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Ecomotive Test Report

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Test Description, Results and Analysis

Aim and objectives

The main aim of this project is to verify the carbon cleaning properties of a chemical substance of unknown composition, here called Ecomotive, through tests in a diesel engine. The specific objectives of the project are to evaluate the effects of Ecomotive on fuel consumption, nitric oxide (NO), total hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO_2) emissions, and exhaust smoke index.

Materials and method

N. 2 diesel fuel was tested in a 2-cylinder, 10 kW diesel engine on a bench test dynamometer, following a sequence of steady-state test modes with constant speed of 2000 rpm and variable load (Table 1). For each load mode the engine volumetric fuel consumption and the exhaust concentrations of NO, HC, CO and CO_2, and smoke index were measured. After this set of experiments were performed, 0.5 L of Ecomotive was added to 9.5 L of N. 2 diesel fuel in the fuel tank and the engine was operated at full load until all fuel blend was consumed. Thereafter, the engine was again operated with N. 2 diesel fuel and the measurements of fuel consumption and exhaust NO, HC, CO and CO_2, and smoke index were repeated following the same test modes as before. In both set of experiments, before and after applying Ecomotive, the measurements were performed from a hot start, following engine preconditioning at idle mode for 10 min. The results are shown by Figs. 1 to 6.

Table 1 – Load ramped steady-state test cycle modes.

MODE	LOAD (kW)
1	1.19
2	2.65
3	3.98
4	5.31
5	6.63
6	7.63

Results and analysis

Figure 1 shows the comparative results of volumetric fuel consumption of N.2 diesel fuel before and after the use of Ecomotive. For all test modes a decrease of fuel consumption is observed after the use of the carbon cleaning product. In average, fuel consumption was reduced by 4.2%, reaching a maximum reduction of 6.5%. Considering this result was produced from Ecomotive actively acting as a carbon deposit cleaner, the observed fuel consumption reduction comes from more efficient combustion as the carbon-free injectors can promote better fuel spray and distribution. Also, the reduction of carbon deposits in the combustion chamber prevents fuel being hidden in the deposit porosities and escaping the combustion process.

Figure 2 shows that after using Ecomotive nitric oxide emissions are increased for medium and high load operating modes, reaching a maximum of 43% increase for mode 5. As combustion becomes more efficient after the use of Ecomotive, higher temperatures are attained in the combustion chamber having as a side-effect the increase of NO. It is expected that an adequate after-burn device may keep NO within acceptable limits as the benefits of more efficient combustion are attained.

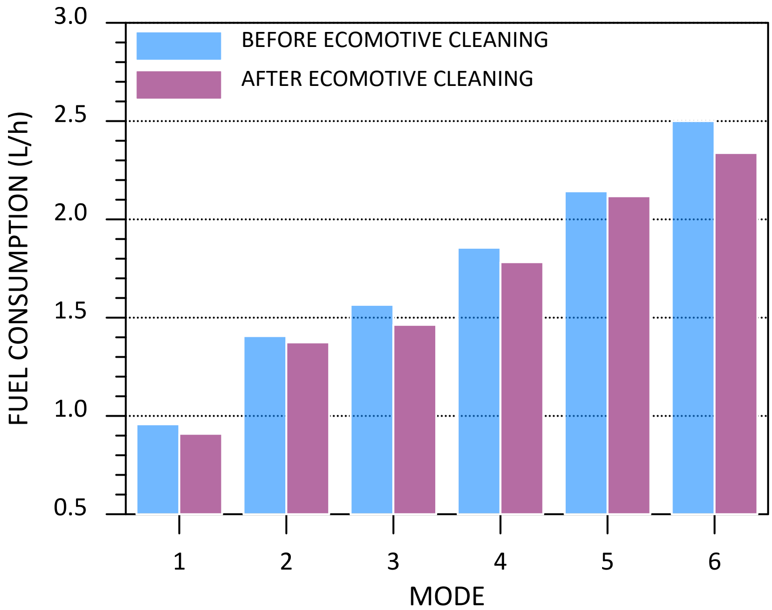

Figure 1 – Comparative fuel consumption before and after Ecomotive application.

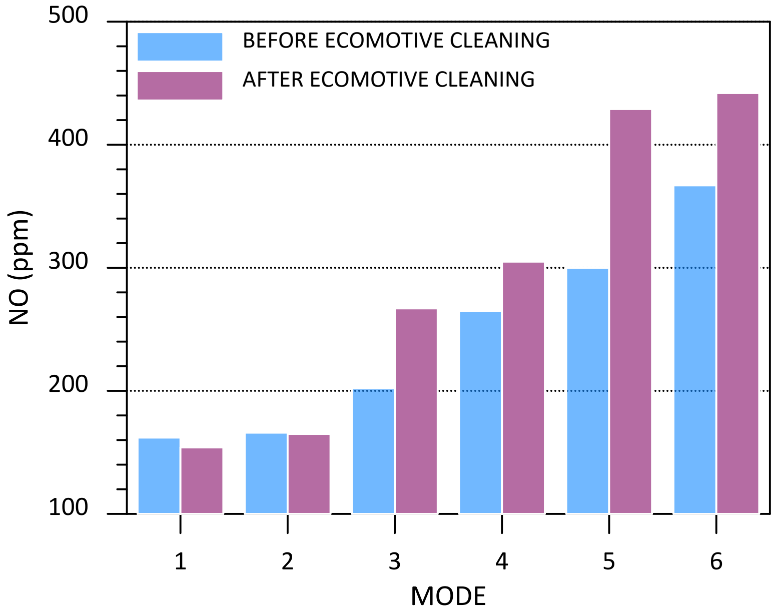

Figure 2 – Comparative nitric oxide emissions before and after Ecomotive application.

In Fig. 3 it can be seen that hydrocarbon emissions were increased for the low-load operating modes after the use of Ecomotive. A possible explanation is that, as the amount of injected fuel for engine operation is relatively small at these conditions, hydrocarbon components decomposing from the deposits still under the action of the carbon cleaning product contribute to increase the exhaust HC concentration. For medium and high load operation, modes 3 to 6, the measured HC emission values were very low, near the equipment detection limit, and therefore do not allow for firm conclusions to be drawn.
Figure 4 displays the reduction of carbon monoxide emissions for all test modes after the use of Ecomotive. The better fuel distribution in the combustion chamber after the removal of deposits from the injector by the chemical product avoids the formation of fuel-rich regions, helping the conversion of CO into CO_2. For the engine operation range investigated the average reduction of CO emissions was 23.7%, reaching a maximum reduction of 38.5% reduction at test mode 6.

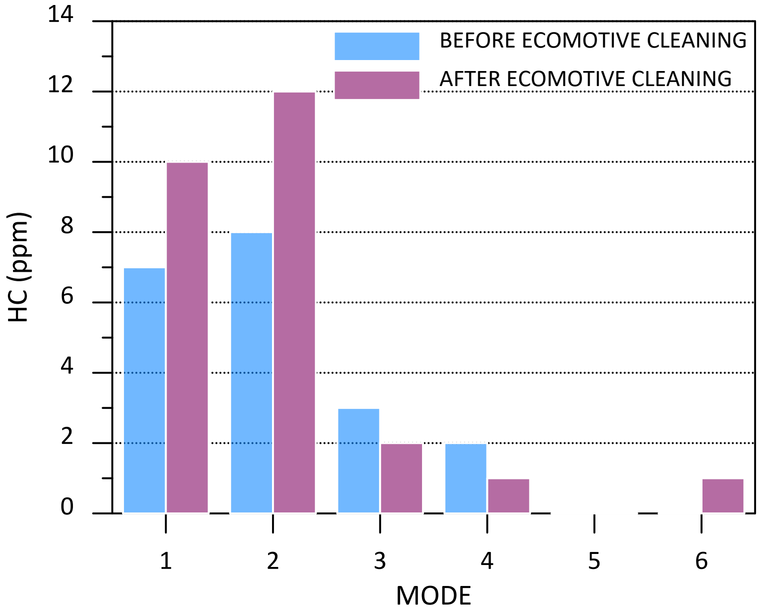

Figure 3 – Comparative hydrocarbon emissions before and after Ecomotive application.

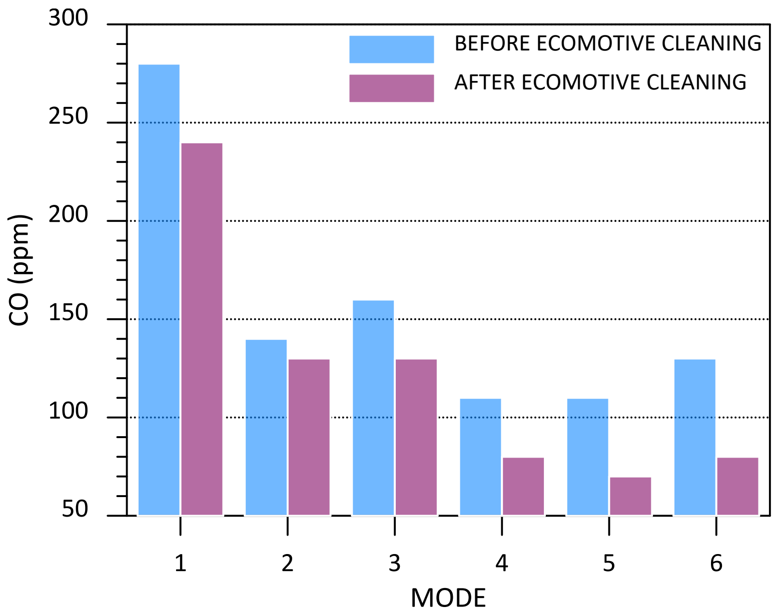

Figure 4 – Comparative carbon monoxide emissions before and after Ecomotive application.

Figure 5 shows that, after the application of Ecomotive, carbon dioxide emissions are slightly increased for nearly all test modes. The exception was test mode 4, where a negligible decrease is observed. The small increase of CO_2 emissions is due to the more efficient combustion attained after cleaning the carbon deposits helping the oxidation of CO into CO_2. The maximum increase of exhaust CO_2 concentration was 4.7% at test mode 1. At this condition the concentration of carbon monoxide leaving the oxidation reaction was much higher than at the other test modes (see Fig. 4), indicating the higher amounts were involved in the conversion process to CO_2.

Figure 7 shows the exhaust gas smoke index results, as an indicative of particulate matter emissions. After carbon deposit removal by Ecomotive the smoke index reduced for all test modes, markedly for the medium and high load modes. As particulate matter emissions from diesel engines are higher under high load conditions, more pronounced reductions can be attained at these operation modes. The average reduction of smoke index for the test modes investigated was 49.9%, reaching a maximum reduction of 82.5% at test mode 3.

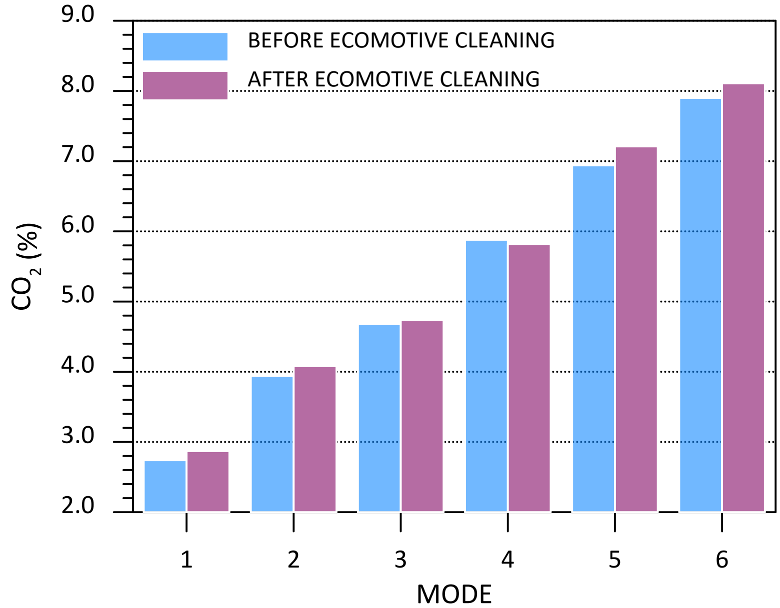

Figure 5 – Comparative carbon monoxide emissions before and after Ecomotive application.

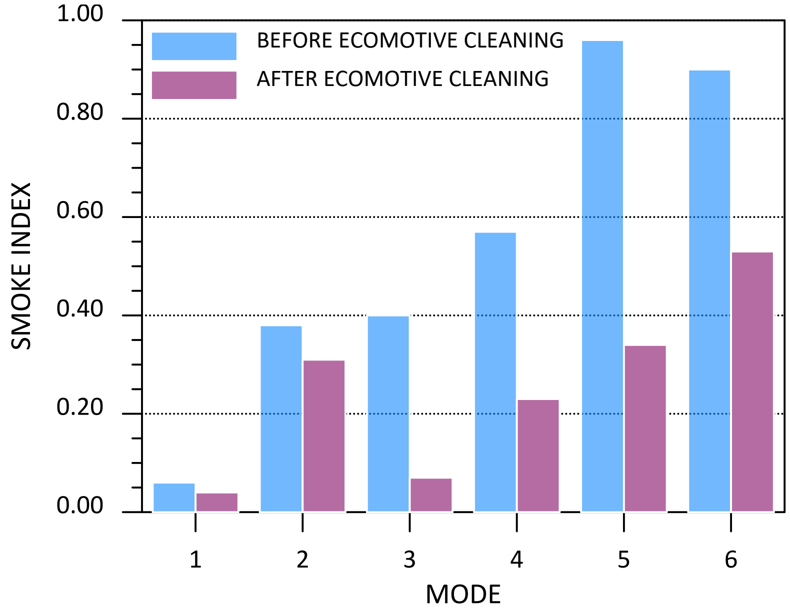

Figure 6 – Comparative exhaust smoke index before and after Ecomotive application.

Conclusions

The application of Ecomotive to a diesel engine operating at constant speed and variable load produced noticeable reductions of fuel consumption, CO emissions, and exhaust gas smoke index. Overall, the results indicate that Ecomotive effectively actuated as a carbon cleaning product. The procedure here adopted added 0.5 L of Ecomotive to 9.5 L of diesel fuel, which total amount typically corresponds to a 1/4 fuelled 40 L automotive tank as recommended by the manufacturer. The optimized amount for more efficient use of the product can be a subject of further investigation. At the tested conditions, the average reductions obtained for fuel consumption, exhaust CO emissions, and smoke index were 4.2%, 23.7% and 49.9%, respectively. On the other hand, NO emissions have been increased after the use of Ecomotive, as a side effect of more efficient combustion being attained. This should be dealt with by appropriate exhaust gas after-treatment devices. Although these results are not exhaustive, they substantiate that the application of Ecomotive as a carbon deposit cleaner can promote significant reductions of fuel consumption, CO and smoke emissions. Further developments in this field can involve combustion chamber visualization and engine component analysis for carbon deposits, particulate matter measurements, other engines and operating conditions and vehicle testing for more comprehensive evaluation.