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Comparative Energy Lost in Local Resistances, Imperical Formulas of Minor Head Loss Coefficient

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Abstract: In this article, the calculation of relative energy loss during the movement of liquids in closed systems, taking into account local resistances, is studied. The methods of calculating the local resistance coefficient were considered, and the dependence of the local resistance coefficient on the current consumption was studied by the grapho-analytical method through the results obtained in the laboratory.

Key words: head loss , minor loss, minor loss coefficient , fluid flow , HM-112.

Introduction: When fluids flow through pipes, they encounter resistance due to friction along the pipe walls and disturbances caused by various components. This resistance results in energy losses, categorized as major and minor head losses. Major losses occur due to friction along the straight sections of the pipe, while minor losses arise from changes in flow direction, velocity, or cross-sectional area caused by fittings, valves, bends, contractions, expansions, and other components. Understanding and minimizing these losses is crucial for optimizing the efficiency and performance of fluid systems, impacting energy consumption, pump selection, and overall system cost

Causes of Minor Head Loss:

Minor losses stem from flow disturbances that generate turbulence and additional friction. These disturbances can be attributed to several factors:

1. Changes in geometry: Bends, elbows, tees, and other fittings introduce sudden changes in flow direction, creating eddies and turbulence.
2. Changes in velocity: Contractions and expansions cause the fluid to accelerate or decelerate, leading to energy losses.
3. Obstructions: Valves, filters, and other components within the pipe introduce flow resistance and generate turbulence.

Calculating Minor Head Loss:

The Darcy-Weisbach equation is commonly used to quantify minor head loss:

$$h_m = \varepsilon \frac{\vartheta^2}{2g} \quad (1.)$$

where :

h_m – minor head loss (m or feet)

ε- minor head loss coefficient

ϑ- flow velocity (m/s or ft/s)

g is the acceleration due to gravity (9.81 m/s² or 32.2 ft /s²)

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The coefficient of local resistance (ε) is an empirical value determined by experiments and tabulated for various components. These values depend on the specific geometry, Reynolds number, and flow conditions.

The change of the local resistance coefficient in relation to the current consumption was studied in laboratory conditions under different conditions. The experiments were carried out using the GUNT HM-112 (Germany) device.

Figure 1 HM-112 laboratory equipment in

Table 1

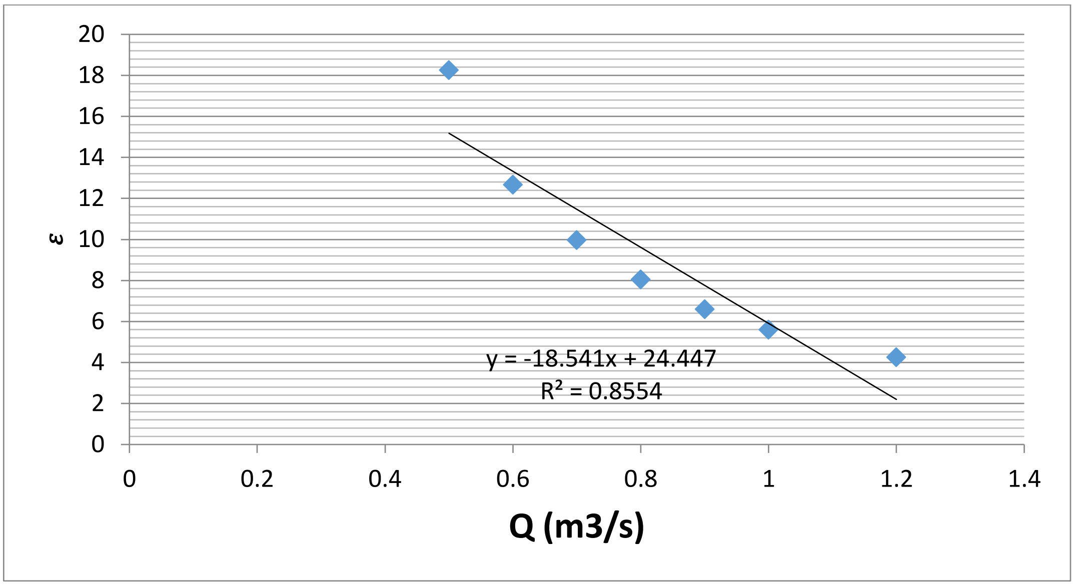
T/r	Q (m^3 /s)	H1 (mm)	H2 (mm)	h_m (mm)	d (cm)	c (m/s)	ε
1	0.5	75	5	70	2.54	0.27424	18.26149
2	0.6	98	28	70		0.329088	12.68159
3	0.7	131	56	75		0.383936	9.982593
4	0.8	166	87	79		0.438784	8.050545
5	0.9	195	113	82		0.493632	6.602479
6	1	233	147	86		0.54848	5.608886
7	1.2	325	231	94		0.658175	4.257391

Experiences are 7 different flow spending as a result according to don't come back of the valve local resistance coefficient was determined . Of this for to the valve access and get out in the part piezometric pressures H_1 and H_2 and in the botometer water spending was determined (Table 1). Received to the results basically the following formulas using local resist coefficient εcalculated:

Head loss : $h_m = H_1 - H_2$ (2.)

Speed : $\vartheta = \frac{4Q}{\pi d^2}$ (3.)

Local resistance coefficient : $\varepsilon = \frac{h2g}{\vartheta^2}$ (4.)



Graph 1 Graph of dependence of local resistance coefficient on liquid flow

According to the obtained results::

Y=-18.541x+24.447 (5.)

The resulting empirical formula was obtained. If we change Y to ε and x to Q in the formula:

ε=-18.541Q+24.447 (6.)

The fifth (5) formula above is formed. It can be concluded that the local resistance coefficient varies inversely with the current consumption.

Conclusion: Minor head losses, while seemingly insignificant compared to major losses, can cumulatively impact the efficiency and performance of fluid systems. Understanding the causes of these losses and implementing strategies to minimize them is essential for optimizing energy consumption, pump selection, and overall system design. By applying the Darcy-Weisbach equation, utilizing appropriate loss coefficients, and adopting design practices that minimize flow disturbances, engineers can ensure the efficient and cost-effective operation of fluid systems across various applications.

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