Pressure Drops

Diagram to determine pipe dia. and related pressure drop

To get a **rough** idea of the pressure drop sustained in pipes and piping or plumbing units (e.g. elbows, cross-overs, valves, etc.) use the diagram overleaf. This chart is based on 1m length pipes and sepc. gravity of 1 kg/dm^3. For different parameters use the conversion formular.

1. Applications

Take the required delivery Q (m^3/h) and the hypothetical flow rate w (m/s) to determine the pipe dia. d (mm). (Usually between 0.5...0.8 m/s for dosing pumps and 2...4 m/s for constant flow, e.g. for centrifugal pumps).

2. Pressure drop through fittings

Determine and **add** the **drag coefficient** ξ for various controls, elbows, etc. installed in the pipe system. Depending on the previously foung/selected flow rate w (m/s) the sum total $\Sigma\xi$ will give the pressure drop for Δp_A (mbar).
For components bulit or fitted in the pipe system and not featured in the diagram use ξ-values.

3. Pressure drop through pipes

Determine the pressure drop Δp_{R1} (mbar) per metre piping as a function of the flow rate w (m/s) and the previously established pipe dia. d (mm).
To determine the overall pressure drop Δp_R multiply the value Δp_{R1} by the number of metres of the piep length.

$$\Delta p_R = \Delta p_{R1} \text{ x pipe length (m)}$$

The pipe was assumed to have a friction or roughness factor of 0.15 mm. This value applies for smooth pipes in process engineering.

4. Total pressure drop

The overall accepted pressure drop is the sum total of the pipe and component-governed losses.

$$\Delta p_{total} = \Delta p_R + \Delta p_A$$

5. Specific gravity correction

Pressure drop for liquids with a spec. gravity of $\neq$ 1 kg/dm^3 can be calculated by multiplying the Δp-values found from the diagram by that spec. gravity:

$$\Delta p = \Delta p_{total} \text{ x } \rho$$

6. Example

Deliver 0.4 m^3/h saline solution (ρ = 1.18) through the following plant:
Metering pump; 0.5 m PVC tubing; shut-off valve (to DIN); 1m PVC tubing; solenoid valve; flow detector; elbow; flow rate meter; elbow; T piece; 4m PVC-tubing.
Find pipe dia. and pressure drop.

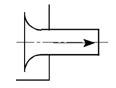
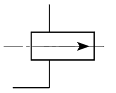
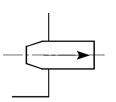
Solution:

The pipe diameter is determined to be 16 mm at a flow rate of 0.55 m/s.
The sum of the ξ-values gives us:

DIN standard valve	3.9
Solenoid valve	6.0
Flow detector	5.8
Elbow	0.5
Flow meter	6.5
Elbow	0.5
T Piece	1.3
$\Sigma\xi$	= 24,5

For w 0.55 m/s, and ξ=24.5 the pressure drop in the instrumentation can be found as Δp_A = 40 mbar.
Furthermore, at a dia.=16mm, the pressure drop in a 1m long pipe is Δp_{R1} = 3.5 mbar.
Thus, the pressure drop to be expected in a 4.5m long pipe system is Δp_R = 4.5 x 3.5 = 15.8 mbar. The overall pressure drop will be the sum total of both these values which has to be multiplied by the ρ:

$$\Delta p_{total} = 40 + 15.8 = 55.8 \text{ mbar}$$
$$\Delta p = \Delta p_{total} \text{ x } \rho = 55.8 \text{ x } 1.18 = 65.8 \text{ mbar}$$

Inlet/outlet socket (e.g. on the container)		ξ = 0.06
		ξ = 0.56
		ξ = 2.8

Instrument	ξ
Ball cock	0.6
Angle seat valve	0.6
Shut-off valve to DIN	3.9
L or T-port valve	3.0
Solenoid valve	6.0
Relief valve	6.0
Flap valve or tapered restrictor	5.8
Floating body/flow-through flow meter	6.5

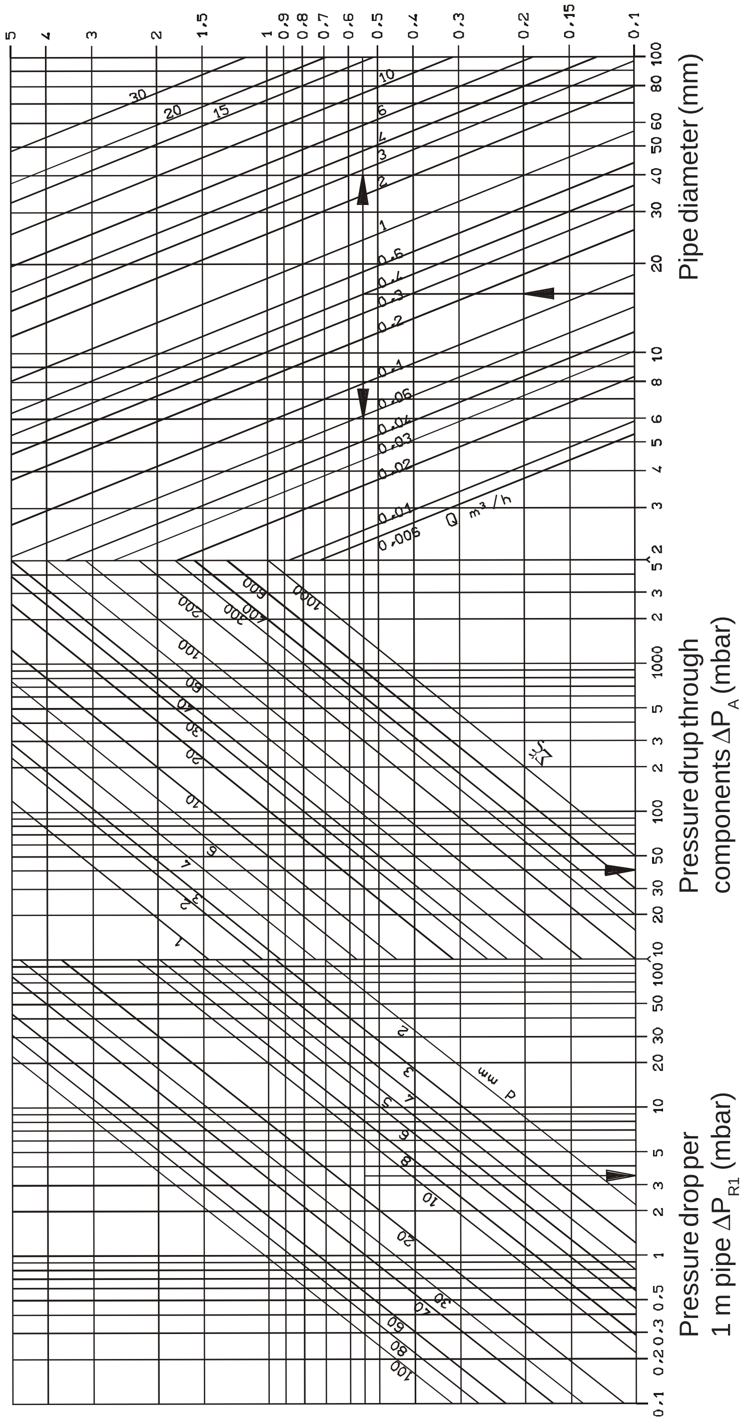
Pressure Drops

Elbow	r/d	1	2	4	6	10
	ξ	0.51	0.3	0.23	0.18	0.2

Bushes/sleeves, restrictors, screwed joints	d/d_1	0.1	0.3	0.5	0.6	0.8	0.9
	ξ	0.45	0.42	0.38	0.3	0.17	0.09

Bend (sharp edge)	α	10	15	30	45	60	90
	ξ	0.04	0.06	0.15	0.3	0.6	1.2

Velocity w (m/s)



Pressure drop for $\rho \neq 1$ kg/dm³ (mbar)

$\Delta p = \Delta p_{ges} \times \rho$

Overall pressure drop (mbar)

$\Delta p_{ges} = \Delta p_R \times \Delta p_A$

Pressure drop in the piep (mbar)

Δp_R = length of pipe (m) x Δp_{R1}

The diagram relates to a density of 1 kg/dm³, 1m pipe and a pipe roughness of k=0.15mm.