Rotating Machines and innovative noise control

KTH CCGEx

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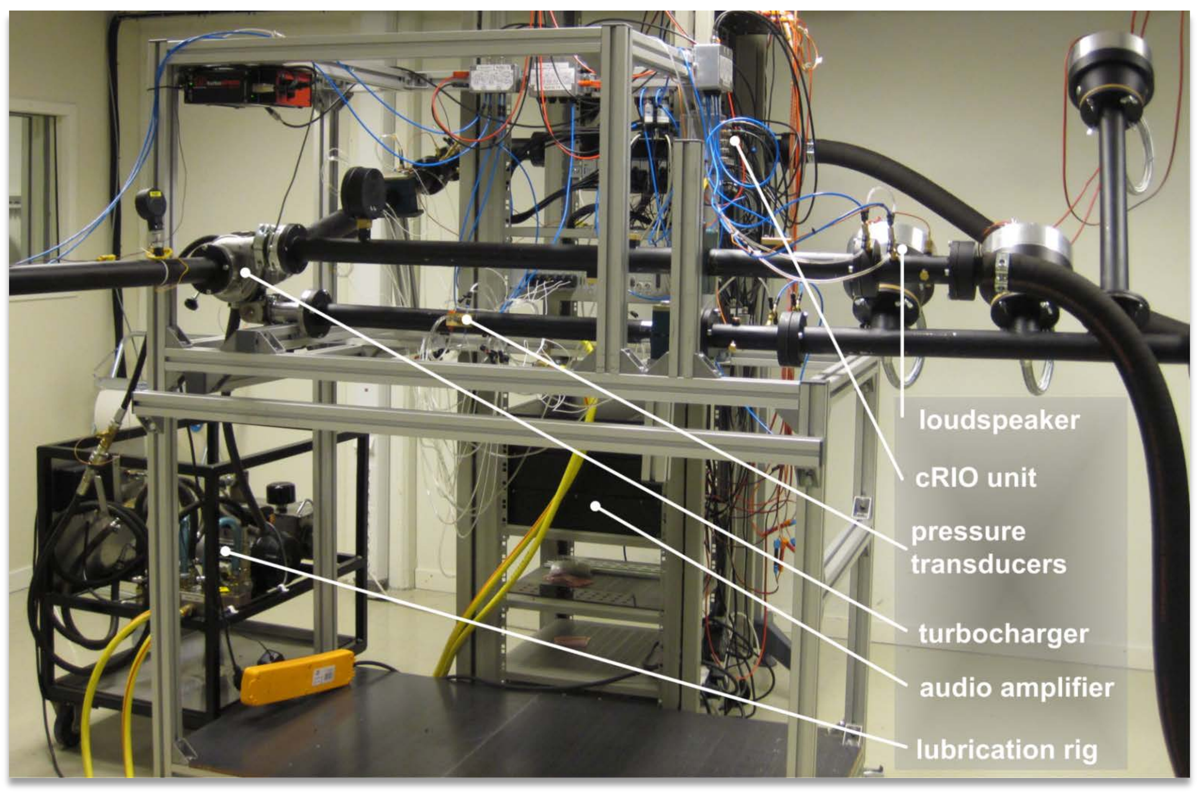
The goal of this project is to develop improved techniques for studying scattering and generation of sound in centrifugal compressors. In particular, to extend previous work to more in depth investigation in unstable flow and sound field coupling including the in-duct sound generation. The experimental work is performed in the unique turbocharger test facility at KTH CCGEx by implementing advanced experimental tools and procedures. In addition, innovative flow channel liners consisting of micro-perforated plates or metallic foams are treated in complementary noise control studies. The investigation involves experimental study of acoustic liners on dedicated high temperature test rig and numerical analyses by means of Comsol Multiphysics® FEM software. The efforts are being taken to determine high temperature acoustical properties as well as to find techniques for the optimization of such noise control solutions. The work is part of a Marie-Curie network on aero-acoustics named FlowAirS (see www.flowairs.eu).

Introduction and Motivation:

Turbochargers (TC) are essential components of modern “rightsized” internal combustion engine units. Although, the principle of TC originates from the early 20th century, two restrictive problems are still encountered today – the high level of compressor noise and compressor surge.

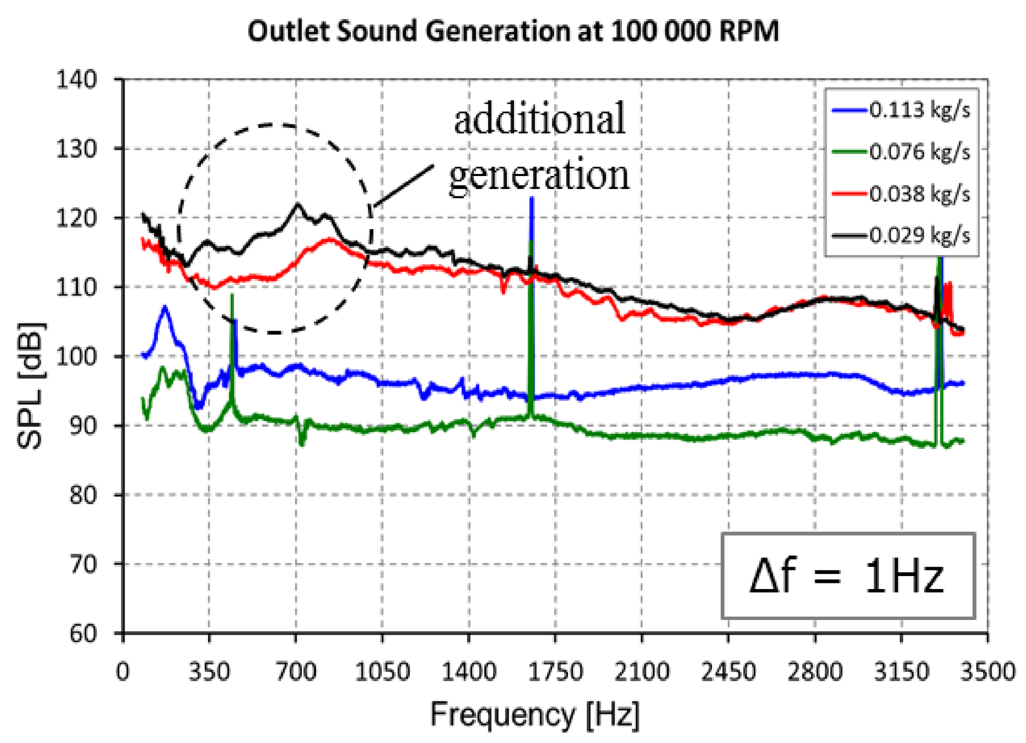
In order to achieve effective noise control, the accurate source characterization data i.e. the acoustic source data independent of the coupled flow-channel system, must be know first. Moreover, it is also assumed herein that generated sound and passive acoustic properties of the compressor contour could play significant role in the surge initiation process. Therefore, the acoustic properties of the TC, including acoustical scattering and sound generation as well as the effects of flow-acoustic coupling, are studied herein by means of detailed and accurate methods. In addition, the optimization techniques for innovative noise control materials, enabling compact jet effective noise control, are also developed.

Setup:

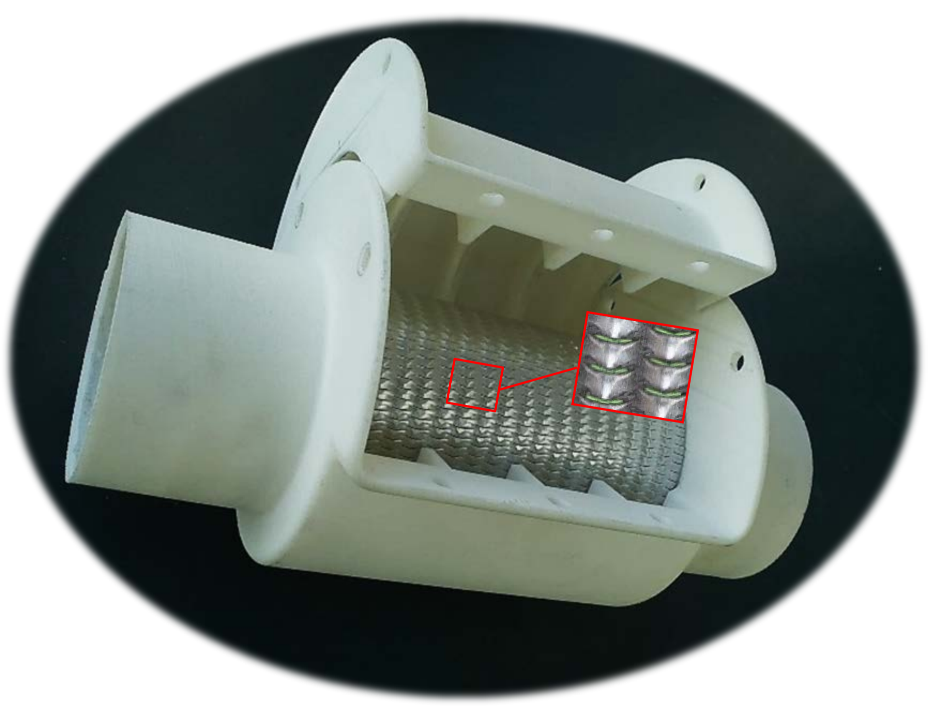


The TC acoustic characterization facility at KTH CCGEx (See the photo) have been used to determine accurate acoustical scattering and source data (full two-port data) at realistic operating conditions.

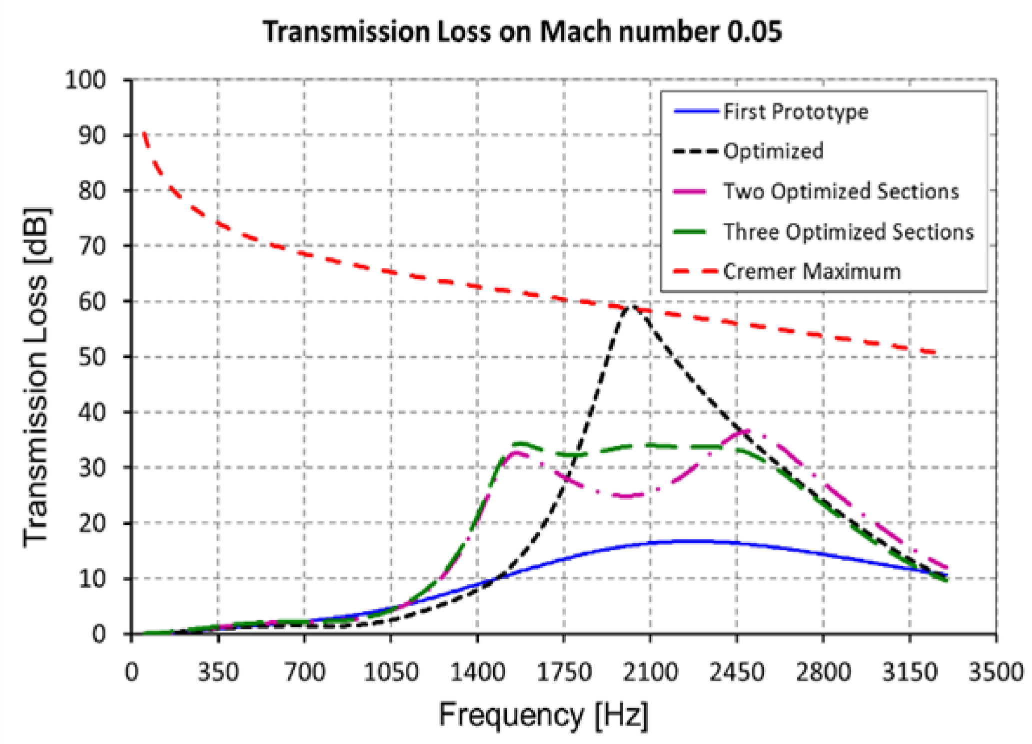
Results:



The sound pressure level (SPL) spectrum of generated sound in the outlet branch of the compressor at constant rotor frequency. The mass flow is varied from maximum to minimum i.e. near surge operation.



The prototype of compact silencer consisting of straight flow channel made of micro-perforated panel (MPP), and adjoining cavity. Such compact silencer concept can provide a very high level of sound dissipation.



Sound transmission loss spectra from the optimization of the compact silencer prototype. The optimization technique is based on so called Cremer optimal acoustic impedance concept.

Summary and Conclusion:

A high level of noise is increased further while operating the compressor near surge conditions which may require additional noise control. An effective noise control can be achieved by means of compact silencer concept when optimized according to the specific sound source. Moreover, the straight-flow compact silencer can provide a fibrous-free noise control with a negligible penalty of pressure drop.

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