LNG Test Rig Movable LSD Vanes

Overview
Dresser-Rand is a major company within the centrifugal compressor industry. Gases are compressed in multistage centrifugal compressors to reduce the volume up to 400 times. At the outlet of the impeller, the flow travels through the diffuser portion of the compressor and energy is lost. Low Solidity Diffuser (LSD) vanes are used to smoothly align the flow and minimize the losses. These vanes are fixed at a certain angle, optimal only for a small range of flow conditions. When the flow conditions deviate from the optimum range, the vanes induce losses rather than reduce due to disruption of the flow.

Dresser-Rand uses test rigs to find the optimized angle and use it in the centrifugal compressors they produce for their customers. However, to test the efficiency of an angle, the entire compressor must be taken apart and the diffuser is switched with one of a different angle. This whole process may take up to 2 weeks costing time and labor. Dresser-Rand is looking for a diffuser design with movable vanes that can be adjusted remotely, removing the need to take the test rig apart.

Objectives
The objective of the project is to design a diffuser with movable LSD vanes that can be incorporated into test rigs for centrifugal gas compressors, with a few critical points to consider:

- The design should be robust and rigid to withstand the high flow pressure.
- Vanes should have a 35 degree range of angular motion (45°-80°).
- An actuation system should be able to change the vane angle remotely with a sensitivity of 0.1 degrees.
- Eliminate gas leakage through the diaphragm.

Approach
- A site visit was performed to understand the design problem and define the customer needs.
- Team members generated design concepts and selected the concept that most suitably satisfies the customer needs.
- A detailed CAD model was made in Solidworks and theoretical analysis was performed through Solidworks, Ansys, and hand calculations to validate that the design meets the objectives.
- Materials for the prototype were chosen and were procured.
- A prototype was manufactured while updating the sponsor about progress and potential design changes to ensure the needs were being met.
- Testing was performed on the prototype to check for vane sensitivity.

Outcomes
- Successful design implementation eliminates leakage and allows precise vane movement.
- Robust design will ensure repeatability.
- Implementing this new design will save Dresser-Rand hundreds of hours of down time.
- Minimal modifications necessary to incorporate design into functioning test rigs.