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THE RECKONING OF THE SONIC PRESSURE AND THE SONIC FLOW WITH THE GRAPHIC ANALYTICAL METHOD

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ABSTRACT
This paper proposed the mathematical reckoning which theory of sonic transmission. This establish the work modality in which can determination the characteristically of the sonic pressure and sonic flow, know the analytical relations and the determination which the basic size graphic-analytical.
Keywords: sonic pressure, temperature**,** friction coefficient, sonic installation.

1. INTRODUCTION

The science which based to the elastic propriety of substance, the transmission of the energies calls the sonic science or sonicity. The sonicity it's different of the hydraulics because in the practical application in view of the fact the flows are practical incompressible. The sonic methods are based in totality on the elastic propriety of the substance and the elasticity is used for the transmission of the energy.

The transmission of the power through the pressure wave is based on the elasticity of the medium, through the energy is transmitted, when the essential of the method be composed of the particle of the medium used in the condition of oscillation around of the medium position.

The principal sonic parameters are:

The *sonic flow* can be writing [2]:

$$Q_i = Q_{a_{max}} \sin(\omega t + \varphi_0) \tag{1}$$

Were: Q_i – the instantaneous flow;
$Q_{a\,max}$ – the maxim sonic flow, or amplitude flow;
ω - Frequency angular.

The *sonic pressure* can be writing similar with the sonic flow in the pipe when are presuming one alternative flow, the instantaneous pressure [2] are:

$$p_i = p_m + p_{a_{max}} \sin(\omega t + \varphi_0) \tag{2}$$

Were: p_m – is the medium pressure in the pipe;
$p_{a\,max}$ – the maxim sonic of the pressure (amplitude).

The *inertia* is the propriety when depend the mass movement, so one liquid spout is "l" length, have hydraulics inertia:

$$L = \frac{\gamma \cdot l}{g \cdot S} \tag{4}$$

when: γ = is a specific gravity of the liquid;

S – the interior section of the pipe;

g – the gravitational acceleration.

The *sonic capacity* or the coefficient of the sonic capacity, C_s is defined by the relation:

$$C_s = \frac{\delta_s}{p_{s_i}} \tag{5}$$

in generally, the growing of the sonic displacement is proportionally which the growing of the pressure, the proportionality constant is the sonic capacity C_s.

2. THE GRAPHIC ANALITYCAL METHOD

We consider the sonic proportional pressure to receiver p_{sir}, the sonic proportional flow to receiver Q_{sir} as the angle α. Through the graphic-analytical method we can find the sonic proportional pressure to generator p_{sig}, the sonic proportional flow to generator Q_{sig} and the angle β. The method can be used just in situation when we not omit the friction and perditanta, to allow the calculus of the values of the instantaneous flow and pressure in the pipe. (Figure 1).

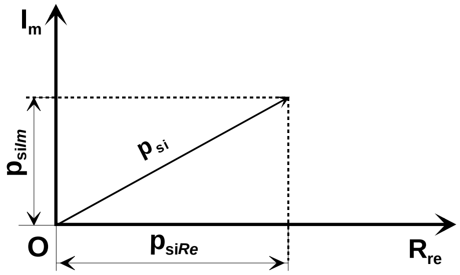

Figure 1. The complex axes system [4]

Writing:

p_{si_g} - the sonic proportional pressure to generator;

Q_{si_g} - the sonic proportional flow to generator;

p_{si_r} - the proportional sonic pressure to receiver;

Q_{si_r} -. the sonic proportional flow to receiver.

To be considered the case when Q_{sir} and p_{sir} the active components, are in quadrature to $\frac{\pi}{2}$.

Used the complexes axes system R_e and I_m (Figure.1) we can write the relation [4]:

$$\overline{p}_{si_r} = \overline{p}_{sir_{Re}} + j\overline{p}_{sir_{Im}} \tag{6}$$

To the start, the general [2] equation when is the connection of this quantity (sonic pressure and flowand result the relation (7):

$$\begin{cases} p_{si_g} = p_{sir_{Re}} \cos\alpha + j(p_{sir_{Im}} \cos\alpha + Q_{sir} \sin\alpha) \\ Q_{si_g} = Q_{sir\,Re} \cos\alpha - p_{sir_{Im}} \sin\alpha + jp_{sir_{Re}} \sin\alpha \end{cases} \tag{8}$$

With relation [2]: $\alpha = \mu l$ and $\mu\lambda = 2\pi$, we can calculate the value of μ and α to use the expression $\mu = \frac{2\pi}{\lambda}$ and $\alpha = \frac{2\pi}{\lambda} l$, were *l* present the length of the pipe, but λ the wavelength.

Writing the report:

$$\frac{p_{sir_{Im}}}{\lambda} = tg\beta = \frac{\psi}{L\omega - \frac{1}{C_s\omega}}, \tag{9}$$

when L_s and C_s are the inertia and the sonic capacity which create the anaphases to receiver, but the ψ constant are known quantity, (her value for water are ψ = 7s [1], were *s* are the section area of the pipe) we can realised the construction graphic in the figure 2.

For the calculus graphics of the sonic pressure and flow we can precede in this way, figure 2:

Numerical example. We must auctioneer a pomp who absorb the force P = 2,5 CP= 1900 kg cm/s. The transmission distance are d= 35 m, a frequency of the sonic flow f = 6,7 rot/s = 6,7 Hz, calculated with the relation $f=\frac{400}{60}=6{,}7\,\text{Hz}$, when the throb is give by the relation $\omega=2\pi\cdot f=2\pi\cdot 6{,}7=42$ rad, the sonic pressure to the pomp haven't outrun 50 kg/cm^2.($p_s \le 50$ kg/cm^2 = 5 10^{-4} Pa). The section of surface of transmission [2] is S = 2, 85 cm^2, so $\psi=7\cdot S=7\cdot 2{,}85=20$.

We calculus the wave length with the relation [2]:

$$\lambda=\frac{v}{f}=\frac{1430}{6{,}7}=213{,}433\text{m}=21343{,}3\,\text{cm}\approx 21400\,\text{cm}.$$

If the length of the pipe is l = 3 500 cm, result the phases angle α is equal with $\alpha=\frac{2\pi l}{\lambda}$ [3], were result:

$$\alpha=\frac{2\pi l}{\lambda}=\frac{3500\cdot 2\cdot\pi}{21400}=1{,}027\,\text{rad}\approx 59^0$$

If p_{sirRe} is the component to p_{sir}, in phases with the pressure of the pomp (were is receiver) and Q_{sir} is the proportional flow, the mechanical force is give by [2]:

$$N=\frac{Q_{sir}\cdot p_{sir}}{2}=19\,000\,\text{kg}\cdot\text{cm/s}=1{,}86\,\text{kW}.$$

We suppose who the phase angle to receiver is to 45^0, result [3]:

$$p_{si_r}=\frac{p_{si_r}}{\sqrt{2}}=\frac{50}{\sqrt{2}}=35\,\text{kg/cm}^3=3{,}43\cdot 10^6\,\text{Pa}$$

By the mechanical force relation we can estimation Q_{sir}:

$$Q_{si_r}=\frac{2N}{p_{si_r}}=\frac{2\cdot 19\,000}{35}=1{,}09\cdot 10^{-3}\,\text{cm}^3/\text{s}$$

Because the general formula for Q_{sir}, p_{sir}, Q_{sig} and p_{sig} are variable, we can replace with the correspondent value of this by report $\frac{Q_{si_r}}{\psi},\frac{Q_{si_g}}{\psi}$. So we obtain the value of: p_{sirRe} = 35; p_{sir} = 50, while Q_{sir} = $\frac{109}{20}=54{,}5$ cm^3/s.

In the international system this value can be:

$$p_{sir_{Re}}=35\cdot 0{,}313=10{,}96\,\text{Pa}$$

$$p_{sir}=50\cdot 0{,}313=15{,}66\,\text{Pa}$$

$$Q_{si_r}=54{,}5\cdot 0{,}313=17{,}07\,\text{cm}^3/\text{s}$$

The reactance to the motor of the pomp is scheduled with the resort, full of capacity is C_s.

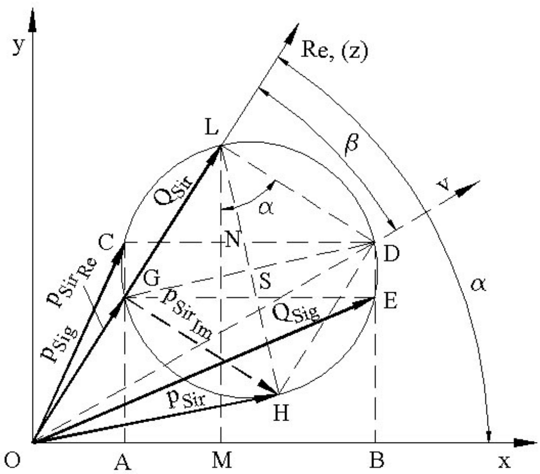

Figure 2. The graphic calculus of the sonic transmission

So result:

$$tg\beta = \frac{p_{sir_{Re}}}{Q_{si_r}} = -\frac{\psi}{C_s \cdot \omega} = -\frac{35}{54,5} = -0,64$$

the value of the angle β is $\beta = -32^0 36'$.

On relation to the tangent of the angle β, we obtain the reactance of the motor pomp.

$$C_s = \frac{tg\beta \cdot \omega}{\psi} = \frac{0,64 \cdot 42}{20} = 1,35\,cm^5/kg = 1,37 \cdot 10^{-11}\,m^5/N$$

We drawing the diagram to the stair, identical up problem, when we can determinate the unknown value: OA = p_{sig} = 33 and OL = Q_{sir} = 65, the angle phases of this can be:

θ = EOC = $29^0 30'$.

We obtain: p_{sig} = 33 kg/cm^2 and $Q_{si_g} = \psi \cdot Q_{si_g} = 20 \cdot 65 = 1300\ cm^3/s$.

When the product [2]: $N = \frac{Q_{sir} \cdot p_{sir}}{2} \cdot \cos\theta$.

So: $N = \frac{33 \cdot 1300}{2} \cdot \cos 29^0 30' = 18600\,W$

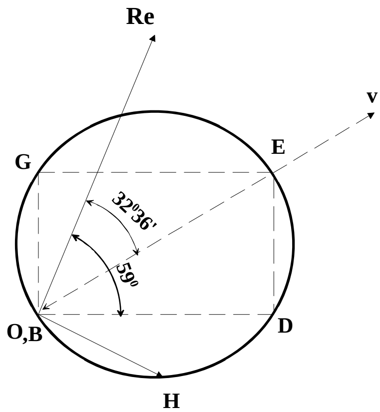

Figure 3. The graphic calculus of the pressure and sonic flow when the receivers work in cavity

In this case the error is: $\varepsilon = 19000 - 18600 = 400$, that is a relative error: $\varepsilon_r = \frac{400}{19000} = 0,021$, or approximately 2%, in this case is very good errors.

We can determinate the value of the sonic pressure to the generator and to receiver, also the sonic flow to receiver when the pomp are working except to produce the mechanical work (figure 3), the generator produce the same flow Q_{sig}..

In this case p_{sir} = 0, but the diagram circle can go in the point O.

Also the point G and A coincide with O. If drawing the horizontal by the point O, we take measure OE = Q_{sig} , obtain the point E to the circle circumference. The meet of the coordinates of the point E, with meet the axes Oy in the point D, we obtain the point D, to circumference and OD is the diameter, of the circle. We can draw also the point L, G and H obtain immediately. So we can determinate Q_{sir} = OL = 66,5; p_{sig} = OG = 39; p_{sir} = OH = 36,5.

3. REFERENCES

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