Return To Index

Determining Tube Size for Hydraulic Systems

Proper tube material, type and size for a given application and type of fitting is critical for efficient and trouble free operation of the fluid system. Selection of proper tubing involves choosing the right tube material, and determining the optimum tube size (O.D. and wall thickness).

Proper sizing of the tube for various parts of a hydraulic system results in an optimum combination of efficient and cost effective performance.

A tube that is too small causes high fluid velocity, which has many detrimental effects. In suction lines, it causes cavitation which starves and damages pumps. In pressure lines, it causes high friction losses and turbulence, both resulting in high pressure drops and heat generation. High heat accelerates wear in moving parts and rapid aging of seals and hoses, all resulting in reduced component life. High heat generation also means wasted energy, and hence, low efficiency.

Too large of a tube increases system cost. Thus, optimum tube sizing is very critical. The following is a simple procedure for sizing the tubes.

Step 1: Determine Required Flow Diameter

Use Tables U13 and U14 to determine recommended flow diameter for the required flow rate and type of line.

The table is based on the following recommended flow velocities:

Pressure lines — 25 ft./sec. or 7.62 meters/sec.
Return lines — 10 ft./sec. or 3.05 meters/sec.
Suction lines — 4 ft./sec. or 1.22 meters/sec.

If you desire to use different velocities than the above, use one of the following formulae to determine the required flow diameter.

$$\text{Tube I.D. (in.)} = 0.64 \sqrt{\frac{\text{Flow in GPM}}{\text{Velocity in ft./sec.}}}$$

OR

$$\text{Tube I.D. (mm)} = 4.61 \sqrt{\frac{\text{Flow in liters per minute}}{\text{Velocity in meters/sec.}}}$$

Step 2: Determine Tube O.D. and Wall Thickness

Using Tables U15 and U16, determine the tube O.D. and wall thickness combination that satisfies the following two conditions:

A. Has recommended design pressure equal to or higher than maximum operating pressure.

B. Provides tube I.D. equal to or greater than required flow diameter determined earlier.

Design pressure values in Tables U15 and U16 are based on the severity of service rating “A” (design factor of 4) in Table U10, and temperature derating factor of 1 in Table U11.

If more severe operating conditions are involved, the values in Tables U15 and U16 should be multiplied by appropriate derating factors from Tables U10 and U11 before determining the tube O.D. and wall thickness combination. Contact the Tube Fittings Division when in doubt.

Allowable design stress levels and formula used to arrive at the design pressure values are given in the following chart. Values in Table U8 are for fully annealed tubing.

Material and Type	Allowable Design Stress fo Design Factor of 4 at 72°F	Tube Specification
Steel C-1010	12,500 PSI	SAE J356, J524, J525
Steel C-1021	15,000 PSI	SAE J2435, J2467
Steel, High Strength Low Alloy (HSLA)	18,000 PSI	SAE J2613, J2614
Stainless Steel 304 & 316	18,800 PSI	ASTM A213, A249, A269
Alloy Steel C-4130	18,800 PSI	ASTM A519
Copper, K or Y	6,000 PSI	SAE J528, ASTM B75
Aluminum 6061-T6	10,500 PSI	ASTM B210
Monel, 400	17,500 PSI	ASTM B165

Table U8 — Design Stress Values

Design Pressure Formula (LAME’S)

$$P = S\left(\frac{D^2 - d^2}{D^2 + d^2}\right) \quad \text{where:}$$

D = Outside diameter of tube, in
d = Inside diameter of tube (D-2T), in
P = Recommended design pressure, psi
S = Allowable stress for design factor of 4, psi
T = Tube wall thickness, in.

Table U9 — Design Pressure Formula

For thin wall tubes ($D/T \geq 10$) the following formula may be Used: **P = 2ST/D**

Dimensions and pressures for reference only, subject to change.