

APPLICATION OF FREQUENCY REGULATOR IN HYDRAULIC SYSTEM FOR REGULATING CAPACITY GEAR PUMPS

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Abstract: Requirements that often arise in practice in the application of hydraulic system are such that they need at any time to respond to changing demands. It is a known fact that the hydraulic pump converts mechanical energy into hydraulic power. Hydraulic pumps are designed so that they can give variable and constant capacity of fluids. Same structure with increased demands that need to respond are characterized by the relative complexity and higher cost price of such pumps. Hydraulics and electronics has been mutually complementary, so that the complexity of a single hydraulic components which would answer growing demands of working devices and machines can meet some simpler components of these areas. For this purpose, a hydraulic system and pump applies a constant displacement with frequency converter instead of complex and expensive pump variable displacement.

Key words: hydraulics, frequency converter, hydraulics system, pump, saving energy

1. INTRODUCTION

The hydraulic system has been used for over a hundred years and during this lifetime experienced a large number of structural transformation. Classic distribution valves with end positions of the working piston, the frame adapted to the requirements of production and mobile machines so they are reducing the volume and weight, and increased working pressures, flow, speed and accuracy of response, service life, operational reliability and efficiency ratios. At the time when this, and other improvements can successfully and / or rationally to meet the requirements, there are new structural forms of hydraulic components. Hydraulic pumps convert mechanical energy into hydraulic energy working fluid. [1], [2], [3] Development of electronics creates new spaces for the development of hydraulics, not only in the field of construction components, but also the management. [1], [2], [3] As part of the basic functions of the hydraulic system, the transformation of energy, construction of the hydraulic system must meet other important requirements: energy loss on the way of transformation of energy must be minimal.

2. HYDRAULIC CONTROL CAPACITY VOLUME PUMPS

From the known relationship of fluid power failure, pressure and flow:

$$P = \frac{p[\text{bar}] \cdot Q[\text{l/min}]}{600(p \cdot Q)} \quad (1)$$

the ratio of the total, useful and power loss due to loss of fluid power pressure and flow is displayed in the form of diagrams ($P = p \cdot Q$) - Figure 1. [2],[5],[12]

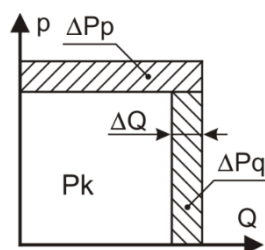


Figure 1 –Total available capacity hydraulic pumps

The total amount of pump power is distributed to usable power, which is marked with P_k , and the loss of power that is lost power due to falling pressure - ΔP_p and lost power due to the loss of flow - ΔP_q .

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The pressure drop and flow in the hydraulic system as a result of losses in the hydraulic components and for them it can be said that they are within acceptable limits, normal. However, if within the hydraulic system reduces the damping oil flow, with the unchanged requires pump pressure is increased to a level that is adjusted to the pressure limiting valve. [1], [4]

2.1. Application of frequency regulator in hydraulic system for regulating capacity gear pumps

Frequency converter control along output frequency and the voltage according to Figure 2, maintaining a constant ratio of voltage / frequency (volt / hertz). Momentum generated is directly proportional to this ratio, which means that at all speeds (up to nominal speed) torque constant and equal to the nominal time. [5] This means that the engine at all speeds and can deliver full torque.

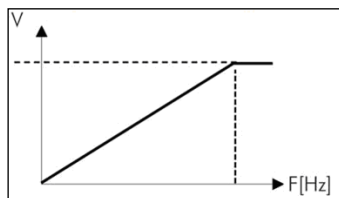


Figure 2–Control frequency converter

The controller can be operated motor with frequency above the nominal (50 or 60 Hz), but in this case it is not possible to further increase the voltage. In this case, the torque decreases, and there is a possibility that the engine at higher speeds can not deliver enough torque to launch a given load. Manage capacity pumps a constant volume capacity happiness is rarely in structures of hydraulic drives.

Only in the last twenty years, in parallel with the development of construction, improvement of technical characteristics and the fall in the price per kW of power, drives modestly, but casco all are used in the construction of hydraulic systems. For this trend was necessary development in the construction of gear pumps, actually their breakthrough in the area of higher working pressures (250 to 300 bar) and higher capacity.

Gear pumps belong to the group pumps with a constant working volume. They belong to the group of volume pump in which the operating means for the suppression of the working liquid two coupled gears. One of the drive gear and receives torque of the drive unit, usually an electric motor, and the second driven gear.

Volume of fluid to be pushed depends on the speed and the size of place between the tooth. Gear pump is a kind of displacement pumps where it is not possible to regulate the capacity of the regulator installation capacity.

Due to the inability installation of hydraulic controller and regulating capacity that makes this pump, the paper presents the application of the frequency converter for the purpose of regulating the number of revolutions of the engine. In this way we achieve that, a simple and reliable hydraulic pump, the hydraulic system may provide variable flow rate as a function of the number of revolutions.

The following figure shows a hydraulic system with gear pump, hydraulic energy source and frequency converter, as well as an electronic component that regulates the pump capacity. The system works so that, when starting, includes an electric motor as a power source, and the frequency at which the regulator sets the reference pressure value that he wants to maintain the system.

By activating the command that the system is put into operation hydraulic pump is started and in accordance with the desired output, i.e. reference value to be reached at the executive body ie. hydraulic cylinder, maintains the set value.

Components of the hydraulic system, on Figure 3, are:

1 hydraulic power pack, 2 - hydraulic valve, 3 - safety valve, 4 - hydraulic cylinder, 5 - hydraulic cylinder for load, 6 - hydraulic accumulator, 7 - frequency converter, 8- PLC CP1L, 9 - a module for acquisition CP1W-MAD11, 10 - DC module 24V, 11 - computer, 12 - pressure transmitter, 13 - manometer, 14 - clutch.

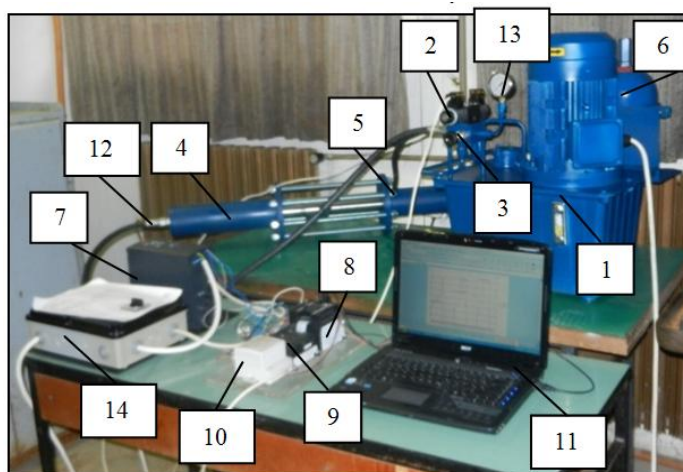


Figure 3–The hydraulic system of regulation capacity gear pump frequency converter[12], [13]

Frequency converter, which serves as the controller has in it integrated PID regulator that maintains a reference pressure. Frequency converter, slightly run-up pump, and then change the speed to pressure remained on the set value. Data on the actual value of the pressure supplied via pressure transmitter mounted on a hydraulic cylinder, precisely at the point where the pressure measured in the hydraulic cylinder, and is directly connected to the frequency converter.

In the event of a major higher the required force, the frequency converter will be changed over speed electric motors and thus will increase the pump flow rate, as it will be needed and higher pressure value that is directly related to the force of the hydraulic cylinder. Also, in case that is needed less force, the hydraulic pressure on the executive body that would, through feedback, respond frequency regulator that will reduce the number of revolutions of the drive shaft has a hydraulic pump and it will give a smaller flow.

Another variant of this experimental work is that the frequency converter is controlled via PLC, which would then pressure value received from the transmitter and sending a command to the frequency converter. The results that have been generated during the experimental part of the city are shown in Figure4 and determine the dependence of the number of revolutions of the electric motor and the pressure in the hydraulic system. From the diagram, it is seen that when changing speed electric motor and changing the pressure in the hydraulic system.

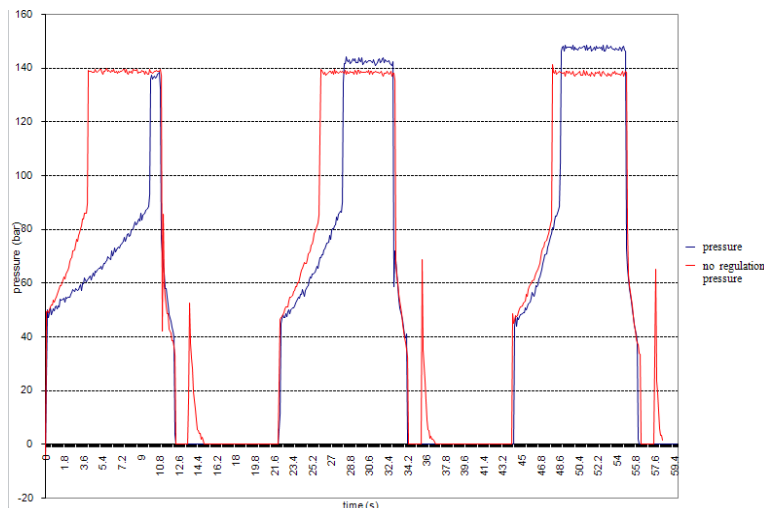


Figure 4–Pressure with and without speed control motors[5], [12]

In the case of the first variant when done directly manage frequency converter which still regulates the necessary force to the hydraulic cylinder, PLC has a role for data acquisition. Which means that the PLC and the module for acquisition connected to a computer, and custom set values and compares them with the reference signal in a closed loop.

3. CONCLUSION

Reduction and rationalization of electricity consumption, as one of the most energy in the industry, has been the subject of many studies. One way of rationalizing consumption electricity, and other forms of savings, is to use a variable speed electric motor drives with frequency inverter.

Designed hydraulic system in which the pump is replaced by a variable capacity pump whose capacity is altered by changing the number of revolutions, removes all doubt about a possible replacement of conventional hydraulic controllers with frequency converters. [12],[13] When the hydraulic system in which it is possible to substitute the variable capacity pump with a constant pump capacity and frequency converter, a dominant influence on the application of the system of regulation of pump capacity has a priceperformance ratio and energy conservation.

The use of frequency converters enables better control of the parameters that affect the operation of the pump. Area viability of the application of frequency regulator in relation to hydraulic, with the same capacity of the pump depends on the pressure and everything is on the higher range of applications of frequency converters is narrow and vice versa. [12]

There is no universal rule, so every hydraulic system and the pump must be the subject of a specific analysis or an exceptional profit for hydraulic systems where the pump can be replaced by a variable capacity pump capacity constant with frequency converter. [12],[13]

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