ISSN 1453 – 7303 "HIDRAULICA" (No. 3/2013)
Magazine *of Hydraulics, Pneumatics, Tribology, Ecology, Sensorics, Mechatronics*

TESTING OF LINEAR PNEUMATIC ACTUATORS WITH HYDRAULIC LOAD

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Abstract: *Actuators are execution elements used in automated mechatronic drives, which generate the useful mechanical work, needed for the working machine, converting hydraulic power generated by positive displacement pumps (Qm x p) into mechanical power (Mm x ω – for rotary motors, respectively Fm x v- for linear motors).*
Testing of linear pneumatic actuators, also called cylinders, by way of the load achieved through a hydraulic system uses test equipment of original design that connects to a hydraulic supply station and to an adjustable pressure air supply unit. Test device users will be companies manufacturing pneumatic cylinders, those reconditioning, as well as training laboratories, top and medium level.

Keywords*: pneumatic actuators, testing, checking, verification.*

1. Introduction

Pneumatic execution elements, currently called pneumatic actuators, are intended to produce useful mechanical work, needed for the working machine in achieving its function within the specific drive chain. In terms of energy transformation, input, output and status variables, actuators turn the pneumatic power (energy) supplied by the generating elements – Qm x p into mechanical power – Fm x v at linear actuators or Mm x ω at rotary actuators- figure 1.1 and 1.2.

Qm - air flow at the engine input (actuator)
p – input pressure
LA – linear actuator (cylinder)
RA – rotary actuator (motor)
Fm – force produced by the linear actuator
v – piston speed
Mm – torque
ω – angular speed

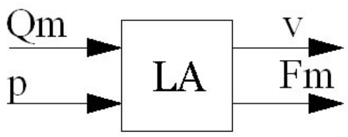

Fig.1.1. Block diagram of linear actuator (LA)

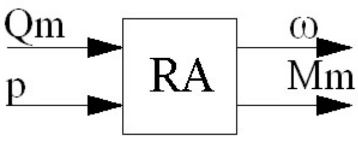

Fig.1.2. Block diagram of rotary actuator (RA)

As it can be seen, hydraulic actuators are classified, in relation to the physical nature of the primary movement performed, into:

- linear actuators;
- rotary actuators.

This article refers to the testing methodology in static mode of linear pneumatic actuators, with wide application in automated drives. In standard constructive design, linear pneumatic actuators are composed of a piston with rod, sealed in a liner, and caps, moving under the action of pressure and airflow - figure1.3. Special constructive design cylinders, also known as pneumatic servo cylinders, have in their structure devices that are controlled and programmed by proportional pneumatic elements.

Fig.1.3. Linear pneumatic actuator (cylinder)
1- brake rod head, 2-damper, 3- threaded sector of rod, 4- seals fitted piston, 5- seal guidance for high speeds, 6- cap, 7- brake throttle

2. Verifying the pneumatic parts

Regardless the design of cylinders, on these devices in order to assess their quality, on the stand there are performed, according to the international standards, the following verifications:

- ✓ type checking - at prototype, zero series and constructive changes;
- ✓ periodic checking - after a period of manufacturing or number of pieces;
- ✓ batch checking.

As part of the methods of verifying the quality, an important role is played by the functional checks performed on pneumatic devices, which are performed on test stands: functional diagram, pressure resistance, exterior and interior tightness, etc.

3. Describing the schematic diagram of the stand

Below is shown the diagram of a stand on which pneumatic cylinders are tested, the antagonistic resistance force is achieved hydraulically – figure 3.1. Adjustment of testing force is performed by two pressure valves in both directions of movement of the hydraulic cylinder rigidly connected to the pneumatic actuator being tested.
On this stand the following checks can be performed:

- pneumostatic pressure resistance;
- exterior and interior tightness;
- operation in idle and load;
- starting pressure;
- minimum travel pressure of the piston;
- minimum and maximum travel speed of the piston;
- thrust and tensile forces;
- plotting the characteristic curves;
- operating time (endurance).

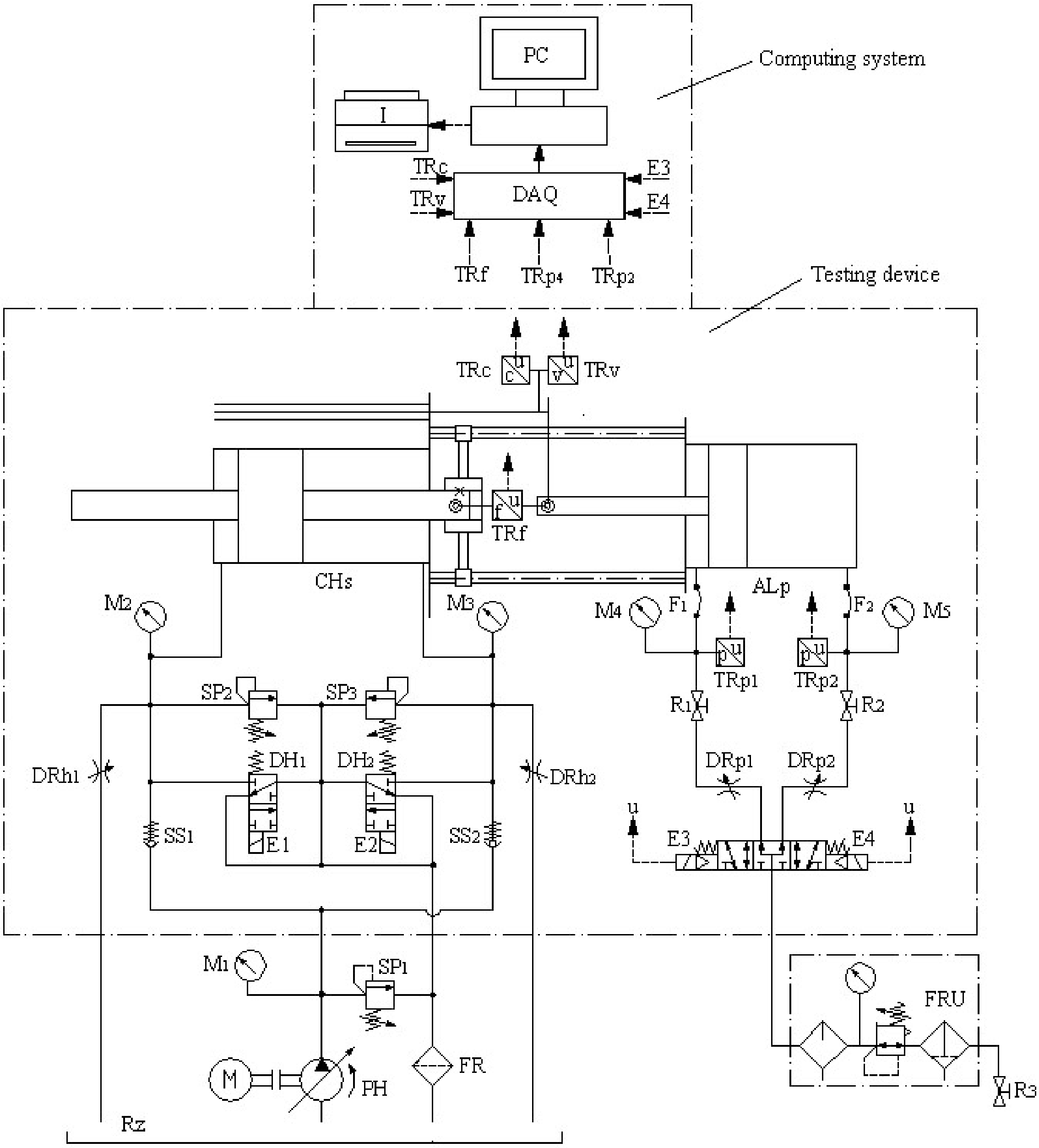

Fig.3.1. Pneumohydraulic schematic diagram for checking pneumatic linear actuators

The test device reproduces under actual conditions operation of pneumatic cylinders on the working machines, where the parameters pressure (which determines force), respectively flow (which determines speed) vary depending on the working cyclogram. The main subassembly of the stand is the test device that comprises the hydraulic load cylinder CHs/HCl, the pneumatic actuator which is tested Alp/LAp, served by the pneumatic installation, measuring instruments and transducers: pressure (TRp1,TRp2), force TRf, stroke TRc/TRst, and speed transducers TRv/TRsp. The hydraulic load system is powered by a low pressure pump with adjustable flow rate PH/HP, whose pressure is adjusted by the valve SP1/V1. Pump flow supplies the two chambers of the cylinder load CHs/HCl and it is designed to eliminate cavitation in the system at piston displacement. Pressure, adjustable in steps, by the valves SP1/V1 and SP2/V2, generates the load (the antagonistic force) on pulling and pushing the cylinder rod CHs/HCl by the actuator being tested.
Furthermore, it is illustrated how a pneumatic actuator is tested in operation at idle and under load:

- after setting the pneumatic cylinder on the stand, the device is connected to the hydraulic pumping unit and the pneumatic installation;
- there are performed 15 ... 20 idle strokes, constantly actuating the electromagnets E1 and E2, and by turns E3 and E4;
- there are conducted tests under load in pressure steps – E1 and E2 not actuated, air pressure being adjusted in the range 0…10 bar by the air preparation unit FRU, and load pressure by valves SP1/V1 and SP2/V2. The pneumatic throttles DRp1/THp1 and DRp2/THp2 are intended to adjust the speed of the pneumatic cylinder which is tested. For working pressures lower than the minimum pressure adjusted by SP1/V1 and SP2/V2 there are used throttles DRh1/THh1 and DRh2/THh2.

Electrical parameters transmitted by transducers to the data acquisition board, DAQ and computer are then printed on the printer I/P.

When checking functionality of pneumatic actuators, information about pressure from pressure transducers TRp1 and TRp2 and about force from TRf allow plotting the diagrams F = f(p) in situations when the rod advances - fig.3.2 and when it draws back – fig.3.2, for various sizes of pistons.

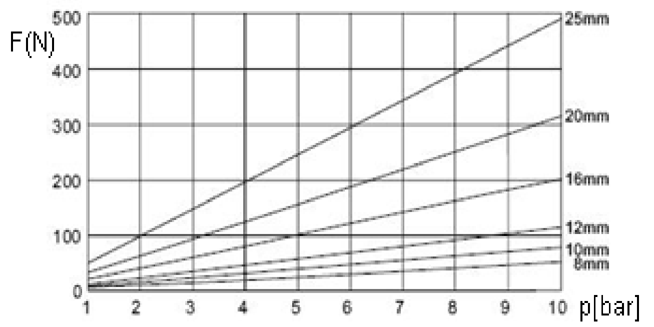

Fig.3.2. Variation of force depending on pressure at rod advancing

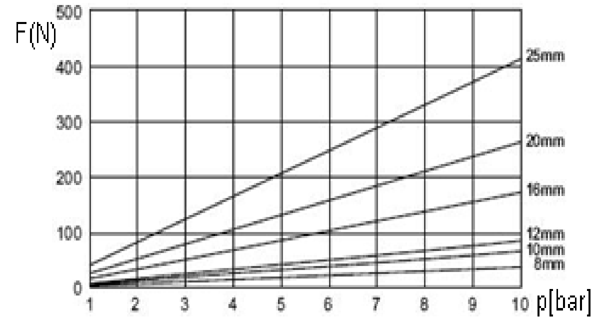

Fig.3.3. Variation of force depending on pressure at rod withdrawal

4. Conclusions

The stand has a large area of applicability at enterprises that manufacture pneumatic cylinders or recondition them, in education within technical high schools, in training people under POSDRU/HRD projects, and in case that it is computerized with transducers and computing system it may be a component of the pneumatics, tribology, mechatronics laboratories in higher education for experiments and research conducted by students and PhD students.

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