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Downsizing and Biofuels: Synergies for Significant CO_2 Reductions

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Summary

Downsizing and the use of the correct biofuels are both proven ways to reduce the well-to-wheels CO_2 emission of gasoline engine driven vehicles. For Downsizing to maintain full-load performance, pressure charging is required. This often results in a compression ratio reduction and an increase in over-fuelling at full load in order to protect exhaust components. Biofuels, which generally have higher octane ratings, seem therefore ideal for aggressively downsized engines, resulting in high levels of synergy.

Ethanol and butanol blend concentrations ranging from 10 to 85% were selected to exhibit consistent octane ratings between each other and two conventional gasoline fuels. An unmodified contemporary passenger car, with a turbocharged gasoline engine, was used to examine the effect of a variety of gasoline/alcohol fuel blends on its performance. These vehicle tests provided a baseline for both the NEDC and Artemis drive-cycles. Comprehensive drive-cycle modelling, based on accurate fuel flow data obtained during testing of the MAHLE downsized engine, indicated that very significant CO_2 reductions are possible under various driving conditions.

Drive-cycle modelling was also used to investigate vehicle transient response, which is key to successful downsizing. A model was developed, and is presented here, to predict the torque build-up of a turbocharged engine. The successful implementation of this model allowed results from transient engine dyno testing to be translated into vehicle acceleration times.

The result of this analysis is the recommendation of suitable fuel and technology combinations for the development of passenger car engines, for the short to mid-term time frame, that deliver a significant reduction in CO_2 while maintaining “driveability”. It was shown that tank-to-wheel reductions of up to 40% in CO_2 emissions are possible with currently available technologies, across both the NEDC and more realistic drive-cycles such as the Artemis cycle. The correct biofuel blends with RON levels between 100 and 102 offer the majority of the benefits and were shown to enable significant further tank-to-wheel CO_2 reduction potential.