ENVIRONMENTAL PERFORMANCE OF DIESEL-FUEL SYNTHETIC OXYGENATES: MALEATES AND CARBONATES

Miłosław Kozak and Jerzy Merkisz
Poznan University of Technology, Poland

Piotr Bielaczyc and Andrzej Szczotka
BOSMAL Automotive Research & Development Center, Poland

Abstract

In the year 2005, the EURO IV fuel specification came into effect and the requirements for diesel fuel properties have become even more stringent. In this way, the potential of diesel fuel for emissions reduction has already been to a large extent exploited and the most emissions-sensitive fuel parameters can now be changed in a narrow range only. The shortfall in NO_x and PM emissions control in diesel engines is, however, so great that more drastic fuel changes will be needed. One of the most promising fuel modifications for exhaust emissions control seems to be oxygenated additives.

The experimental results presented in this paper were obtained within a research program investigating the effect of different synthetic oxygenates on emissions from diesel passenger cars. The objective of this study was to select the most promising oxygenate compounds as blending components in diesel fuel for further advanced testing and practical application. The results of the first part of the program were presented during the 31st FISITA World Automotive Congress – Yokohama 2006 (see paper F2006P048). In that part of the program, oxygenates from the glycol ethers chemical family were tested and obtained results were promising. In the second part of the program, oxygenates from another chemical families i.e. maleates and carbonates were tested.

The tests were conducted on light-duty vehicles equipped with DI – Common Rail turbocharged engines, meeting the Euro IV emissions regulation and representing the latest technology in production at the start of the research program. The New European Driving Cycle (NEDC), with separate measurement of urban and extra-urban phase, was selected as a representative test for this study. The total PM, CO, HC, NO_x and CO_2 as well as fuel consumption were measured. In some cases, the modal analysis was also made. Five different synthetic oxygenated additives were tested. Each of them was evaluated as a fuel additive at a concentration of 5% v/v in the same base diesel fuel. The base diesel fuel was a Euro V diesel fuel.

The results of the experimental tests showed that maleates and carbonates as oxygenated fuel components reduce substantially PM emissions (Figure 1), however, the NO_x emissions for oxygenated fuels were always slightly higher than for neat diesel fuel. The effectiveness of PM reduction was higher for maleates and carbonates than for glycol ethers at the same concentration in fuel. Moreover, maleates and carbonates produced lower increase in NO_x emissions than glycol ethers. Considering total PM and NO_x emissions changes, it can be stated that maleates and carbonates produce even more favorable shift in the PM/NO_x trade-off than glycol ethers. However, on the other hand, maleates and carbonates cause increase in CO and HC emissions whereas glycol ethers generally reduced this emissions effectively.

Therefore, the effectiveness of the oxygenated additives in the reduction of exhaust emissions is not directly dependent on the oxygen content and their chemical structure plays also an important role. As far as CO_2 emissions and fuel consumption are concerned, only slight increases were recorded for all oxygenated fuels (resulting from a lower calorific value).

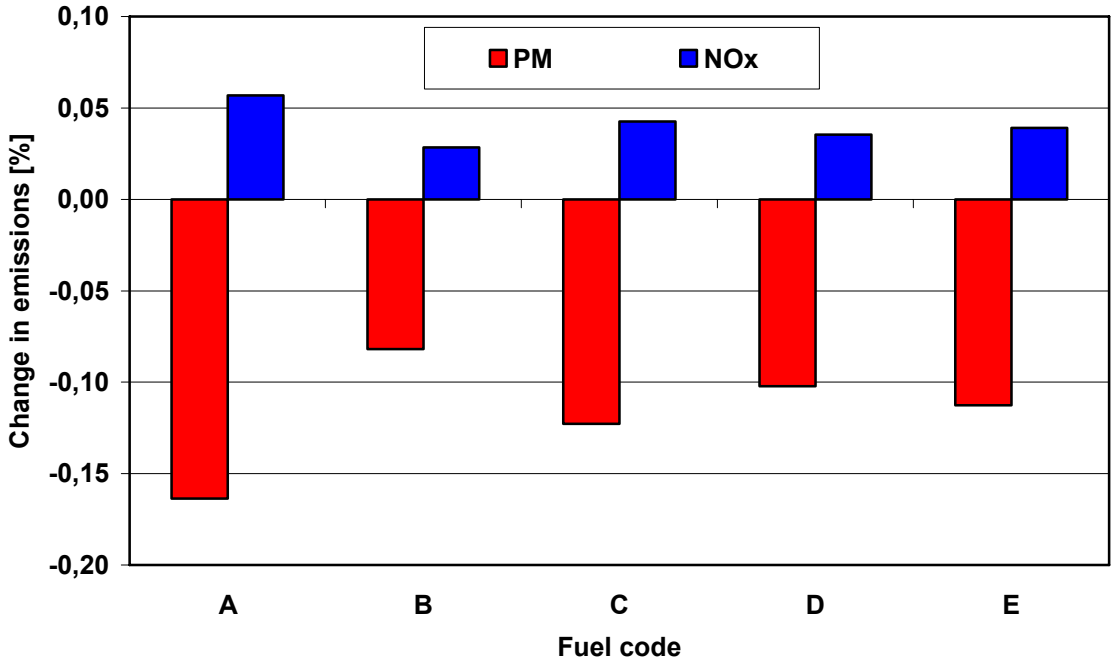

Fig. 1. The influence of different diesel-fuel synthetic oxygenates (maleates: A, B, C and carbonates: C, D) at 5% concentration on the PM and NO_x emissions changes during the New European Driving Cycle