# PARAMETER TO DESIGN A HYDRAULIC SYSTEM

1. The load must first – **45 tons**.
2. Cylinder stroke must be determined – **2 m**
3. Cylinder speed must be determined – **3m/min (3000mm/min)**
4. Determine the working pressure – **19 MPa**
5. Relief valve pressure is approximately 10% above the working pressure – **WP say 22MPa**

1. Cylinder Area.

$$Area = \frac{Tons \times 1000 \times 9{,}81 \times 1{,}2}{Working\ Pressure}$$

Area = $mm^2$
Tons = Load
1000 = 1000 kg per ton
9,81 Newton per kilogram
1,2 = 20% on the cylinder area to overcome seal friction.

$$Area = \frac{45 \times 1000 \times 9{,}81 \times 1{,}2}{19}$$

$$\underline{= \mathbf{27881{,}05\ mm^2}}$$

2. Cylinder bore diameter

$$Dia = \sqrt{\frac{Area \times 4}{\pi}}$$

$$= \sqrt{\frac{27881{,}05 \times 4}{\pi}}$$

$$\underline{= \mathbf{188{,}41\ mm}}$$

3. Cylinder Wall Thickness, using Lamé's Formula for Thick Wall Cylinders.

$$t = \left(\frac{D}{2}\right)\left[\left\{\sqrt{\left\{\frac{(S+P)}{(S-P)}\right\}}\right\} - 1\right]$$

D = Cylinder bore diameter in millimetres
S = Yield stress of cylinder steel. Using ST 52 Steel with a safety factor of 3 the yield stress = 98 $N/mm^2$
P = Relief valve pressure setting

$$= \left(\frac{188{,}41}{2}\right)\left[\left\{\sqrt{\left\{\frac{(98+22)}{(98-22)}\right\}}\right\} - 1\right]$$

$$= \left(\frac{188{,}41}{2}\right)\left[\left\{\sqrt{\left\{\frac{(120)}{(76)}\right\}}\right\} - 1\right]$$

$$= \left(\frac{188{,}41}{2}\right)\left[\left\{\sqrt{\{1{,}5689\}}\right\} - 1\right]$$

$$= \left(\frac{188{,}41}{2}\right)[1{,}2565 - 1]$$

$$= \left(\frac{188{,}41}{2}\right)[1{,}2565 - 1]$$

$$= \frac{188{,}41 \times 0{,}2565}{2}$$

$$\underline{= \mathbf{24{,}16}\ \boldsymbol{mm}}$$

4. Rod diameter

$$Dia = \left\{\sqrt[4]{(Tons \times L^2)}\right\} \times 33$$

Tons = Load to be lifted

L = The cylinder stroke **in metres**

The formula is derived from Euler's formula and using a safety factor of 5.

$$Dia = \left\{\sqrt[4]{(45 \times 2^2)}\right\} \times 33$$

$$\underline{= \mathbf{120{,}87}\ \boldsymbol{mm}}$$

**5.** Pump flow rate

$$Q = A \times V \times 10^{-6}$$

Q = Pump flow rate in litres per minute

A = Cylinder area in $mm^2$

V = Cylinder /velocity (Speed) in mm per minute

$$Q = 27881{,}05 \times 3000 \times 10^{-6}$$

$$\underline{= \mathbf{83{,}64\ litres\ pr\ minute}}$$

**6.** Power requirement (kW)

$$kW = \frac{MPa \times litres\ per\ min \times 1{,}2}{60}$$

kW = kilowatt
Litres per minute = Pump flow rate
1,2 = 20% extra power to overcome hydraulic losses

$$kW = \frac{22 \times 83{,}64 \times 1{,}2}{60}$$

$$\underline{= \mathbf{36{,}8}}$$

7. Motor Amperage

$$Amps = \frac{kW \times 1000}{Volts \times 0{,}8 \times \sqrt{3}}$$

Amps = Power consumption
kW = Electric motor kilowatt
Volts = Factory voltage Generally 380 V; 440V; 550V
0,8 = Power factor
√3 = For use with 3 phase electricity supply.

$$Amps = \frac{36{,}8 \times 1000}{380 \times 0{,}8 \times 1{,}73}$$

$$\underline{= \mathbf{159{,}03}}$$