

REPAIRING AND TESTING OF THE HYDRAULIC SERVO VALVES

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Abstract: (*Arial, 11pt, Italic, Justify*)

The equipment which must work at high values of speed and response frequencies and reach optimum performance need to have their hydraulic installations equipped with servo valves. The costs of production of the servo valves are very high, due to their mechanical complexity and they are not compatible at all with the contaminated fluids, cause of the small gaps between the parts in motion and of the very small apertures of nozzles. If these installations are not properly maintained servo valves can be damaged very quickly and can only be remedied in centers (laboratories) by specialized personnel. The paper presents ways of identifying a faulty servo valves, symptoms and possible causes and their testing.

Keywords: *hydraulic, servovalve, testing, fault*

1. Introduction

The equipment which must work at high values of speed and response frequencies and reach optimum performance need to have their hydraulic installations equipped with servo valves. The modern servo valves are very reliable components, due to the major improvements applied to them in the course of time. The costs of production of the servo valves are very high, due to their mechanical complexity and they are not compatible at all with the contaminated fluids, cause of the small lost motions between the parts in motion and of the very small apertures. These very performant equipment are therefore suitable for sophisticated systems and require a rigorous maintenance.

These prerequisites regarding precision and dynamics of the hydraulic drives lead to the use of hydraulic devices of control with high performances. The dynamic performances of the servo valves with direct command, are limited at 80 Hz and of those with piloting stage at about 100 Hz. Beside the influence of the hydrodynamic forces, the performances of the hydraulic devices are much influenced by the dynamics of the electromechanic actuators, which drive, directly or indirectly the slide.

The close loop drives have been utilized a lot lately. In a drive of this kind with close loop or with servo control, the servo valves are the key elements, with the greatest impact upon the static and dynamic features of the drive system.

The servo valves must provide high fluid flows and dynamic features, high rigidity of the system at load and very slight deviations of position of the operating element, from the prescribed position.

For reaching this must be accomplished the following:

- High degree of accuracy at the execution of the bushand servo valve slide, for obtaining a symmetric and linear signal flow function
- Reduction of the mass of the parts in motion

- Reduction of the interference forces which have a negative impact upon the slide dynamics friction forces, hydrostatic forces, hydrodynamic forces and impulse forces
- Reduction of power losses of the piloted servo valves and minimization of the control chambers volumes
- Improvement of the dynamics of the electromechanic convertor.

2. The description of the servo valves

Due to the afferent performances, the most widely spread servo valves are those with two stages see fig.1 These type of servo valves have beside the compulsory pilot, a stage of hydraulic amplification, directional type. The pilot which comprises the couple motor and the nozzle flap amplifier may be considered and sometimes it is even utilized as a servo valve with an amplification stage. This is a classic directional valve with marks executed in a higher precision class. The symbol of this type of servo valve may be seen in fig.2

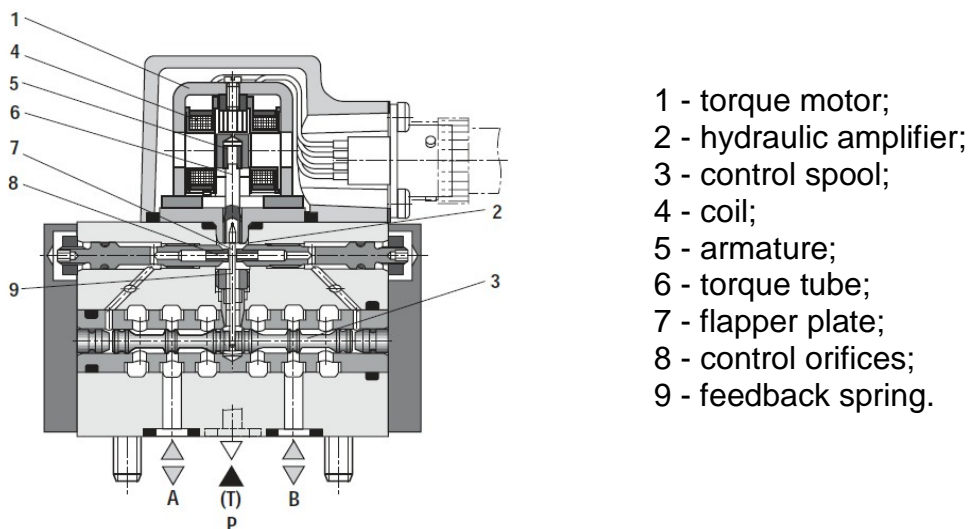


Fig. 1 Rexroth servo valve type 4WS2EM

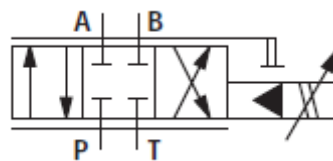


Fig. 2 Servo valve symbol

The servo valves are commanded with electric signal applied to the spools of the couple motor. The two spools may be connected serially or in parallel. With a few exceptions, the servo valves use only c.c.signal.

The hydraulic installations which enclose servo valves must take into account some very strict conditions:

- The installed flow of the pump must be 10% higher than the highest flow supplied by the servo valve

- The servo valves must be protected with a filter of 5 + 15 um This filter is recommended to be put as an individual protection for each servo valve. It is recommended that the safety filter of the servo valve to be deprived of by pass valve
- The pressure valve which maintains pressure almost constant on the input in the valve must be chosen in such a way that for the range of the flows discharged in the basin during work the variation of the adjusted pressure to be below 10 bar
- It is recommended that the hydraulic cylinders which equip the hydraulic installation to be with bilateral rod of the same diameter. This ensures a good stability allowing also an easier and more accurate calculation of the hydraulic system and also bring simplification of the electronic control system.
- It is recommended that servo valves to be placed as close as possible to hydraulic motors they serve. Is indicated as links of servo valve with hydraulic motor to be rigid (pipes) or not to vary their volume at pressure variations.
- It is recommended that between pumping group and servo valve be mounted a hydropneumatic accumulator whose size is determined by the pump flow and the operating mode of the system. It is necessary to provide manual controls to bring hydraulic motors in the original starting position.
- It is recommended that the hydraulic system be equipped with oil cooling - heating system to ensure a temperature of 45 to 55 °C during operation.

3. Finding faults in installations with servo valves

If it is found that the system that comprises a servo valves is not working, for testing can be replaced with another spare servo valves, and if you do not have a backup servovalve will proceed as follows:

- Shall be measured the command signal of servovalve thus checking the electronic system operation:
 - If electronic block does not give electronic signal to needed parameters search fault here and fix
 - If electronic block give control signal and if one can not vary manual the signal it must be used an external signal generator.
 - If the load does not move (at external command signal) put gauges on the supply and return ports of servo valve. If the supply pressure is good that means the pressure source is good and then continue searching fault.
 - Place pressure gauges on motor ports. Vary the control signal and check output pressure at motor ports.
- If we have not a gradual increase in pressure means that the servovalve is damaged.

Faulty servovalves must be removed from a system only after the place around them it is cleaned. For servovalve removal first disconnects electrical connector, remove the screws with which it is fixed and mount the replacement servo valve whose protective cover was removed previously. Finally, the protective cover is mounted on demounted servo valve, to prevent dirt entering in the joints and losing O-rings.

To see if servovalves can be repaired these should be sent to specialized laboratories operated by highly qualified personnel .

4. Repairing servovalves

The symptoms of main defect encountered in servovalves can be:

- The servovalve give flow only one way and the electric control gives no results (nozzle clogged)
- Servovalve not respond to commands (broken coil, clogged nozzles);
- Presence of flow without giving an electric command, flow which decreases at electric command in a certain sense (shifted null);
- Unequal flow at equal control level for both polarities (asymmetry)
- large hysteresis on reversing electrical control (friction between the spool and sleeve due to impurities)
- High flow at null that can not be canceled by adjustments (high wear of spool and sleeve edges).

Removal and installation of servo valves should be done only by specialized personnel and only based on accurate and complete instructions. The place where is made removal and instalation must be perfect clean. Because of the size of the nozzles and small gaps between moving parts any impurity can cause blockage of servovalve. Dismantled parts shall be placed on a non-metallic surface. On removal is well to note (mark the relative positions of the parts). Spool must be handled with care not to damage the edges. He should not be placed on hard surfaces. It is advisable to avoid removing the nozzle if it leads to change their position and if does not have the possibility of resettlement at fixed odds. If they are removed have to avoid damaging them, especially if there does not exist conditions to recalibrate them. After cleaning and repair servovalve component parts are assembled at place, then appropriate adjustments will be made and will be drawn static characteristic.

5. Testing of servovalves

Testing of servovalves is made on specialized stands. Such a stand for servo valves testing (Fig. 3) consists of: a tank on which is fixed a plate for connecting servovalve in testing circuit, a pumping group, pressure and flow transducers, a servocontroler and a computer equipped with data acquisition board.

Testing is as follows:

- 1) Check that stand and equipment fitted on it corresponds with mounting scheme;
- 2) Adjust supply pressure to servovalve at nominal value
- 3) The input current is passed several times through the circuit
- 4) The testing application is opened on the computer and then start the testing, after that the program generating the increasing steps of control signal and flow given by the servovalve is recorded and after draw the characteristic diagram
- 5) Check that the machine pressure remains relatively constant throughout the current cycle
- 6) periodic signal applied continuously allows recording characteristics during a complete cycle



Fig. 3 Servo valve mounted on stand for testing

Periodic signal during a complete cycle $\pm I_{max}$ [mA] (maximum control current in both directions) applied to servo valve for plotting the characteristic is generated by a software application (Fig. 4). The application allows recording the data for further processing. The application generates the control signal and carries signals from the transducers through a data acquisition board.

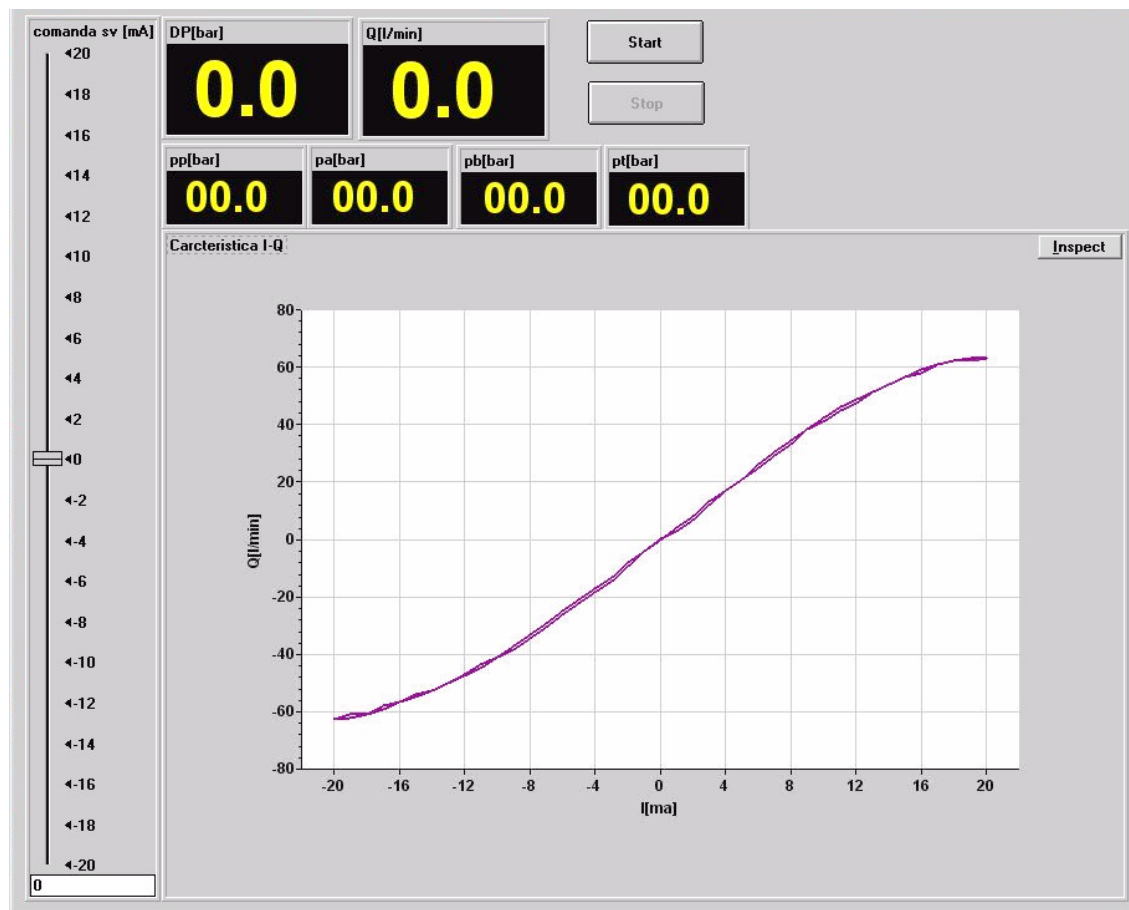


Fig. 4 Panel of the testing application made in TestPoint medium

From a recorded chart can be seen if hysteresis is large, if the parameters stipulated in the data sheet (maximum output at maximum control signal) are touched and if the chart is asymmetric or if null is shifted.

6. Terms of putting into service the installation with a new installed servo valve

Before mounting a servo valve in the system is necessary, especially in complex installations that had a very long operating since last oil change, to make a washing of a hydraulic installation. For this the servo valve is replaced with a special adapter plate for washing, on which is mounted an electrically controlled directional valve that can provide equivalent flow with that one given by the servo valve.

In some cases instead of servo valve is mounted a simple plate that directly connect the tank port with inlet pressure port. All pumps are started at low pressures (with safety valves opened, checking not to appear control signals to servo valves). Adjust safety valves at the values set by the designer.

Are given commands to the directional valve who replaced the servo valve to achieve the rated machine cycle speed of hydraulic motors. Check at the same time outward leakage appearance. Aftyer a while it stops the operation of the installation and replace the washer plate with the new servo valve. Are gived to the servo valve electrical signals covering all the field of control. Give commands in automatic mode making the final adjustments at the control electronics as well as the hydraulic. It is well that all adjustments to be made at recommended hydraulic medium temperature and designer prescription which is in domain 45 to 50° C. The null of servo valve should be adjusted according to actual conditions of automatically cycle (supply pressure, back pressure and oil temperature). Verification of correct adjustment of null is made by cutting electric connection of servo valve, in which case if the electronics is well adjusted, operated element must remain in place. After 3 hours filter cartridges are replaced with new ones.

7. Conclusions

Servo valves are high performance equipment and are suitable for sophisticated installations and systems.

Servo valves are sensitive devices and their use must meet a number of strict conditions such as:

- proper filter of oil to keep them in working order;
- respecting the installation instructions for servo valves can be achieved maximum of performance.

Repair of servo valves must be performed only by qualified personnel, otherwise these can be irreversibly affected.

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