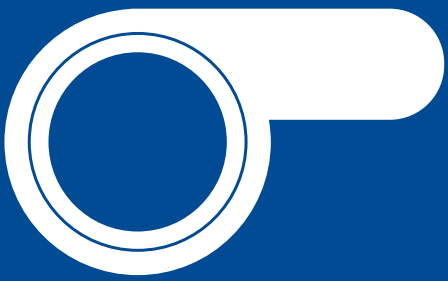


ReSiSTant

Industrial Compressor

1 BIONIC SURFACE TECHNOLOGIES

2 Fraunhofer IFAM

3

4 IDONIAL

5 Lufthansa Technik

6 MAN Energy Solutions

7 nanto cleantech SINGULARITY MATERIALS

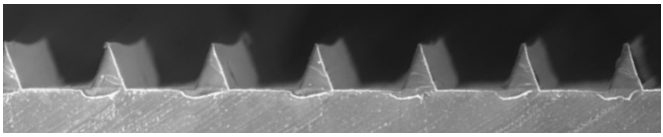
8 RINA

9 IKDG | RWTH AACHEN UNIVERSITY

10 TU Graz Graz University of Technology

Background & Motivation

The overall goal of the project is to achieve an increase of efficiency of 1% in both pilots.



The project is divided in three main parts: First, the investigation and prediction of the aerodynamics as well as feasible riblet geometries, including their benefit on the efficiency. Second, testing and evaluation of possible coating materials in the needed size range and operating conditions as well as tests with and without the riblets in the test rig to confirm the predicted improvements. Third, validation of riblet structures applied on pilot machines to investigate their behavior in real-life applications.

Aerodynamics
. Calculation of Riblet-Geometries
. Numerical simulation of Riblet-Effect
. Determination of number of Riblets and position

Materials & Application
. Feasibility study of different material and application techniques
. Development of Riblet material for industrial compressors
. Nanofunctionalization & -structures for industrial compressors

Testing & Evaluation
. Test rig for industrial compressors
. Tests w / wo Riblets
. Pre-evaluation for materials and nanofunctionalization

Assessment of Testing and Material-Application
. Selection of material & application technology
. Selection of Riblet-structures
. Selection of type of nanofunctionalization & - structures

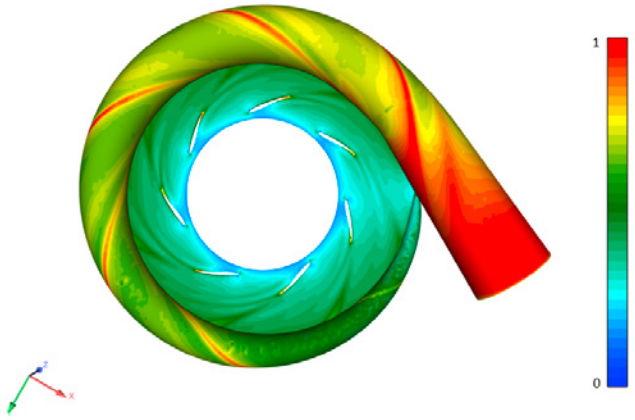
Demonstrators and production prototypes
. Production of Riblet-coated parts for demonstrators
. Tests at demonstrators

In-service tests operation of demonstrators and business case evaluation

Concept & Approach

MAN Energy Solutions participates in the ReSiSTant project with its Competence Centre Centrifugal Compressors located at Zurich as part of the R&D and production network, which is leading all centrifugal compressor research and development actions. In this context, it is ensured that all research activities are in line with global design practices, latest standards and state-of-the-art achievements in turbomachinery.

MAN Energy Solutions intends to use the riblet technology in new commissioned compressors as efficiency is a selling point. Compared to conventional finishing processes such as manual grinding, this new application method is more economical and easier to implement. Thus, the next step in the ambition to deliver highest quality and reliability to competitive prices is achieved.
Through the worldwide MAN Energy Solutions service network, the new technology could also be implemented all over the world in operating machines and running facilities, which could therefore operate more efficient and with lower emissions.

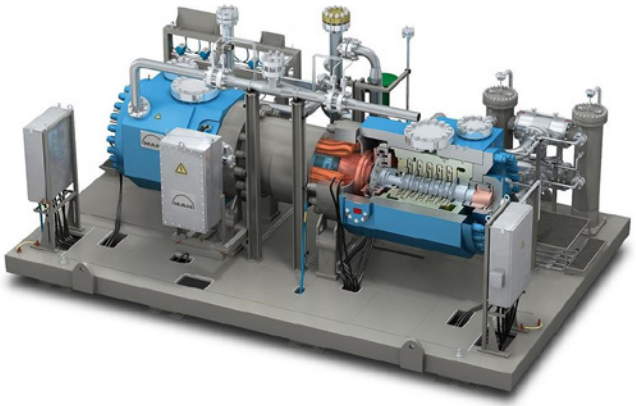


RWTH Aachen provides not only the needed test rig for the coating validation, but also valuable expertise on measurement methods to detect the efficiency increase. The investigation of the riblet effect in a wide range of compressor operation is based on a thorough aerodynamic analysis of the compressor flow.
The size and direction of the riblet geometry are obtained via the patented algorithm of BST within the scope of CFD-simulations. The corresponding performance characteristic is experimentally validated with the certified riblet test bench at BST.

Technology & Demonstrators

Nevertheless, future processes have to become even more efficient, flexible and reliable to achieve the goals of the climate friendly energy supply system in Europe, as the annual energy consumption is predicted to steadily increase.
Improved surfaces and coatings using nanoparticles offer a great potential to achieve increased efficiency, reliability and multiuse functionality. Adapted from sharkskin textures, so called riblet structures were developed based on nanotechnology and biomimetics. They reduce the drag of the fluid on the wetted surfaces, resulting in lower wall shear stresses thus higher efficiencies. Furthermore, these riblet structures can be applied during maintenance via a coating with imprinted structures. Further surface improvement can be achieved with nanoparticles added in the coating or as additional layer.

To validate the benefits of such coatings, two phases of testing are required: Firstly, their performance is thoroughly examined in a model test rig, in the second step the effects are observed in a full size pilot compressor.



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