Altair HyperWorks
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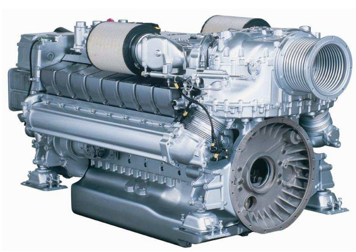
A Tognum Group Company

CASE STUDY

HyperWorks CFD Optimization Helps MTU Improve Diesel Engine Compressor Blade Performance



Overview

To increase turbo charger efficiency, global diesel engine supplier MTU Friedrichshafen GmbH combined Altair's HyperWorks computer-aided engineering (CAE) software suite with a computational fluid dynamics (CFD) solver. Combining the morphing capabilities of HyperMesh (the pre-processor for finite-element [FE] analysis and CFD) with HyperStudy (the solver-neutral design study and optimization tool), MTU redesigned the shape of the compressor blades to improve pressure gain and efficiency. The redesign, in turn, increases the fuel efficiency of the engine.

Business Profile

MTU Friedrichshafen GmbH supplies diesel engines and complete drive systems for ships, heavy land and rail vehicles, industrial applications and decentralized power generation plants. Covering diesel engines from 20 kW to 9,100 kW and gas turbines, the range of products is one of the most modern and wide-ranging in the sector. To control and monitor its engines and drive plants, the company develops and manufactures its own custom-tailored electronic systems.

"Including HyperWorks and CFD in the design process cuts development time and enables us to perform automated design and optimization studies."

Dr. Mario Dittmann,
MTU Friedrichshafen GmbH

Challenge

The purpose of an engine compressor is to increase the fluid pressure by transforming the kinetic energy of the flow into pressure. An important system component is the rotating impeller for flow acceleration, Fig. 1. The geometric shapes of its blades have a strong impact on the overall performance of the system. The goal is, therefore, to optimize the blade layout for maximum pressure gain.

Fig. 1: *Impeller of a radial compressor*

Traditionally, blade design optimization is a manual process. The geometry is modified in a CAD system, re-meshed in a pre-processor and analyzed using CFD simulation. The process usually takes multiple iterations to achieve an optimal design.

Solution

The compressor blade design optimization process is automated using HyperMesh and HyperStudy in combination with a CFD solver. Based on the numerical grid of the initial design, HyperMesh's morphing technology is applied to generate shape variants ("shapes"). The linear combination of different shapes yields new designs without the need to re-mesh the model. HyperStudy optimizes the blade shape for maximum pressure ratio by running subsequent CFD analyses with updated shape variable values. Using advanced optimization algorithms, HyperStudy automatically finds the best blade design for the given pressure ratio problem.

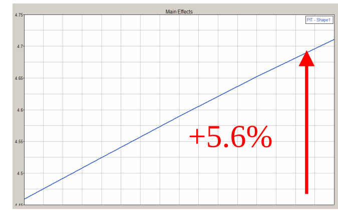


Fig. 2: *Increase of the pressure relation for the optimized design*

Results

As a result of the optimization process, the pressure ratio between inlet and outlet was increased by 5.6 %, compared to the initial design shown in Fig. 2. For the optimized design, the trailing edges of the splitter and the main blades are moved in the rotational direction of the compressor. The increased pressure ratio is used in the charging process of the downstream-located engine and results in a higher engine power and better fuel efficiency.

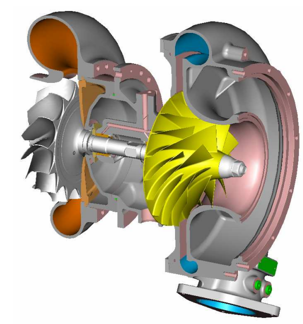


Fig. 3: *Radial compressor with optimized impeller (yellow)*

Benefits

- Better design performance: 5.6% pressure ratio increase.
- More efficient process through use of automation and mathematical optimization.
- More robust design process since the solution is independent of the experience of the designer.

Altair HyperWorks

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