УДК 622.276.52

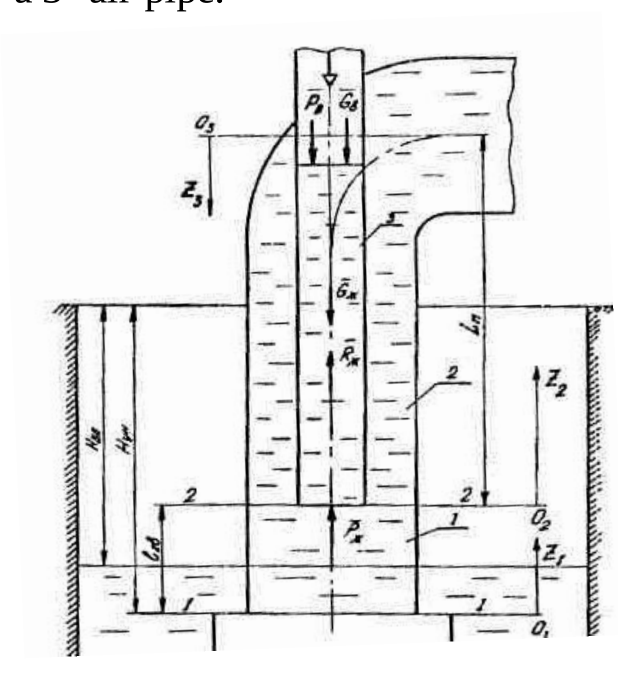
DYNAMICS OF A POINT OF VARIABLE WEIGHT AND THE DIFFERENTIAL EQUATIONS OF MOVEMENT OF A LIQUID IN PNEUMATIC HYDRAULIC PATHS PUMP HOUSE-AIR-LIFT INSTALLATIONS DURING START-UP.

Konshin D.V., student
Ignatov A.V., candidate of technical sciences,
Donetsk National Technical University

Mesherskiy has established that if the weight of a point changes during movement the basic differential equation of movement of Newton is replaced with the following equation of movement of a point of variable weight:

$m\frac{d\bar{v}}{dt} = \bar{F} + \bar{R}$, Where $\bar{F}$ and $\bar{R} = \frac{dm}{dt}\overline{U_r}$ — the set and jet forces.

Let's consider transients in pneumatic hydraulic paths pump house-air-lift installations which circuit is resulted in figure where the 1- delivery pipeline of the pump and the having pipeline air-lift ; 2- elevating pipe; a 3- air pipe.



The settlement circuit pump -air-lift adjustment

Transients during start-up are considered in the assumption, that the pump already works and submission of compressed air in an air pipe air-lift starts to be carried out. The period of replacement of a liquid from an air pipe by the compressed air down to his break through the amalgamator in an elevating pipe air-lift is investigated. For drawing up of the differential equation of movement of a liquid in an air pipe we use the equation of dynamics of a body of the variable weight, written down in projections to an axis Z_3:

$$m\ddot{Z}_3 = \sum F^e_{kz_3} + \frac{dm}{dt} \cdot U_{z_3},$$

Where m-weight of a liquid in an air pipe, kg; Z_3 - coordinate of a free surface of a liquid in an air pipe; $\sum F^e_{kz_3}$ - the sum of projections to an axis Z_3 of the external forces working on a liquid moving in an air pipe, H; U_{z_3} - a projection to an axis Z_3 of a vector of speed of weight of water moving in an air pipe during its branch, m/s.

$$\sum F^e_{kz_3} = P_{вз} + G_в + G_{жс} - P_{жс} - R_{жс},$$

Where $P_{вз}$ - force of pressure of compressed air, H; $G_в$ - a gravity of volume of air, H; $G_{жс}$ - a gravity of volume of a liquid, H; $P_{жс}$ - force, pressure working on weight of a liquid in an air pipe on the part of the bringing pipeline; $R_{жс}$ - force of resistance to movement of a liquid in an air pipe, H.

$$\ddot{Z}_3 = \frac{1}{N_1 + N_2 Z_3} \cdot \left(\frac{N_3}{\dot{Z}_3} + N_4 \frac{Z_3}{\dot{Z}_3} + N_6 Z_3^2 + N_8 + N_9 P_2\right) + N_5 + N_7 \dot{Z}_3^2,$$

Where $N_1 = \rho \cdot L_n F_{вз}$, $N_2 = -\rho \cdot F_{вз}$,

$N_3 = V_0 P_a, N_4 = \rho_0 V_0 g,$

$N_5 = g,\ N_6 = -\rho \cdot F_{вз},\ N_7 = -\frac{\lambda_3}{(2d_{вз})},\ N_8 = -P_a F_{вз},\ N_9 = -F_{вз}.$

Thus, in view of the equation of indissolubility of a stream of movement of a liquid in pneumatic hydraulic paths pump house-air-lift to installation it is described by the following system of the nonlinear differential equations of the second order:

$$\begin{cases} D_1\ddot{Z}_1 + D\dot{Z}_1^2 + D_3\dot{Z}_1 + D_4 Z_1 = P_2 + D_5, \\ M_1\ddot{Z}_2 + M_2\dot{Z}_2^2 = P_2 + M_3 \\ \ddot{Z}_3 = \dfrac{1}{(N_1 + N_2 Z_3)} \cdot (\dfrac{N_3}{\dot{Z}_3} + N_4 \dfrac{Z_3}{\dot{Z}_3} + N_6\dot{Z}_3^2 + N_8 + N_9 P_2) + N_5 + N_7\dot{Z}_3^2, \\ \dot{Z}_1 F_{xв} + \dot{Z}_3 F_{вз} = \dot{Z}_2 F_n \end{cases}$$

Where P_2- hydrostatic pressure in section 2-2, $F_{xв}$- the area of section of the bringing pipeline, $м^2$,V_0-productivity of the compressor at atmospheric pressure $P_a = 9{,}8 \cdot 10^4$ Pa, $м^3$/c, ρ_0- density of air under normal conditions, кг/$м^3$. λ_3-coefficient of hydraulic resistance at movement of a liquid in an air pipe; $d_{вз}$-diameter of an air pipe, m.