Key Messages from AMF Research

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Alcohol Application in CI Engines

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Danish Technological Institute, Denmark (DTI)
VTT Technical Research Centre, Finland (VTT)
Scania AB, Sweden.

Major Conclusion

The project has shown that neat alcohols can be applied at very high compression ratios in diesel engines with the same performance as conventional diesel fuel. The performance was achieved by applying different ignition improvers in the form of new as well as a well known additive. Blends of alcohols and diesel showed a reduction in particulate emissions from a compression ignition engine with lower compression ratios.

Background

Alcohols, like methanol and ethanol, are obvious fuels for spark ignition engines because of their high octane numbers. However, there is increasing interest in applying alcohols as fuel for diesel engines, because of the foreseeable lack of diesel fuels in the future. An option is to use an additive, together with ethanol, in heavy-duty ethanol diesel engines. Today, such engines are manufactured by Scania. These engines are running with so called Etamax D fuel, which consists of 95% hydrous ethanol, together with an ignition improver, corrosion inhibitor, and denaturants (methyl tertiary-butyl ether [MTBE], isobutanol). This fuel is manufactured by SEKAB in Sweden. Recently, new ignition improvers have become available. The behavior of alcohols with these additives in diesel engines needs to be investigated, which is the focus of the present investigation. Another option is to use blends of alcohols and diesel fuels, another topic for investigation.

Research Protocol

Different activities took place. In Part A, tests were carried out at VTT, involving a Scania heavy-duty high-compression ignition engine designed for alcohol application. The purpose was to study the behavior of neat ethanol and methanol and ethanol together, with a commercial ignition additive and two new alternative additives. In Part B, the same fuels were tested in an experimental engine at DTU. The main purpose was to study the combustion behavior based on the measured heat release patterns. In Part C, the influence of alcohol addition to diesel was investigated at DTI. Different blends of diesel and alcohols (methanol, ethanol, and butanol) were tested in a Scania heavy-duty diesel engine with a lower compression ratio.

Key Findings

New ignition improvers for alcohol application in diesel engines are now available, and two of these were tested, together with a well-known ignition improver, in this investigation. These new ignition improvers have been found to work well with ethanol in a Scania compression ignition engine with a very high compression ratio (28:1). For methanol, the fuel system of the engine needs to be modified in order to manage the higher amounts of fuel flow needed due to the lower calorific value of the fuel. The relative specific fuel consumption measurements are shown in Figure 1. The injection timing needs to be optimized for the individual fuels (alcohol + ignition improver), since the rate of heat release was found to differ from one fuel to the other (Figure 2). In addition, different blends of diesel and alcohols, methanol, ethanol and butanol, were tested in another Scania heavy-duty diesel engine with a lower compression ratio (16:1). The addition of alcohols to diesel was found to decrease particulate emissions in general, and the gaseous emissions were unchanged, except at idle operation at which aldehyde, carbon monoxide, and hydrocarbon emissions increased.

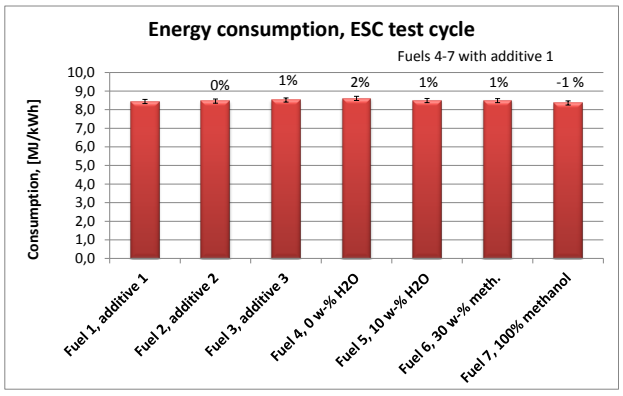

Figure 1. Specific fuel consumptions

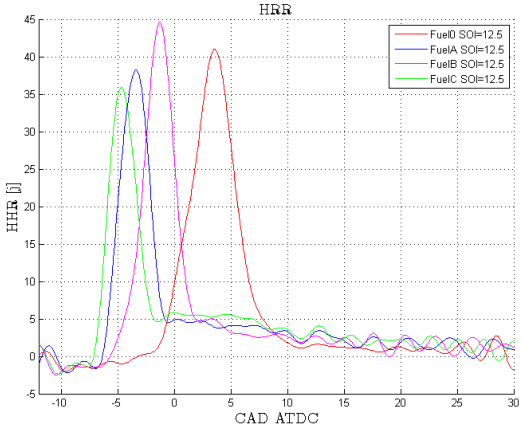

Figure 2. Differences in rate of heat release