

#### **D. Selection and Use Criteria**

The University of Texas emulsified diesel fuel operational assessment identified a number of "user issues", including: higher cost, engine manufacturer's reluctance to extend engine warranties when alternative fuel formulations such as diesel fuel emulsions are used, the perception of detrimental effects on certain type engines, fuel-water separation concerns, and perceived health and safety issues. These observations were based on interviews with various users at different test and project locations in the northeast, southwest, and west coast. Other reports, including the Brunswick Mine Study provide an evaluation of similar worker and potential customer concerns.

Since this technology has been introduced into commercial practice relatively recently, there is a lack of currently documented information on longer term user issues such as storage stability of mixed fuel, and the affects of ambient temperature on emulsion performance

Diesel fuel emulsions generally do not appear to be a good application for vehicles or equipment that operate primarily at high speed and/or high load. Care should be given to assessing the operating characteristics of the candidate vehicles/equipment. Where the operating modes tend to be at lower loads and/or speeds fuel emulsions have been used successfully

Typically, reduced power and fuel economy are related to the water content in the emulsified fuel, but engine operating mode (full power vs. low power) also affects the degree of reduction. These impacts in terms of costs, tradeoffs and the related benefits of achieving emission reductions with emulsified diesel fuels are a function of the properties of the specific emulsified fuel formulation, vehicles and equipment the emulsion will be used in, and duty cycles of operation.

#### **E. Costs**

Available data suggest that the incremental cost of emulsions ranges from \$0.25 to \$1.00 per gallon of finished fuel product, depending on the volume purchased, time period for the fuel supply contract, and distance from the supplier to the user.

#### **F. Product Quality, Delivery, Storage and Fueling**

Much of the same precautions and lessons learned from use of ULSD and biodiesel can be applied to diesel fuel emulsions. Since emulsions contain water, there are potential use and storage problems related to their water content. Establishment of good fuel handling and storage practices and use of segregated equipment will help to minimize such problems.