THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICHAL ENGINEERING, ISSN 1224-5615
2012

THE POSSIBILITIES OF INCREASING EFFICIENCY AND CONFIDENCE OF THE CALCULATIONS FOR HYDRAULIC CYLINDERS PROVIDED WITH CUSHIONING SYSTEM AT END OF RACE

Assoc.Prof.Dr. Eng. Niculai HAUK
"Dunarea de Jos" University of Galati
Dept. of Mechanics

ABSTRACT

Working with specialized software, fluid flow analysis has the disadvantage of being time-consuming. Also, modern computers are needed. This paper presents a way of combining simulation with specialized programs of fluid flow with programs specifically designed to analyze the hydraulic brake cylinders at the end of the race. After the necessary calibration, we can achieve mutual simulations of system operation including hydraulic cylinder with brake at the end of the race in less time and with a high degree of confidence.

KEYWORDS: hydraulic cylinders, mechanism

1. INTRODUCTION

Obtaining reliable results with calculations in a reasonable time is a necessity. The final check on the physical model is a solution which can often be too late and too expensive. Therefore it is proposed a method to combine the speed of calculation software programs designed with a more general nature.

This solution greatly reduces the time required for various analyses and increases the level of trust that the calculations made.

Bear in mind that a number of calibration parameters come from previous physical experiments [3].The range in which they are distributed must be well known to use the data to the calculation results as close to reality (for viscosity, density, compressibility, etc.).

2. OBTAINING BODIES OF FLUID

As fluid flow software package was used FloWizard conducted by ANSYS.

Besides data on the working fluid used, 3D drawings are required in areas that will produce flow.

Direct use of the 3D model of the hydraulic analysis does not show us too much. Figure 1 shows the design of all hydraulic brake cylinders at maximum stroke. It contains a large number of components. Construction details dont allow the program to determine body fluid formed in the cylinder. That’ s why additional 3D processing designs are necessary to lead to an acceptable program model.

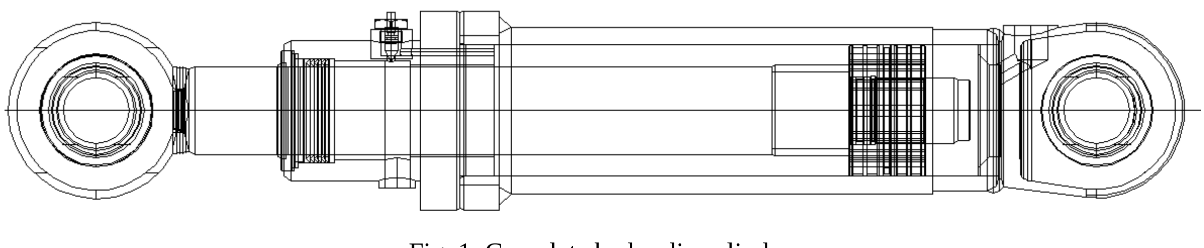

Fig. 1. Complete hydraulic cylinder

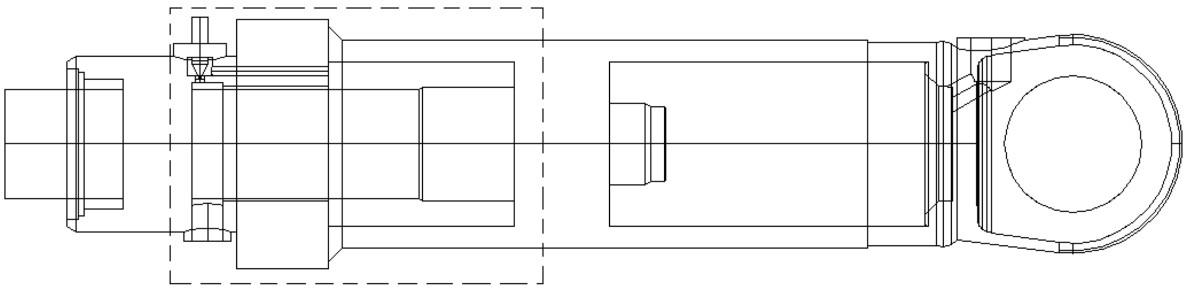

Fig. 2. Transformed hydraulic cylinder

Figure 2 shows the transformed cylinder, accepted for automatic extraction of body fluid. The new design includes a single solid element.

The area surrounded by the dotted line contains the space that will form the body of liquid. Figure 3 shows a body of liquid which marked the move with speed ***v***. The corresponding flow velocity or displacement surface is marked with the speed input data.

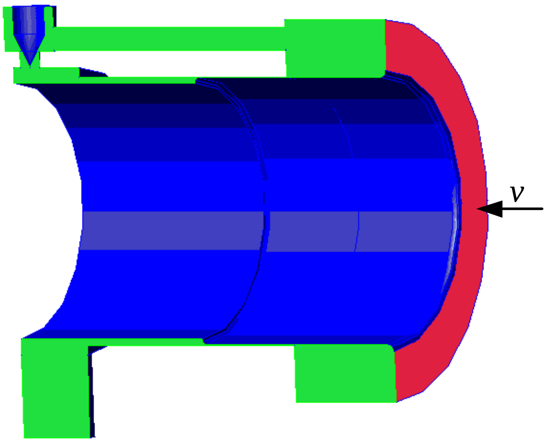

Fig.3. Section through the body fluid

Another way to achieve body fluid design is its direct drawing in 3D. This mode is more difficult but has the advantage to obtain more easily body fluid, from different races, by operating 3D objects.

3. RESISTANT HYDRAULIC FLOW IN PARALLEL MODEL

In Figure 4 is shown a section through the area where the hydraulic resistances of the hydraulic cylinder are placed. Oil flow generated by the piston movement follows paths T1 and T2.

Path T2 is constant and resistance to hydraulic geometry depends on $\sqrt{Re(Q_{T2})}$.

T1 Path has variable geometry. There are two stages:

- a – bush 1 has not entered a hole in the body 2;
- b - a bush broke into the void of body 2.

Flow discharged through two hydraulic resistances is:

- the corresponding area of a

$$Q_e = Q_{T_2} + Q_{T_1} = \sqrt{\frac{2\cdot\Delta p_{23}}{\rho}}\cdot\left(\sqrt{\frac{1}{\frac{1}{Cd_{duz}^2 A_{duz}^2}+\frac{1}{Cd_{dr}^2 A(z)^2}}} + C_{dS}A_{CS}\right) \quad (1)$$

- the corresponding area of b

$$Q_e = Q_{T_2} + Q_{T_1} = \sqrt{\frac{2\cdot\Delta p_{23}}{\rho}}\cdot\left(\sqrt{\frac{1}{\frac{1}{Cd_{duz}^2 A_{duz}^2}+\frac{1}{Cd_{dr}^2 A(z)^2}}}\right) + \frac{\pi\cdot D_m\cdot\delta^3\cdot\Delta p_{23}}{12\eta\cdot l_S} \quad (2)$$

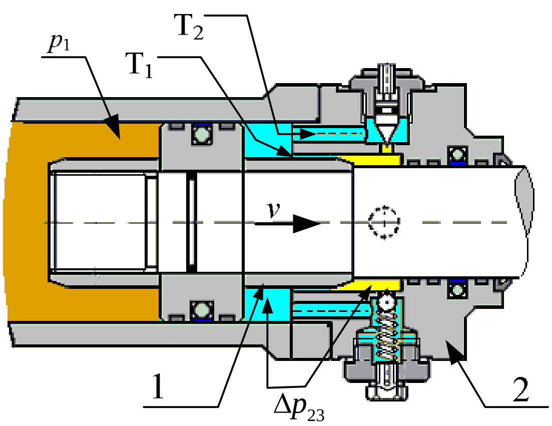

Fig.4. Pressures and Paths followed by the hydraulic oil

Exhaust flow rate depends on all mobile hydraulic cylinders. Axial forces seeking equilibrium are depending on the mechanism of the hydraulic cylinder to which it belongs.

Differential equations describing the model:

- Equilibriums of the mechanical components of the mechanism operated;
- The conditions of continuity of flow hydraulic circuits.

Solving systems of differential equations depends on determining how to divide the exhaust flow of two parallel paths. Solving solution is based on the fact that the same pressure difference is recorded regardless of the path followed.

4. SIMULATION RESULTS

To integrate the differential equations describing the behavior of the activated mechanism, numerical methods were used. Some of the input data (identical or similar) were used for analysis of fluid flow with specialized programs.

In Tables 1 and 2 are the results of numerical simulations. Has been considered different input data:

- Opening of hydraulic resistance;
- Pressure valve opening pressure.

Table 1. $z_{dr} = 0.5\ mm$, p_{S0} =2.5 MPa

t	x	v	p_1	Δp_{23}	Q_{T_1}	Q_{T_2}
ms	mm	mm/s	MPa	MPa	l/s	l/s
0	0	1	0.13	0.00	0.01	0.00
25	1	53	2.81	0.00	0.31	0.00
50	3	125	3.23	0.00	0.73	0.00
75	7	198	3.00	0.00	1.15	0.00
100	13	261	2.65	0.00	1.52	0.00
125	20	301	0.00	0.00	1.75	0.00
150	27	297	0.00	0.00	1.73	0.00
175	34	293	0.00	0.00	1.71	0.00
200	42	291	0.03	0.00	1.69	0.00
225	49	291	0.08	0.00	1.70	0.00
250	56	291	0.18	0.11	1.69	0.00
275	64	289	0.95	1.67	1.66	0.02
300	71	287	1.62	3.17	1.63	0.04
325	78	286	2.43	4.62	1.60	0.07
350	85	279	2.54	5.88	1.55	0.08
375	92	262	2.64	6.71	1.43	0.09
400	98	240	2.77	7.12	1.29	0.10
425	104	217	2.89	7.24	1.16	0.10
450	109	197	3.01	7.21	1.04	0.10
475	114	180	3.10	7.11	0.94	0.10
500	118	166	3.18	7.01	0.87	0.10
525	122	155	3.24	6.92	0.80	0.10

The graphical representation of the parameters of interest is made in Figure 5.

Table 2 presents the results of a similar virtual experiment. Were increased the opening of the adjustable hydraulic resistance and the opening pressure of the pressure valve.

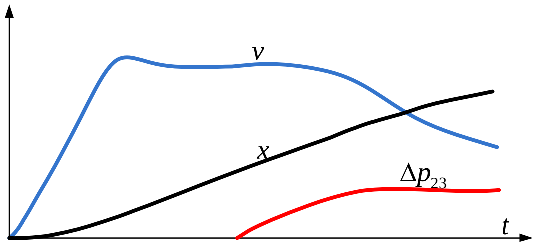

Fig. 5. Graphic results of numerical integration for $z_{dr} = 0.5\ mm$, p_{S0} =2.5 Mpa.

Table 2. $z_{dr} = 1\ mm$, p_{S0} =2.5 MPa

t	x	v	p_1	Δp_{23}	Q_{T_1}	Q_{T_2}
ms	mm	mm/s	MPa	MPa	l/s	l/s
0	0.0	1	0.13	0.00	0.01	0.00
25	1.0	109	6.45	0.00	0.63	0.00
50	5.6	257	6.39	0.00	1.49	0.00
75	13.1	312	0.00	0.00	1.82	0.00
100	20.8	304	0.00	0.00	1.77	0.00
125	28.3	298	0.00	0.00	1.73	0.00
150	35.7	293	0.00	0.00	1.71	0.00
175	42.8	291	0.06	0.00	1.69	0.00
200	50.3	292	0.13	0.00	1.67	0.00
225	27.4	291	0.20	0.33	1.65	0.05
250	64.8	289	0.94	1.67	1.49	0.19
275	72.1	288	1.45	2.89	1.43	0.25
300	79.3	287	2.12	4.03	1.38	0.29
325	***86.4***	***286***	***2.68***	***5.12***	***1.35***	***0.33***
350	***93.6***	***285***	***3.19***	***6.15***	***1.30***	***0.36***
375	100.7	284	3.70	7.14	1.27	0.39
400	***107.8***	***284***	***4.18***	***8.08***	***1.24***	***0.42***
425	***114.9***	***283***	***4.64***	***8.98***	***1.21***	***0.44***
450	122.0	282	5.09	9.85	1.18	0.46

The graphical representation of some variation of the parameters in Table 2 is made in Figure 6.

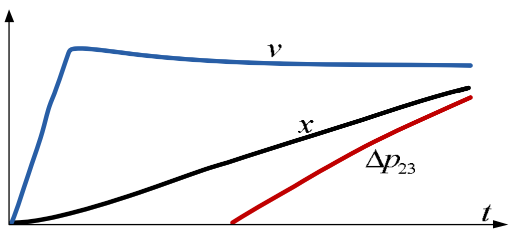

Fig. 6. Graphic results of numerical integration for $z_{dr} = 1\ mm$, p_{S0} =6 Mpa.

From the two virtual experiments, it is found that the race braking occurs only if the mechanism and the hydraulic characteristics are brought into line. If there is a brake in the first experiment at the end of the race, in the second it is missing. Such information can not be obtained when using specialized programs on fluid flow.

The virtual experiment conducted in Flowizard starts from three-dimensional structure of the hydraulic cylinder and viscosity data flow environment. It is not take into account the behavior mechanism in which the action occurs. From such simulations we can obtain information on differences between inlet and outlet pressure of the working fluid in hydraulic resistance. In Figures 7 and 8 are the results of simulations for the body of liquid input flow corresponding to areas marked in Table 2.

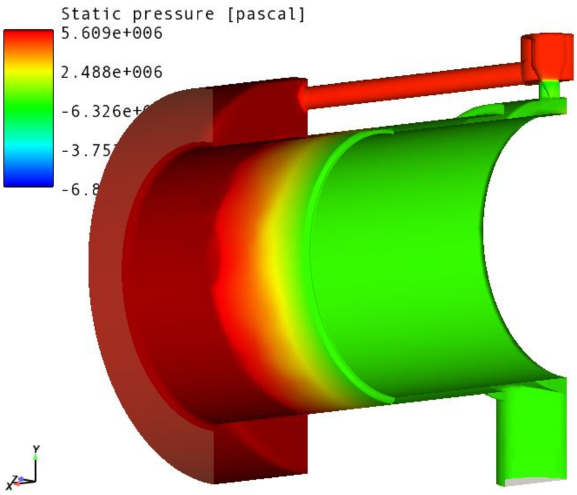

Fig. 7

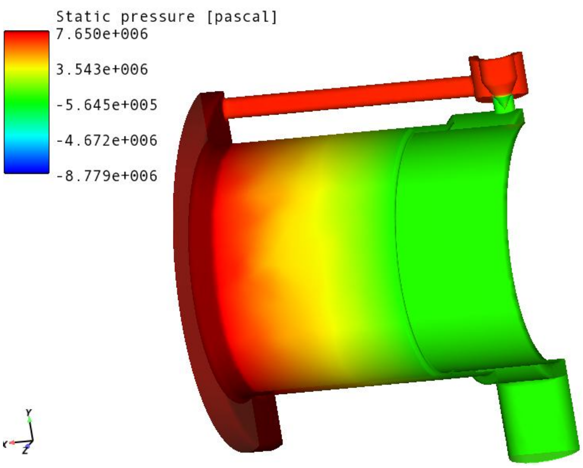

Fig. 8

We can get an idea about the complexity of the flow through the system resistant hydraulic fluid following lines shown in Figure 9.

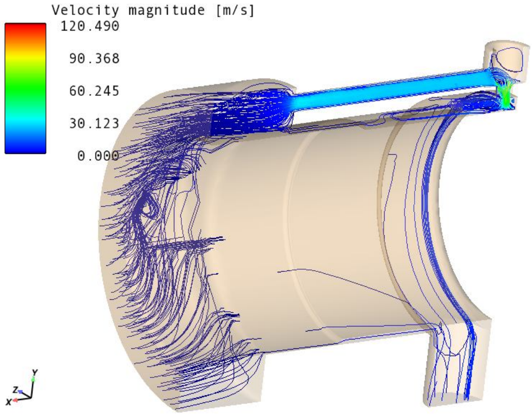

Fig.9. Fluid lines

To achieve symmetry simulation were considered the body of fluid and the flow.

5 CONCLUSIONS

Comparing results of two types of experiments are found an approximation of them.

In assessing the approximation of the results it should be considered:

- The complexity of the systems described mathematically and graphically;
- The accuracy of calculation adopted in order of their classification in acceptable timeframes;
- The real situation in which small misalignments produce significant changes in flow and pressure drop.

The two work modalities complement each other, exchange data is essential for accurate assessment of the analyzed systems.

The combined use of two types of virtual simulations can lead to substantial savings by reducing time of analysis and design.

REFERENCES

[1] **Deacu L., Banabic D., Radulescu M.M., Ratiu C.**, *Tehnica hidraulicii proportionale*. Cluj-Napoca, Editura Dacia, 1989.

[2] **Hauk N.** *Contributii teoretice si experimentale privind comportarea in regim dinamic a cilindrilor hidraulici montati pe excavatoare*. Doctoral dissertation – Universiti "Dun`rea de Jos" Galati, 1998.

[3] **Hauk N., Simionescu C**. *A method for determining the pressure loss coefficients*. THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI ,FASCICLE XIV MECHANICHAL ENGINEERING, ISSN 1224-56152012

[4] **Poole A. D., Booker J. D.** *Design methodology and case studies in actuator selection. Mechanism and Machine Theory* , Vol. 46. Issue 5

[5] **Voinea, R., Deciu, E., Dragomirescu, C.**, *Technische Mechanik*, Ed. ALMA Craiova, 2009.