STALL DETECTION AND INFLUENCE OF AIR INJECTION ON THE PERFORMANCE OF A SINGLE STAGE AXIAL COMPRESSOR

Taylan Ercan, Turkey
Supervisors: T. Arts & J.-F. Brouckaert

Adequate stability is an important feature of any compressor design. The desire to reduce compressor size, weight, and complexity by reducing the number of stages and eliminating variable vanes leads to higher loading per stage and more severe matching problems. For these reasons, there has been a fairly constant activity over the last decades devoted to early detection of compressor instability and to the development of active and passive techniques aimed at increasing stability. Many of these techniques feature injection of air into the tip region of compressor rotors, since high pressure air is readily available from compressor bleeds. The motivation is often to find what is the best compromise i.e. where to suck, where to blow and with which mass flow and how in order to design afterwards a passive treatment that does naturally this optimum configuration.

The first objective of this project was to detect stall in the R2 compressor by means of time resolved pressure measurements and to characterize the stall pattern by defining the number, speed and span of the rotating cells in the annulus. For this purpose, stall detection theory has been studied; new fast response probes according to the theory have been designed, manufactured and calibrated. Unsteady pressure measurements in and out of stall have been done at tip, mid-span and hub to characterize the stall.

The second objective of this project was to investigate the influence of air injection at the rotor tip on the stall margin and the performance of the compressor. For this purpose, an air injection system has been designed, manufactured and installed in the facility. Steady pressure and temperature measurements have been done to get the baseline configuration characteristics. Air with different mass flows, injection directions and injector numbers has been used and an optimum configuration has been defined to increase the stall margin. The performance parameters are compared with the baseline configuration to understand the influence of injection. An increase of 5% in the stall margin has been achieved with the optimum configuration of the injection.

The comparison of compressor characteristics with and without injection is given in the below figure.

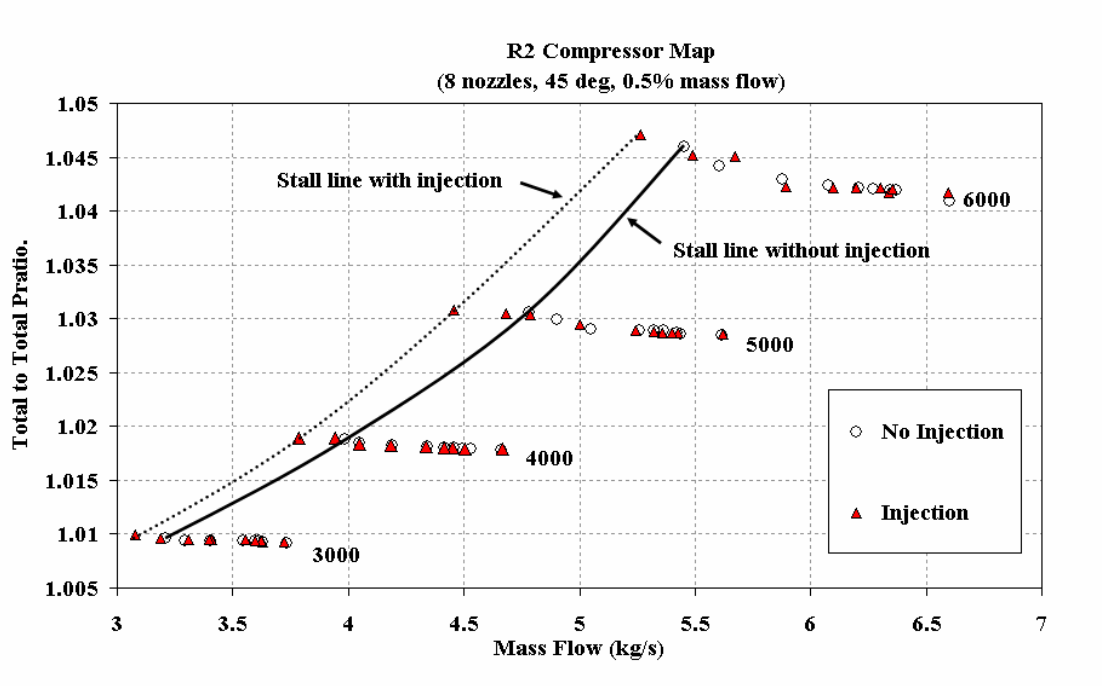

Figure 1: R2 Compressor Map