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THE THEORETICAL EFFECT ABOUT THE FRICTION IN THE SONIC FLOW

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ABSTRACT
In this paper we propose to analyses the alternative flow in the parallel installation including the capacity, and the friction resistance In this paper we show the caloric effect due to the displacement of the low in the friction resistance calculate. We propose to calculate the section of the friction resistance in the parallel installation, were we know the capacity and the flow and sonic pressure.
Keywords: sonic pressure, temperature**,** friction coefficient, sonic installation

1. THE EFEECT OF THE FRICTION IN THE SONIC FLOW
We proposed to observe the effect of the friction to owe the variation of the different elements components to enter in calculus of this friction and the importance of this element, the relation to caloric effect who we can develop (figure 1).

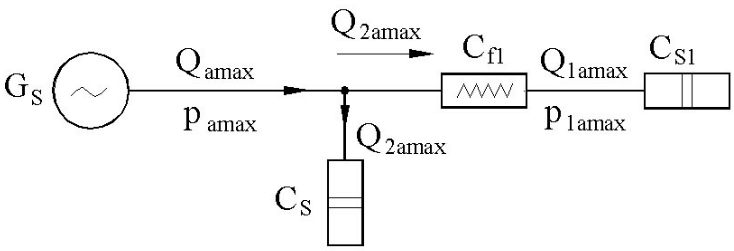

Figure 1. The sonic circuit with one friction resistance

The relation of the connection by the friction, flow and sonic pressure is:

$$p_{a\,max} = C_f \cdot Q_{a\,max} \tag{1}$$

The calculus of the volume of capacityes is:

$$V = \frac{\pi \cdot D^2 \cdot 1}{4} = \frac{\pi \cdot 7^2 \cdot 62{,}5}{4} = 2405{,}282\ \text{cm}^3 = 2405282\ \text{mm}^3$$

$$V_1 = \frac{\pi \cdot D_1^2 \cdot l_1}{4} = \frac{\pi \cdot 7^2 \cdot 38}{4} = 1462{,}411\ \text{cm}^3 = 1462411\ \text{mm}^3$$

The section of the piston is:

$$S = \frac{\pi \cdot D^2}{4} = \frac{\pi \cdot 4^2}{4} = 12{,}566\ \text{cm}^2 = 1256{,}6\ \text{mm}^2$$

$$Q_{a\,max} = S \cdot 1 \cdot \omega = 12{,}566 \cdot 1 \cdot 146{,}61 = 1842{,}5\ cm^3/s = 1842500\ 10^{-3}\ mm^3/s$$

For calculus of the capacity we need the relation:

$$C_S = \frac{V}{E} = \frac{2405{,}282}{1{,}4 \cdot 10^5} = 0{,}01718\ cm^5/N = 1718\ mm^5/N$$

$$C_{S1} = \frac{V_1}{E} = \frac{1462{,}411}{1{,}4 \cdot 10^5} = 0{,}010445\ cm^5/N = 1044{,}5\ mm^5/N$$

The friction capacity is:

$$C_f = \frac{C_S + C_{S1}}{\omega \cdot C_S \cdot C_{S1}} = \frac{0{,}01718 + 0{,}010445}{146{,}61 \cdot 0{,}01718 \cdot 0{,}010445} = 1{,}05\ N{\cdot}s/cm^5 = 1{,}05\ 10^{-5}\ N{\cdot}s/mm^5$$

The force of installation is:

$$P_{max} = \frac{Q^2_{a\,max} \cdot C_{S1}}{4 \cdot \omega \cdot C_S \cdot (C_S + C_{S1})} = \frac{(1842{,}3)^2 \cdot 0{,}010445}{4 \cdot 146{,}61 \cdot 0{,}01718 \cdot 0{,}027625} = 127373{,}8\ (N{\cdot}cm/s)$$

$$P_{max} = 127373{,}8\ (N{\cdot}cm/s)\ )\ (rad) = 9{,}81 \cdot 127{,}3738\ \frac{daN \cdot m}{s} = 1849{,}53\ W = 1{,}7\ CP$$

$$p_{a\,max} = \frac{Q_{a\,max}}{\omega\ (C_S + C_{S1})} \sqrt{1 + \frac{C_{S1}}{C_S} + \frac{1}{2}\ {\frac{C_{S1}}{C_S}}^{2}} = \frac{1842300}{146{,}61\ \ (2762{,}5)}$$

$$\sqrt{1 + \frac{1044{,}5}{1718} + \frac{1}{2}\ {\frac{1044{,}5}{1718}}^{2}} = 6{,}0905$$

$$p_{a\,max} = 6{,}0905\ N/mm^2 = 6{,}0905\ MPa$$

The product $P = \frac{p_{a\,max} \cdot Q_{a\,max}}{2}$ give the apparent force with the value need for calculus of the force factor to installation:

$$P = \frac{p_{a\,max} \cdot Q_{a\,max}}{2} = \frac{6{,}0905 \cdot 1842300}{2} = 5{,}610345 \cdot 10^6\ N{\cdot}mm/s$$

$$P = 5{,}610345 \cdot 10^6\ N{\cdot}mm/s = 561{,}0345\ \frac{daN \cdot m}{s} = 5503{,}75\ W\ (rad) = 7{,}485\ CP$$

The force factor to installation is:

$$\cos\theta = \frac{P_{max}}{P} = \frac{1{,}78}{7{,}48} = 0{,}27376 \text{ were } \theta = 76^0\ 14'.$$

$$\cos\theta = \frac{P_{max}}{P} = \frac{0{,}85}{5{,}1} = 0{,}167 \text{ were } \theta = 80^0\ 23'$$

The numerical value of the $Q_{a\,max1}$ and $Q_{a\,max2}$ we can determinate. Also we have:

$$\vec{Q}_{2a\,max} = \omega \cdot C_S \cdot p_{a\,max} = 146{,}61 \cdot 1718 \cdot 6{,}0905 = 1534050{,}6\,mm^3/s = 1{,}534 \cdot 10^6 \frac{mm^3}{s}$$

$$Q_{1a\,max} = \omega \cdot C_{S1} \cdot p_{a\,max} \cdot \sqrt{1 + (\omega \cdot C_{S1} \cdot C_f =)^2} =$$

$$= 146{,}61 \cdot 1044{,}5 \cdot 6{,}06052 \cdot \sqrt{1 + (146{,}61 \cdot 1044{,}5 \cdot 1{,}05 \cdot 10^{-5})^2} =$$

$$= 1{,}766 \cdot 10^6 \frac{mm^3}{s}$$

If we suppose who the friction are represented by a pipe with the interior diameter d_i = 2 mm, the section of this pipe can be:

$$S_f = \frac{\pi d_i}{4} = \frac{\pi \cdot 2^2}{4} = 3{,}1415\ mm^2$$

The maximum of the speed:

$$v = \frac{Q_{1a\,max}}{S_f} = \frac{1{,}766 \cdot 10^6}{3{,}1415} = 0{,}562 \cdot 10^6\ mm/s = 56{,}2\ m/s$$

The efficacy speed we obtained used the formula:

$$v_{ef} = \frac{v}{\sqrt{2}} = \frac{56{,}2}{\sqrt{2}} = 39{,}748\ \ m/s$$

the coefficient of the friction is equal with:

$$k = \frac{v_{ef}}{100 d_i} + \frac{9}{100 d_i} \cdot \sqrt{\frac{v_{ef}}{d_i}} = \frac{39{,}748 \cdot 10^3}{200} + \frac{9}{200} \cdot \sqrt{\frac{39{,}748 \cdot 10^3}{2}} = 205{,}08$$

The capacity of friction is:

$$C_f = k \cdot \frac{1}{S_f \cdot 10^2}$$, where the length of the pipe is:

$$l = \frac{C_f \cdot S_f \cdot 10^6}{k} = \frac{1{,}05 \cdot 10^{-5} \cdot 146{,}61 \cdot 10^6}{205{,}08} = 7500\ cm = 7{,}5\ m$$

We observe who this pipe is too length for used in practical, also we need to used a small pipe with w small diameter.
In this case we use a pipe interior diameter from 3 mm, in this case the surface is.

$$S_f = \frac{\pi d_i}{4} = \frac{\pi \cdot (3)^2}{4} = 7{,}068\ mm^2$$

$$v = \frac{Q_{1a\,max}}{S_f} = \frac{1{,}766 \cdot 10^6}{7{,}068} = 24983\ mm/s = 24{,}983\ m/s$$

$$v_{ef} = \frac{v}{\sqrt{2}} = \frac{24{,}983}{\sqrt{2}} = 17{,}666\ m/s = 1766 cm/s$$

The friction coefficient calculated to take into account by the dimension in cm.

$$k = \frac{v_{ef}}{100d_i} + \frac{9}{100d_i} \cdot \sqrt{\frac{v_{ef}}{d_i}} = \frac{1766,6}{100 \cdot 0,3} + \frac{9}{100 \cdot 0,3} \cdot \sqrt{\frac{1766,6}{0,3}} = 81,9$$

$$l = \frac{C_f \cdot S_f \cdot 10^6}{k} = \frac{0,105 \cdot 10^6 \cdot 0,0768}{81,9} = 98,45\,\mathrm{cm} = 984,5\,\mathrm{mm} \approx 1\mathrm{m}$$

2. CONCLUSION

We observe who the optimal length is from 1 meter, again the interior diameter of the friction pipe are from 3 mm, we observe who the constructive dimension of the experimental stall.

3. REFERENCES

[1] Constantinesco, **G.**, Theory of Sonics: A Treatise on Transmission of Power by Vibrations, The Admiralty, London, 1918.
[2] Constantinescu, G., Teoria sonicității, Editura Academiei R.S.R., Bucureşti , 1985.
[3] Pop, I., Marcu, I. L., Personalități în știință şi tehnică - Gogu Constantinescu, Editura AGIR, Bucureşti, 2004.
[4] Pop, I., Tratat de teoria sonicității, Editura Perfomantica, Iasi 2006.
[5] Popa, Bazil, s.a., Manualul inginerului termotehnician, vol. I, Ed.Tehnică, Bucureşti, 1986.
[6] Constantinesco, G., Haddon, W., Transmission of impulsive forces through liquids, patent no. 182206/1920.
[7] Constantinesco, G., Haddon, W., Liquid wave transmission, patent no. 132027/1920.
[8] Constantinesco, G., Haddon, W., Hydraulic power transmission, patent no. 24231/1920.