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Loss of Napor in Cylinder Pipe Flow

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Abstract: The study of smooth and uneven forward motion of hydraulic smooth and rough pipes, channels and streams, in which the work of hydraulic calculation of hydraulic resistance and pressure loss is solved.

Keywords: pressure, laminar, turbulent, Reynols number, hydraulic jump, Frud number.

Some of the flow energy is expanded to overcome resistance (hydraulic resistances) present in the fluid motion, and as a result flow energy is reduced (lost). Reasons for the loss of flow energy: the viscosity of fluid the geometric configuration of the flow area, the roughness of the solid body wall (surface) that limits the flow, the types of fluid flow, and so on.

The energy ofoqiminingfluid flow is lost along the flow due to the following reasons: laminar or turbulent flow, moderate or non-moderate currents,calm and rapid currents, hydraulic shock, hydraulic jumps and so on. Numerous experimental studies have shown that during fluid motion its energy loses the amount of energy expanded to overcome local resistance to fluid motion, and this amount depends on flow configuration types of fluid flow, and influencing forces (mass and surface), depending on the condition of the flow-limiting wall (smooth or not smooth), and various other factors. To do this, it is necessary to determine the pressure and avarege velocities of the flow in different section along the channel (pipe). These quantities are determined using the Bernulli equations, the energy conservation equations. But it is also necessary to take into account the loss of energy in these equations, and this is called the loss of pressure in hydraulics.

Tpypes of pressure loss.

A certain amount of flow energy is expanded to overcome the resistance (hydraulic resistance) to the movement of the viscous fluid, and they are divided into two types of loss of pressure:

Thus the total loss of pressure in the piping system is written as follows:

$$h_{иш} = \sum_{k=1}^{N} h_{к.уз} + \sum_{n=1}^{N} h_{лм} \quad h_{иш} = \sum_{k=1}^{N} h_{к.узуз} + \sum_{n=1}^{N1} h_{пж} \qquad (1)$$

Such as a loss of relative energy is mainly an irreversible process in which sometimes mechanichal energy is converted into heat energy. The mechanism of resistance forces is much more complex, it is formed mainly as a result of small (current) fluctuations and their interactions, which are formed according to the viscosity properties of the liquid under complex conditions. For example, in a plane motion of a fluid that is independent of time in the channel (where the average velocity of the fluid is assumed to be constant along the length of the channel) this experimental relationship is axial for the longitudinal loss of pressure. [1]:

$h_{kuz} = v\vec{V}^{m}$, (2)

Here $\vec{V}$ - average velocity v – to the length aand width of the pipe both depends on smoothness of the wall and , m depends on the type of flow for example if , $m = 1$ for laminar flow , it is assumed to be $1{,}75 < m < 2$ for turbulent flow. In general, in this case the local loss of h –pressure, according to the Bernoulli integral, is written as follows:

$$h_{xc}=\Delta H_n= (Z_1+\frac{\cap}{\rho g}+\alpha_1\frac{V_1^2}{2g}) - (Z_2+\frac{P_2}{\rho g}+\alpha_2\frac{V_2^2}{2g}), \quad (3)$$

Here ΔH_n – the difference of pesometric pressure; $\gamma = \rho \cdot g$; $H=Z+\frac{p}{\rho g}+\alpha\frac{V\cup}{2g}$ - is called hydrodynamic pressure and it potential energy $(Z+\frac{p}{\gamma})$ and relative kinetic energies consists of the sum $(\alpha\frac{V\cup}{2g})$

Loss of napor along the length, local the dynamic, the fluid showing the losses properties of $\frac{V^2}{2g}$ are expressed in terms of quantity

(the ratio of energies per unit mass) represented and written by Weisbach formulas;

$$h_{uz} = \zeta_{uz}\frac{\vec{V}^2}{2g}; \qquad h_j = \zeta_j\frac{\vec{V}^2}{2g} \quad (4)$$

ζ - is called the loss of pressure coefficient.

ζ_{uz} – length loss coefficient of along pressure.

ζ_j the loss of pressure local coefficient.

To study the effect of pressure (where E_u - Eyler number is a finite quantity), we need to determine to what prameteres this quantity of flow depends:

$$\pi_{\Delta P}=\frac{\Delta p}{\rho V^2} = f_1(R_e, F_ч, W_e, C_a, K_C, \pi_\Delta)$$

Hydraulic parameters for flow in the pipe.

Laminar flow. This amount is the time-independent distribution of viscous fluid in a pipe with a cross-sectional circles $[S]$

$$V=-\frac{\gamma \cdot i}{4\mu}(C^2-a^2).$$

The average velocity of such a liquid particle

$$\vec{V} = \frac{Q}{\omega}; \qquad Q = 2\pi\int_0^a Vrdr \quad (5)$$

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We determine the average velocity from the equations: $\vec{V} = \frac{\gamma \cdot i}{8\mu} a^2$ here $\gamma = \rho g, i -$ hydraulic slope.

We now determine the Coriolis coefficient for this flow.

$$\alpha = \frac{1}{\omega \vec{V}^3} \int_{(c)} V^3 d\omega = 2 .$$

The test voltage $\tau = -\mu \frac{du}{dr}$ determined by equation (5) and the linear variation along the radius of the voltage from equation (5) is determined by: $\tau = \rho gi \, {}^{r}\!/\, z$.

The test voltage is zero at the center of the pipe and its maximum value is achived at the pipe

$$\tau_{max} = \frac{\gamma ia}{2} .$$

If the pipe is horizontal, the change in pressure length along it is determined as follows (figure-1.1)

$$h_{tr} = \frac{P_1 - P_2}{\gamma} . \qquad (6)$$

Based on the above similarity theory, along the length of pressure. The loss will be as follows:

$$h_{tr} = 2 f_3 \left(\frac{\Delta}{4R}, \frac{\ell_\Delta}{4R}, \mathrm{Re}, Fz, Ka \right) \cdot \frac{\ell}{4R} \cdot \frac{V^2}{2g} .$$

$\Delta=0$, $\ell_\Delta=0$, $k_a=0$, $F_r \to \infty$ if we say (pipe smooth, laminar flow) the effect of gravity is considered to be very small

$2f_3(\mathrm{Re}) = \lambda$ and then $\lambda = 2f_3(\mathrm{Re})$we get the formula Darcy-Weisbach

$$h_{tr} = \lambda \cdot \frac{\ell}{a} \cdot \frac{V^2}{2g} , \qquad (7)$$

λ - leson coefficient – hydraulic friction coefficient.

$\frac{h_{mp}}{\ell} =$ from the above equations (2), (4), (5) when the *i*–hydraulic slope is introduced we get the Poisyl Gaben formula:

$$h_{tr} = \frac{2\mu\ell\vec{V}}{gd^2} . \qquad (8)$$

for the hydraulic slope (*d*=2*a*) the following equationcan be written:

$$i = \frac{2\tau_0}{\gamma a} . \qquad (9)$$

we determine the lesson coefficient by equations (7) and (8).

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$$\lambda \frac{\ell}{a}\frac{V^2}{2g} = \frac{32\gamma V}{gd^2}$$

Figure 1.1. flow in a horizontally located cylindrical tube.

Even if the pipe cross section is not circular, the course coefficient will depend on the Reynolds number. $\lambda = \frac{A}{R_{e_{dr}}}$, $d_r = 4R$.

The value of A depends on the amount of sand, new and old, the smoothness of the surface, the amount of corrosion and sediment adhering to the surface.

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