POLITECHNIKA ŚLĄSKA

WYDZIAŁ MECHANICZNY TECHNOLOGICZNY

Rozprawa doktorska

Dominik Rabsztyn

Metoda oceny stanu technicznego pomp wyporowych na podstawie analizy przebiegu pulsacji ciśnienia

Promotor

Prof. dr hab. inż. Piotr Gendarz

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Summary

The thesis presents the results of research aiming to determine the possibilities of applying the phenomenon of pressure pulsation for assessment of the technical condition of positive displacement pumps used in hydrostatic drives. The research process was divided into three stages: theoretical, experimental and practical verification.

The theoretical part was based on the analysis of chosen parameters of hydraulic drives which influence the frequency and amplitude of pressure pulsation in a positive displacement pump discharge line. The flow rate pulsation of a positive displacement pump was connected with the pressure pulsation in a hydraulic line by the means of predetermined $G_{q1/p1}$ transmittance modules. The impact of the line parameters on either intensification or suppression of the phenomenon was analyzed. The results led to a proposal to adapt the discharge line at the design stage in a way that minimizes adverse events caused by the pulsation of the pump. This objective will be especially difficult to achieve in systems with variable speed pumps.

During the empirical part an experimental analysis was conducted in order to establish the influence of chosen parameters of a drive and working fluid on the course of pressure pulsation in a testing station. The analyses aimed to empirically determine the possibility of recording the increase in ΔQ internal leakage in positive displacement pumps based on changes in the course of pressure pulsation. The results gained indicate that internal leaks in a positive displacement pump caused by its typical, regular usage are not strongly correlated with pumping pressure pulsation. Thereby, it is impossible to detect excessive internal leaks in a pump used regularly through measurement of the course of pumping pressure. However, it is possible to detect excessive decrease in pump performance caused by the pump's one (or several) displacement unit failure. Further stages of the research focused on the analysis of the influence of hydraulic hose line parameters on a capability to suppress or intensify the pressure pulsation amplitude. The research conducted aimed to confirm the influence of chosen geometrical parameters of a hydraulic line as well as the speed of pressure wave c_0 on the capability of modifying the amplitude of the course of pressure pulsation. The results confirm that it is legitimate to take into account dynamic parameters of hydraulic lines in the process of flow conduits selection. The final stage of the laboratory experiments paid particular attention to the analysis of the influence of leakage in the pump's suction line on the course of pressure pulsation. It has been proved that it is possible to detect the aeration of working fluid by analyzing the course of pressure pulsation.

In last stage, a practical verification test was conducted which attempted to apply the analysis of the course of pressure pulsation in order to determine the technical condition of piston pumps in an industrial environment. The analysis of pulsation allowed the detection of a mechanical malfunction in a displacement unit.

The results of theoretical and experimental research were interpreted against time and frequency. The time analysis was conducted in order to establish the peak-to-peak value of pumping pressure which is responsible for generating excessive noise and vibration. It also leads to the excessive fatigue of elements in a hydraulic system. Analyses against frequency were conducted with the aim of identifying the frequency response irregularities in a tested gear pump which can be used for diagnosing the pump's exploitation condition.