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SELF OSCILLATORY HIGH PRESSURE (70 MPA) MULTIPLIERS, WITH LOGIC HYDRAULIC ELEMENTS, FOR HYDRO-FORMATION LIQUIDS, EXPERIMENTAL RESULTS

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Abstract: *This paper presents the experimental results of the experimental equipment of the self oscillatory high pressure (70 MPa) multipliers, with logic hydraulic elements, for hydro-formation liquids, as part of a national research contract, which is relating to a flexible modular system for plastic deformations true hydro formations with high hydraulic pressure, with a high level of technology for producing complex parts for auto vehicle construction technology, aeronautics or top industrial fields. The experimental results from the experimental equipment where achieved through a National Instruments interface and analyzed with a specialized software, Mathlab. The confirmation of the theoretical models are checked throw comparison with experimental results through data acquisition from the real model.*

Key words: *Hydro-formation, dynamic, high-pressure, simulation, multiplier.*

1. INTRODUCTION

This paper presents the experimental results of the experimental equipment of the self oscillatory high pressure (70 Mpa) multipliers, with logic hydraulic elements, for hydro-formation liquids, as part of a national research contract, which is relating to a flexible modular system for plastic deformations true hydro formations with high hydraulic pressure, with a high level of technology for producing complex parts for auto vehicle construction technology, aeronautics or top industrial fields. The experimental results from the experimental equipment where achieved through a National Instruments interface and analyzed with specialized software, Mathlab. The confirmations of the theoretical models are checked throw comparison with experimental results through data acquisition from the real model.

2. EQUIPMENT DESCRIPTION

This project is proposing to presnts the experimental results of the modular and flexible system for plastic deformations with high pressure like a very performant technology for aviation, automotive industry or other hygh technology industrial areas.

The novelty of the solutions is focused on generating and control of high pressure (700–2800 bar) with hydraulic self-oscillating multipliers and uses it in innovative construction of the system. It is developing a new conception – stand for testing the hydro-formation technology by plastic deformation and modular equipment capable to satisfying a range of forms resulting from the sheet of billets for plates and tubes.

Generally in the construction of the Hydro-formation equipment is used hydrostatic installations command drive based as shown in Fig. 1.

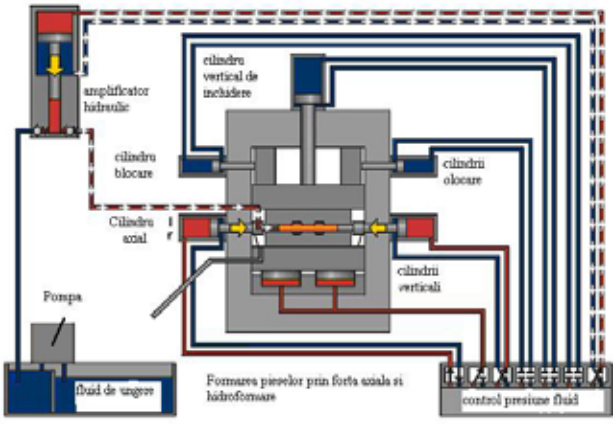

Fig. 1. Hydrostatic stand scheme for Hydro-formation.

Multiplier used in the installation of hydro-formations is built to operate in automatic auto-oscillating regime, depending on the pressure of the fluid hydro-formations so the power consumed by the hydraulic power plant to remain relatively constant.

The operation is automatically change to overcome the pressure provided by the hydro-formations fluid pump the 12 MPa on the first stage on the multiplier to 70 MPa for the last stage on the multiplier as in the diagram in Fig. 2.

First experiments was projected to be applied over a plate sheet including in a circular mould as in Figs. 3 and 4.

Operation of the hydro-formation equipment started with the introducing of the form in the mold. The hydraulic cylinder of the press secures the mold and other controls the friction force between the two shells of the mold.

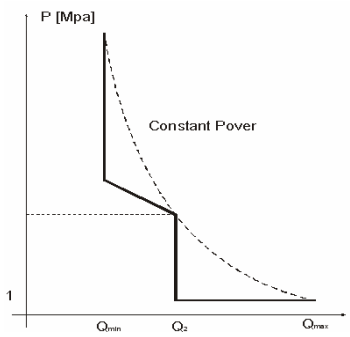

Fig. 2. Multiplier working diagram.

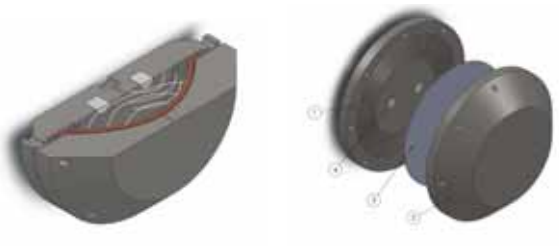

Fig. 3. 3D design of the sheet deforming mould through hydro-formation.

Fig.4. First stage experimental sheet deforming mould through hydroformation.

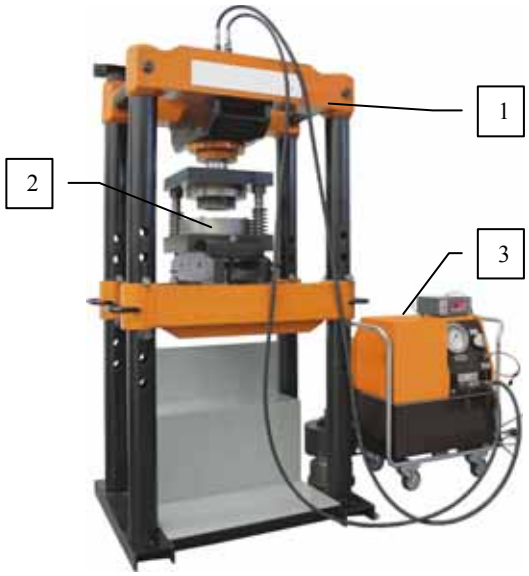

Fig. 5. Experimental equipment for deforming through hydro-formation.

The experimental equipment (Fig. 5) is composed of the main frame of the hydraulic press 1, the sheet mould 2, and the high pressure power plant 3.

The multiplier MH has the functional role to generate high pressure in the mold and hydro-formation fluid using the energy of the hydraulic oil from the powering system.

If the procedure involved the hydro-formations of a tube, another two additional cylinders are used to apply the sealing system at the end of the tube.

All the pressures in the system are strictly controlled.

The installation uses one type of fluid: high pressure hydraulic fluid used for powering the system.

A normal rate of pressure amplifying is 1 to 4 so with a pressure of 320 MPa in the powering system we can obtain 128 MPa in the hydro-formation liquid (Fig. 6).

The chart diagram of the multiplier system is presented in Fig. 7.

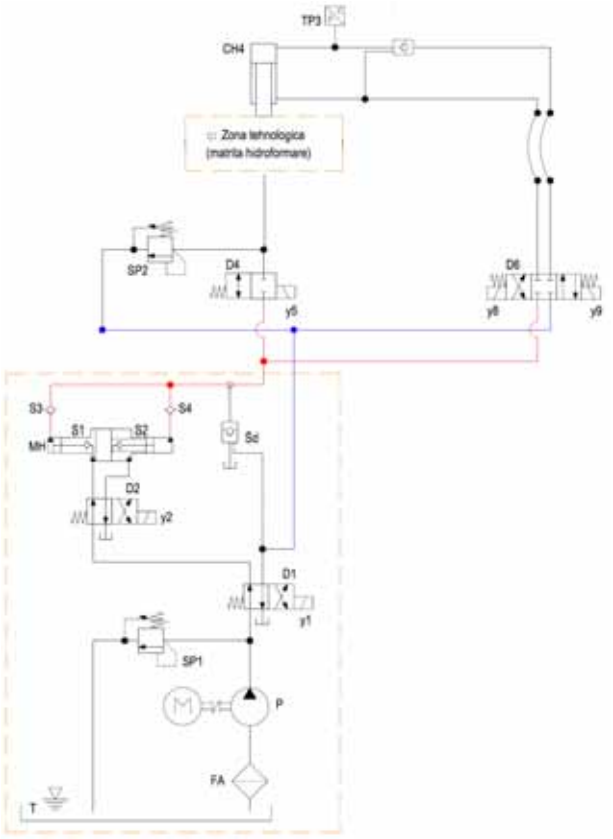

Fig. 6. Hydraulic diagrame of the experimental equipment for deforming through hydroformation.

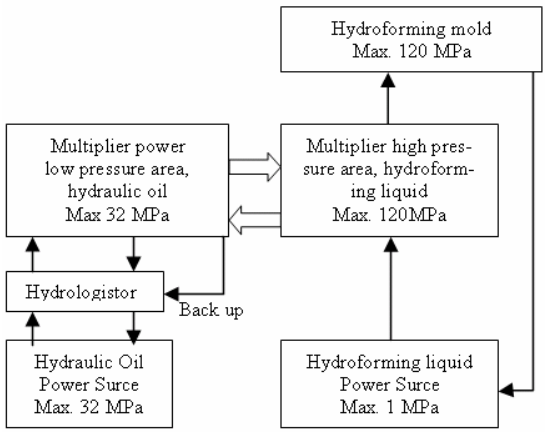

Fig. 7. Hydraulic diagram of the multiplier system.

3. D2 VALVE DESCRIPTION

MH can work in auto-oscillating mode or with external reference command. The distribution valve D2 was designed and produced to generate this function.

D2 is composed by a body with the connection points to "P", "T" and "A" (connection to the multiplier), a 3/2 hydrologistor, an accumulator and a small electrical valve with coils.

The hydrologistor has a section for command. A hydroststic pressure applied on that surface change the position of the valve and sense of the hydraulic flow through the main cylinder of the multiplier. A small orifice in the multiplier body has the role on feedback signal for the hydrologistor. When the cylinder reaches the maximum course the orifice is opened and the oil generate a pressure on the command surface of the hydrologistor, change his position and connect the cylinder to "T". This allows the multiplier to sweep to starting position. When the starting position is reached the hydrologistor change his position again and send the pressure in the lowest pressure area of the multiplier. The circle of operation repeats each time with a maximum calculated frequency around 12–15 Hz which means a high oil pressure flow 0.6 l/min at 70 MPa.

On the first stage (Fig. 8) of the 3D design important was that the valve can be designed in that way as well as with an external electrical command to change the position of the multiplier and to determine in that way the main working parameters. The first stage project was optimized for a better flow of the hydraulic oil and self-oscillating operation (Figs. 9 and 10). To decrease the commutations times was introduced in the system an 0,25 l accumulator charged at 5 MPa with the working pressure at 12–16 MPa. The position of the accumulator besides the hydrologistor was changed as well as the oil envelop the hydrologistor body and flows simultaneously through all orifices more efficiently. This allow to reach a working frequency up to 25–27 Hz.

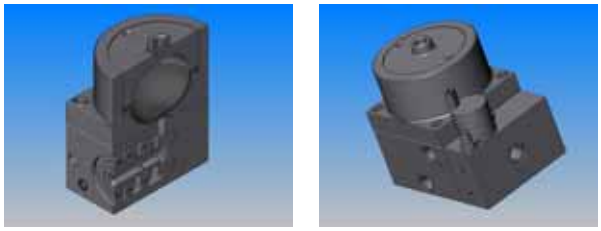

Fig. 8. First stage of the experimental model of D2 valve.

Fig. 9. Optimized model of the experimental D2 valve.

Fig. 10. 3D design of the optimized model of the experimental D2 valve.

hydrologidtor accumulator common body

Fig. 11. Physical parts of the experimental D2 valve.

4. EXPERIMENTAL RESULTS

The novelty of the solutions is focused on generating and control of high pressure (700–2 800 bar) with hydraulic auto-oscillating multipliers and uses it in innovative construction of the system (Fig. 11).

The symulation which was presented on ICMAS 2008 on the paper *Self oscillatory high pressure (70 mpa) multipliers, with logic hydraulic elements, for hydroformation liquids. simulation of dynamic operation* [1] shows that teoreticaly we can produce self oscilation at a frequency around 22 Hz.

In Fig. 12 it is observed the form of kinetic energy of the piston generator, for course work and race for withdrawal, the amount reaching its theoretical value of 75 J for the course and 180 J for race return.

This difference is explained by the fact that the withdrawal to achieve high frequencies is opting for small active area so for very high speed work. In practice this energy is absorbed by the pressure accumulator intro-

Fig. 12. Simmulation, the block diagram of the piston & hydrologistor working together.

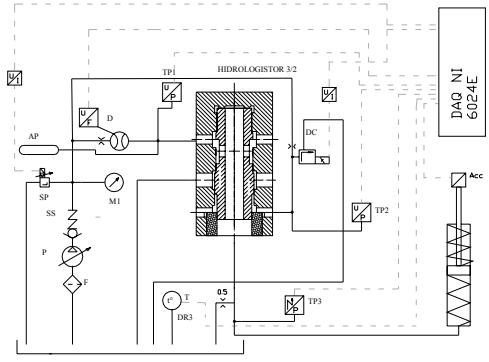

Fig. 13. Hydraulic diagram of the experimental equipment for working characteristics of the hydrologistor.

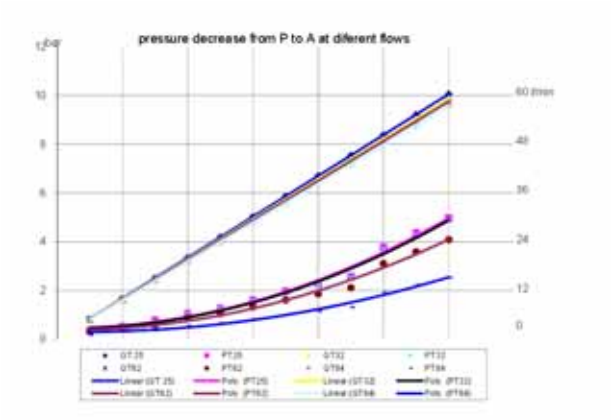

Fig. 14. Hydraulic characteristics of the hydrologistor at different temperatures.

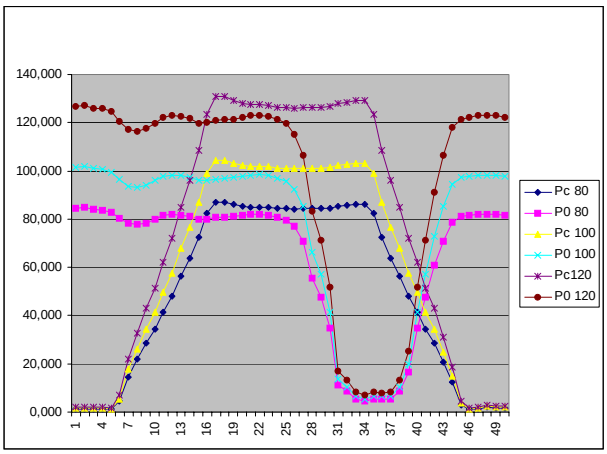

Fig. 15. Commutation characteristics of the hydrologistor.

duced into the work of the multiplier (Fig. 13) and later used for the race, the difference being absorbed in the table multiplier.

Increased frequency of up to the limit of stability of the generator can be done by increasing pressure of work to the value of 240 bar (Figs. 14 and 15).

In Fig. 16 we can see that the multiplier auto-oscillates at 22 Hz, consumes a yield of about 24 l / min, a swing of 6 mm but generate an impact energy of 120 J for the course. Basically the energy cannot be taken over.

5. FURTHER RESEARCH

We assume that the next step of the future research will be studied with the finite element analyses and optimized for a proper design. Regarding those great pressures a proper analyze for the pistons bodies, one way valves, and sealing system should be done.

After optimizing the operational parameters of each component, the multiplier can be exploited to the limit of stability, and new materials for components will be also tested for viability of the structure.

6. CONCLUSIONS

The purpose of this experiment was to check if the mathematical model of hydraulic auto-oscillating multi-

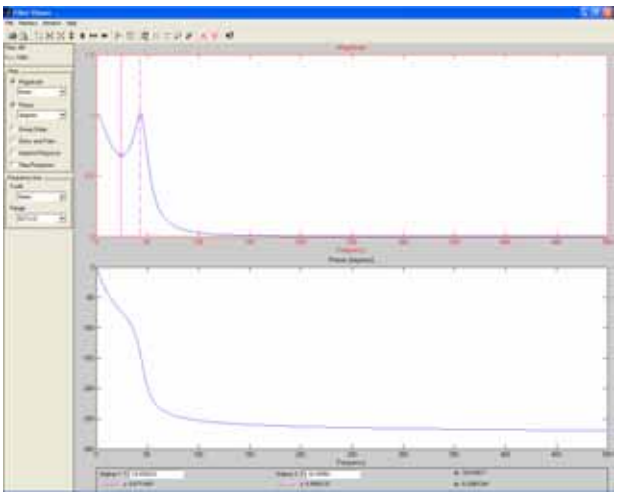

Fig. 16. Main working frequency and dynamical characteristics of the hydrologistor.

plier, can be experimental analyzed and optimized for dynamic behavior using in his construction hydrologistors which are ideal for working in the dynamic systems.

As demonstrated by the end of the previous chapter we have managed to achieve some experimental high performance, comparable and with the generators produced over the performance so far on the world market.

Multipliers operated directly by the automation or in self oscillating regime has a great practical applicability in hydro-formation work in the field of aviation and automotive design.

Analyzing the momentum and the kinetic energy of our simulation of the multipliers, comparing with the data from experimental research has found on an overall a decrease in the flow consumed by 10% and increase to 12% of the amount of kinetic energy of the multiplier piston, with a correspondence of 85% from the experimental parameters to those form the simulation.

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