Optimization of a Casing Shear RAM circuit with SimulationX

TNO-0004

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1. Introduction

The subsea industry is meeting new challenges due to more extreme depths and wells with high pressures and temperatures. This has led to an increased focus on automatic safety systems and verifications of these. In order to properly verify that deep-water system works as designed, it is no longer enough with just an onshore FAT (Final Acceptance Test). This is because the behavior of accumulators are very different when tested onshore, versus under real operating environment. The significant difference is the (outside) operating pressure and temperature. This is particularly applicable when accumulator's operating-pressure exceeds 5000 psi.

The industry's constantly receives new requirements from operators and local governments. This puts a lot of focus on the design of temporary subsea well barrier systems as BOP's and IWOCS.

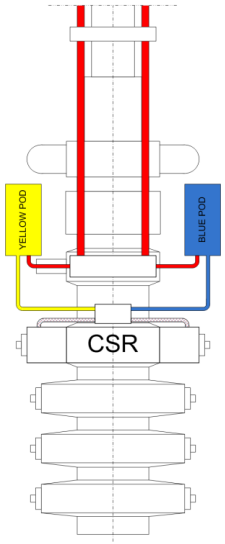
In order to be in compliance with these increased requirements and regulations, we see that more and more of the major suppliers and operators want to use SimulationX® when designing the subsea BOP system and yielding great results. The program's graphical user interface along with special libraries for electrical and hydraulic subsea systems, gives a quick-to-read model, that are well suited for more detailed studies of the design systems.

This example describes an optimization of a Casing Shear RAM (CSR) closing circuit using SimulationX®. The example is taken from a real BOP system and shows what can actually be achieved by using modern tools in the design process.

2. Description of the System

A BOP valve is available in several designs depending on the task the valve is supposed to have in the system. The BOP valve in this example is a CSR that is tasked with cutting the well casing. The scenario would be that the situation requires the well to be shut down quickly, during completion with well casing in the bore. The valve is also called "super shear RAM". It can be closed alone or as one of several valves in an automatic sequence. The energy used to close the valve is usually stored in subsea accumulators so that the automatic sequences can be completed regardless of whether there is communication with the surface or not.

The valve is controlled by two independent control-pods called "yellow" and "blue" pod, as shown in the figure below.



The lines between the pod and CSR are tubes and pipes with bends and elbows.

The CSR actuator in this example has a total volume of 149 liters to close. With an inner diameter (ID) of 15.56 mm on the pipes and closing time around 20 seconds, we will get high fluid velocities, which again in turn give large pressure drops. With the help from SimulationX®, the element that gives the greatest pressure drop can be identified and alternative solutions tested. In this way, the circuit will be optimized and closing time reduced.

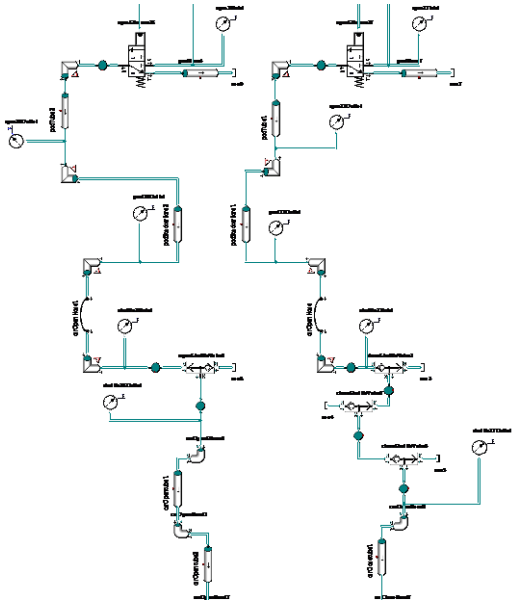
3. The model in SimulationX®

The model is set up by using the elements (building blocks) from SimulationX® standard library.
These elements makes modeling faster and the level of details on the different parts of the circuit can be gradually increased without changing the model itself along the way.

The library in SimulationX® contains elements for pipes, pipe bends and elbows and various pipe couplings that are necessary in the effort to optimize control circuitry. By studying the different elements in detail, we can

easily identify where the losses of pressure are. Standard components such as pipes, hoses and valves can be tested virtually, before the final decision on component selection has been made.

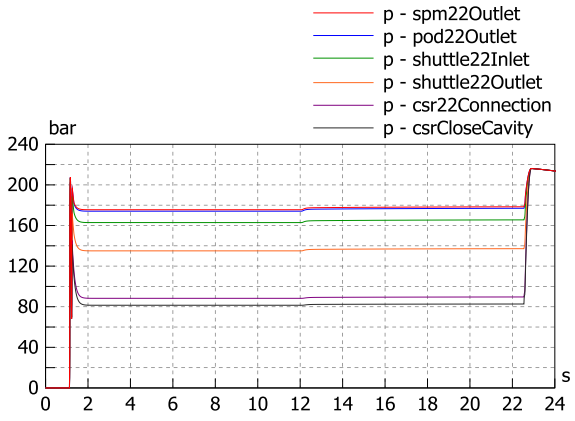
The figure below shows a section of the model in SimulationX©.



The model of the control lines are made using elements from the standard library, and have a high level of detail. In addition, pressure gauges are placed in the system model, so that pressure transients in the lines can be plotted and items with high losses can be identified.

4. Results from SimulationX©

In this example, the circuit started with a closing time of nearly 22 seconds as shown in the plot below.



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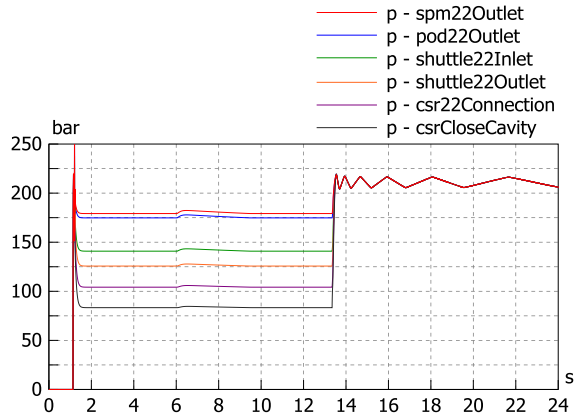
This shows the pressure transients for «Close» line for the CSR between the pod's SPM valve to the valve actuator's "Close cavity" before optimization begins. We see very clearly that the high pressure losses are across the shuttle valve and the pipe length from the shuttle valve to the actuator gate. The same plot is made for the actuator's "Open" line.

By modifying the circuit to increase the dimentions of the shuttle valves and tubes/hoses between shuttle valves and valve actuator, the total loss of control lines has been decreased, and shut down times are reduced by 40% - from 22 to 13 seconds.



This example shows how we can optimize the design, by using SimulationX©, and find simple solutions for improvement. In the same way, it can be used as a tool for trouble shooting and to identify operational limits related to malfunctions, such as leaks. We can run the complete closing sequences on a BOP at different depths and with different drill pressures in order to study what happens in the different circuits and to find the optimum shut-down sequence that provides quick and most importantly, a safe shutdown.

For more information about the possibilities in SimulationX©, please contact your closest Agito office or visit our web page www.agito.no.

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