RMS
Rotating Machinery Services, Inc.

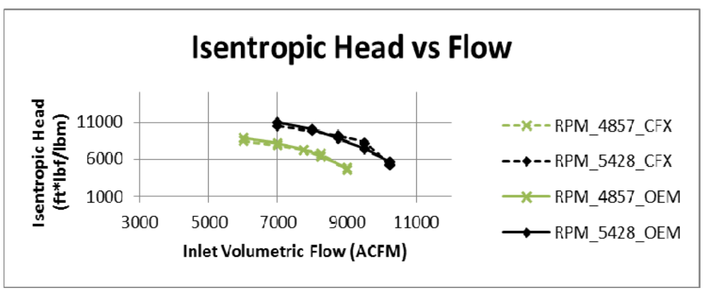
COMPUTATIONAL FLUID DYNAMICS

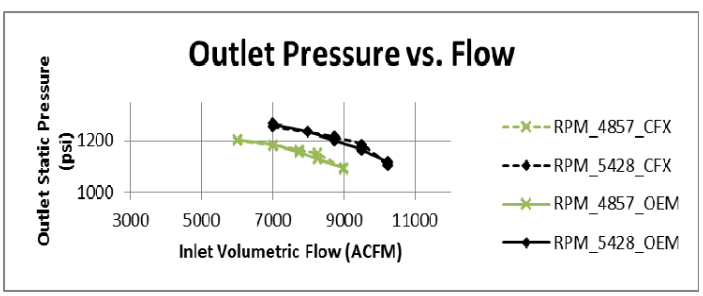
By Ryan Montero

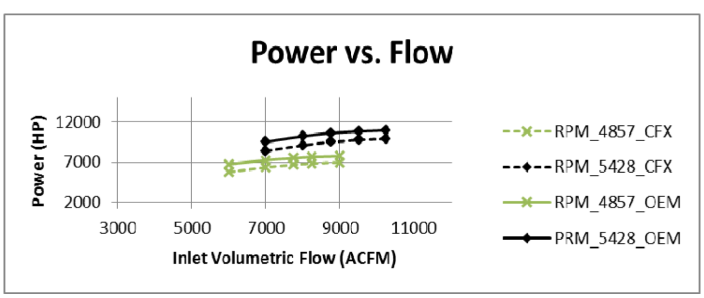
Current Computational Fluid Dynamics (CFD) software packages provide the user with the capability to accurately model the flow field through even the most complex of flowpaths. The flow is simulated by implicitly solving the viscous Navier-Stokes equations, vector equations which define fluid motion, over the domain specified by the user. Higher order CFD software has become increasingly popular as an engineering tool over the past few decades. Although the Navier-Stokes equations were produced in the 19th century, the computational power required to carry out the numerical solution has only become widely affordable recently. CFD software packages have proven useful as design tools in the Aerospace & Defense industry, the automotive industry, and many other fields where fluids are used for power generation. For turbo machinery, CFD analysis gives the user accurate predictions for flow conditions throughout the machine and expected machine performance. It also provides the ability to analyze and research more complex issues such as blade erosion and deposition.

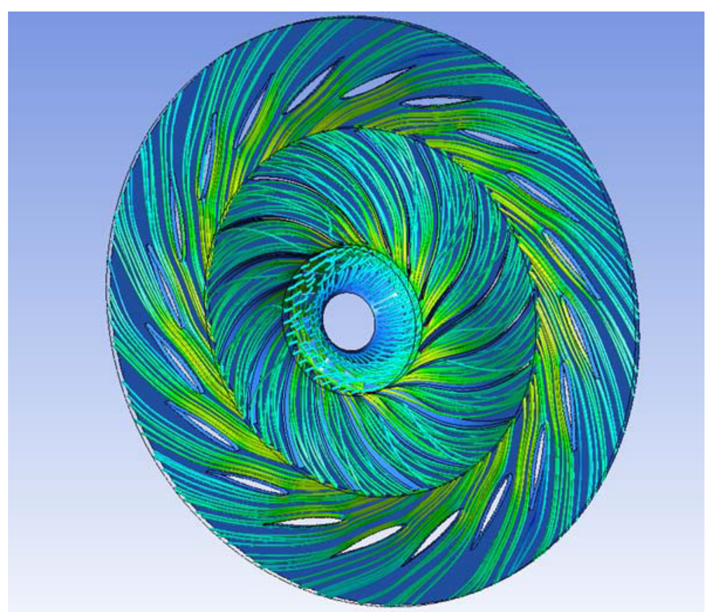
At RMS a performance study was done on an existing centrifugal compressor stage including the intake casing, rotating section, and diffuser. The goal of this analysis was to anticipate machine performance using the CFD software package called CFX. The parameters that were calculated by CFX were to be compared to existing values on a performance map of the existing machine in order to determine the OEM power map's expected intake and diffuser efficiency as well as expected mechanical losses.

The CFX model consisted of the existing rotating section, and a simple intake and diffuser. Machine speed and mass flow rate were varied and relevant quantities such as power, outlet pressure, and thermodynamic head were recorded for each point on the speed line. These recorded values were then overlaid, for comparison, on top of the existing OEM map. It is worth noting that the power calculated by CFX is gas power only and does not include mechanical and other parasitic losses.









As anticipated the results showed that while the outlet pressure and isentropic head values matched well between the CFX analysis and the OEM map, the power plots were significantly different. The OEM map values for required power were consistently larger than the gas power values calculated through CFX. The difference gives the engineer useful information on how the OEM estimated mechanical and other parasitic losses.

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