M. Diesel Exhaust Gas Recirculation Corrosion Effects

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Objective

- Assess the effect of diesel engine operating parameters, especially exhaust gas recirculation (EGR) fraction, on corrosion rates of materials of construction.

Approach

- Establish working relationships with diesel engine manufacturers.
- Deploy corrosion probes in manufacturer's test stands.
- Evaluate the performance of probes under various test conditions.
- Determine correspondence between probe performance and that of the materials of construction.

Accomplishments

- Gained access to a manufacturer test stand and deployed the probe.
- In conjunction with a manufacturer, obtained corrosion information as a function of various operating parameters.
- Demonstrated probes to be affected following changes in engine operating regimes.
- Determined that corrosion was not significant until the onset of water condensation.

Future Direction

- Continue collaboration with engine manufacturers.
- Install probes with different "sensing" materials.
- Determine the correspondence between probe performance and that of the materials of construction.
- Ascertain the cause(s) for corrosion behavior.

Introduction

To reduce NO_x emissions, EGR systems have been deployed in diesel engines. This approach reduces peak combustion temperatures and hence NO_x emissions. The use of an EGR system leads to accelerated corrosion that is considered to be associated with the formation of sulfuric acid. While it has been observed that corrosion tends to follow dewpoints, there are indications of maxima in corrosion rates with dewpoint temperature. Two regimes have been identified. The first is in the temperature range between the dewpoint of the acid that forms and the dewpoint of water where strong acid is formed; the second is below the water dewpoint where very weak acid is formed. Both of these acids, strong (50–70%) and very weak (500 ppm), are very aggressive corrodents of the proposed materials of containment, aluminum and cast iron.

Approach

A CEION corrosion probe was installed in a test engine at the manufacturer. The probe was connected to the associated interfaces; to data acquisition, corrosion rate analysis software; and to display systems. The manufacturer exercised the engine under various operating conditions, including EGR fractions, temperature, and gas composition. The data were analyzed to determine correlations between corrosion rates and engine operating conditions. Samples of condensate were collected and later analyzed at Oak Ridge National Laboratory.

Conclusions

Corrosion rates increased significantly with onset of water condensation. The condensate, having appreciable levels of acid, showed a pH of approximately 2.5. As anticipated, the concentration of sulfuric acid varied with the sulfur content of the fuel.