Project 05: Simulating loads at the hydraulic cylinder using a throttle check valve

Project definition

How is load pressure generated in a hydraulic system?

The hydraulic lifting unit of a machine tool is loaded. For the user, it is interesting to know which influence the loads have on the extension and retraction times of the hydraulic cylinder. To analyze this, values for different loads should be recorded. In this way, the influence of the load on the move behavior of a hydraulic cylinder shall be defined.

Project tasks

- Set up hose system according to circuit diagram
- Simulate various loads
- Measure and record the movement times of the hydraulic cylinder
Project steps

- **Getting information:** In which state is the training system? What exactly is to be done?

- **Planning:** Selecting informational documents. Viewing the circuit diagram. Considerations on components and measuring point selection. Considerations on the exercise setup at the training system.

- **Deciding:** Selecting the components. Determining the connections between components. Connecting measuring points; securing inactive measuring points.

- **Execution:** Determining system behavior regarding various loads. Recording measured values.

- **Checking:** Which direction of actuation leads to the extension of the hydraulic cylinder?

- **Evaluation:** How is the system behavior influenced if the application of various loads is simulated using a throttle check valve?
Safety instructions

To ensure operability and to make sure possible risks of machines and systems are identified, the safety regulations must be observed prior to and during the execution of the tasks.

The correct, fixed connections of the components via hydraulic hoses can be checked by slightly twisting the hoses.

It must be ensured that pipes and hoses are connected to all ports - if applicable also to those of the Minimess lines - or that the ports are closed by plug screws. If ports are left open, leakage oil may drip on the floor causing a slip hazard.

Prior to commissioning the hydraulic control, i.e. prior to starting the hydraulic pump, it must be checked if all pressure control valves are set to minimum pressure (spring unloaded) and all throttle valves are opened. In addition, it has to be checked if the tank is filled with hydraulic fluid according to the specifications in the operating instructions.

When the system is commissioned, jets of hydraulic fluid may be ejected through open ports, which may lead to severe injuries (cutting jet).

Notice:

The hose couplings can be easily connected to the coupling plugs if the residual pressure is unloaded.

This is done as follows:

1. Completely unload the pressure relief valve (counter-clockwise)
2. Open the throttle valves
3. Actuate directional control valve
4. Unload pressure reducing valve (clockwise)

Never use force!!!
### Parts list of hydraulic components of the training system WS200

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Designation</th>
<th>Type</th>
<th>Rexroth material number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>1</td>
<td>Compact power unit ANTRIEBSAGGREGAT TS-WS200 220V/50HZ 1X</td>
<td>R961008683</td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>1</td>
<td>P/T distributor with integrated pressure relief valve VERTEILER TS-HC100</td>
<td>R961008654</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>2</td>
<td>Hose line SCHLAUCH AB23-14/2SC-08/N10-N10X.630</td>
<td>R900087365</td>
<td></td>
</tr>
</tbody>
</table>

### Parts list of hydraulic components for the exercise setup

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Designation</th>
<th>Type</th>
<th>Rexroth material number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.10</td>
<td>1</td>
<td>Hydraulic cylinder</td>
<td>CD70F25/16-200</td>
<td>R961003494</td>
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<tr>
<td>1.20</td>
<td>1</td>
<td>Throttle check valve DRV06-1-1X/V</td>
<td>R961002495</td>
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<tr>
<td>1.30</td>
<td>1</td>
<td>Hydraulic distributor VERTEILER HPF-DZ4.2N-W</td>
<td>R961002485</td>
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<tr>
<td>1.40</td>
<td>3</td>
<td>Manometer MANOMETER 100BAR</td>
<td>R961002715</td>
<td></td>
</tr>
<tr>
<td>1.50</td>
<td>3</td>
<td>Hose line SCHLAUCHLEITUNG ZN10031-08-W00NN-630</td>
<td>R961002474</td>
<td></td>
</tr>
<tr>
<td>1.60</td>
<td>2</td>
<td>Hose line with Minimess connection SCHLAUCHLEITUNG ZN10031-08-W00MM-630</td>
<td>R961002481</td>
<td></td>
</tr>
<tr>
<td>1.70</td>
<td>1</td>
<td>Directional control valve, manual actuation 4WMM6 G5X/</td>
<td>R961002550</td>
<td></td>
</tr>
</tbody>
</table>

1) ... Double-acting hydraulic cylinder with piston rod on one side (differential cylinder)
Circuit diagram for project exercise 05
Project execution

Attach the components required according to the table "Parts list of hydraulic components for the exercise setup" to the training system.

Install hose lines according to the circuit diagram for project exercise 05.

Screw the measuring line of a manometer to the Minimess connection of the P/T distributor on hand-tight. Screw the measuring line of further manometers to the Minimess connection of hydraulic hoses on hand-tight.

The system pressure relief valve must be completely unloaded. To do this, completely screw out the adjustment element of the valve counter-clockwise.

The directional control valve port A is connected to the piston side of the cylinder.

Directional control valve port B is connected to the annulus side of the cylinder by means of a throttle check valve. The throttling direction is from the annulus side of the cylinder to directional control valve port B. In the opposite direction, the connection is not throttled by the throttle check valve.

The system pressure is measured at the measuring port of the P/T distributor using a manometer. Measure the pressure levels at the piston side and the annulus side of the cylinder using additional manometers.

Open the throttle valve completely. To do this, completely screw out the adjustment element of this valve counter-clockwise.

Switch on the power unit at the control box. The temperature of the hydraulic fluid should be between 25 and 35 °C.

The directional control valve must be actuated to establish the connection between P and A (push lever to the left and hold in position). Next, slowly screw in the adjustment element of the system pressure relief valve until the hydraulic cylinder extends.

When the hydraulic cylinder has reached its end position, keep the directional control valve actuated (continue to hold lever turned to the left). Continue to close the system pressure relief valve until the system pressure is at 40 bar.

Now switch the directional control valve so that it connects P and B (lever to the right); the hydraulic cylinder retracts.

Extend the hydraulic cylinder again while closing the throttle check valve (screwing it in clockwise) until the hydraulic cylinder extends at a pressure according to the table below on the piston side of the cylinder. Since the hydraulic cylinder cannot be loaded with real loads, the load is simulated using a throttle check valve.
Read the pressure levels while the cylinder is moving and enter the values in the table below. In addition, measure the extension and retraction times of the hydraulic cylinder at various system pressure levels using a digital stopwatch with a minimum resolution of 0.1 s (recommended: Stopwatch digital quartz 1/100 s; mat. no. R900061256):

<table>
<thead>
<tr>
<th>System pressure (in bar)</th>
<th>Pressure (in bar) Piston side of cylinder</th>
<th>Pressure (in bar) Annulus side of cylinder</th>
<th>Extension time (in s)</th>
<th>Retraction time (in s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>10</td>
<td>18</td>
<td>2.8</td>
<td>1.8</td>
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<tr>
<td>15</td>
<td>15</td>
<td>25</td>
<td>2.8</td>
<td>1.8</td>
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<td>1.8</td>
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<td>28</td>
<td>25</td>
<td>40</td>
<td>2.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

The following questions must be answered:

▶ How high are the pressure levels on the piston side and the annulus side of the cylinder when the hydraulic cylinder has reached the end position of its extension?

**40/0 bar**

▶ How are the pressure levels on the piston side and on the annulus side of the cylinder influenced when the directional control valve is not actuated and is located in its central position?

**The pressure levels fall slowly.**

After determining the values, completely unload the system pressure relief valve (completely screw out adjustment element counter-clockwise) and switch off the power unit.

**Notes for trainers:**

*The measured values were determined for the training system WS200. If other equipment is used, the values may vary due to system differences.*

*It is important for the trainees to learn that the pressure levels in the hydraulic cylinder and in the system are determined by the loads. Due to pressure intensification, the pressure in the annulus area of the hydraulic cylinder may be higher than the system pressure.*

*The velocity remains unchanged at higher load pressure since the hydraulic pump always delivers the same hydraulic fluid volume to the system.*

*Directional control valves with a spool valve in the housing require tolerances. These tolerances inevitably cause leakage.*
Assessment of the work results

1. The system pressure relief valve can only be set when the hydraulic cylinder has reached the end position.

2. By means of a throttle valve in the supply/discharge of the annulus side of the cylinder, it is possible to simulate a load.

3. The pressure levels correspond to the loads on the hydraulic cylinder.

4. The pressure in the annulus area of the cylinder is higher than the pressure in the piston area of the cylinder.

5. Movement time remains unchanged at higher load pressure.

6. When the hydraulic cylinder reaches the end position of its extension, the pressure in the piston chamber increases to maximum system pressure, while the pressure in the annulus area falls to 0 bar.

7. If the directional control valve is not actuated (central position), the pressure in the piston chamber falls to 0 bar since a directional control valve is not leakage-free.

Project/trainer information

In this exercise, the following knowledge should be acquired:

- The pressure in the system and in the actuators is determined by resistances and loads.
- The maximum system pressure is only reached in the end position.
- If the load pressure increases, the cylinder movement time or the cylinder movement speed remain unchanged.