Hydraulic Cylinder Sizing

Project: ____________ Part/Position: ____________ Prepared by: ____________

Sample document - numeric values are only included in the purchased Pro export.

Overall assessment: PASS - buckling check and compression check of the piston rod meet the requirements.

Inputs

Bore D	– – – mm
Piston rod diameter d	– – – mm
Operating pressure p (gauge)	– – – bar
Efficiency eta	– – –
Flow rate Q	– – – l/min
Stroke s	– – – mm
Mounting case (Euler case)	– – –
Mounting dimension l_0 (retracted)	– – – mm
Piston rod material	– – –
Required buckling safety S_erf	– – –

Areas and forces

Piston area A_1	– – – mm^2
Annulus area A_2	– – – mm^2
Area ratio phi = A_1/A_2	– – –
Theoretical push force p·A_1	– – – N
Theoretical pull force p·A_2	– – – N
Push force extending F_1 = p·A_1·eta	– – – N
Pull force retracting F_2 = p·A_2·eta	– – – N

Motion, oil demand and power

Piston speed extending v_1	– – – m/s
Piston speed retracting v_2	– – – m/s
Stroke time extending t_1	– – – s
Stroke time retracting t_2	– – – s
Cycle time t_1 + t_2	– – – s
Volume extend stroke V_1	– – – l
Volume retract stroke V_2	– – – l
Volume per cycle	– – – l
Hydraulic power Q·p	– – – kW
Required drive power Q·p/eta	– – – kW

Piston rod verifications

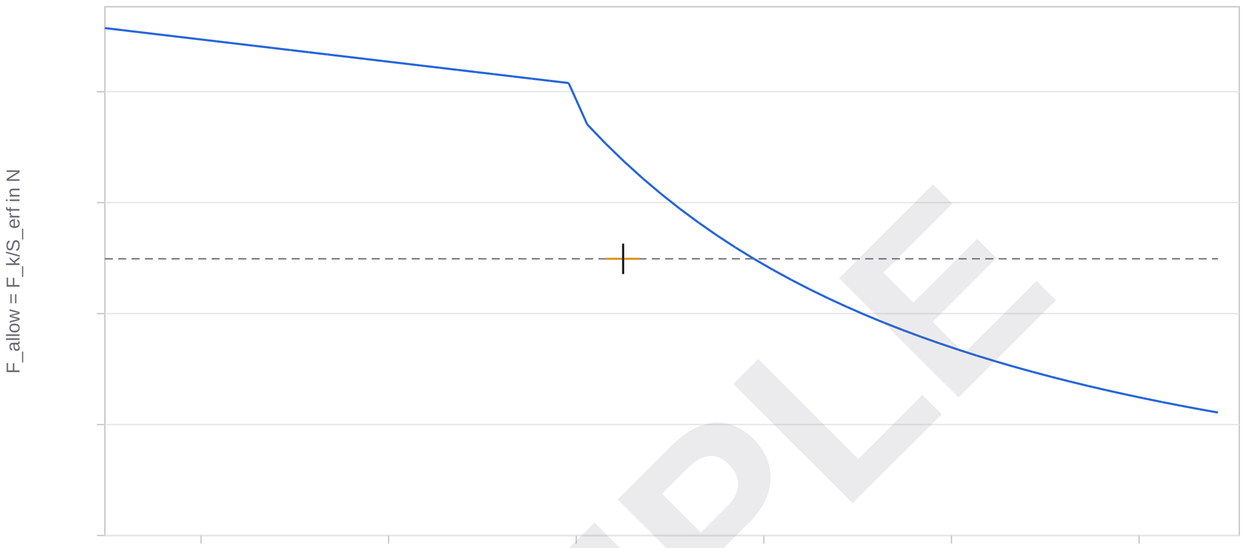
Criterion	Value	Limit	Status
Buckling safety S = F_k/F_th	– – –	– – –	● PASS
Compression check S_d = R_e/sigma_d	– – –	– – –	● PASS

Buckling verification (Euler/Tetmajer)

Free length l = l_0 + s	– – – mm
Buckling length l_k = beta·l	– – – mm
Rod cross-section A	– – – mm^2
Second moment of area I = pi·d^4/64	– – – mm^4
Slenderness ratio lambda	– – –
Governing range	– – –

Buckling stress sigma_k	– – – N/mm^2
Buckling force F_k = sigma_k·A	– – – N
Allowable force F_k/S_erf	– – – N
Compressive stress sigma_d = F_th/A	– – – N/mm^2
Maximum free length at S_erf	– – – mm
Maximum permissible stroke	– – – mm

Allowable compressive force over the free length



free length l in mm (dashed: applied compressive force, cross: operating point)

Calculation basis

Forces and motion: when extending, the operating pressure acts on the piston area A_1 = pi/4·D^2; when retracting only on the annulus area A_2 = pi/4·(D^2-d^2). The effective piston force is F = p·A·eta (– – – bar = – – – N/mm^2). The piston speed follows from v = Q/A, the stroke time from t = s/v and the oil demand from V = A·s. The hydraulic power is P = Q·p (with Q in l/min and p in bar: P in kW = Q·p/600), the drive power P/eta.

Buckling verification: the extended piston rod is conservatively treated as a straight, centrically loaded bar of rod diameter over the free length l = l_0 + s. The mounting case gives the buckling length l_k = beta·l and, with the radius of gyration i = d/4, the slenderness ratio lambda = l_k/i. Above the limit slenderness lambda_g Euler applies (sigma_k = pi^2·E/$lambda^2$), below it Tetmajer (sigma_k = a + b·lambda); the stress is capped at the yield strength. The safety S = F_k/F is checked against the theoretical compressive force without efficiency; fluid power practice requires – – – to 5.

Validity: static analysis without acceleration, friction or back-pressure terms, without initial deflection of the rod and without guidance forces from the cylinder tube. The efficiency eta covers cylinder and drive losses together.

Note: The results are design and orientation aids. They do not replace independent verification, calculation and approval by a qualified person. The terms of use at maschinenbaurechner.de apply.