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REGARDING THE EFFICIENCY OF THE DECELARATION THROUGH IMPEDANCE COILING OF THE HYDRAULIC CYLINDERS

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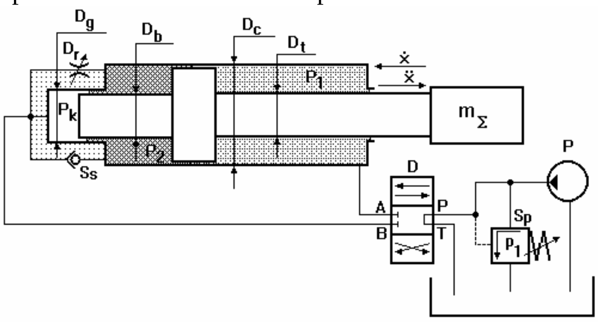
ABSTRACT

The paper present a point of view sustained by calculations about the efficiency of the deceleration system by impedance coiling of the hydraulic cylinders. It is shown that the simple presentation of the impedance coiling system doesn't lead automatically to obtain an evident deceleration of the assembly piston-bar-moved mass. Added to the assembly of important factors which can be controlled and can induce the deceleration there is a number of random factors which have a significant influence.

1. Introduction.

In case that the initial speed of impact from a course extremity is bigger than a critical value it can be shown mechanic forces who's effect is taking out of function of the hydraulic cylinders or of the trained mechanical systems. The actual tendency is to increase of the working speed to avoid impact high speed it's used the deceleration of end of course. This deceleration is partial consuming the kinetical energy of the mobile masses generating deceleration of those and having as effect an impact with a smaller speed then the critical speed.



Most usual the deceleration at the end of course is realized by impedance coiling of the hydraulic agent. This process is made by introducing on the final part of the course of a hydraulic resistor who provide a higher pressure on the passive back face of the piston shown as in fig.1.

In this figure is shown a hydraulic cylinder with deceleration at one end of the course together with the minimum action hydraulic installation. The hydraulic installation is made of :

- P pump which can be with " constant " or variable flow rate;
- Pressure valve Sp adjusted to open at the p1 pressure;
- The distributor with 3 position D;
- Sens valve Ss;
- Impedance coil Dr with the hole area A0.

It must be taken into account :

- the deceleration start before the closing of the space where p2 pressure is taking place meaning before the moment when the jack border plan coincide with the border of the D diameter cylinder;
- one part of the flow rate is passing through the diametral check between the jack and the cylinder body with a variable drop pressure which depend of the overlap length;
- the flow rate coefficient are variable into the small numbers of Reynolds domein;
- shows rulling forces in guideways and tightenings which depends on movement.

It can consider two periods in the deceleration fenomen evolution :

- first starting from the position of the mobile plan B-B (fig.1) enough away from the position of the fix plan A-A when it can taking into account that deceleration hasn’t strted yet and until the moment when the two planes are superimposed.

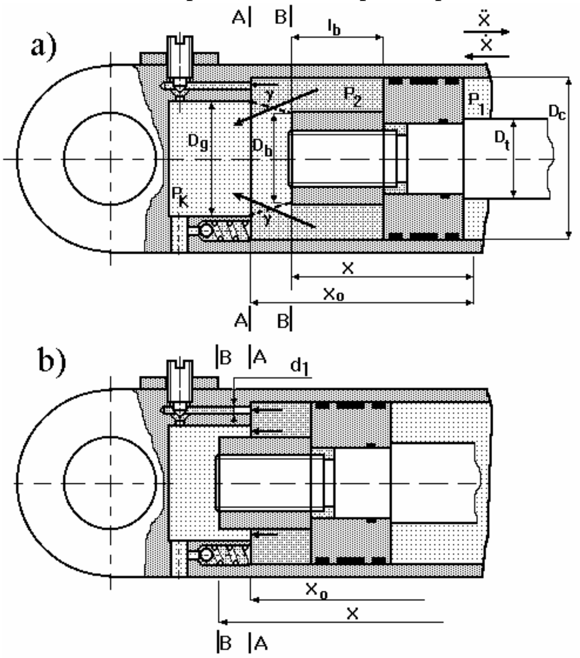


Figure 2. Fazes of the deceleration through impedance coil.

- the second step start from the moment of superimposed of the planes and ends at the starting of the mechanical impact (fig.3); in fig. 4 is presented detailed the impedance coil.

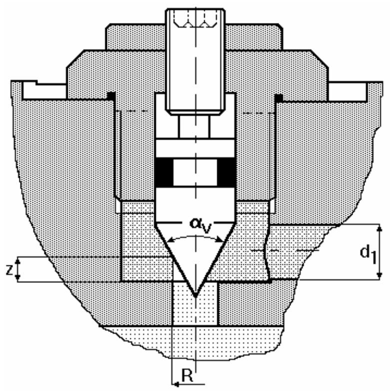


Figure. 4. Section through impedance coil with cone-shape needle.

Taking into account the mechanical balance of the assembly elements and the continuity equation of the flow rate it have made a mathematical model which shown the assembly function.

$$f = \begin{cases} f_a(x,\dot{x},\ddot{x}) = 0 \ pentru 0 \le x \le x_0 \\ f_b(x,\dot{x},\ddot{x}) = 0 \ pentru x_0 < x < x_0 + l_b \end{cases} \tag{1}$$

where

$$f_a(x,\dot{x},\ddot{x}) = m_\Sigma \ddot{x} - p_k \cdot \frac{\pi}{4} D_c^2 - \frac{\pi}{4}\left(D_c^2 - D_b^2\right) \cdot \frac{\left[\dot{x} \frac{\pi}{4}\left(D_c^2 - D_b^2\right)\right]^2 \rho}{F^2(x,\dot{x})} - \sum F_f(\dot{x}) + p_1 \frac{\pi}{4}\left(D_c^2 - D_t^2\right) \tag{2}$$

and

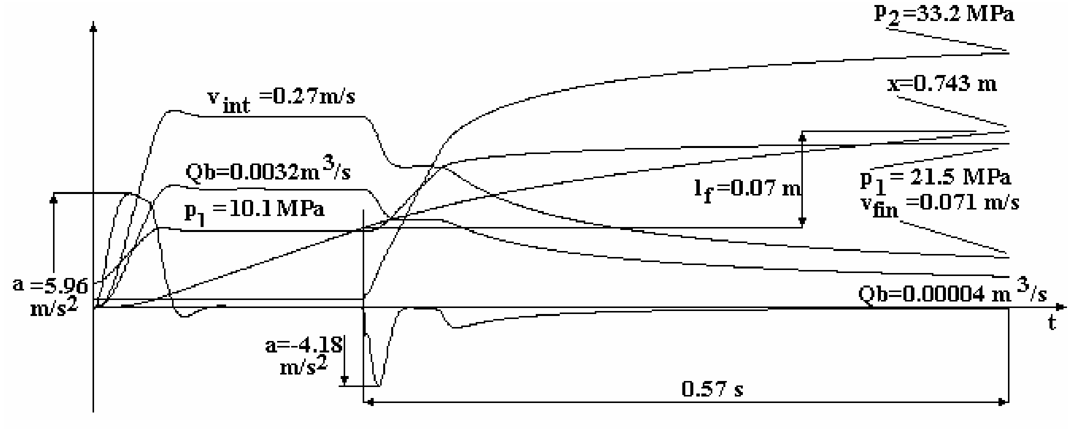
$$f_b(x,\dot{x},\ddot{x}) = m_\Sigma \ddot{x} + p_1 \frac{\pi}{4}\left(D_c^2 - D_t^2\right) - \Delta p_{2k} \frac{\pi}{4}\left(D_c^2 - D_g^2\right) - p_k \frac{\pi}{4} D_c^2 - \sum F_f(\dot{x}) \tag{3}$$

2. Numerical simulation.

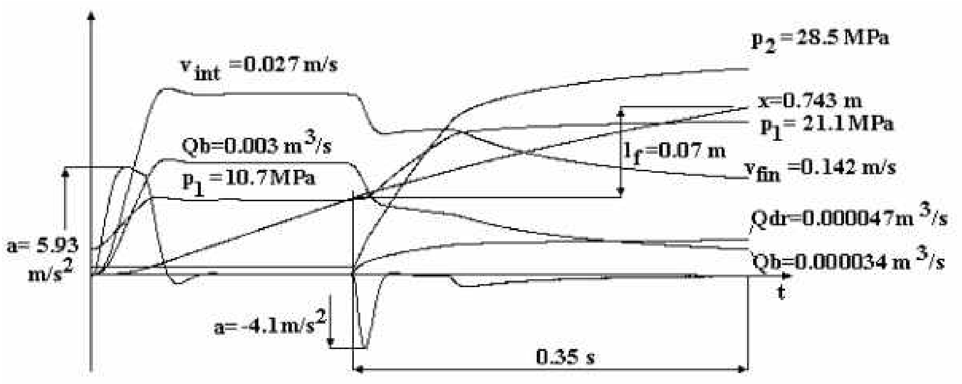
Steping from the mathematical model it have been made a numerical simulation of different situation of deceleration through impedance coiling at one end of the course. The simulation have generated a lot of curves which show the variation types of functions which presents interes regarding time.

The main parameters of the numerical simulation are:

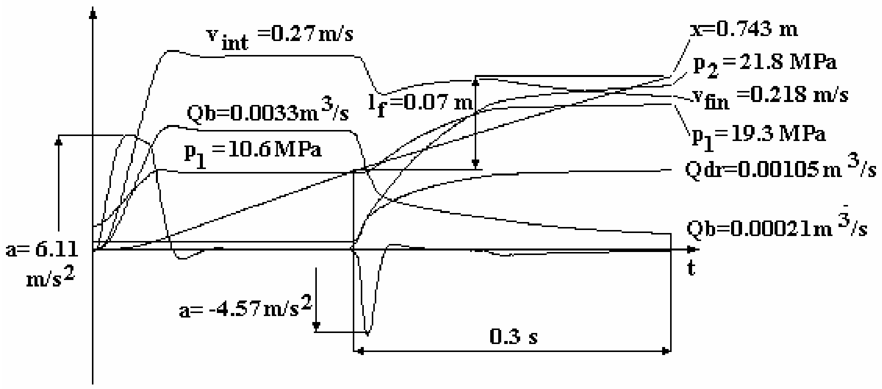
- the draw bar diameter 80mm;
- the diameter of the zone which enter into the jack 84.07mm;
- the jack diameter...................83.76 mm;
- the nozzle diameter ....7 mm;
- the length of the jack 70mm;
- the length of the nozzle..............85 mm;
- the addendum angle of the impedance coil needle ....60^0;
- the diameter of the impedance coil orifice 7mm;
- start position .... 620 mm;
- chosen time increment ....0.0002 s;
- the density of the hydraulic agent................................. 905Kg/m^3;
- the kinematics slimy at ...323 K ..30cSt;
- the temperature of the hydraulic agent ....46.5^0C;
- impedance coil critical Reynolds......256;
- body/jack check critical Reynolds.....260;
- maximum impedance coil flow rate coefficient..................................0.134;
- maximum check of flow rate coefficient..................................... 1;
- the mass of moved body............2001Kg;
- adjustment of the pressure for the pump valve...................................... 18MPa.



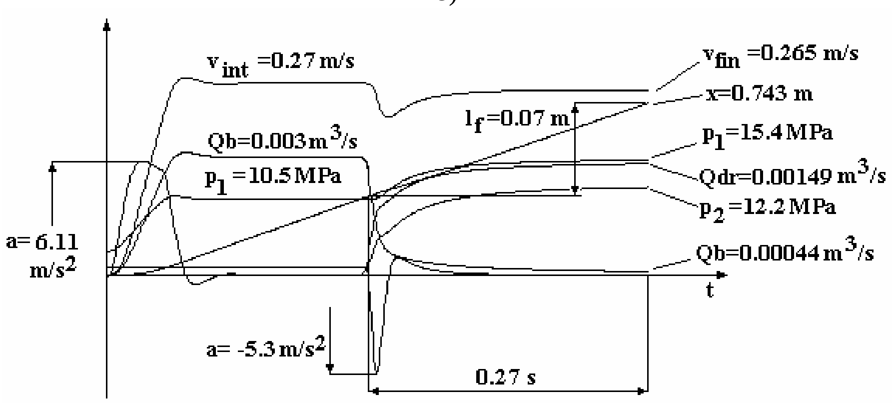
a)



b)



c)



d)

Figure 5.

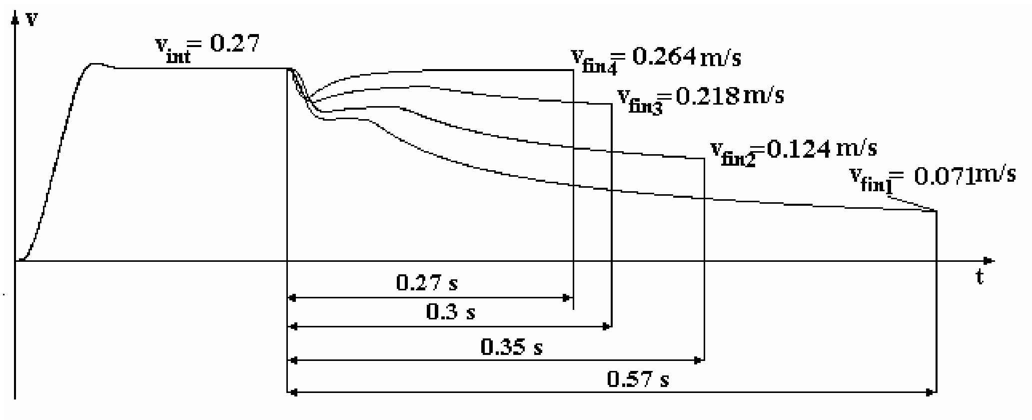


Fig. 6 The influence of the opening of impedance coil toward impact speed.

In fig. no 5 (a,b,c,d) are shown the results of the numerical simulation for four situation.
The modification appeared on the deceleration zone due to the opening of the impedance coil so it can be seen from the table no. 1.

Tabel 1

Simulare numeric`							
Regim continuu		Fr@nare					
p_1 MPa	p_S MPa	p_{1fin} MPa	Δp_{fin} MPa	v_{init} m/s	v_{ffin} m/s	t_{fs} s	z_{dr} mm
10.1	4.1	21.5	32.2	0.27	0.07	0.57	0
10.0	3.99	21.1	27.5	0.27	0.142	0.37	0.25
10.6	4.24	19.3	20.8	0.27	0.218	0.29	0.5
10.5	4.2	15.4	11.2	0.27	0.265	0.27	1

As technological force it was considered the resistance taken by a hydraulic cylinder having a diameter of the active section of 180 mm and where the pressure is ps. The small modifications of ones of the parameters heve been realized for compare with the simulation from the stand ant to be seen the measure with which the mathematical model show the relity.

3. Conclusion.

It can be seen that the tendency of reduceing the speed of the mobile essembly depends of the impedance coil caractheristics of it’s opening and of the check between the deceleration jack and the orifice through which that penetrate over a precise opening of the impedance coil it’s influence can be neglected , the speed is not changing during deceleration through impedance coiing toward the initial speed (at last simulation vinit – 0,27 m/s and vfin – 0,265 m/s). It can be shown in that ultimate case the pressure valve not open all the flow rate produce by the hydraulic pump it’s taken by the working hydraulic cylinder so the appearance of no deceleration.

In fig. no 6 is shown a compare situation of the fpur before calculated simulated situation. It can be seen how the final speeds are increasing and the time of arrival to the impact decreasing.
It must be underlined the fact that in real conditions the deceleration jack and the hole in which penetrate are not covering. In case of contingence hydraulic resistor modify very much [ ] aleatory factor which depend of a lot of situations.
That is the reason why we consider necessary that hydraulic cylinder with deceleration through impedance coiling at one end to be adjust individually on specialized stands.

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