

MECHATRONIC MODULE FOR SPEED CONTROL IN HYDRAULIC DRIVES

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Abstract: The system designed for speed control in hydraulic drives is built on a dedicated module that contains components which gives them the “mechatronic” features. The “mechanics” consist of a proportional directional control valve and flow sensors, the “electronics” consist of controller drive and adapters for sensors, and the “informatics” consist of application software that implement the system functionality. The paper presents a hydraulic system that uses this kind of mechatronic module in order to control the speed of cylinder rod.

Keywords: mechatronic, hydraulic drive, electronics

1. Brief introduction in the mechatronic field

The early 70s imposed a new stage in the evolution of modern engineering by the appearance of an interdisciplinary field of science and technology called "Mechatronics", the principles of which mechanical, electronic and software are integrated to obtain a product with superior feature. Mechatronics can be considered a promoter of concurrent engineering. The development of mechatronic systems cannot be completed without a permanent cooperation between specialists in the fields of mechanical, electronic and informatics technologies. It is well known two-way relationship between mechanical and electronic subsystems in the sense that the electronics influences the shape and functionality for mechanics - often taking over its functions. Also the mechanical subsystem functionality requires the development of electronics.

Figure 1.1 shows the mechatronic system concept in which mechanics, electronics and informatics work together to perform a certain function.

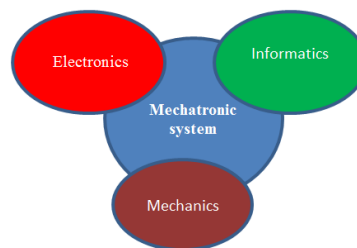


Fig. 1. Mechatronic system concept

It can be considered three stages in hydraulics development, basic hydraulic drives that have as the main feature “force”, the automated hydraulic systems have the additional attribute “precision” and the hydraulic mechatronic systems that received in addition “intelligence”.

The mechatronic module described in this article is used to control the speed of a cylinder rod in hydraulic equipment through monitoring and control the flow.

2. Mechatronic module and system description

The mechatronic module is built on a proportional directional control valve, as mechanics, electronics for drive it, and two flow sensors to monitoring the flow. In the schematic diagram, shown in figure no. 2, are distinguished three specific components of mechatronic systems: *mechanics* is made by a proportional directional control valve *DP*, and two flow sensors *TD1*, *TD2*; *electronics* contains a data acquisition board *DAQ*, the adapters for flow sensors *AD1*, *AD2* and

the controller for valve drive, *informatics* contains applications software developed to control the output valve flow through controller and data acquisition board.

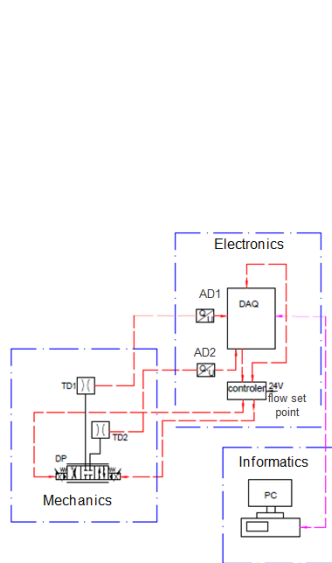


Fig. 2. Mechatronic module-schematic diagram

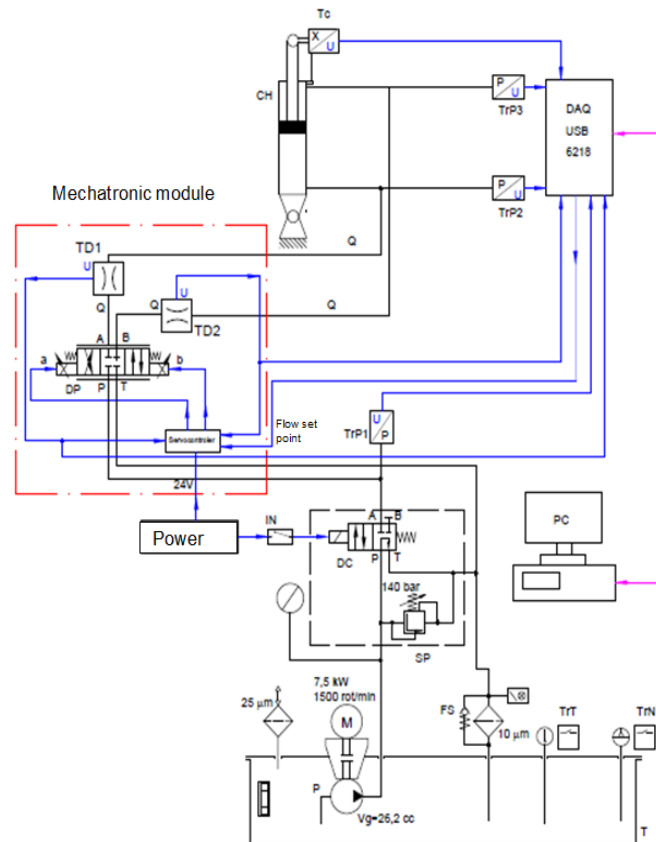


Fig. 3. Hydraulic drive that contain the mechatronic module

In order to test the capacity of the mechatronic module to control the speed, in the laboratory condition has been developed an experimental hydraulic system. As is shown in figure no 3, it contains the mechatronic module, the hydraulic cylinder *CH*, and the fluid pressure-source represented by a fixed flow rate pump *P* driven by the electric motor *M*, the oil tank *T* and conditioning elements of the working fluid: filters *FS*, temperature sensor *TrT*, level sensor *TrN*.

3. Hydraulic system testing

Analysis system functionality was achieved both in terms of theoretical and experimental, through numerical simulation and tests on laboratory stand.

In order to compare the simulation results with the experimentally ones was developed a testing program that was implemented in both situation. The objective of the testing program was getting value imposed constant speed of 100 mm/s, for different loads, constant or variable ones.

These different types of loads has been obtained through a load simulator consists of a load hydraulic cylinder powered by an auxiliary power source (i.e. manual pump).

The simulation diagram, shown in the figure no.4 presents the hydraulic system consists of power source, the proportional directional control valve, the hydraulic cylinder, the load simulator and the electronics consist of a PI regulator.

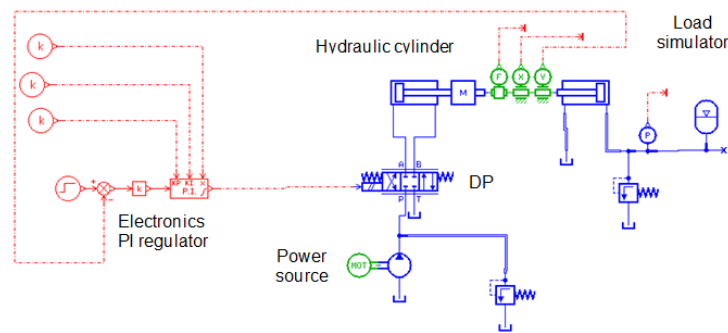


Fig. 3. The simulation diagram

The simulation results obtained for an imposed speed value of 100mm/s, are presented in below table. In this case on the load cylinder was applied a constant force of 5000N, and the speed value reached at 100mm/s in 2.5 s.

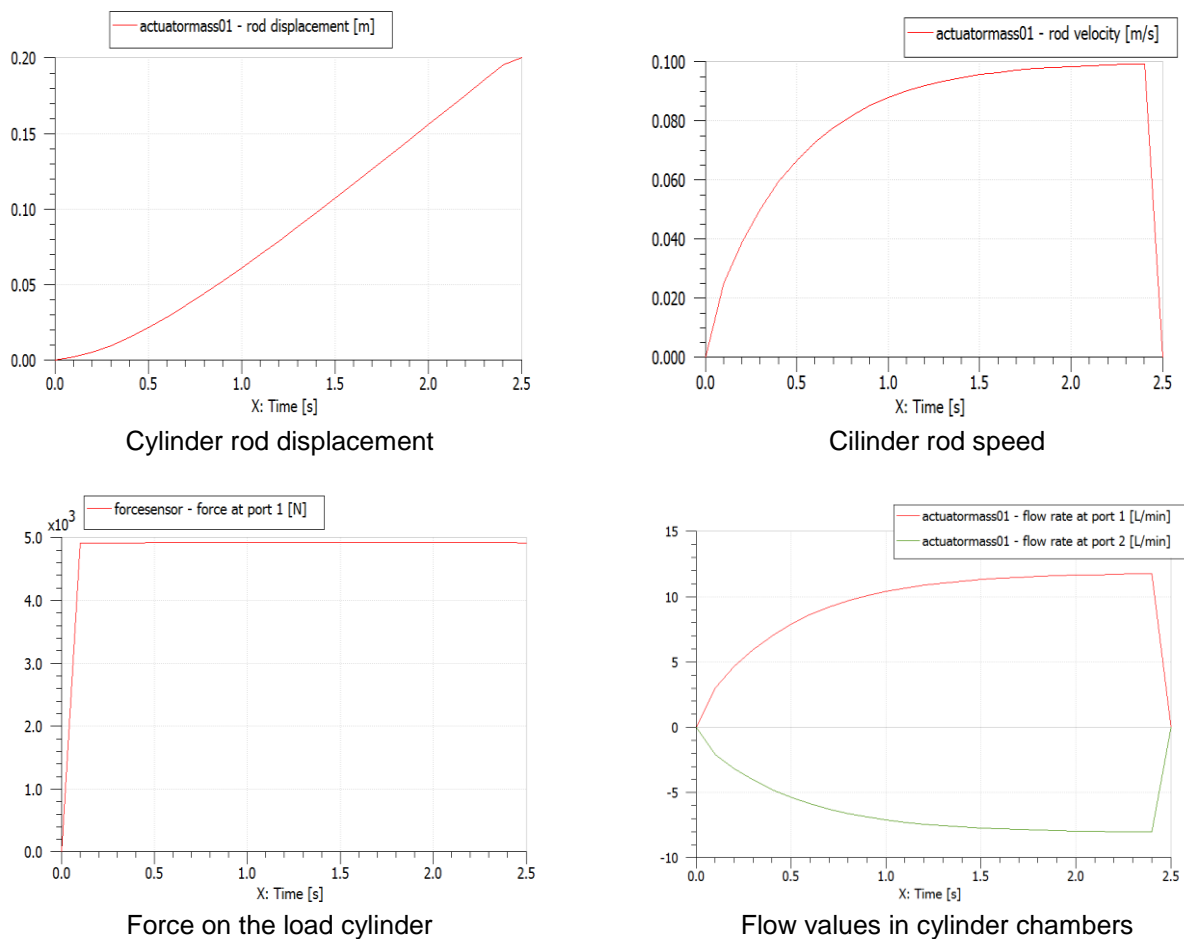


Fig. 4. Simulation results

The experimental testing was done on the specialised test stand was adapted so as to maintain conditions used numerical simulation. As is shown in figure no. 5, it was developed a load simulator based on a hydraulic cylinder and a manual pump that helped to obtain constant loads during the tests. The mechatronic module contained a proportional directional control valve and a gear wheel flow meter.

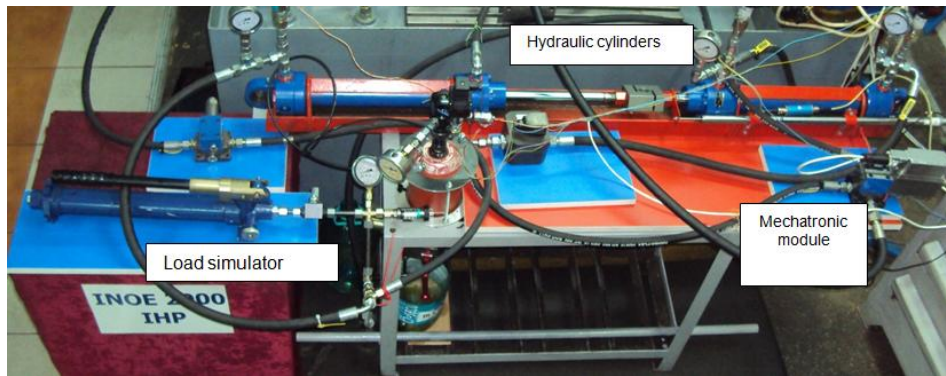


Fig. 5. The test stand

The testing program was implemented on dedicated application software developed under LabView Platform. The application panel and the specific working blocks are presented in fig no 6 and the fig. no 7 presents the experimental results obtained for a 100mm/s imposed speed value.

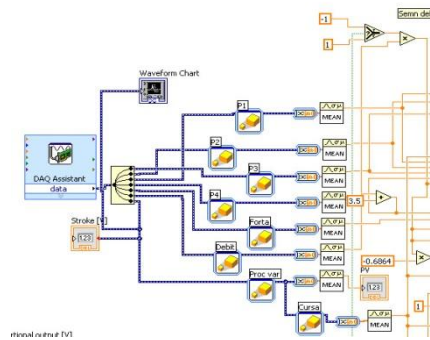
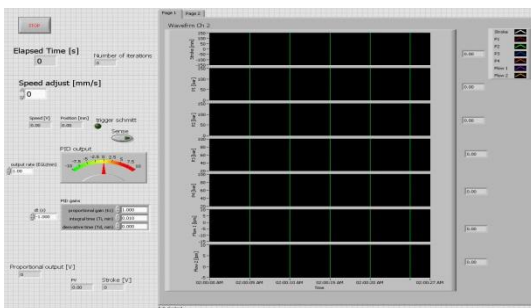


Fig. 6. The testing software application

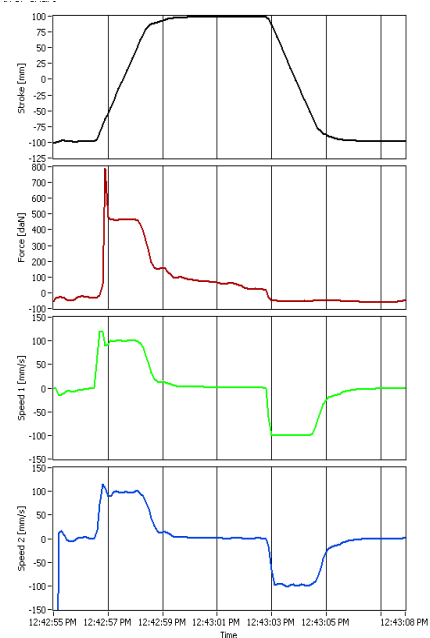
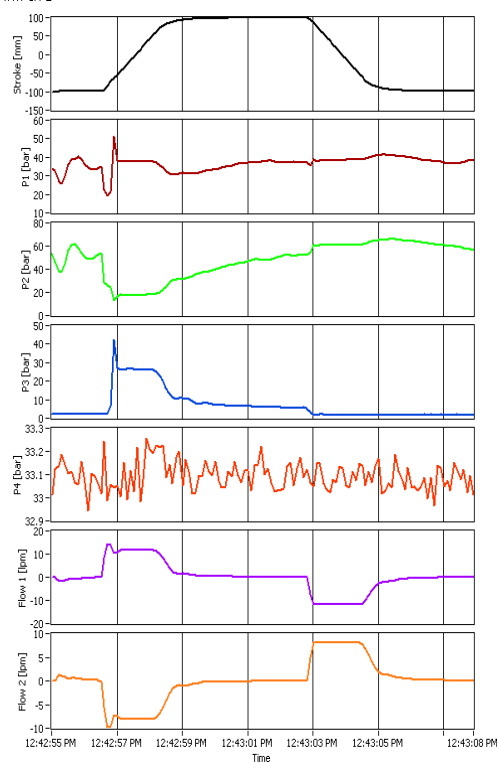


Fig. 7. Experimental results

The experimental diagram, obtained in same condition like theoretically one(imposed speed value 100 mm/s), shows that testing result are closed to the theoretically result: rod displacement 200 mm, working pressure 25 bar, force on load cylinder is almost 5000N ant also the system reaches to the 100 mm/s speed value in almost 2 s.

4. Conclusions

Comparing the theoretical and experimental data it can be said that the results obtained in the numerical simulation are very close to the experimental one both quantitatively and qualitatively (the allure of variation), the deviation being around 5%.

At first glance, given the complexity of the hydraulic system fitted with flow control mechatronic module, it can be concluded that the theoretical results are very close to the experimental ones, the numerical simulation program have a capacity of very good description of the dynamic behavior, especially when referring to the steady evolution. Regarding the transient dynamic evolution can be observed occurrence override for some parameters obtained in experimental research.

References

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