Centrifugal Impeller Axial Movement Study

Overview
The most critical component of a centrifugal compressor is the impeller which adds kinetic energy to the gas stream and is responsible for 60% of the static pressure rise. The impeller is fitted onto the shaft through a shrink fit approach where the impeller bore is heated either at the heel (back end) or the toe (front end), then the bore shrinks onto the shaft and locks into place. When high rotational speeds exceed a certain threshold, the contact status of the contact surface changes and causes the impeller to have a slight axial movement on the shaft. This movement affects the whole rotor which should be avoided.

Objectives
To ensure reliability of the impellers, the team is to determine the threshold speeds at which the impeller begins to move axially along the shaft using different shrink fit fit values. In addition, optimization of the impeller geometries is to be found to reduce the likelihood of axial movement.

Approach
- Analysis of impeller provided by Dresser-Rand is run in ANSYS Mechanical
- Shrink fit of 2 mils/inch is simulated through frictional contact and fixed at the center shaft
- Mesh of 0.2 in is applied through whole geometry with an extra fine mesh at areas of interest
- Rotational velocity input from 0-10,000 rpm is analyzed
- Threshold speed of original geometry and heel shrink fit of 2 mils/in is found
- Threshold speed of different shrink fit locations and values is found
- Geometry is altered on SolidWorks and analyzed in ANSYS to find optimal impeller geometry

Outcomes
- Threshold speed of original geometry and heel shrink fit value of 2 mils/inch is 5820 rpm. Safe operational speeds are between 0-5800 rpm.
- Shrink fit value of 2.5 mils/inch increased threshold speed by 700 rpm. Therefore, higher shrink fit values are recommended to improve reliability.
- Toe-fit is more reliable than a heel-fit
- Decreasing the heel increased the threshold speed. Whereas, increasing the heel decreased the threshold speed. It is recommended to decrease the heel to improve reliability.