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Impact of intake manifold design on intercooler efficiency in turbocharged internal combustion engines

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Introduction

The efficiency of the intercooler in turbocharged vehicles is a critical factor in modern engine performance. By cooling the compressed air before it enters the engine's combustion chambers, the intercooler increases air density, improving the air-fuel mixture and enhancing power output. This process not only boosts engine performance but also contributes to better fuel efficiency and reduced emissions, making it an essential component in high-performance and environmentally conscious automotive engineering. In these studies, advanced measurement methods such as Computational Fluid Dynamics (CFD) and software like ANSYS Fluent were utilized to analyze and optimize the performance of the intercooler.

Three geometric models of the simplified piping supplying air to the intercooler were made. The intercooler itself consists of 5 segments of the same dimensions (in order to simplify the numerical model, ribs were not made). The geomterical models can be seen in Figures 1, 2 and 3.

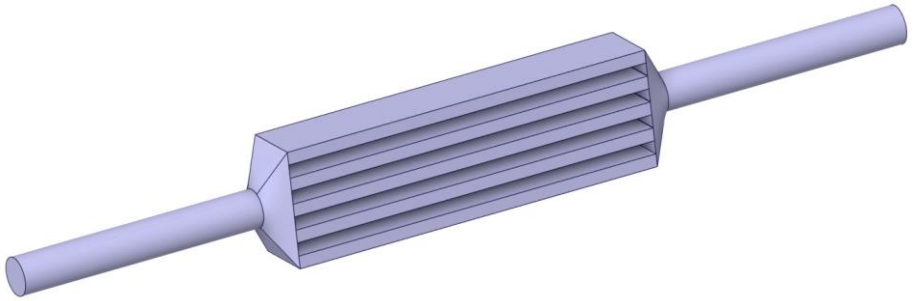

Figure 1. Geometric model with straight piping

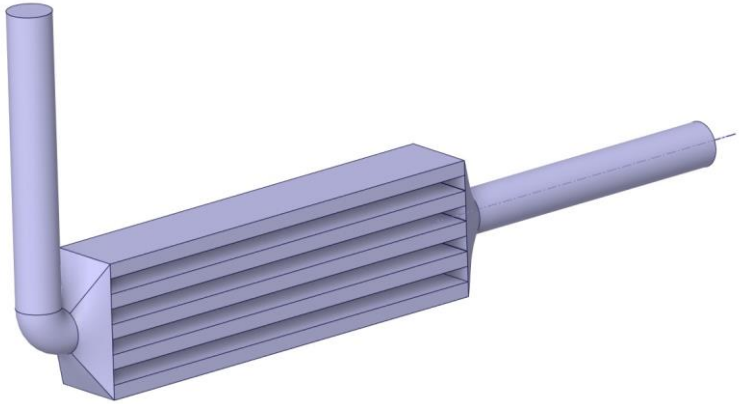

Figure 2. Geometric model with one 90 degrees bend

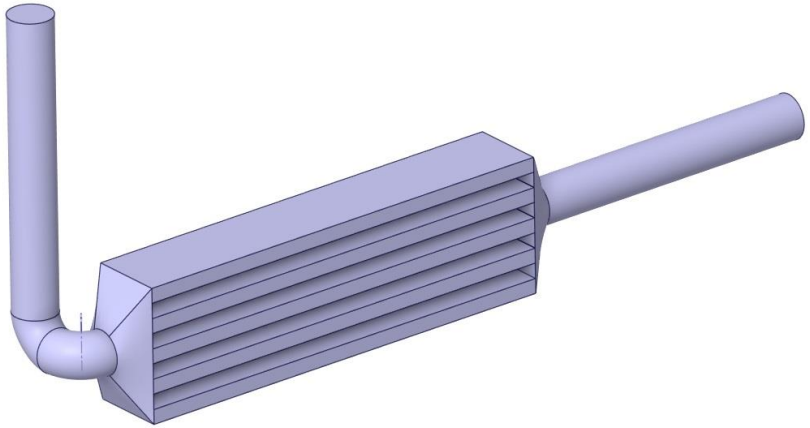

Figure 3. Geometric model with two 90 degrees bends

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Research and results

The discrete model used for the calculations consisted of about 20 million Poly-Hexcore elements. the mesh of the discrete model can be seen in Figures 4 and 5. the k-epsilon turbulence model was used, and 500 literations were made in each case, with residuals at the 10e-04 level.

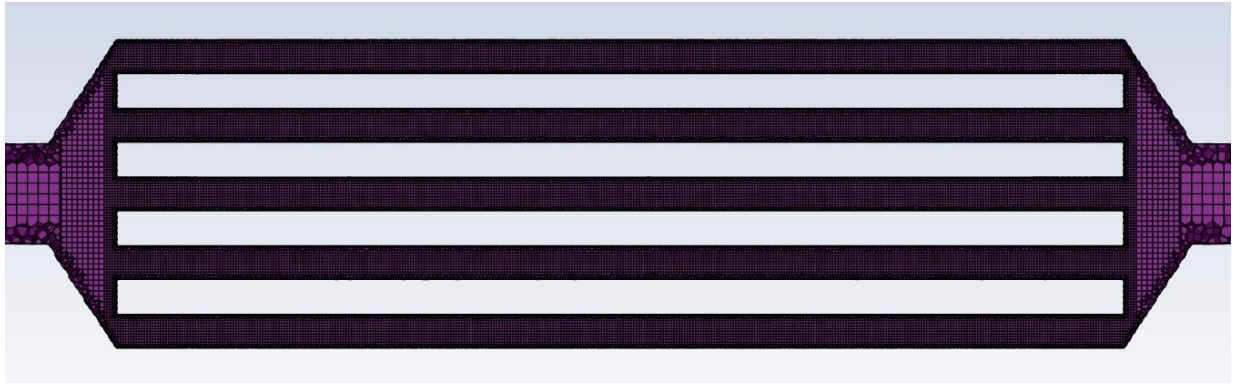

Figure 4. Mesh made of Poly-Hexcore elements

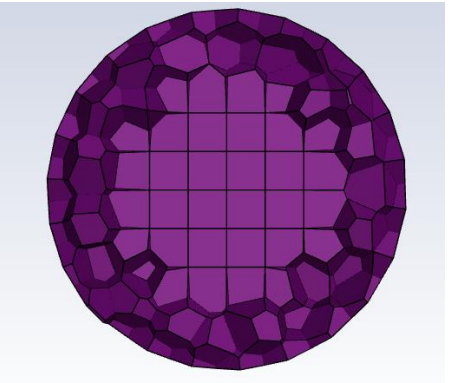

Figure 5. Mesh made of Poly-Hexcore elements

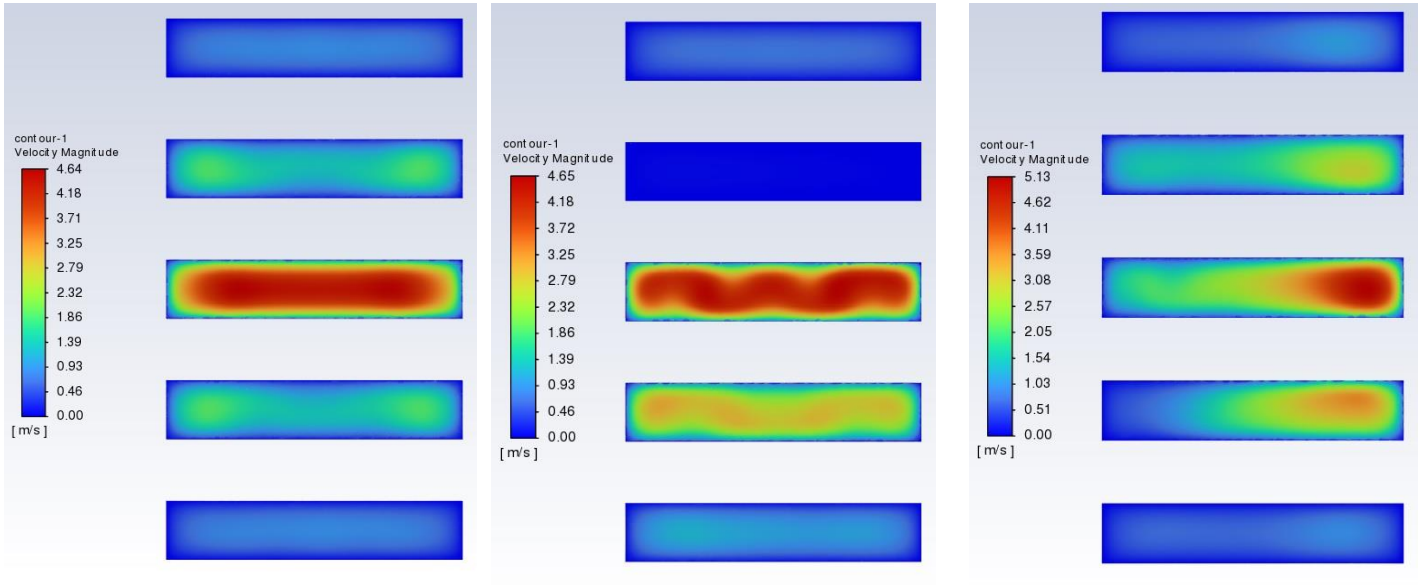

Figure 6. Results of calculations for individual piping geometries

The results of the measurements can be seen in Figure 6 a), b) and c). From them it can be seen that the shape of the piping has a significant effect on the speed of air flow in the intercoller. Consequently, on its efficiency because its surface area is not sufficiently utilized. This knowledge will be used in future research in the design of appropriate air guides that will allow more efficient use of the entire surface of the intercoller.

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