Hydraulic cylinder project

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QTY3S6

Contents

1) Abstract:

Hydraulic cylinders are actuation devices that use pressurized hydraulic fluid to produce linear motion and force. They are used in a variety of power transfer applications, and can be single or double action.

2) Introduction:

2.1 Problem statement

Taking into account the input data, select a commercially available double stroke hydraulic cylinder from a hydraulic cylinder catalog, then replace all the seals/gaskets/guide rings with new ones and check the wall thickness of the cylinder and the caps and the diameter of the piston rod.

2.2 Objective

Select a hydraulic cylinder and seals that satisfy all the working conditions.

3) Discussion:

3.1 Cylinder selection

The selection of the cylinder depends on the working pressure, the bore diameter (piston diameter), and the stroke.
Taking the input data $p = 10\ MPa$, $D = 125\ mm$, and $l = 150\ mm$.
Selecting from Rexroth Bosch group.

-Selecting cylinder of product key:

CDT3/MS2/125/90/150F1X/B11HHDMWW

Which is a cylinder of 125 mm bore, 150 mm stroke, and 90 mm rod diameter.

3.2.1 Rod diameter

$d_{min} = D\sqrt{\frac{\varphi-1}{\varphi}}$, where $\varphi = 2$.

$d_{min} = 88.4\ mm$, the rod diameter of the selected cylinder is alright.

3.2.2 Wall thickness

Material of selected cylinder is C35E, with yield strength $R_e = 300\ MPa$.

Minimum pipe thickness

$$S_o = \frac{D \cdot P}{\frac{2R_e}{z} - P} = 7.74\ mm$$

For the selected cylinder the bore $D = 125\ mm$, and the outer diameter $D_{out} = 160\ mm$. Then,

$$S = \frac{D_{out} - D}{2} = 17.5\ mm$$

So, the thickness of the cylinder is alright.

3.2.3 Rod buckling

Length of rod $L = J + 2 \cdot stroke = 579.5\ mm$, where $J = 279.5\ mm$ from catalog.

Slenderness ratio

$$\lambda = \frac{4L}{d} = 25.8$$

Rod material of selected cylinder is C45E, with $R_e = 370\ MPa$.

As $\lambda < 100$, use Euler's formula.

$$F_t = \frac{\pi^2 \cdot I \cdot E}{L^2} = 19877057\ N$$

Where

$$I = \frac{d^4 \cdot \pi}{64} = 3220623\ mm^4$$

And the modulus of elasticity E is,

$$E = 2.1 \times 10^5\ Nmm^{-2}$$

The safety factor in this case

$$Z = \frac{F_t}{F} = 162$$

Where

$$F = \left(\frac{D^2 \cdot \pi}{4}\right) P = 122718.5\ N$$

As $Z > 3.5$, the rod is okay for buckling.

3.2.4 Cylinder caps dimensioning

Material: St52, with $R_e = 355\ MPa$.

$$\sigma_w = \frac{R_e}{Z} = 187\ MPa$$

Minimum wall thickness of caps

$$h_{min} = \frac{0.6 \cdot D \cdot P}{\sigma_w} = 0.02\ mm$$

Which is more than the actual thickness so the cylinder is suitable.

3.3 Seals selection

All the seals are selected from SKF industrial seals website:
(https://www.skf.com/group/products/industrial-seals)

We have 6 seals to select:

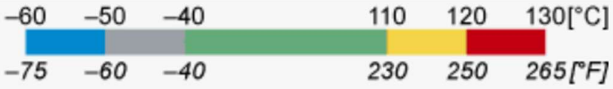
1)O-rings:

Designation	O-ring		
	Inside diameter	Width	Dash-number
	ID [mm]	CS [mm]	
OR 120.32X2.62-N70	120.32	2.62	158
OR 120.37X1.78-N70	120.37	1.78	048
OR 120.7X5.33-N70	120.7	5.33	
OR 122.0X1.25-N70	122	1.25	
OR 122.0X2.5-N70	122	2.5	
OR 122.0X3.0-N70	122	3	
OR 122.0X4.0-N70	122	4	
OR 123.0X4.0-N70	123	4	
OR 123.19X5.33-N70	123.19	5.33	352

2)piston seal:

Designation	Profile	Dimensions			Max. operating parameters	
		Cylinder bore diameter	Piston groove diameter	Housing width	Pressure	Temperature
		D [mm]	d [mm]	L [mm]	max. [bar]	$T_δ$ max. [°C]
LCP-125X110X12.5-ND1	LCP	125	110	12.5	690	130
LCP-125X112.7X14.7-ND1	LCP	125	112.7	14.7	690	130

SCP PISTON SEALS

Material codes	Slide ring: • Suffix E5E → P-2501 • Suffix E5D → P-2551 Energizer: A-8526
Pressure	Up to 690 bar (10 000 psi)
Speed	Up to 1 m/s (3.2 ft/s)
Temperature range	

3)rod seal:

Designation	Profile	Dimensions			Max. operating parameters	
		Rod diameter	Housing diameter	Housing width	Pressure	Temperature
		d [mm]	D [mm]	L [mm]	max. [bar]	$T_δ$ [°C]
PTB-90X100X6.6-J1S	PTB	90	100	6.6	400	120
PTB-90X100X7.7-J1S	PTB	90	100	7.7	400	120
PTB-90X98X8.8-J1S	PTB	90	98	8.8	400	120
SIL 90X100X12.5	SIL	90	100	12.5	350	110

STD ROD SEALS

Material codes	Sealing ring: U-1003 X-ring: A-8501
Pressure	Up to 400 bar (5 800 psi)
Speed	Up to 1 m/s (3.2 ft/s)
Temperature range	

4)piston guide rings:

Designation	Design	Dimensions			Max. operating parameters	
		Inside diameter	Outside diameter	Groove width	Speed	Temperature
		d [mm]	D [mm]	L [mm]	max. [m/s]	max. [°C]
WAT-120X125X5.6-E8D	WAT	120	125	5.6	1	120

5)rod guide ring:

Designation	Design	Dimensions			Max. operating parameters	
		Inside diameter	Outside diameter	Groove width	Speed	Temperature
		d [mm]	D [mm]	L [mm]	max. [m/s]	max. [°C]
WAT-90X95X10-E8D	WAT	90	95	10	1	120
WAT-90X95X13-E8D	WAT	90	95	13	1	120
WAT-90X95X15-E8D	WAT	90	95	15	1	120
WAT-90X95X15.3-E8D	WAT	90	95	15.3	1	120
WAT-90X95X20-E8D	WAT	90	95	20	1	120
WAT-90X95X25-E8D	WAT	90	95	25	1	120
WAT-90X95X6-E8D	WAT	90	95	6	1	120
WAT-90X95X6.3-E8D	WAT	90	95	6.3	1	120
WAT-90X95X9.7-E8D	WAT	90	95	9.7	1	120

6)wiper seal:

Designation	Design	Dimensions			Max. operating parameters	
		Rod diameter	Housing diameter	Housing width	Speed	Temperature
		d [mm]	D [mm]	L [mm]	max. [m/s]	max. [°C]
DTW-90X100X7-J2G	DTW	90	100	7	0.75	120
HW-90X100X7-J2G	HW	90	100	7	0.75	100
MCW-90X104X8-E6Q	MCW	90	104	8.5	1.5	120
MCW-90X105X7-E6Q	MCW	90	105	7.5	1.5	120
MCW-90X106X8-E6Q	MCW	90	106	8.5	1.5	120
MCW-90X110X7-E6Q	MCW	90	110	7.5	1.5	120
PA 90X100X7X10	PA	90	100	7.5	1	110
PAD 90X104X8X11	PAD	90	104	8.5	1	110
PADV 90X104X8X11	PADV	90	104	8.5	1	110

4) References

1. Design aid
2. Rexroth Bosch group
3. SKF https://www.skf.com/group