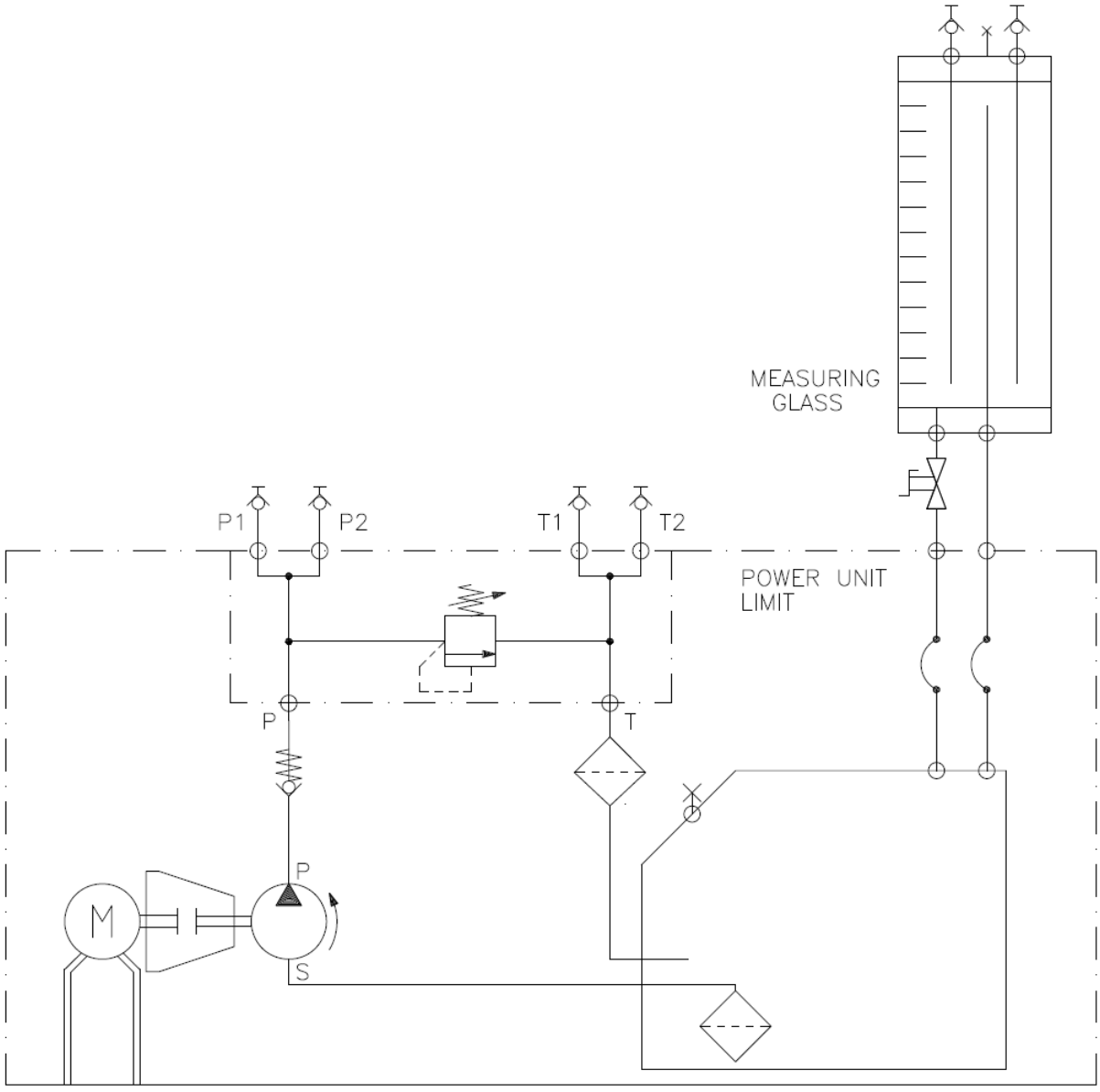
**Pressure Relief Valve, Direct Operated**

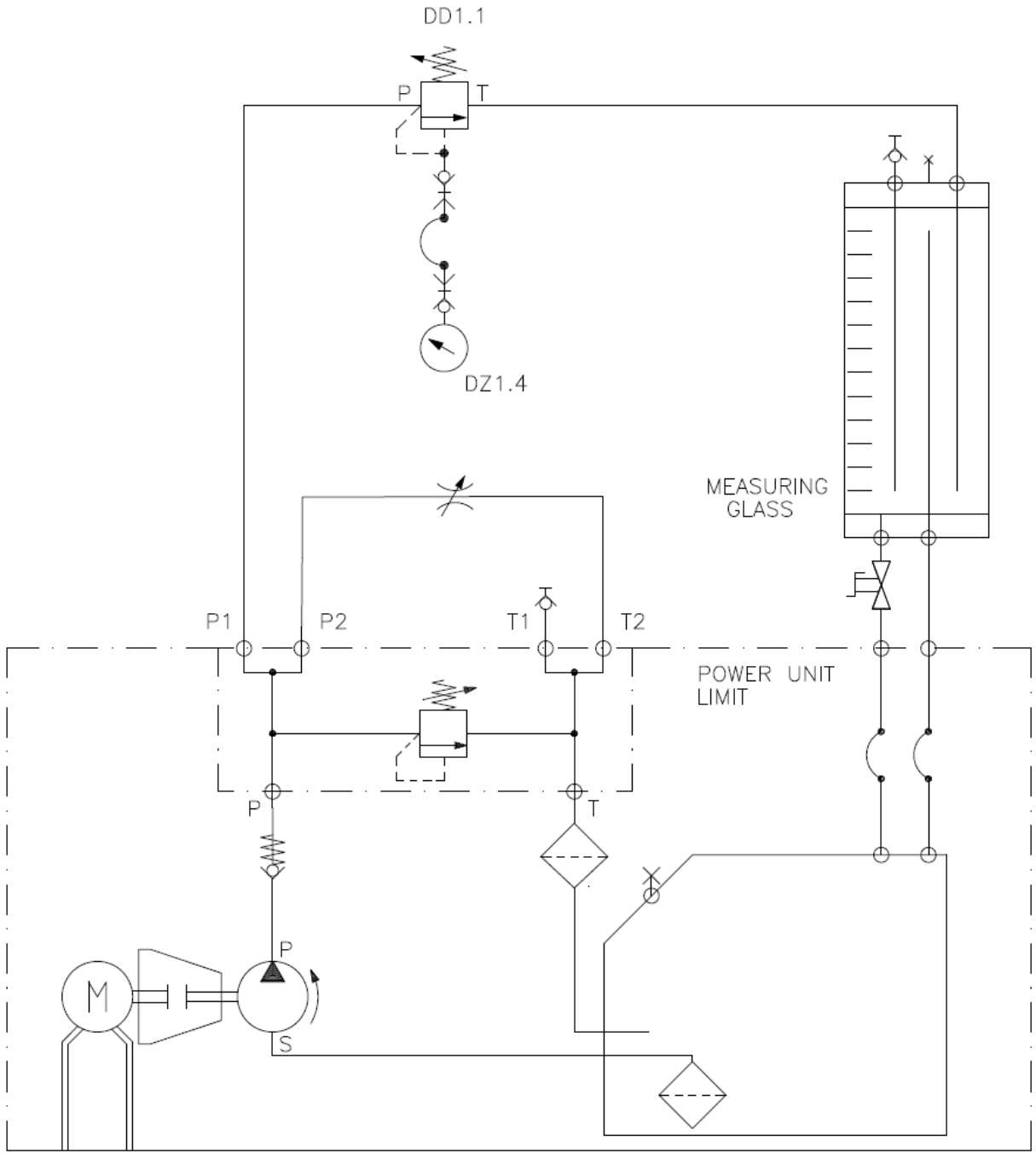
**Description of experiment**

The function of a pressure relief valve is to safeguard the pressure in a system or part of a system so as to avoid damage or accidents caused by pressure overload. In order to be able to assess the characteristics of a direct operated pressure relief valve in a system, its characteristic curve must be known. The characteristic curve describes the dependence of the pressure on the volume flow rate.
In order to determine the characteristic curve, a direct operated valve DD1.1 is connected in parallel with a hydraulic resistance. Suitable resistances are throttle valves or normally closed pressure control valves. The volume flow rate across the pressure relief valve is one parameter of the characteristic curve. The other is system pressure

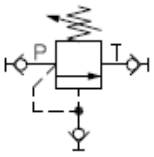
**Description of exercise**

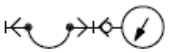
Consider a circuit with which the characteristic curve of a pressure relief valve can be measured and sketch it below.




DD1.1
P
T
DZ1.4
MEASURING
GLASS
P1
P2
T1
T2
POWER UNIT
LIMIT
P
T
P
M
S

**Components:**
You will require the following components:

| | | |
|---|---|---|
| 1x | Pressure relief valve DD1.1 |  |
| 1x | Throttle valve DF1.2 |  |

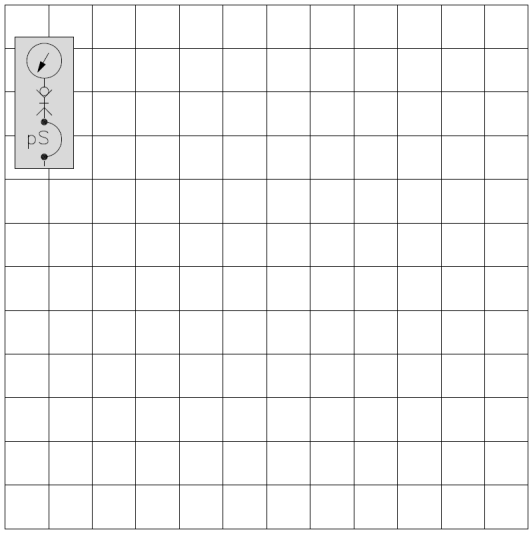
| | | |
|---|---|---|
| 1x | Pressure gauge DZ1.4 |  |

Pressure hoses
Stop watch

Before beginning the experiment read the **Rules for hydraulic trainer operation** sheet.

**Setting up the experiment**
Set up the circuit observing the following points:

1. Make sure the pump is switched off and the circuit is not pressurized.
2. Mount the individual components on the training stand grid and interconnect them according to the hydraulic schematic



**Experimental procedure**

**Determining the characteristic curve of the pressure relief valve DD1**
Steps in the experimental procedure:

1. Has your instructor checked the constructed circuit?
2. Check again that all connection hoses are firmly coupled.
3. Back out the setting of the pressure relief valve DD1.1 to a setting of zero on the scale indicator (see photo)
4. Open the throttle valve DF1.2 completely (fully CCW)
5. Ensure that the red E-STOP button is not engaged on either side of the trainer (rotate button to reset).
6. Open the shut-off valve on the measuring glass to allow it to drain to tank
7. Switch on the pump via the green START push button.

Note to instructor:

There is no mechanical stop to prevent the handle of the relief vale being backed out further than this zero point. Doing so will disengage the threads however and and the handle will simply spin and "wobble".

If this occurs, re-engage the threads by aligning the knob with the valve body and re-start the threads.


**Exercise Part I**
The system pressure is to be measured dependant on the position of the control knob of the pressure relief valve DD1.1

a) Close the fine throttle valve DF1.2 by turning the adjustment knob completely clockwise.
b) With the control knob on the pressure relief valve DD1.1 set at zero on the scale indicator read the pressure at gauge pS and record this in table 1.
c) Turn the control knob of the pressure relief valve clockwise one turn at a time and enter the pressure read at the pressure gauge DZ1.4 in table 1.

**Exercise Part II**
The (Q-p) flow-pressure dependence of the pressure relief valve is to be measured at a maximum pressure setting of 40 bar.

a) Ensure that the throttle valve DF1.2 is closed completely

b) Set the system pressure to 40 bar with the adjustment knob of the pressure relief valve DD1.1

c) Using the stopwatch, measure the time to fill 1 litre into the measuring glass i.e. measure the time between oil level readings of 1 litre and 2 litre. Record this time in table 2.

d) Open the throttle valve DF1.2 by 0.2 turns (with the valve closed pick a reference point on the stem of the valve adjustment and rotate the knob by two digits as shown in the following photos)

Valve DF1.2 closed

Valve DF1.2 open 0.2 turns

e) Measure and record the time to fill 1 litre and the pressure at pS at each of these settings.

f) Conventionally the flow rate is given as liters per minute (L/mim). We will also follow this convention. We can calculate this flow rate using the following formula.

$$Q = \frac{\text{volume}\,(1\,\text{litre})}{\text{measured time}\,(\text{sec})} \text{ x } \frac{60\,\text{seconds}}{1\,\text{minute}}$$

$$Q = \frac{60}{measured\_time(\text{sec})}$$

**Exercise Part III**

The cracking pressure of the pressure relief valve is to be determined. The setting of relief valve DD1.1 should remain unchanged from exercise II
(i.e. maximum pressure should be 40 bar)

a) Open the throttle valve DF1.2 completely (minimum pressure should be seen on the gauge and there should be no flow at the measuring glass)

b) Begin slowly closing the throttle valve DF1.2 until you notice oil flow start at the measuring glass. Note the pressure at which this flow stream first begins.

Pressure: 28 bar

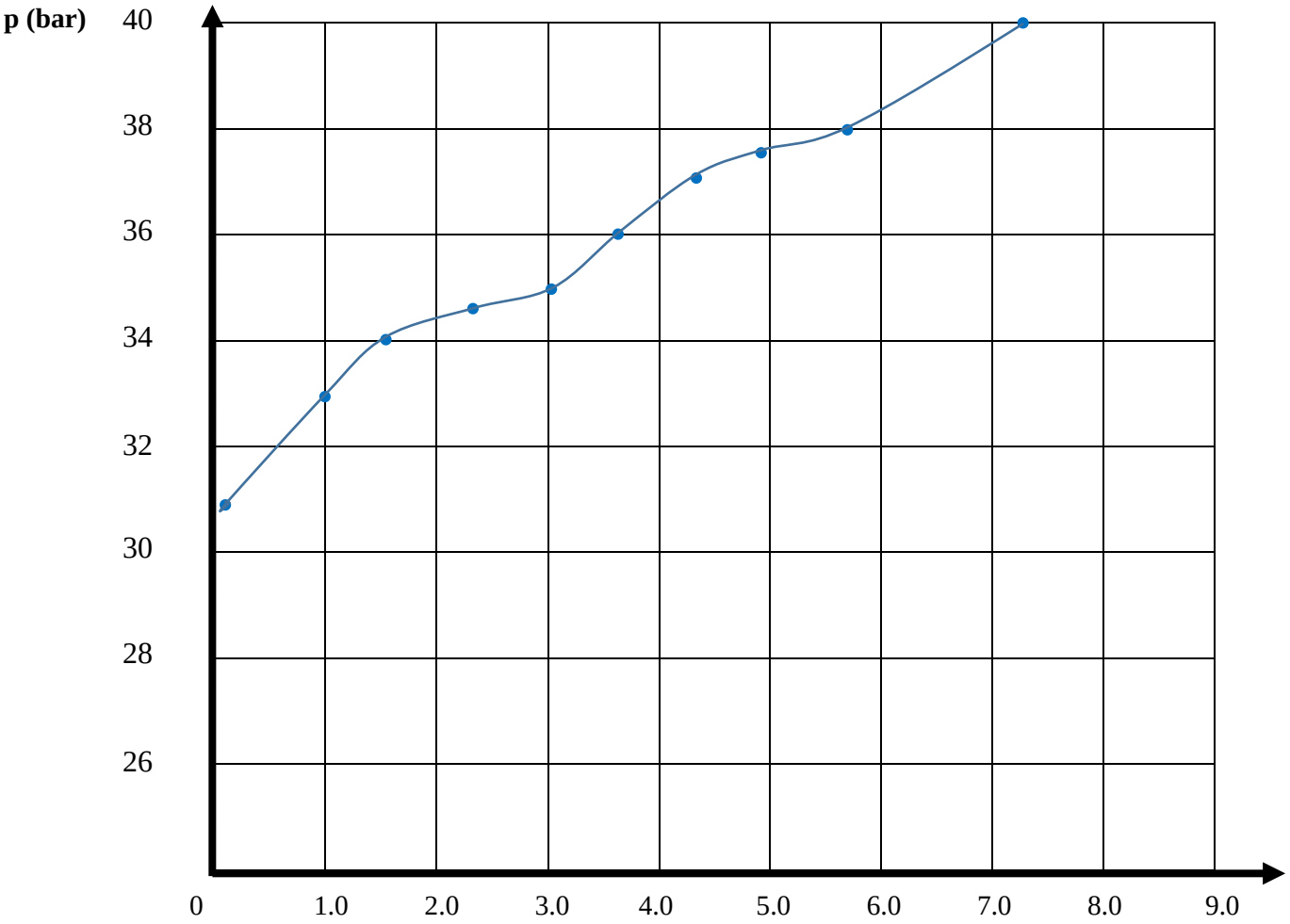
**Evaluation**

| Turns of control knob DD1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pS (bar) | 5 | 5 | 8 | 17 | 29 | 43 | 50 | 50 | 50 | 50 | 50 |

**Table 1**

| Throttle valve | System pressure pS in bar | Time to fill 1 litre (seconds) | Flow through pressure relief valve Q (l/min) |
|---|---|---|---|
| **Closed** | **40** | 8.22 | 7.3 |
| **0.2 turns** | 38 | 10.57 | 5.68 |
| **0.4 turns** | 37.5 | 12.1 | 4.96 |
| **0.6 turns** | 37 | 13.84 | 4.34 |
| **0.8 turns** | 36 | 16.36 | 3.67 |
| **1.0 turns** | 35 | 19.91 | 3.01 |
| **1.2 turns** | 34.5 | 25.97 | 2.31 |
| **1.4 turns** | 34 | 37.4 | 1.60 |
| **1.6 turns** | 33 | 60 | 1.0 |
| **1.8 turns** | 31 | 1200 | 0.05 |
| **2.0 turns** | 28 | - | 0.0 |
| **Fully open** | 3 | - | 0.0 |

**Table 2**




**Characteristic curve of table 2**

**Conclusions**

I. Even with the pressure relief valve in the full open setting there is still some pressure _____.

II. The characteristic curve shows the dependence of the ____pressure_____ on the flow rate.

III. The pressure at which the relief valve begins to open is referred to as the ____cracking_____ pressure.

IV. Pressure relief valves are used primarily as __safety valves_____.