Altair HyperWorks
The Engineering Framework for Product Design™

CASE STUDY

HyperWorks CFD Optimization Increases Catalytic Converter Life and Efficiency for Eberspächer

Overview

To increase the product life and efficiency of its industry-leading catalytic converter, global automotive supplier Eberspächer GmbH used Altair's HyperMesh (the finite-element analysis [FEA] and computational fluid dynamics [CFD] pre-processor) and HyperStudy (the solver-neutral design study and optimization tool). Both are part of HyperWorks, the engineering framework for product design. Combining the morphing capabilities of HyperMesh with HyperStudy, Eberspächer redesigned the shape of its catalytic converter to increase the flow uniformity and decrease the pressure drop. The redesign, in turn, increased product life and efficiency.

Eberspächer

Business Profile

Founded in Germany in 1865, Eberspächer is one of the world's leading manufacturers of exhaust technology, pre-heaters and auxiliary heaters for passenger cars, transporters, trucks, buses, construction vehicles and boats. With 6,000 employees, Eberspächer operates in 16 countries and partners with the world's major automotive manufacturers.

"Using HyperWorks, we significantly cut development time by automatically optimizing the exhaust gas system."

Dr. Joachim Braun
CFD Senior Analyst
Eberspächer GmbH, Germany

Challenge

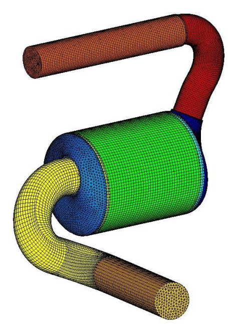

Fig. 1 *Exhaust Gas System*

While internal combustion engines are widely used, especially in the automotive industry, a major drawback of these engines is their production of pollutant emissions, such as carbon monoxide, unburned hydrocarbons and nitrogen oxide. Catalytic converters are used to transform these pollutants into less harmful products. To maximize the performance of a catalyst, the shape of the exhaust system must be optimized under fluid dynamic aspects. The flow should be as uniform as possible in the cross-section of the catalytic converter, and the total pressure drop between the inlet and outlet of the exhaust system should be minimized. CFD is applied successfully to understand and analyze the flow features in catalytic converters. In the traditional design method, the geometry is modified in a CAD system according to the results of the CFD simulation, and then remeshed. This approach is time-consuming and prone to error. Furthermore, because mathematical optimization strategies are not used, an optimal design is not guaranteed.

Solution

The catalyst design process was automated using HyperWorks' HyperMesh and HyperStudy. Because HyperMesh is capable of doing parametric mesh-based shape changes (morphing), no CAD data is needed during optimization. In this method, first HyperStudy updates the shape variable values based on the optimization algorithm. Then, the morphing technology of HyperMesh updates the CFD model. Finally, HyperStudy submits the CFD analyses. This loop is repeated until an optimum design is found. In the redesign, shape features, such as bend curvature, entrance diameter and inlet cone width are varied to maximize the flow uniformity. Additionally, the pressure drop over the exhaust system is constrained.

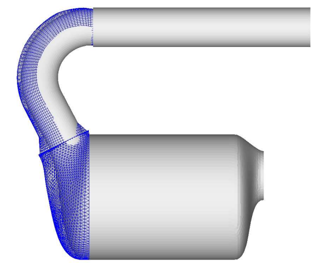

Fig. 3: *Comparison of the initial design (shaded) and the optimized design*

Results

The optimization method offered a design that has a 12-percent higher uniformity index and a 16-percent lower pressure drop (Figure 2). The optimized design has a larger inlet cone and a wider bend (Figure 3). Figure 4 shows the absolute axial velocity contours in the inlet cone for the initial and the optimized designs. The increased uniformity index extends the efficiency of the catalytic converter, whereas the decreased pressure drop reduces the power lost by the exhaust system. With CFD optimization, engineering time is also reduced because this method requires less user interaction.

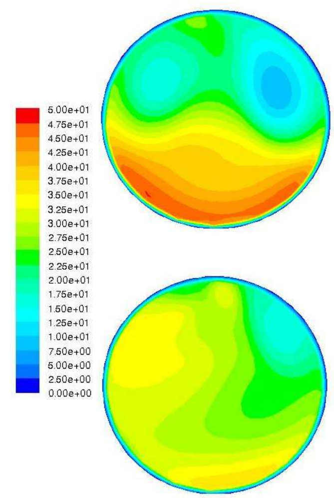

Fig. 4: *Absolute axial velocity contours in [m/s] in cross section of the original design (top) and the optimized (bottom)*

Benefits

Using HyperStudy to perform design studies, Eberspächer not only was able to produce an optimum design, but also reduced engineers' time to do repetitive and non-value-added work, such as creating new CAD files and re-meshing. Moreover, the new catalytic converter is more efficient and has a longer life.

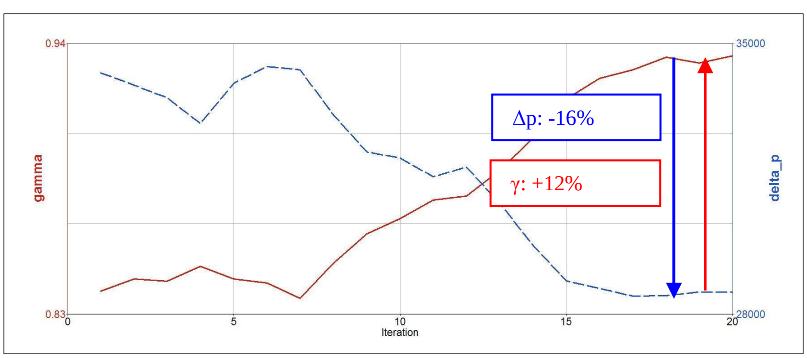

Fig. 2: History of the uniformity index γ and the pressure drop Δp

Altair HyperWorks

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