



Case Study #10 Reducing Erosion and Improving Product Reliability through Flow Modeling

Summary

To determine the limits for products undergoing erosion due to high flow rates, MindMesh Inc. performed several CFD analyses. These analyses were crucial in dealing with flow induced erosion which occurs daily in multiple industries, (Fig. 1). With this we were able to determine how erosion affects products, evaluate product design, and improve the overall reliability of products. Understanding the design, the flow characteristics, and materials of products allowed us to understand the design limits and provide insight to the clients.

Challenges:

- Accurately model flow and flow induced erosion
- Reduce premature product failures

Results:

- Predicted flow induced erosion
- Improved and optimized design to minimize erosion



Fig. 1: Valve badly eroded

About the Client(s):

Flow modeling was developed and addressed for several clients. Flow analysis and erosion affects multiple sectors of the industry, including oil and gas, consumer goods, and processes industries. Through flow modeling and predicting erosion, products can be brought to the market sooner and improve product reliability.

Challenge:

The purpose of conducting flow modeling (CFD), was to gain knowledge of the design and interpret the data gathered under several different states of erosion. Many industries view erosion as problematic due to reduction in loss of wall thickness and abrasion during operation. Erosion is a very complex physical behavior. It involves active flow of fluid, especially fluids with inclusions such as solids and sands that progressively erode away materials over time. The problem becomes more challenging at higher flow rates. In the oil and gas industry, as well as many others, erosion becomes a very costly issue. The challenge therefore, was to not only accurately model these multiple states of erosion, but to interpret the data effectively so it can be used for further design improvements. With this data, we aimed to improve the life cycle of products and reduce premature failures

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How Did We Help?

By using CFD, we have a jumpstart in understanding the potential for erosion of critical components and products before they are designed and potential failures in service can be determined. A traditional approach is to first look at flow dynamics, analyze pressure drop, and wall shear to subjectively interpret the erosion potential. This information is used to estimate erosion rates, using empirical and semi empirical models.

The original design of the valve (Fig. 2), show high erosion due to the operating flow rates. Essentially a jetting action due to the close clearance between the valve base and the plunger, resulted in erosion. The particular product in question tended to erode away quickly, in about 90 minutes which was unacceptable to the client. We first replicated the problem by analyzing the design at its intended flow rate. We observed that the design had very sharp corners, which resulted in high jetting velocities. This, coupled with improper material selection, resulted in high erosion. We then performed a series of design optimizations without affecting the package space, (design space). We also provided the right combination of materials for the plunger and valve base that further optimized the design and reduced erosion. The optimized design increased the life of the product, even after extended flow tests (10 hours), and did not show significant erosion.

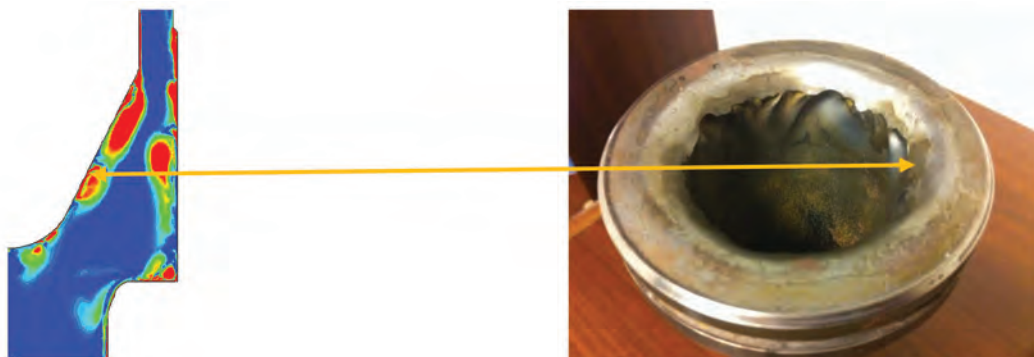
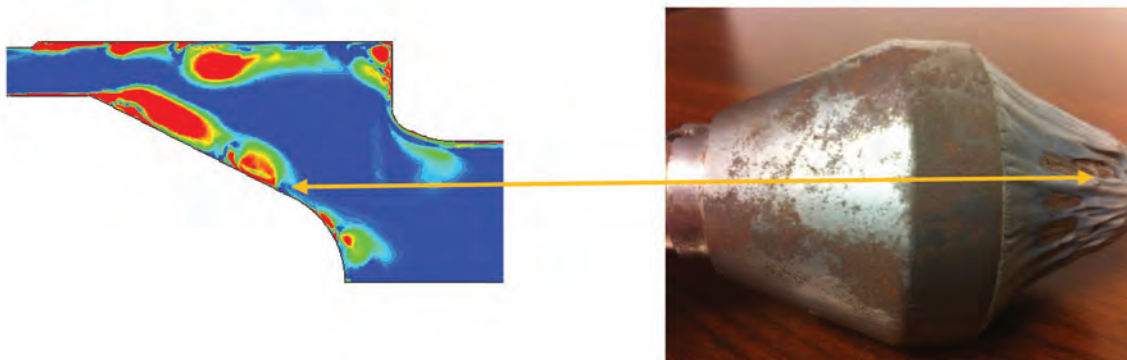


Fig.2: Erosion effects after 1.5 hours on original design of mud valve (top and bottom)



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Results:

By performing this flow modeling for erosion, this is what was achieved:

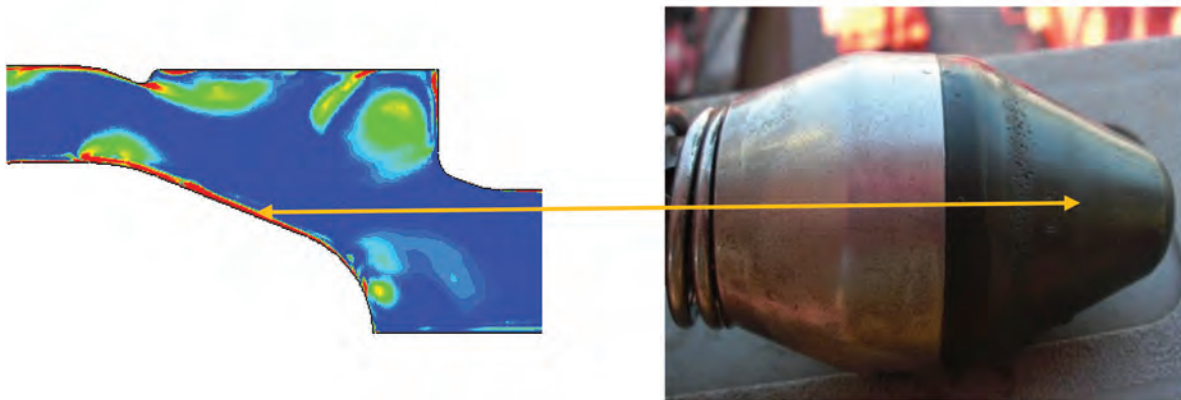
- We performed flow analyses under varying flow rates with varying concentration of solid content to study the impact of erosion on the products
- We predicted the erosion in the existing design
- We optimized the design that reduced sharp geometric transitions
- We reduced erosion rates by recommending a different combination of materials

Value to Client(s):

- We provided insight into the mechanics of erosion for their products
- We replicated the original design
- We improved product performance We optimized design of products (Fig. 3)



Fig. 3: Erosion effects after 10 hours on optimized design of mud valves (top and bottom)



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