THE INFLUENCE OF THE COANDA EFFECT UPON THE HYDRODYNAMIC FORCES IN THE HYDRAULIC COMMAND RESISTANCES

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ABSTRACT

In this paper the author presents some aspects concerning the influence of the Coanda effect on the behavior of the oil flow through the hydraulic command resistances. The experimental result, show that for some particular geometrical configuration, where the Coanda effect takes place, the hydrodynamic force and also the flow coefficient increase. Based on the experimental work, the author designed a geometry in order to reduce compensate the hydrodynamic forces on the piston.

INTRODUCTION

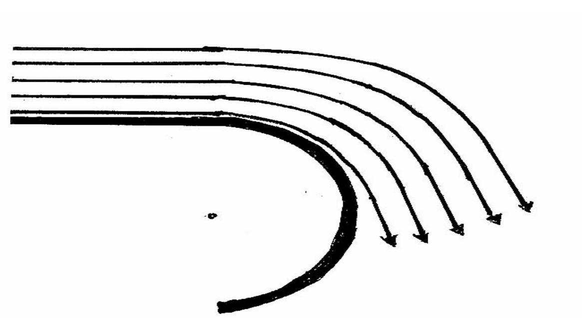

Figure 1. Coanda effect

The Coanda effect consists of the attachment of the flow on the wall, when it has a particular shape, known as volet, or Coanda surface (Figure 1). This is a cause for the presence of a force between the wall and the jet.

Considering that the actuator (torque motor, proportional electro-magnet, piezo-dynamic, magneto-stricter or electro-chemical actuator) make the displacement of the piston, it is very important that the resistance forces on it to be as small as possible. Usually, the forces that take place in a hydraulic command resistance are presented in figure 2 (figura 1 ASME). The most important force that has the main influence is the hydrodynamic force.

Considering the constancy of the flow, the small section of the resistance generates the increasing of the velocity of the jet at the entrance in the piston chamber. According with Bernoulli

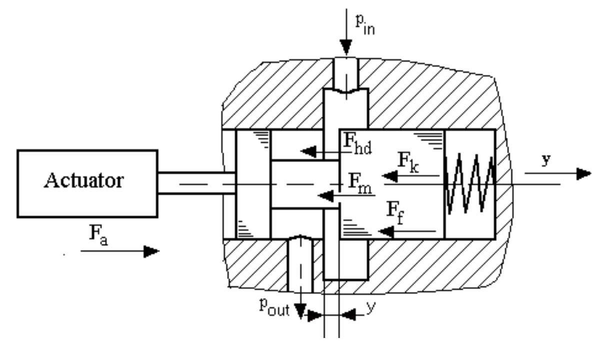

Figure 2. The forces in the resistance

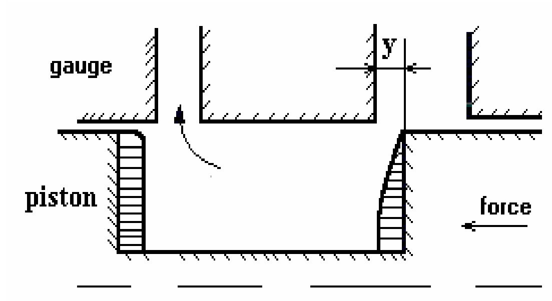

Figure 3. Hydrodynamic force

law, the pressure will drop in that area. The hydrodynamic force is generated by the difference between pressure on the two sided of the piston (Figure 3).

The tendency of the hydrodynamic force is to close the resistance. If the flow is high, the value of the hydrodynamic force can be bigger even of the force generated by the actuator. This is the reason that drives the research to compensate the hydrodynamic force. There are two methods: first to insert automatic position control and the second is to design the geometry of the resistance.

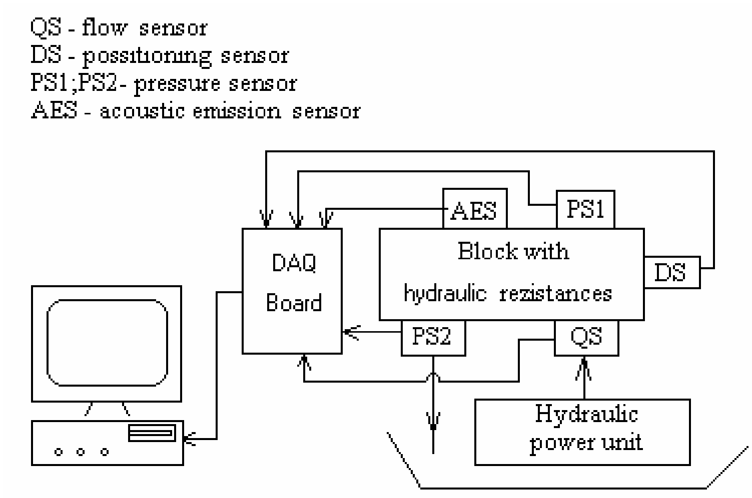

Figure 4. The experimental stand

EXPERIMENTAL RESULTS

The author made the measurements of the parameters for some different types of hydraulic

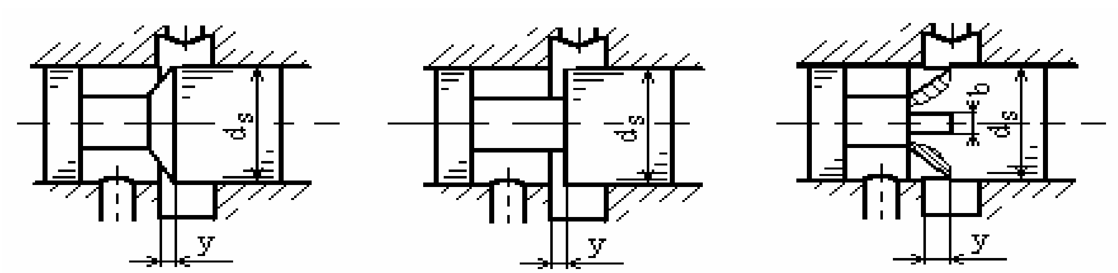

Figure 5. Different types of resistances

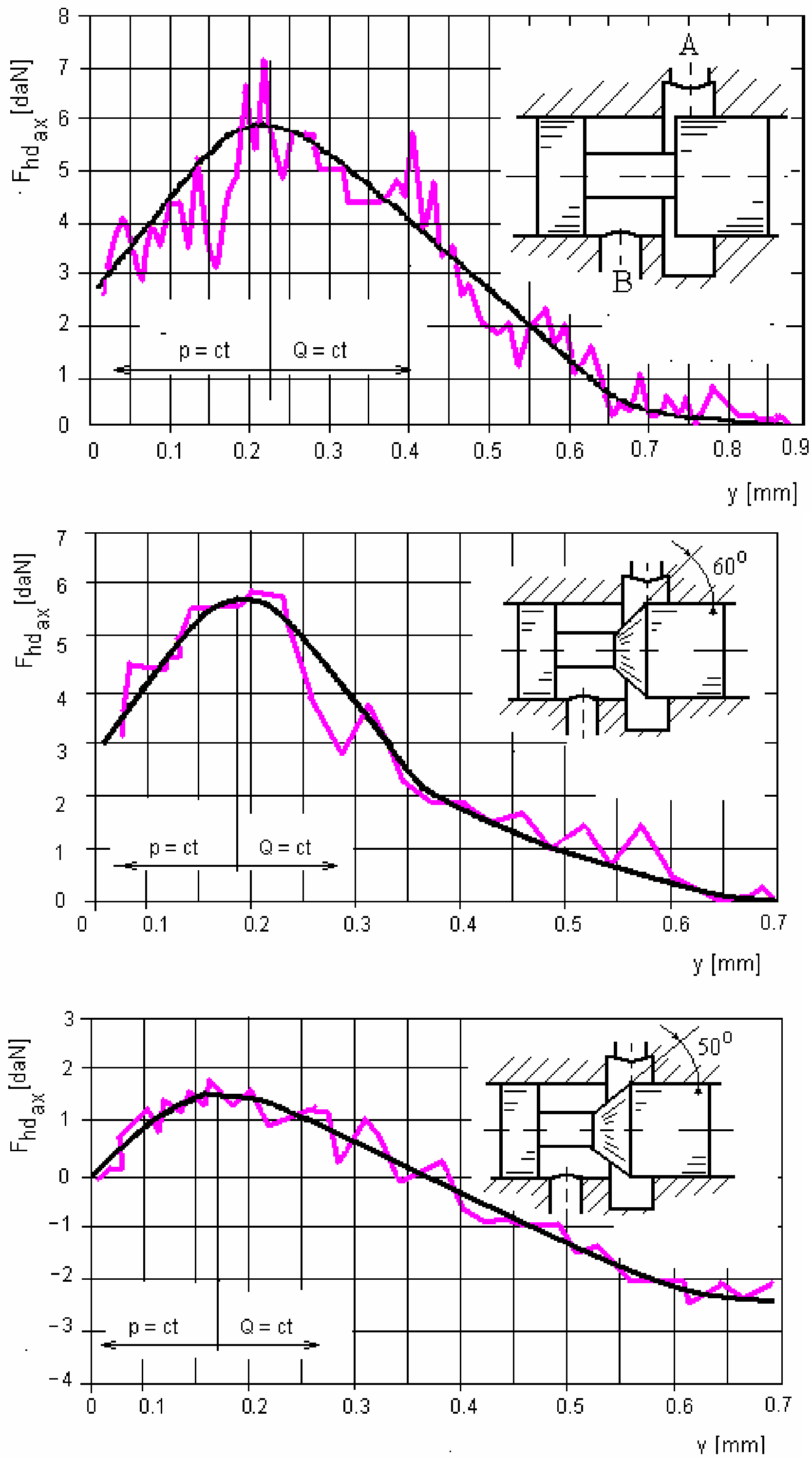

Figure 6. Hydrodynamic forces in hydraulic resistances

command resistances. The experimental stand is presented in figure 4 and the resistances in figure 5

In the technical literature the angle that flow enters the piston chamber is around 69°. This value can be lower at small piston displacements.

During the research on hydraulic command resistances a special behavior was found on resistances having this angle. Generally, as the angle of the resistance decreases, the hydrodynamic force decreases too (Figure 6).

The results of the experiment indicate that for the angle of 70° the force has a value as high as for the sharp edge resistance (Figure 7).

In order to confirm the supposition that the reason for this behavior is the Coanda effect, the author design and made oil flow visualization stand. It could be measured the entering angle of the oil into the piston chamber. Its measured value was 68°.

The difference between the theoretical value and the measured one can be explained by the sharpness of the edges.

CONCLUSIONS

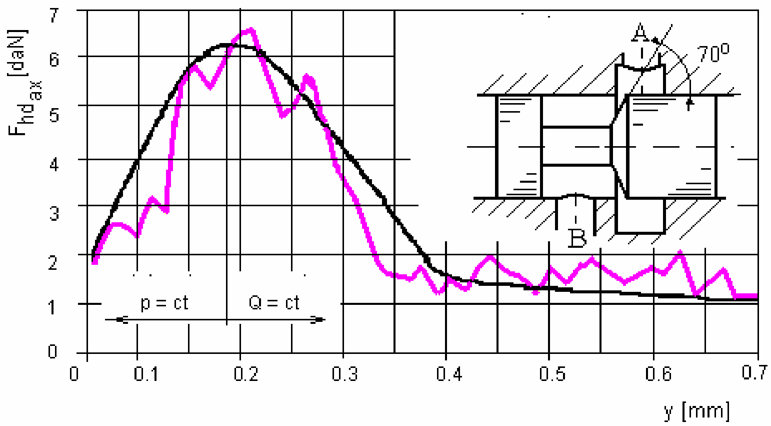

Figure 7. Hydrodynamic forces in hydraulic resistances

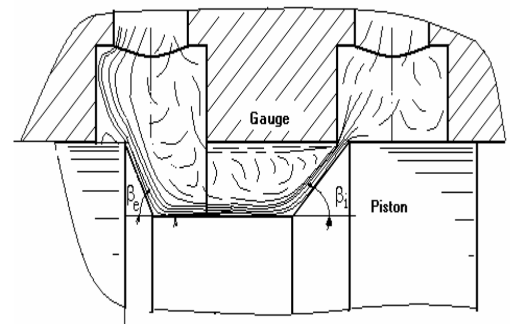

Figure 8. A new construction for the piston, based on a combination between regular geometric shapes

The experiments confirm that the presence of the Coanda effect increases the value of the hydrodynamic forces on the entrance of the oil into the piston chamber. The aim of the research was to reduce the hydrodynamic forces in hydraulic command resistances. Using the experimental results a new piston shape was made (Figure 8).

This shape uses a 70° angle for the resistance from the exit of the oil from the piston chamber. This construction changed the sign of the force added by the presence of the Coanda effect, reducing the hydrodynamic force.

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