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Enhancement of internal combustion engine performance and cycle efficiency by optimizing the exhaust system based on simulation models

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The exhaust system is an indispensable part in any internal combustion engine, being responsible for the scavenging of burned gas discarding the excess heat. The exhaust system can extremely affect the engine cycle efficiency, where the pressure waves can ease or disturb the gas scavenging process. Small changes in both diameter and length of the exhaust headers lead to sensible variations in the engine's performance. A proper manifold design can save significant amounts of fuel. Thus, the focus in this paper will be comparing the various designs of exhaust headers and representing their effects on the engine performance. A wide range of designs are modelled in this paper, which will aid in optimising exhaust systems. An analytical approach is used to determine the most efficient exhaust headers design. The engine is modelled based on a Honda CBR 600 RR with a modified intake system, where a restrictor is installed at the air inlet, while the power train is modelled to simulate a formula student car. The model simulates the engine and its effect on the car's overall performance. Various exhaust configurations are implemented using this model, in order to demonstrate the effects on power, torque and efficiency for each design. The results show that simple modifications to the exhaust headers can save a considerable amount of energy compared to the conventional design, and in the same time maintaining a better engine performance.

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Novel method of atomization of automobile fuels into micro-droplets

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Fine droplets have developed surfaces offering enhanced rates of heat and mass transfer and result in higher efficiency of performance of automobile engines. Recently, new method of generation of mists of ultra-fine droplets has been developed in our laboratory. The invented liquid-atomization process is based on formation of ensembles of micro-sprays, and includes disintegration of bubble shells on liquid surface by gas jets. In the experimental studies, a prototype device implementing the new atomization method was utilized to generate droplets of two types of automobile fuels: 1) petrol, having research octane number (RON) of 95, and 2) diesel. The dispersant of the fuels was compressed atmospheric air supplied at room temperature and pressures in the range of 2-3.5 bar. The obtained droplet size distributions and droplet concentrations were measured using a Malvern Spraytec device. Flow rates of the generated droplet mists were examined by means of continuous weighing the fuel container during the atomization. The prototype device allowed production of ultra-fine mists of petrol droplets of 0.4-0.6 μm Sauter mean diameters (the corresponding arithmetic mean diameters were 0.2-0.3 μm) with volumetric concentrations in the range of 13-21 ppm and flow rates of 340-500 mg/s. For the diesel fuel atomization, the obtained mists had Sauter mean droplet diameters of 2.1-2.3 μm (arithmetic mean diameters among 0.4-0.6 μm), volumetric concentrations of droplets in the range of 22-27 ppm and flow rates of 20-45 mg/s.

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