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Evaluating the effect of methanol-unleaded gasoline blends on SI engine performance

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Introduction: Today, all kinds of vehicle engines work with fossil fuels. The limited fossil fuel resources and the negative effects of their consumption on the environment have led researchers to focus on clean, renewable and sustainable energy systems. In all of the fuels being considered as an alternativefor gasoline, methanol is one of the more promising ones and it has experienced major research and development. Methanol can be obtained from many sources, both fossil and renewable; these include coal, natural gas, food industry and municipal waste, wood and agricultural waste. In this study, the effect of using methanol–unleaded gasoline blends on engine performance characteristics has been experimentally investigated. The main objective of the study was to determine engine performance parameters using unleaded gasoline and methanol-unleaded gasoline blends at various engine speeds and loads, and finally achieving an optimal blend of unleaded gasoline and methanol.

Materials and Methods: The experimental apparatus consists of an engine test bed with a hydraulic dynamometer which is coupled with a four cylinder, four-stroke, spark ignition engine that is equipped with the carbureted fuel system. The engine has a cylinder bore of 81.5 mm, a stroke of 82.5 mm, and a compression ratio of 7.5:1 with maximum power output of 41.8 kW. The engine speed was monitored continuously by a tachometer, and the engine torque was measured with a hydraulic dynamometer. Fuel consumption was measured by using a calibrated burette (50cc) and a stopwatch with an accuracy of 0.01s. In all tests, the cooling water temperature was kept at 82±3˚C. The test room temperature was kept at 29±3˚C during performing the tests. The experiments were performed with three replications. The factors in the experiments were four methanol- unleaded gasoline blends (M0, M10, M20 and M30) and six engine speeds (2000, 2500. 3000, 3500, 4000 and 4500 rpm). Methanol with a purity of 99.9% was used in the blends. All experiments were performed at 50% open throttle. Engine performance characteristics for fuel blends were compared with unleaded gasoline.

Results and Discussion: The experimental results showed that adding methanol to unleaded gasoline increased brake torque and brake power in the M10 and decreased in the M30 compared to merely usingpure gasoline. Engine behavior when using M20 blend was similar to that of using pure gasoline (M0). The brake power and torque at engine speeds 2500, 3000, 3500 and 4000 rpm for M10 were increased by 5.42%, 7.76%, 14.89% and 16.78% compared to when these parameter relate to pure gasoline (M0), respectively, whereas the brake power and brake torque for M30 blend at engine speeds 2000, 2500, 3000, 3500, 4000 and 4500 rpm compared to when using pure gasoline was decreased by 6.91%, 8.1%, 6.23%, 5.29%, 4.59% and 14.27%, respectively.

The experimental results showed that brake specific fuel consumption for M30 blend was increased at all engine speeds. The increase in specific fuel consumption values for this blend from 2000 - 4500 rpm were 17.78%, 16.38%, 13.06%, 10.99%, 14% and 19.11%, respectively. Also, the specific fuel consumption for the M20 was similar to the specific fuel consumption of pure gasoline. Comparing the brake specific fuel consumption of M10 to M0 fuel at 2500, 3000, 3500, 4000 and 4500 rpm this parameter was decreased by 1.9%, 6.03%, 8.91%, 13.85% and 5.55%, respectively.

As the methanol content in the fuel blends increases, brake thermal efficiency also increases at all engine speeds and in all used fuels blends. The thermal efficiency at 2000, 2500, 3000, 3500, 4000 and 4500 rpm using M10 was increased by 3.73%, 8.12%, 12.43%, 15.57%, 22.34% and 12.01%, respectively in comparison to pure gasoline. These values for M20 were 4.14%, 7.82%, 10.12%, 13.37%, 18.94% and 13%, and for M30 were 2.69%, 3.89%, 6.35%, 8.01%, 5.12% and 0.78%.

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Conclusions: From the results of the study, the following conclusions can be deduced:
1- Using methanol as a fuel additive to unleaded gasoline causes an improvement in engine performance.
2- The largest increment in engine torque and brake power compared with M0 showed about 16.78% with M10 at 4000 rpm.
3- Minimum brake specific fuel consumption was obtained at 4000rpm with M10 fuel.
4- Thermal efficiency increased compared to the pure gasoline usage at all engine speeds and in all used fuel blends. The largest increment in brake thermal efficiency compared with M0 showed 22.34% with M20 at 4000 rpm.
5- The 10 vol. % methanol in fuel blend gave the best results for all measured parameters at all engine speeds.

Keywords: Engine performance, Methanol-gasoline blends, SI engine, Specific fuel consumption, Thermal efficiency