Case Study #6: 2D RCD Seals

Challenges:

- Accurately model different states of RCD seals
- Build better knowledge base

Results:

- Accurately calibrated and validated RCD seal models so deformation modes were captured

Summary

Rotating Control Device (RCD) seals are devices used to control pressure during drilling. In order to gain a better insight of the RCD seal, MindMesh explored avenues to improve the seal design and expand our knowledge base of the seal. Used for both offshore and onshore drilling, this device makes a seal around the drill string while the drill string rotates and contains wellbore fluids under pressure (Fig. 1). The RCD seal prevents the release of these fluids while being used.

Fig. 1: *2D Axi-symmetric model of RCD seal used for our analysis*

About the Client:

This client is a leading RCD seal manufacturer and is the industry's fourth largest provider of oil and gas services. One of the main focuses of this industry leader is to provide its clients with some of the industry's best rates on services with minimal risk. Offering several models of the RCD seal, this client provides options for their consumers and ensures needs are met for a variety of drilling operations. This company is always expanding and exploring new and innovative ways to stay at the forefront of their expertise.

Challenge:

RCD seals are extremely important and act as a secondary barrier to contain wellbore pressure during drilling operations. The purpose of analyzing these seals was to gain knowledge and interpret the data gathered. Operational influences such as temperature and pressure could be studied as they are considered major factors so that design envelope could be measured. The challenge therefore, was to not only accurately model these different states of RCD's, but to build a better knowledge base of the seals and interpret the data effectively so it can be used for further design.

How Did We Help?

RCD's are needed to seal the drill pipe and also ensure that no fluid returns to the surface and cause potential accidents. A lot of these safety devices have been developed over time through trial and error and a lot of testing. The art of development has been somewhat lost, so our involvement in the project was to understand the overall mechanics of the seals and replicate the behavior of the seals. In addition to this, we wanted to understand the working regime of RCD's under different wellbore pressure, different materials, and different operating temperatures, (categorized RCD performance), so that we understand the sensitivity of the design and the working regimes of the tool.

We discovered that the seal undergoes very large deformation, especially under wellbore pressure and while sealing on the tool joint. The diametrical changes can be over an inch in variation which caused a lot of distortions of the seal. The fact that these seals undergo such large deformations over repeated cycles caused premature failure. However, our analyses ensured that these deformations can be modeled reliably and the information can then be transferred to the product designer so further improvements could be made.

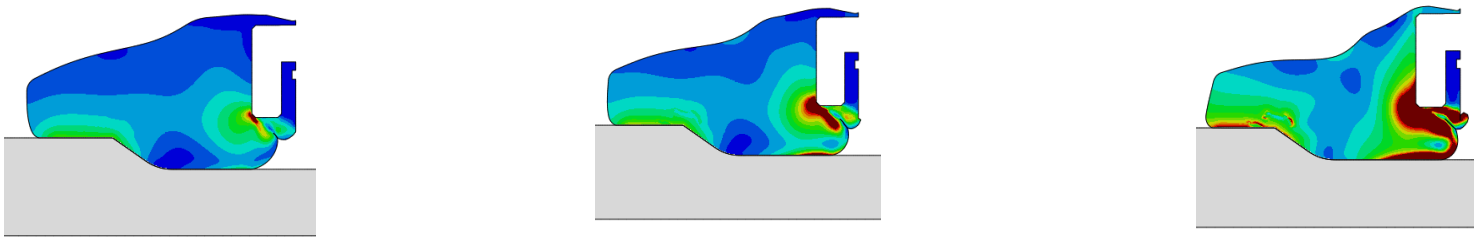

Fig.2: *RCD seals under stress of different external pressure*

Results:

By performing nonlinear FEA Analysis on RCD seals, we achieved the following results:

- Material calibration and validation on the RCD seals to ensure that deformation modes were captured (Fig. 2)
- We subjected the RCD to large states of deformation on the drill pipe and tool joint and evaluated its deformation, stresses and strains
- We subjected the RCD to varying degrees of external pressure while sealing over the drill pipe and its tool
- Its deformation modes, critical strains, and stresses were evaluated and communicated to the client
- We developed stable FEA methods to be able to analyze RCD's under very large deformation when subjected to geometry changes and external pressure variations (Fig. 3)

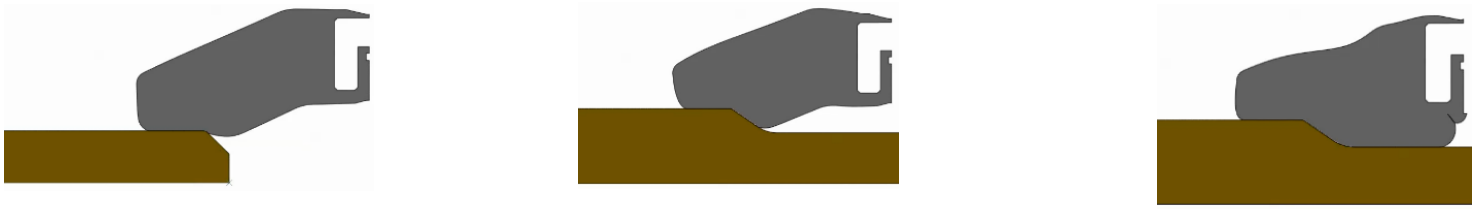

Fig. 3: *Deformation of RCD seal*

Value to Client:

- We developed stable and consistent FEA methods for RCD seals
- We conducted a series of design sensitivity models that helped the client improve the design of the seals
- We suggested methods to improve reliability of the seals