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Decreasing of Sliding Friction in Hydraulic Piston Damper

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Abstract: The published paper deals with the decreasing of sliding friction in hydraulic cylinder with double-ended piston rod. The hydraulic cylinder extrudes oil through the throttling gap placed in the external bypass, and so the throttling gap works as a hydraulic damper. Commercial hydraulic cylinder is the simplest way to ensure the fluid flow through the bypass. The hydraulic piston is manufactured with minimal leaking around the piston rod and maximal sealing of the piston. It results in high friction losses particularly caused by piston and piston rod sealing. This causes the undesired increase of force in whole range of velocities. The main goal of this paper is a proposal of suitable design and material selection which decreases friction losses. The measurement of all components, which contribute to the increase of shear friction, is described (piston rod sealing, piston sealing, dust cover, sliding tapes). The piston rod sealing has a significant effect on the total frictional force. New seals were designed and measured. The material NBR with suitable design modification of seal preload is the best solution for low shear friction operation of hydraulic cylinder.

Introduction

The majority of the available hydraulic damping systems have a seal of moving parts which creates the friction losses. This friction losses have a negative influence on the effectiveness of the damping system. For the progressive semi-active damping system is this problem significant. The friction losses in the system cause decreasing of a dynamic range (ratio of maximal to minimal damping force) which has negative influence to effectiveness of the damping system [1].

An important group of damping systems forms the systems where hydraulic fluid is extruded through the throttling gap placed in the external bypass by hydraulic cylinder. The most affordable option is commercially manufactured hydraulic cylinder which creates flow through external bypass. This hydraulic cylinder is manufactured with minimal leakage around the piston rod and maximal sealing of the piston. This causes large friction losses.

The main goal of this paper is a proposal of suitable design and material selection which decreases friction losses in commercial available hydraulic cylinder.

Materials and methods

In the paper, two experiments are presented. The first experiment should detect which component of hydraulic cylinder creates significant friction losses. Between piston rod and hydraulic press, the load cell and positon sensor were placed. Data acquisition system Dewetron and software Dewesoft were used. Commercially available hydraulic cylinder with double-ended piston rod (piston rod ø18, piston ø32, stroke 50 mm) was measured. This variant contains a few sliding tapes (piston rod and piston) from PTFE/Bronze, two piston rod seal T20 (Novathan), two dust covers PU5 and piston seal Omegat OMK. The friction for 4 different configurations was measured – 1) original state, 2) removed dust cover, 3) removed dust cover + piston rod seal and 4) removed dust cover + piston rod seal + piston seal.

The second experiment was composed of hydraulic cylinder, hydraulic pulsator Inova, load cell and position sensor. The tested hydraulic cylinder was assembled from measured piston rod seal, sliding tapes and piston seal. The piston rod seal T20 from Novathan, modified (change preload)

T20 from NBR and compact seal PTFE/NBR were measured. The whole hydraulic system was filled with damping oil. Inlet and outlet from hydraulic cylinder were connected by hydraulic hose. Hydraulic pulsator generated a movement of hydraulic piston (sin 1 Hz, stroke 20 mm).

Results

The results indicate that dust cover, piston seal, sliding tapes of piston and piston rod have minimal influence of the total friction losses. The piston rod seal has a significant effect to total friction losses. For this reason, different piston rod seals were measured (Fig. 1). The smallest friction losses exhibits the modified piston rod seal T20 from NBR. The friction force for this variant was in the range of 20 to 25 N.

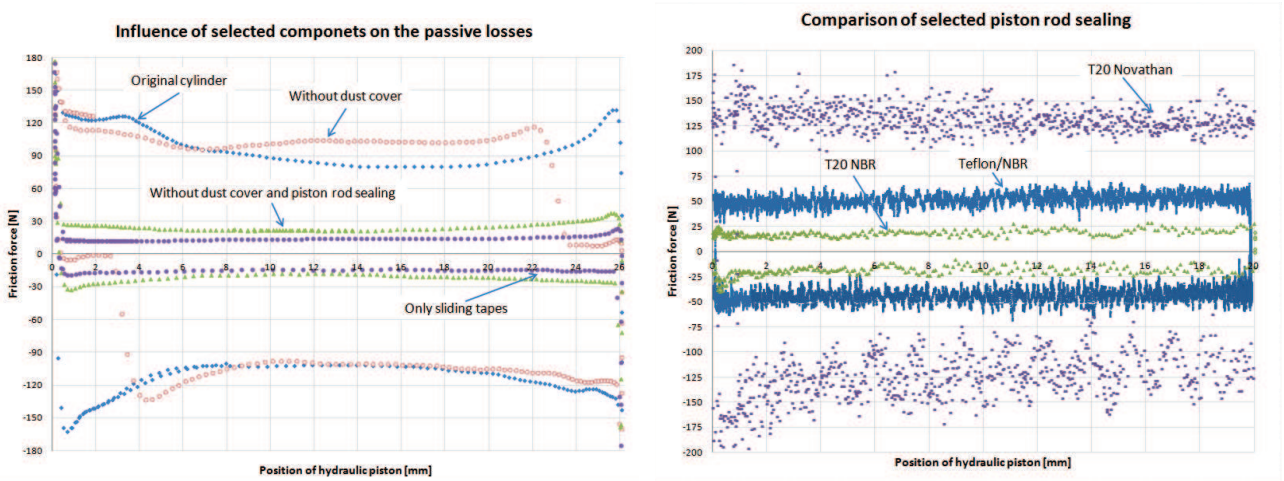

Fig. 1: Influence of components on the passive losses (left), comparison of piston rod sealing (right)

Conclusion

Modified piston rod seal from NBR had the smallest friction losses. However, this type of seal exhibits significant dependence of friction losses on the pressure in hydraulic system. Therefore, the piston rod seal from NBR is suitable for low pressure in hydraulic systems. For higher pressure in damping system, PTFE/NBR piston rod seal is more suitable, according to preliminary measurement. This type of seal exhibits a small dependence of pressure on friction losses.

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References

[1] G. Yang, B.F. Spencer, J.D. Carlson, M.K. Sain, Large-scale MR fluid dampers: modeling and dynamic performance considerations, Engineering Structures, 2002, vol. 24 (2002) 309-323. DOI: 10.1016/s0141-0296(01)00097-9.