AS | MOSLEY

CASE STUDY

3D STRUCTURAL ANALYSIS OF INTERVENTEK 6 3/8" 15000 PSI IN-RISER REVOLUTION VALVE

OVERVIEW

AS Mosley has successfully completed 3D analysis of an in-riser revolution valve for Interventek Subsea Engineering. Ahead of product launch, A S Mosley was assigned to undertake thorough 3D analysis of the product, to test and verify its structural capacity in high temperature and high pressure environments.

The positive outcome of this project, has enabled the valve to enter production. Its first commercial application is in the Gulf of Mexico for well-intervention operations.

INNOVATION

Interventek has developed an in-riser revolution valve system to address the limitations of conventional ball valves which use the ball to both cut and seal. During shearing, damage can occur to the ball which can compromise the sealing ability of the valve. The patented Interventek valve bore closure mechanism separates the cutting and sealing surfaces to increase reliability and well-control safety.

Landing string systems which include this type of valve are deployed within the BOP of a marine riser to facilitate completion or intervention operations and may involve the use of coil tubing, braided cable or slickline. Interventek has manufactured a 6 3/8" bore, 15000 psi in-riser valve for use in the spanner joint of a simplified landing string system.

"A S Mosley provided us with an efficient and cost effective service, enabling production of a thorough validation document package for independent review.

They provided feedback and communicated key results in a timely manner throughout, while supporting with the assessment of design optimisations during the project."

Interventek, August 2017

CHALLENGE

To allow the revolution valve to operate in a landing string system, it is required to fit within a marine riser BOP stack (typically 18 ¾" inner diameter).

To achieve this, the rotary actuator which operates the valve is contained entirely within the diameter of the main body.

This constraint on space meant that a complex geometry was designed to house the actuator necessitating the most accurate methods of structural assessment.

It was identified that the area around the actuator cavity and main body to actuator cap interface required assessment via finite element analysis (FEA) to verify structural capacity for the proposed application.

A S Mosley performed analysis on the structural and pressure containing components using the ANSYS Workbench software package.

The valve is designed to API Spec 6A with a 15000 psi recommended working bore pressure capacity and 10000 psi working pressure in the control chambers.

The valve is also required to sustain tension and bending applied through the landing string as well as hydrostatic external pressure, due to the contents of the marine riser.

In addition to API 6A, the finite element analysis was performed in accordance with ASME VIII, Division 2 and ISO 13628-7 (API 17G).

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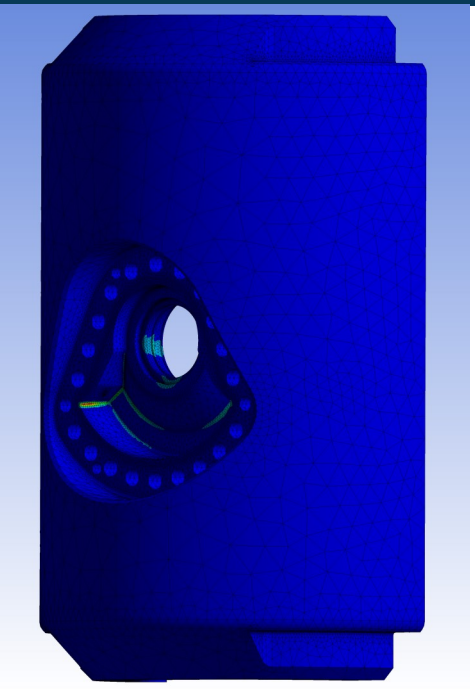
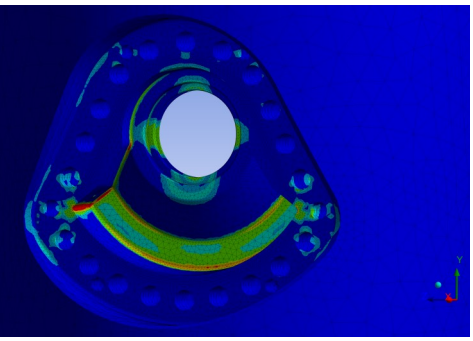
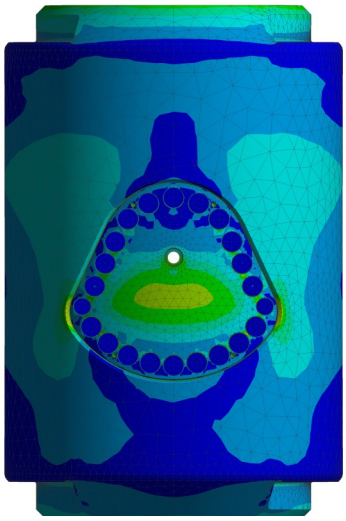
3D STRUCTURAL ANALYSIS OF INTERVENTEK 6 3/8" 15000 PSI IN-RISER REVOLUTION BALL VALVE







SOLUTION

A half symmetry model of the valve's main body and actuator cap was built using ANSYS R18.0, with the actuator cap bolt pretensions and frictional contacts applied. Material properties were defined as elastic-perfectly plastic and a non-linear analysis was performed.

The load cases to be assessed were agreed by A S Mosley and Interventek and included single load cases to define control, bore and external pressure capacities as well as tension and bending limits. Combined tension and pressure load cases were analysed to verify tension versus pressure relationships.

Each load case was assessed against local plastic strain limits defined in ISO 13628-7.

After the peak local strain limit was determined, several paths through the material were chosen as possible global failure paths. The equivalent total strain was extracted along the chosen paths and the average strain through thickness was calculated.

In compliance with ISO 13628-7 Annex D.2.5, peak strains and average strains, which may result in plastic collapse, were assessed against defined limits. A plot of displacement against applied load was also produced to show that the zero stiffness criteria for global instability outlined in ASME VIII, Division 2 had not been exceeded.

A ratcheting assessment was performed to ensure that plastic shakedown would occur under cyclic loading to working capacity. This was shown to be the case over several cycles of applied tension at working pressure where residual plastic strain returned to the same level with each load cycle.

RESULTS

The 3D finite element analysis performed by A S Mosley found that the 6 3/8" 15000 psi ball valve had sufficient structural capacity to meet the loading requirements for its use as part of a subsea landing string assembly.

The analysis was submitted and accepted for third party design review by Lloyd's Register. The valve has now been manufactured, qualified and delivered for use in well interventions in the Gulf of Mexico.

Communication between A S Mosley and Interventek involved several review meetings, where analysis results and acceptance criteria were discussed in detail.

Excellent communication and fast response times throughout the project meant that A S Mosley was able to complete the task within the required timeframe and to budget, while being reactive to design changes.

AS MOSLEY
ENGINEERING ANALYSIS AND **DESIGN CONSULTANTS**
Petmathen Laundry Cottage | Oyne | Insch | Aberdeenshire | AB52 6RU
T +44(0)1464 851 144 E info@asmosley.com W www.asmosley.com

AS MOSLEY
OFFSHORE SIMULATION