IMPELLER PERFORMANCE CONSIDERATIONS WHEN SPECIFYING WELDING TOLERANCE

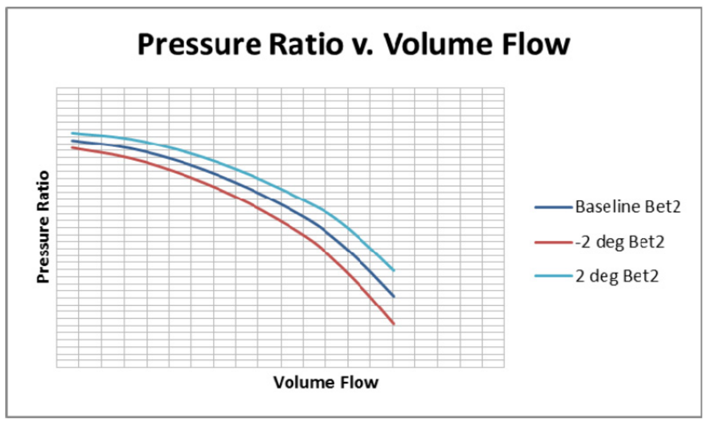
By Ryan Montero

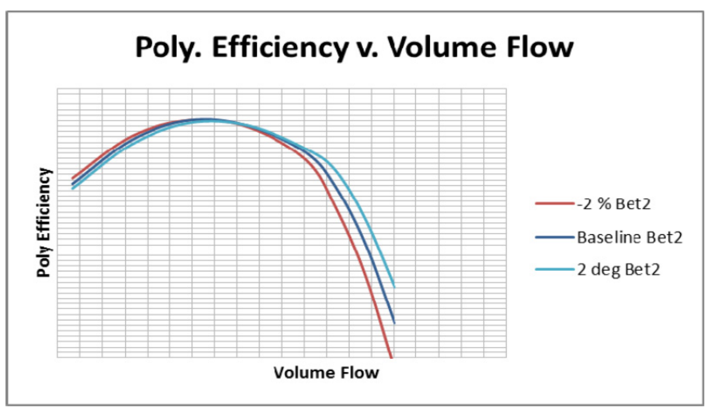
A unique, and sometimes troublesome, feature of centrifugal compressors is the complex shape of the working flowpath. Most other typical turbomachine configurations such as steam turbines, axial compressors, and expanders have more simple and "straight through" flowpaths where the machine is adding or deriving work from the gas. For many of these, the blades can be connected to the rotating shaft via slots which connect the root of the blade to the rotating disc. In the case of centrifugal compressors, especially those with covered impellers, the blades are typically welded in place onto the disc hub because of the unique and relatively complex shape of the flowpath. Much like the blades in simpler flowpaths, important parameters such as incidence angle, throat area, and discharge angle significantly affect machine performance. In order to ensure impeller performance, the specifications for the allowable deviation on the fabricated part from the drawing must be considered relative to the impact that deviation on each parameter would have on the impeller performance.

A brief study was performed to evaluate the sensitivity of centrifugal compressor stage performance to small changes in impeller geometry. This study gave valuable information on necessary tolerance values that minimize adverse effects on performance. A baseline case was generated and then each parameter was changed and compared to the original. The analysis for this study was completed using a meanline analysis package geared towards centrifugal compressors. A centrifugal compressor stage with a vaned diffuser and elliptical volute was created and was refined to match, within reason due to time constraints, the impeller performance of the third stage impeller in a known machine.

The parameters varied were: throat area, discharge passage width, inlet blade angle, and discharge blade angle. Throat area and discharge passage width were varied up to +/- 2% of the initial value while inlet and discharge blade angles were varied by +/- 2 degrees. Machine speed and inlet operating conditions were held constant while machine pressure ratio and polytropic efficiency were compared. The changes in inlet angle and throat area had very little effect on discharge conditions and machine flow rate (<< 1% difference).

The geometric parameters that showed the greatest sensitivity were discharge passage width and the blade discharge angle. The rate of flow change for deviation of discharge passage width was 1% of flow per 2% of width change. As seen in the figures below the discharge angle was much more sensitive at 2.2% of flow for every 1 degree deviation.





For more information:
Ryan Montero
Email: rmontero@rotatingmachinery.com
Tel: 484-821-0702

Headquarters
2760 Baglyos Cir.
Bethlehem, PA 18020

Houston Office
16676 Northchase Dr., Ste 400
Houston, TX 77060

rotatingmachinery.com
Tel: 484-821-0702
Parts: rms@rotatingmachinery.com

Rotating Machinery Services, Inc.