The procedure for determining the local and global flow characteristics of spool valve SMHR 22.59.010 in order to be fitted to the assembly SMHR S.22.59.000

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Abstract: *This procedure was designed within the Hydraulic Laboratory of INCREST-INCAS, in the '80s, to provide a unique way of checking and qualification of local and global flow characteristics of the spool valve SMHR S.22.59.010, in order to be fitted to the servo SMHR assembly S 22.59.000.*

Key words: *hydraulic servomechanism SMHR, spool valve, flow characteristics.*

INTRODUCTION

Automatic tracking hydraulic systems are known as servomechanisms. They are divided into two categories: mechanohydraulic servomechanisms, where the both input and output are of mechanical nature and electrohydraulic servomechanisms, where the input is of electrical nature.

Also, there are servomechanisms which are able to receive simultaneously mechanical and electrical input signals.

In the Hydraulics Laboratory of the former INCREST, now INCAS, were made several hydraulic servomechanisms, which have equipped later various aircrafts, especially military ones.

In all cases, the input signals cause a displacement of a slide valve that controls the hydraulic fluid to and from the chambers of a linear or rotary type hydraulic engine [1-6]. These spool valves are of various types: plan or rotary, with different types of coverage: overlaps or underlaps.

The spool valve generally consists of two parts − sleeve and spool. In general, spool valves with four active edges and various overlaps or underlaps were studied in Laboratory, as follows:

− For the SH.04 and SH.05 servomechanisms, of Dowty type, and mounted on IAR 93 aircraft, in the aileron and tailplane control chains, the spool valve is provided with four active edges and **underlap**; their production was taken over by Turbomecanica;

− For the SH.06 and SH.07 servomechanisms, of SAMM type, to be mounted on the IAR 330 helicopter, in the main rotor, and in the anti-torque rotor, respectively, the spool valve is of **rotary** type; their production was also taken over by Turbomecanica;

− For the servomechanism SMHR acting the ailerons of IAR 99 Hawk, the spool valve is plane with **overlap**.

The S.22.59.000 SMHR servomechanism was fully designed, approved and patented in the former INCREST, and also the entire production was done here.

The correction and laboratory verification of the sleeve-spool assembly − their pairing − was the most difficult operation.

In the 90's, specialists from the companies "Aeroteh" and "Avioane Craiova" tried to complete this operation but did not succeed.

In fact, in the INCREST Laboratory verification procedures of the SMHR S.22.59.010 spool valve were homologated for determining the flow static characteristics of the spool valve spool.

– The flow characteristic is the curve of variation in flow rate through the spool valve according to the sleeve-spool relative opening under a pressure drop of 105 kgf/cm2; the condition of 105 kgf/cm2 pressure drop takes into account the servomechanism displacement without output load, when almost all the energy of the working fluid is consumed in the inlet-outlet openings of the spool valve.

The measurement of the flow characteristic is made by means of a particular experimental device, in which the spool valve assembly is inserted. The device must provide the servomechanism operating conditions.

The following values are defined:

a) The global flow characteristics relative to the spool total opening

b) The local flow characteristics relative to about 1/10 of the spool total opening

The flow characteristics, local and global, are measured for each of the four pairs of ports, two pairs of admission and two pairs of discharge. The relative deviations of the characteristics shall not be greater than 10-15%.

The limits for the spool valve characteristics were taken from INCREST Technical Report [6]. The testing and experimentation equipment is located in the hydraulic laboratory of INCAS and is still operational.

DETERMINATION OF LOCAL FLOW CHARACTERISTICS [4]

Local flow characteristic is determined for 10% of the total displacement (0.1 mm). To determine the flow characteristics the following operations are to be done:

1. The spool is placed in neutral position (position where the leakages are zero).

1.2. The device is supplied in A (Fig. 1) with hydraulic oil Aero shell fluid 41 at a pressure of 105 daN / cm ^{2} and a temperature of fluid in the range of 25-35 ° C.

1.3. The spool is moved until a flow of 6-12cm ^{3}/ min. is obtained at the UP sleeve. This defines a hydraulic null for the inlet port practiced in the sleeve.

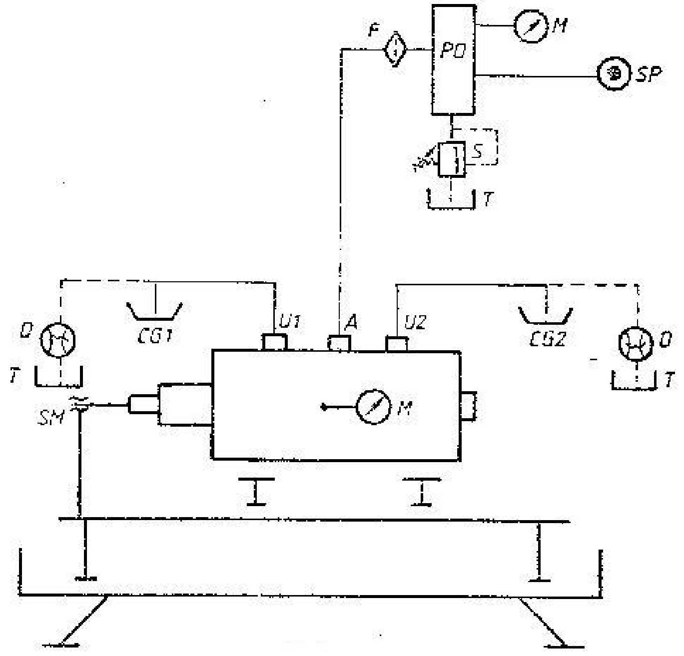
From this point successive displacements of 0.02 mm to 0.1 mm are made measuring the flow for each step.

Warning: If after several attempts higher flow rates than those between 6-12cm^3/min are obtained it follows that the radial clearance between the sleeve and spool is larger than permitted and the respective spool-sleeve pair shall not be accredited.

Volumetric flow measurement is made with graduated cylinders and a seconds counter. The same applies for the U2 sleeve.

The diagram $Q = f(xd)$ is drawn, where Q is the flow in cc/sec, and xd is the spool displacement in mm.

The values thus obtained should be within the tolerance range comprised between the upper and the lower deviations, as represented in Fig. 2.



SP-Pressure source,
PD-Distributing plate,
S- Pressure valve,
F-Filter,
CG1,CG2-Graduated cylinders,
D-turbine flowmeter,
T-tank,
M-manometer,
SM-micrometer screw,
A-supply sleeve,
U1,U2-sleeves for intake1 and 2,
D-device SDV 2800

Fig. 1. Device for characteristic determination

f(x) =56.7*x   Local standard characteristic
finf(x) =0.2075+63.125*x   x= [0; 0.1]
fsup(x) =-0.2175+50.375*x   x= [0.0043; 0.1]

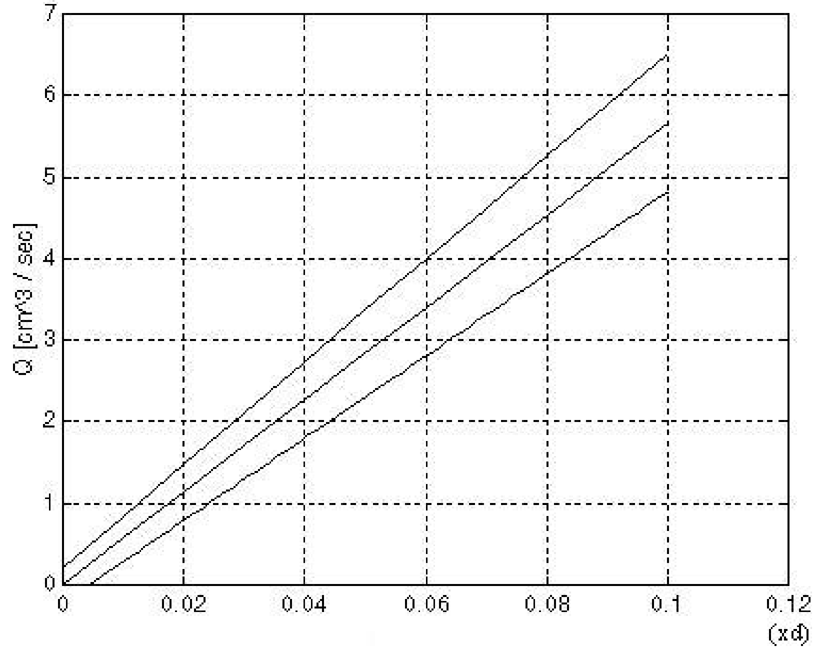


Fig. 2. Local standard characteristic, see [6]

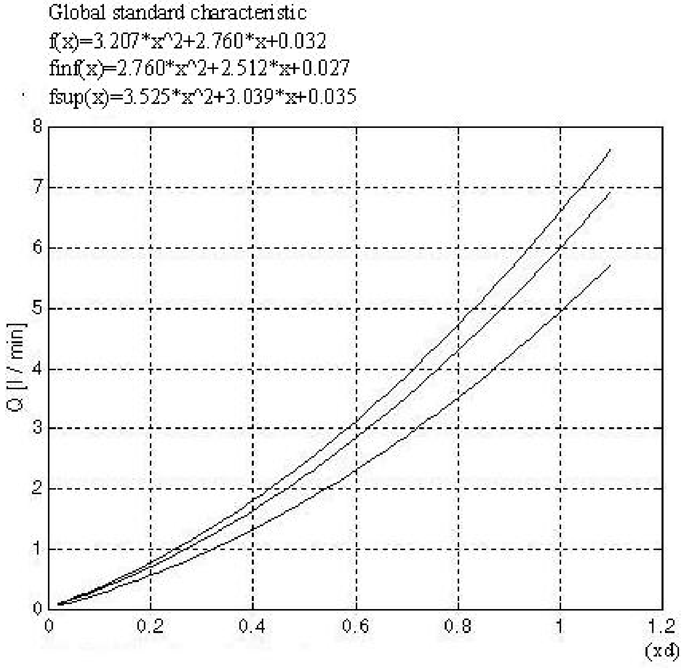


Fig. 3. Global standard characteristic, see [6]

DETERMINATION OF GLOBAL FLOW CHARACTERISTICS [4]

The following operations are done.

− The spool is placed in neutral position as for 1.1.

U1 is connected to a flow meter with a range of $0 \div 10$ l/min. The flow measurement is made with this flow meter.

− The spool is brought in the same position as shown in 1.3 and from this point it is moved with the following values: 0.1, 0.3, 0.5, 0.7, 0.9, 1, 1.1 mm, thus recording the flows obtained for each of these displacements. The moving beyond the 1 mm (which is the total length of the port for this spool valve) is made to see if the port is longer than 1 mm. Paragraphs 2.1, 2.2 and 2.3 are repeated for U2 (the other intake).

− The diagram $Q = f\,(xd)$ is drawn, where Q is the flow in cc/sec, and xd is the spool displacement in mm. The values thus obtained should be within the tolerance range comprised between the upper and the lower deviations, as represented in Fig. 3.

REFERENCES

[1] I. Ursu, F. Ursu, *Active and semiactive control*, Romanian Academy Publishing House, 2002.

[2] I. Ionescu, C. Mares, *Aspects of mecanohydraulic and electrohydraulic system*, Romcartexim Publishing House, 1997.

[3] C. Calinoiu, D. Vasiliu, N. Vasiliu, I. Catana, *Experimental Modeling, Simulation and Identification of the Hydraulic Servomechanisms*, Technical Publishing House, Bucharest, 1998.

[4] *** *AQ NA AQ 557 Procedure, 1986,* INCAS Hydraulic Laboratory Archive.

[5] *** INCAS (INCREST) Technical Reports for SMHR qualification tests, 1982-1984.

[6] *** Theoretical and experimental data concerning qualification testing and flight clearance for aircraft servomechanism SMHR. *National Institute for Scientific and Technical Creation – INCREST Report*, N-5303, 1984, Bucharest, elaborated I. Ursu, approved Catalin Theodorescu.