INVESTIGATION OF AN EXHAUST FLOW AND DESIGN OF A NEW EXHAUST VALVE FOR AN INTERNAL COMBUSTION ENGINE

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In order to improve the efficiency of an internal combustion engine, the flow during exhaust process; when burning gases leave the combustion chamber and go through the exhaust pipe; is investigated (Fig. 2). The main parameters, that influence engine efficiency, during the exhaust stroke are thus mass flow rate and pressure loss. The objectives of this study is first to understand and improve the flow parameters by local geometrical changes and then from this results to deduce different new exhaust valve designs.

The first part corresponds to the numerical study of the exhaust geometry and flow using a CFD solver developed at VKI (Thor). The valve optimization is mainly studied in 2D and for a lift (valve opening) of 10mm. Then the different improvements are checked and validate for the full lift range. From the multiple computations made, it has been proved that it was possible to improve efficiency of the exhaust process by local geometrical changes. Despite the fact that 2D and axisymmetric configurations show large differences in the flow topology, the conclusions obtained in 2D are also valid in axisymmetric for the geometries tested.

From this numerical investigation, two interesting designs were retained. The first one corresponds to modifications of the valve curve and allows great improvement of the pressure loss regardless of the mass flow. The second one modifies the combustion chamber angle to allow improvement of the mass flow for certain lifts. (Fig. 1)

Finally to complete the computations; experiments were conducted in a 2D test section under steady conditions. For this, the setup has been improved with respect to real engine conditions at the inlet (cylinder pressure) and at the outlet (exit pipe pressure). The full range of lifts has been tested with Schlieren visualizations of flow combined with pressure and temperature measurements. By this way it was possible to visualize the effect of the back pressure control. These tests showed good agreement (see Fig. 3) with computations suggesting that our code (Thor) is reliable for the next step which is a full multi-objective optimization. The facility has been then prepared and calibrated to implemented for experiments the two new valve designs. Schlieren visualizations, pressure and temperature measurements will allow characterization of the efficiency of the new designed shapes.

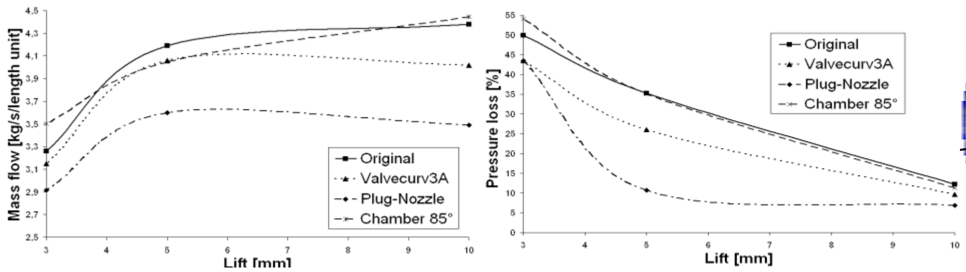

Figure 1: Mass flow & pressure loss for from 2D computations

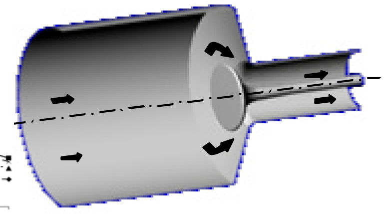

Figure 2: Exhaust modelling

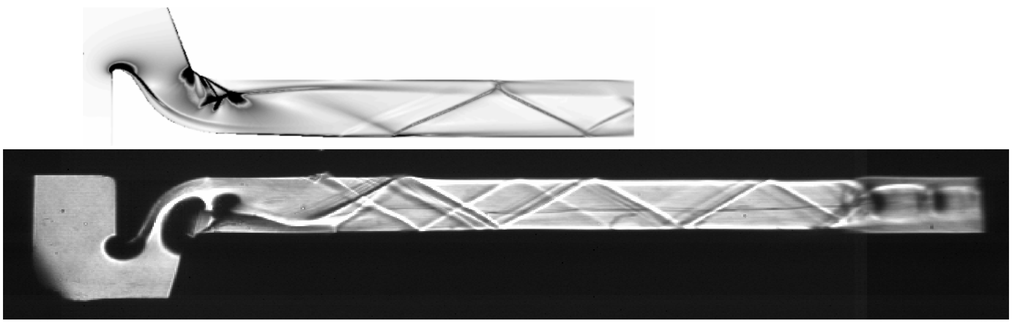

Figure 3: Schlieren visualization compared with density results from the lift 10mm computation.