

Loss of head calculation 压力头损失的计算

当设备或管线铺排在泵前和泵后时，涉及的压力损失是有限的

Already during design of the plant and piping layout in front of and behind the pump, losses can be limited when considering:

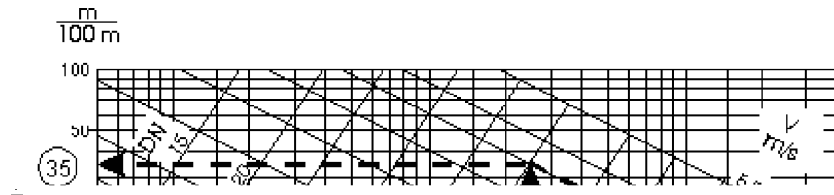
- the pipe diameter is sufficiently dimensioned, 管径充分大
- less fittings are used, 接头尽量少
- fittings with low friction loss are selected, 选择摩擦损失足够少的接头
- short pipe runs are planned. 管子尽量短

Loss of head in straight pipe runs

直管内压力损失趋向

The diagram shows the loss of head for straight pipe runs as a function of a pipe length of 100 m and a given flow velocity v depending on the flow rate and the pipe diameter.

下图显示出直管内压力损失的趋向 每 1 0 0 M管长损失压力 进管流速 V 与流量和管径有关



Example: 举例

Flow rate 流量 $Q = 25 \text{ m}^3/\text{h}$
 Pipe diameter 管径 $d = 50 \text{ mm}$
 From the diagram results: 从图表得出
 Flow velocity 流速 $v = 3.5 \text{ m/s}$
Loss of head 压力损失 $H_v = 35 \text{ m}/100 \text{ m}$

The loss of head in fittings can be determined almost exactly when using adequate pipe lengths. 当管长足够时，弯头损失的他里被精确确定

The loss of head in a fitting is considered equal to a straight pipe with corresponding length. 一个弯头压力被定义成相应长度的管长

This calculation is valid only for water and fluids similar to water.

此计算结果仅适用水或与水类似的流体

With the same diameter of pipes and fittings we can simplify the calculation.

同样的管径和弯头直径能使计算简化

Equivalent pipe lengths in meter for fittings 对弯头用相应的管长表示

(valid for $Re \geq 100,000$ and roughness $k \leq 0.04 \text{ mm}$) r o u g h n e s s - - 粗糙度

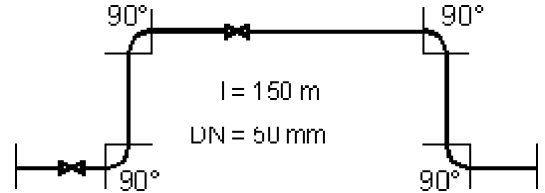
**Loss of head caused
by fittings**

弯头导致的压力损失

Diameter DN [mm]	25	40	50	65	80	100	125	150
Equivalent length [m]	0.3	0.5	0.7	1.0	1.3	1.8	2.5	3.5

Loss of head calculation

举例	Example:	
流量	Flow rate	Q = 25 m ³ /h
直管长	Straight pipe length	l = 150 m
直径	Diameter	DN = 50 mm
90度弯角	Elbow 90°	4 pieces
易流阀	Free-flow valves	2 pieces



从上表 1.6 from diagram (page 16):

$$v = 3.5 \text{ m/s}$$

$$H_v = 35 \text{ m}/100 \text{ m pipe length}$$

从表格上 from table:

4 个弯头相当与管长	equivalent pipe length 4 elbows:	$l_{\text{bend}} = 1.1 \times 4 = 4.4 \text{ m}$
2 个易流阀相当于管长	equivalent pipe length 2 free-flow valves:	$l_{\text{slide}} = 1.2 \times 2 = 2.4 \text{ m}$
直管长	straight pipe length:	$l_{\text{pipe}} = 150.0 \text{ m}$
总管长	total pipe length	$l_{\text{total}} = 156.8 \text{ m}$

loss of head: 损失压力

$$H_{\text{total}} = H_v \times l_{\text{total}}$$

$$H_{\text{total}} = \frac{35}{100} \times 156.8 = 55 \text{ m}$$

层流损失压力 Δp_v 可用 Hagen - Poiseuille 公式计算出
with laminar flow (high viscosities) the loss of head Δp_v can be calculated using the Hagen-Poiseuille formula:

$$\Delta p_v = \frac{v_M \times 32 \times \eta \times l}{d^3 \times 10^3}$$

$$H_v \times 10 \approx \Delta p_v$$

$$v_M = Q/A \text{ [m/s]}$$

$$\eta \text{ [Pa s = kg/m s]}$$

$$l \text{ [m]}$$

$$d \text{ [m]}$$

$$\Delta p_v \text{ [bar]}$$