Case Study for Mobile Applications

Simulation of Counter Balance Valves with DSHplus

Counter balance values are a popular choice for securing cylinders or hydro-motors to keep them from moving due to their own weight or the weight of a load. Lifting devices such as cranes and platforms, hydraulic bridges and industrial machinery all make use of counter balance valves. While they come in handy for the application, the correct valve must be selected in order for it to operate in a stable manner. An accurate simulation model of the valve can help to verify stable operating conditions of the hydraulic system. There are different methods to model these valves depending on the focus of the simulation. Two standard methods are shown below.

Winch on a fishing trawler with counter balance valve

Option 1: Physical Model

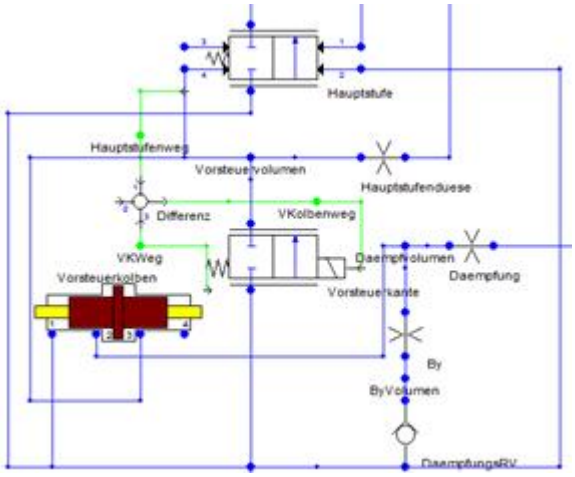
A discrete model of the valve's subcomponents is built using physical parameters. This type of modeling is useful for studying internal effects, but it requires detailed knowledge of the construction. For each manufacturer, the component set-up of the simulation model has to be changed depending on the construction. This is even true for different models from the same manufacturer. Furthermore, accurate modeling produces small hydraulic volumes which lead to long simulation times. This approach is best suited for component development.

Pros:

- Simulation model can be used for component development
- Component internal effects can be studied during the simulation run

Cons:

- Requires detailed knowledge of the component's part dimensions
- Component model setup is manufacturer specific
- Long simulation times for small intermediate fluid volumes



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Option 2: Measurement Based Model

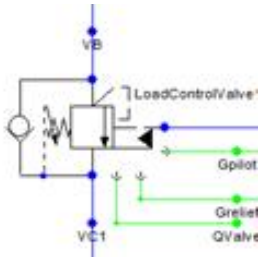
A measurement based component model is manufacturer independent with regard to the model setup. Simulation times will be faster since there are fewer components and small volumes involved. It is of course not possible to study any internal effects of the valve and parametrization does require measurement data for the whole range of operation of the modeled system. Due to its fast calculation speed this approach is best suited for system simulation.

Pros:

- Shorter simulation times
- Model setup is manufacture independent

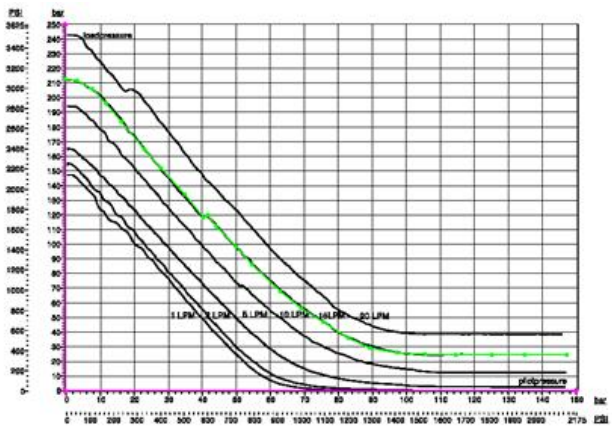
Cons:

- Requires measurements of the component's behavior
- Component internal effects cannot be studied



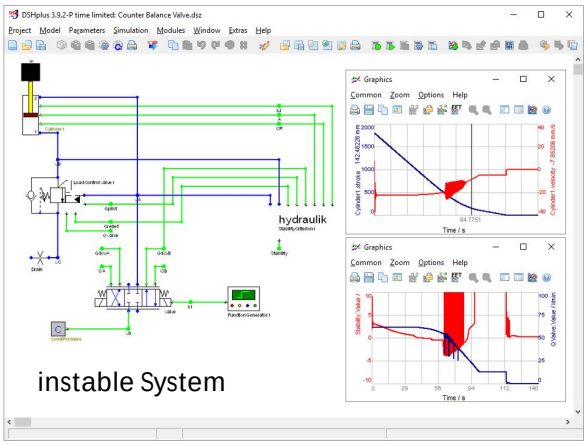
Obtaining parameters from measurements

Measurements at different points of operation are compiled into a 3D-look-up table, which is used in the compact model of the counter balance valve. In the component's parameter dialog the look-up table is selected and simulation can begin immediately.

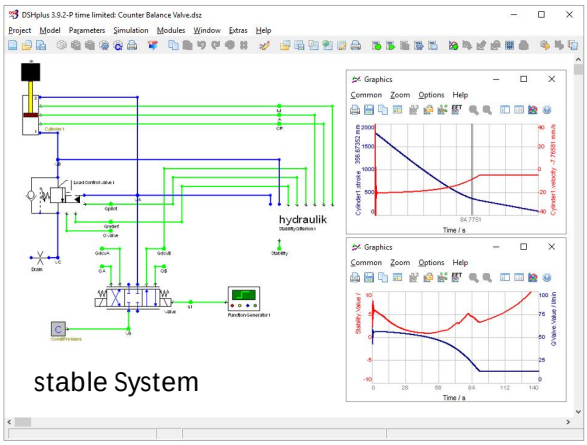


Simulation using a counter balance valve model

Simulation of the system's operational envelope will validate component dimensions etc. The counter balance valves can then be checked for stability by varying the loads and pressures (e.g. due to environmental conditions) for different points of operation.



instable System



stable System

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Solution Highlights

By offering an easy to use graphic based modeling concept for dynamic, nonlinear 1D-system simulation, DSHplus enables the user to

- model hydraulic systems in any desired level of detail
- simulate the dynamic behavior of complex fluid power systems
- link DSHplus models with other software via co-simulation
- export the models source code for external use

DSHplus is able to support the general engineering of mobile hydraulic systems with simulation models with typical system level detail as well as with high-fidelity physical models, This allows for a comprehensive performance analysis while supporting simulation driven optimization techniques, to improve the system's performance. With a measurement based approach the overall system performance can be analysed and the selection of components (e.g. counter balance valves, s. above) optimized, while equation based physical modeling allows insight into component internal processes.

Typical applications

- cranes (truck-mounted cranes, dockside cranes, ...)
- mobile elevating work platforms
- turntable ladders
- winches
- excavators
- machines for materials handling
- telehoist load luggers

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