Proceedings of CHT-17
ICHMT International Symposium on Advances in Computational Heat Transfer

May 28-June 1, 2017, Napoli, Italy

CHT-17-197

Numerical investigations on the performance of an engine fueled with gasoline-nbutanol blends

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In this work, the performance of a "downsized" spark-ignition engine fueled by gasoline and bio-butanol blends has been analyzed.

Experimental tests have been carried out at operating points ranging from low up to medium engine speed and load. The engine has been fueled with gasoline and butanol/gasoline blends B20 and B40 (20% and 40% butanol mass percentage) 40% of butanol mass percentage is the operating limit for the normaly engines in circulation

The first investigations were aimed to assess the main differences among the different fuels in terms of output torque, efficiency, combustion duration and optimal spark timing. Experimental tests have been carried out at stoichiometric mixtures.

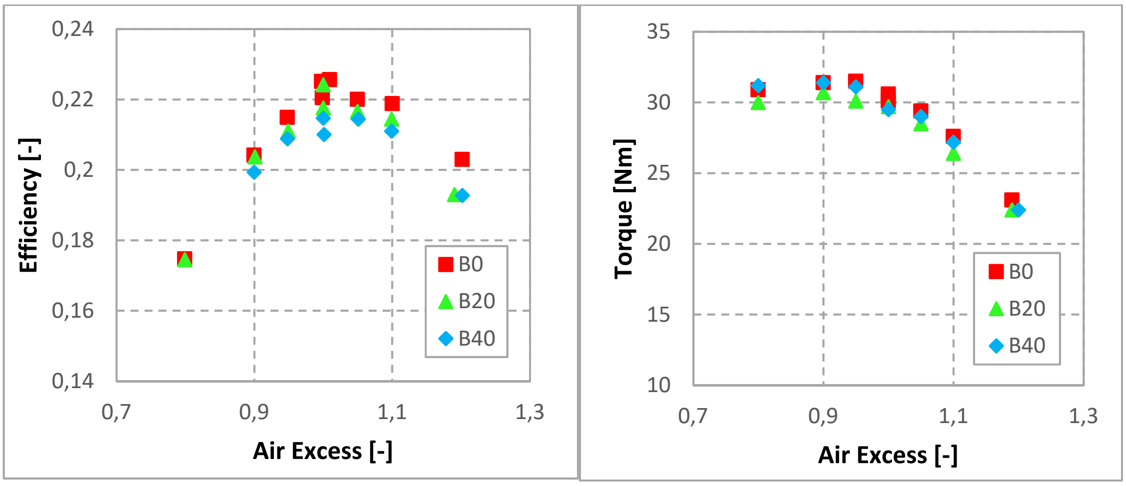

Figure 1 - Engine efficiency(left) and Torque (right) versus the relative air to fuel ratio. Engine operating at constant speed and constant MAP

Both the engine torque and thermal efficiency slightly decrease (about 4 percent) when the blend alcohol content increases.

Later, the pollutant and the CO_2 emissions, for both rich and lean mixtures of pure gasoline and gasoline bio-butanol blends, have been measured. In general, firing with alcohol blends, HC emissions decrease, while the other pollutants remains the same. The CO_2 slightly increases.

Table 1 - Main values measured for stoichiometric air-fuel operation. Hydrocarbon emissions have been measured as hexane equivalent.

	Torque	Specific fuel consumption	Overall efficiency	CO	CO_2	NO_x	HC	Exh. gas temperatur e	Flame development duration	Rapid burn duratio n
	[Nm]	[g/kWh]	[-]	[g/kWh]				[°C]	[°]	
B0	31.2	370.2	0.224	45	1235	9.7	1.0	664.4	23.7	19.8
B20	30.0	387.6	0.221	44	1280	18.3	1.0	655.0	23.4	19.3
B40	29.9	418.0	0.212	46	1340	20.1	1.0	651.2	23.3	19.0

A 1-D model has been used reproduce the whole engine lay-out and able to estimate the performance of an engine fueled by gasoline-butanol blends.

This model has been used to predict the engine performances a partial load and for percentage of butanol greater than 40%. Several n-butanol/gasoline mixtures, differing for the alcohol contents (B0, B20, B40, B60, B80, B100) been analyzed.

Results show that both torque and indicated efficiency decrease when small quantities of alcohol are added to the gasoline. On the contrary, when the engine is fueled by neat n-butanol, torque and efficiency reach values about 2 % higher than those obtained with neat gasoline.

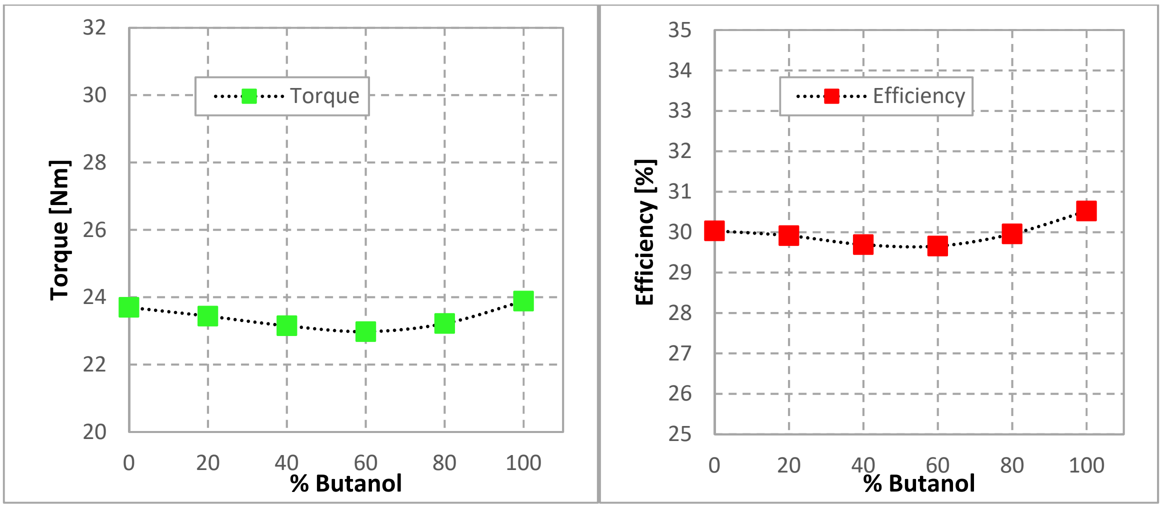

Figura 2 - Torque (right) and Engine efficiency(left) versus Butanol concentration.

Furthermore, the optimal spark timing, for alcohol-gasoline mixture operation, must be retarded (up to 13 %) in comparison with the correspondent values of the gasoline operation.