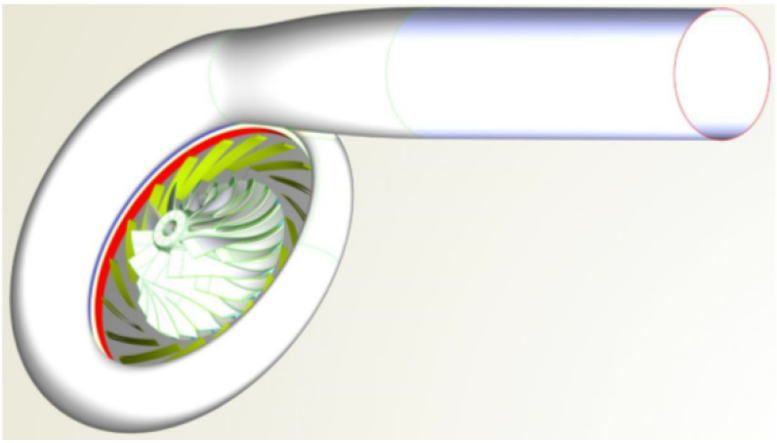
Hessisches Kompetenzzentrum
für Hochleistungsrechnen

Efficient Gas Engines for Maritime Applications of the Next Generation



Introduction

Not only in automotive and aviation industries, but also in shipping the engine manufacturer are forced by new environmental standards to increase efficiency and reduce emissions. The forced induction of internal combustion engines by turbochargers is playing an important role in this process. New engine concepts like gas engines having increased requirements on the turbocharger and therefore require new design methods. [1]

Goal of this project is to extend the existing design process of centrifugal compressors, which is based on 1-dimensional design techniques or the scaling of existing compressors, by a process chain for an automatic design optimization with the aid of high resolution threedimensional computational fluid dynamics. This extended design philosophy will be utilized to optimize an existing centrifugal compressor with a vaned diffusor in terms of surge margin and efficiency. Simultaneously, Computational Structural Mechanics will be carried out to ensure the components' structural integrity. All the obtained knowledge will be used to identify lossincreasing design features and to formulate novel design guidelines. [1]

Methods

The aerodynamic evaluation of the designs is done by using a finite volume discretization and the Reynolds-Averaged Navier-Stokes equations. The structural integrity is checked by an finite element approach. The overall optimization is carried out using evolutionary algorithms combined with response surface models.

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Researchers
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Project Term
2019 - 2020

Clusters
Lichtenberg Cluster Darmstadt

Software
Python

Additional Software
Altair Simlab , Calculix , Esteco ModeFrontier , Numeca (Fine/Turbo, IGG, IGG-Autogrid and CfView) , CAESES

Institute
Gasturbinen, Luft- und Raumfahrtantriebe (GLR)

University
Technische Universität Darmstadt

Partners
MTU Friedrichshafen, NUMECA Ingenieurbüro, Friendship Systems

Funded by

BMWi

Figures

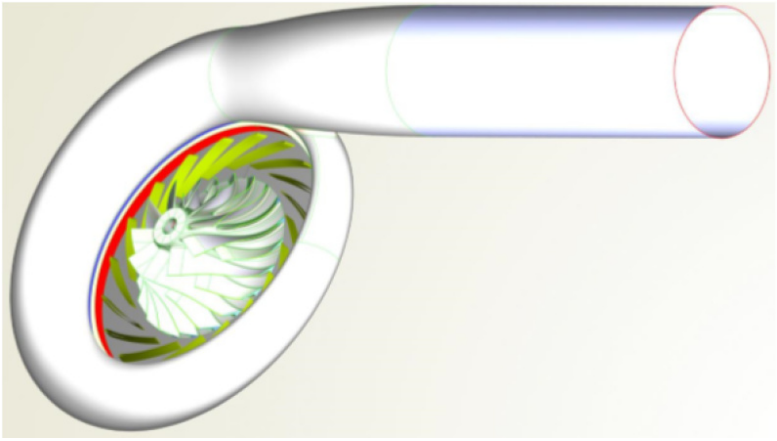

Figure 1: Parametrized geometry model of impeller, diffuser and Volute

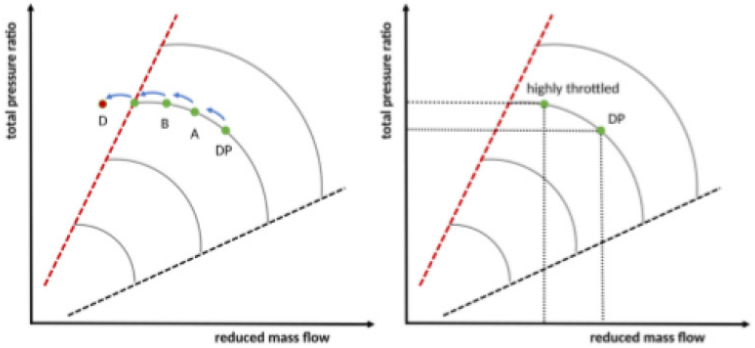

Figure 2: Evaluation of the surge margin. Left: iterative evaluation, Right: estimation

Publications

J. Ratz; S. Leichtfuss; M. Beck; H.-P. Schiffer; F. Fröhlig: "Surge margin optimization of centrifugal compressors using a new objective function based on local flow parameters", Proceedings of 13th European Conference on Turbomachinery Fluid dynamics & Thermodynamics, Lausanne, Switzerland; April 8-12, (2019). https://doi.org/10.3390/ijtpp4040042

Ebert, F.: "3D-CFD Geometrie- und Strömungsfeldanalyse einer Radialverdichter Designdatenbank mittels Korrelationsfunktionen" (2019).

Schneider, P.: “Evaluation und Weiterentwicklung einer Auf Basis lokaler Strömungsgrößen definierten Zielfunktion für die Optimierung von Radialverdichtern hinsichtlich des Pumpgrenzabstands” (2019).

Reference

[1] Projektbeschreibung zum Programm des BMWi: „6. Energieforschungsprogramm“, (2016).

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