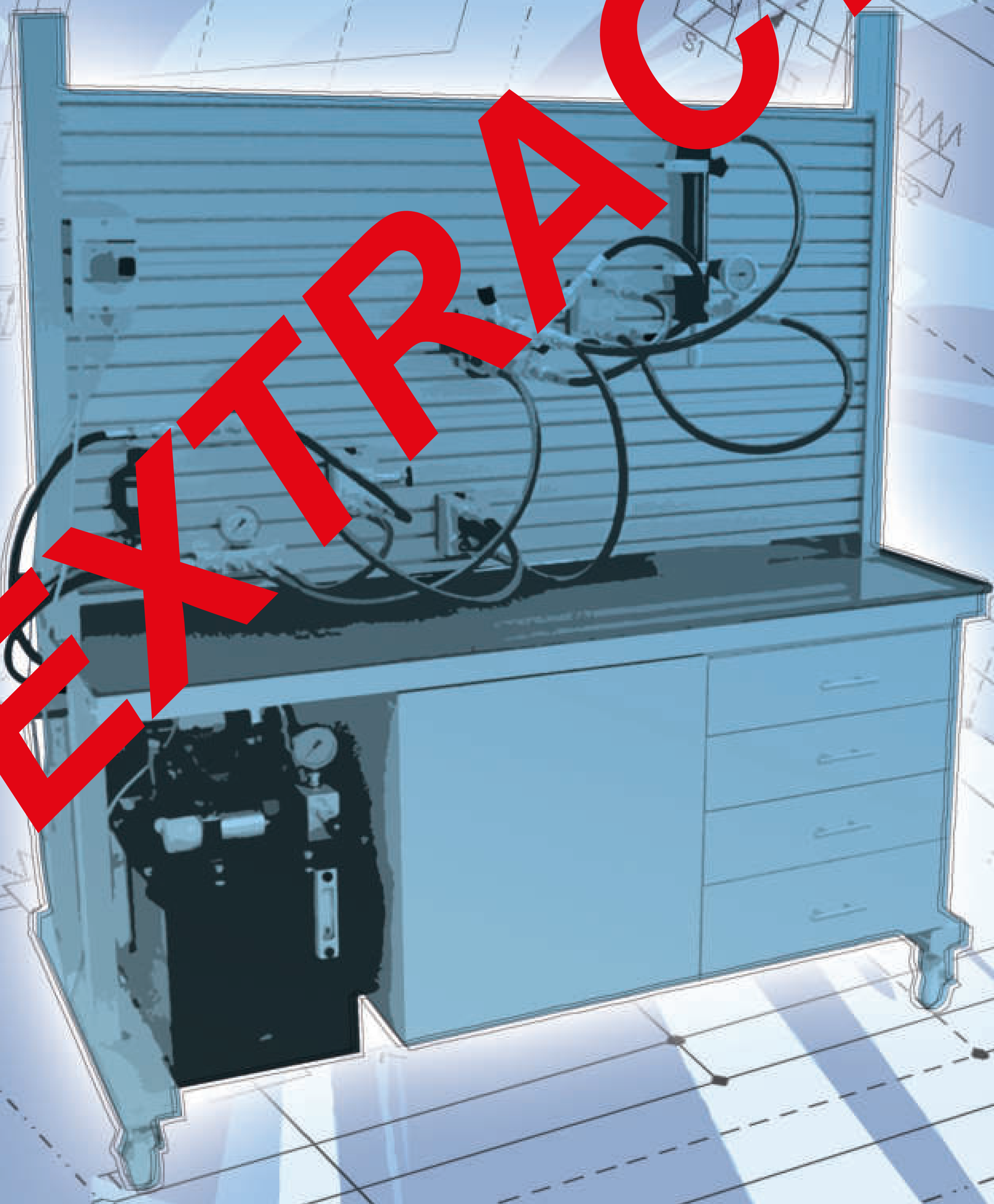
HYDAC TRAINING CENTER

Training Manual
Hydraulic – Teacher



Training Manuel Hydraulic – Teacher

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Exercise 01.01.01: Pressure

Exercise description:

In this circuit, a hydraulic cylinder is controlled using a 4/3 directional valve.

Hydraulic systems make it possible to transfer very large forces in small spaces. In this exercise the basics of this will be demonstrated using the example of a hydraulic cylinder.

In the centre position of the 4/3 directional valve, the pump circulates oil into the tank at almost zero pressure. There is no movement of the cylinder.

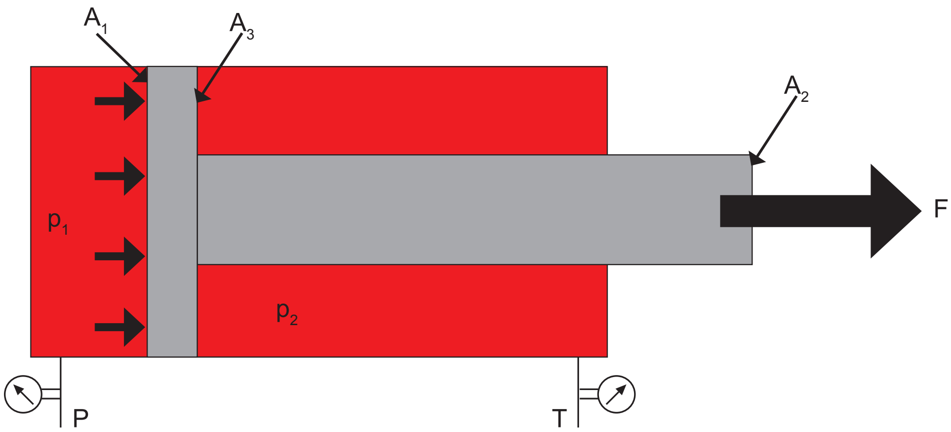
The force can be calculated from the piston area A and the pressure p:

$F = A \cdot p$

$p = 1\ bar = 10^5\ kg/(m \cdot s^2)$

$F = 1\ N = kg \cdot m/s^2$

$A_k = m^2$



In order to show that pressure and force are related, a spring-loaded hydraulic cylinder can be used. In addition there is the possibility of using a Euler cylinder with buckling bar. Neither are supplied as standard with the hydraulic trainer.

Complete circuit:

In the circuit diagram on the following page, the valves included in the item list need to be completed (symbol and name).

Set up test:

a. Power unit OFF
b. Set up circuit
c. Pressure relief valve open
d. Needle valve closed
e. Directional valve switching position **0** (neutral)

Execute test and observe (sequence):

1. Unit ON
   Setting the pressure can only be done in the end position of the hydraulic cylinder and in the corresponding switching position of the directional valve
2. Directional valve in switching position **b**
3. Set pressure to 30 bar
4. Open needle valve by ½ turn, approx. 100°
5. Directional valve switching position **a**, hydraulic cylinder extends

Analysis:

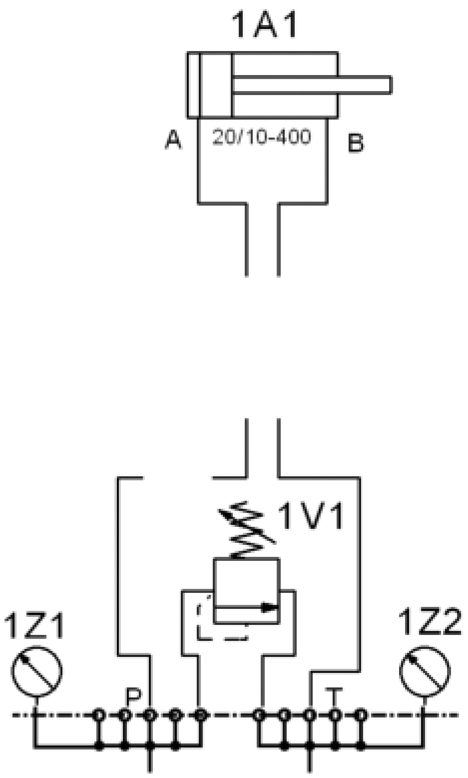
- Retract the hydraulic cylinder again. Repeat the test from step 2 onwards at a pressure of 45 and 60 bar.
- Do you notice a difference in the velocity of the piston at the different pressure settings?
  → Pressure (p) gives force. Flow (Q) gives velocity. Reduced velocity indicates an undersupply of pressure.

Calculation:

- Calculate the force F for the three different pressure settings.
- What mass (kg) could be lifted with the three pressure settings?

Item list and circuit diagram:

Item	Part	Description	Quantity
1	3474896	Pressure relief valve	1
2	3475124	Needle valve	1
3	3629228	Differential cylinder Ø20/Ø10 - 400 stroke	1
4	3638239	4/3 directional valve	1
5	3537338	Hydraulic hose 0.7 m	6



Solution sheet (student)

Solution sheet (teacher)

Pressure (bar)	Force (N)	Mass (kg)
30	924.5	94.2
45	1413.7	143.0
60	1849.0	188.5

Calculation:

$F = A \cdot p$

$p = 1\ bar = 10^5\ kg/(m \cdot s^2)$

$F = 1\ N = kg \cdot m/s^2$

$A_k = m^2$

$g = 9.81\ m/s^2$

$A_k = d_k^2 \cdot \pi/4$

$F_G = m \cdot g \quad [kg \cdot m/s^2]$

Diameter dk from type description of the hydraulic cylinder (see item list):

$d_k =$ piston diameter $= 20\ mm = 0.02\ m$

$d_s =$ rod diameter $= 10\ mm = 0.01\ m$

$A_k = (0.02\ m)^2 \cdot \pi/4 = 0.00031416\ m^2$

$F_1 = 0.00031416\ m^2 \cdot 30\ bar \cdot 10^5 = 924.5\ N$

$F_2 = 0.00031416\ m^2 \cdot 45\ bar \cdot 10^5 = 1413.7\ N$

$F_3 = 0.00031416\ m^2 \cdot 60\ bar \cdot 10^5 = 1849.0\ N$

$m = F/g$

$m_1 = 924.5\ N/9.81\ m/s^2 = 94.2\ kg$

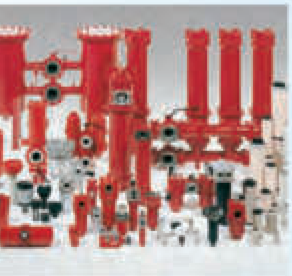
$m_1 = 1413.7\ N/9.81\ m/s^2 = 143.0\ kg$

$m_1 = 1885.0\ N/9.81\ m/s^2 = 188.5\ kg$

Why are there different velocities?

- The circuit includes a pressure-dependent needle valve
- There is an accumulator built into the hydraulic power unit (only noticeable when the needle valve is wide open)
- Undersupply
- Hydraulic cylinder is unloaded

Pro.: Speichertechnik DEF 3.000



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Pro.: Verfahrenstechnik DEF 7.700

Prospekt: Fluidservice DEF 7.929

Pro.: Compact-Hydraulik DEF 5.300

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HYDAC | INTERNATIONAL

HYDAC Systems & Services GmbH
TRAINING CENTER

Hirschbachstraße 2
66125 Dudweiler/Saar
Germany

Phone:
+49 (0) 68 97 / 509 -1022

Fax:
+49 (0) 68 97 / 509 - 1014

Internet: www.hydac.com
E-Mail: E-learning@hydac.com

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