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Rheological Characteristics of Hidraulic Oil

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ABSTRACT

This paper presets the study of the rheological characteristics of the hydraulic oil over the temperature range of 40-90oC and for shear rates between 3 and 1312 s-1. The measurements were performed on a Haake VT 550 rotational rheometer with a HV1 sensor. The analyzing results, it was noticed a decrease in dynamic viscosity for the temperature and shear rate, as increase for tested hydraulic oil and for all temperatures at which determinations were performed. The decreasing dynamic viscosity with increasing shear rate and temperature shows that hydraulic oil has characteristics of non-Newtonian pseudo plastic fluids.

KEYWORDS hydraulic oil, temperature, shear rate

INTRODUCTION

Viscosity is the most important physical property of hydraulic oil H32, which has fundamental importance for studying of hydraulic components and systems efficiency. The optimal dynamic viscosity of hydraulic oil H32 for a hydraulic system is a compromise between the lubrication requirements and the mechanical and volumetric efficiency [1-3,8]. The usage of thinner hydraulic oils, as long as the fluid flow is laminar, will achieve higher hydraulic-mechanics efficiency ratings. However, the usage of thinner hydraulic oil H32 will incur increased leakage within the hydraulic components, thus reducing the volumetric efficiency of the system. In addition, the lubricating properties of hydraulic oil H32 may become marginal as the dynamic viscosity is reduced to an excessively low value [1,8].

Conversely, the application of more viscous hydraulic oil H32 will increase the volumetric efficiency of the given hydraulic system, but at the same time energy losses will increase due to higher hydraulic oil H32 friction. The suction ability of pumps is one of several limiting factors which define the maximum value of dynamic viscosity tolerated by the hydraulic system. If friction losses exceed the suction ability of the pump, the hydraulic oil H32 will not completely fill the suction inlet and this will result in cavitations.

Another important limiting factor, for allowed increasing of hydraulic oil H32 dynamic viscosity in hydraulic system, is the loss of lubricating function. It should be emphasized that reasons for the loss of lubricating function at low and high values of dynamic viscosity are completely different. In addition to the three previously mentioned requirements that define hydraulic oil H32 dynamic viscosity in the hydraulic system, the application of servo and proportional hydraulic systems introduce the fourth requirement: to keep value of dynamic viscosity in constant amount [1,8].

From this short review of problems and requirements, which appear in the hydraulic system, it can be seen that dynamic viscosity of hydraulic oil H32 is a very significant construction characteristic [4-8].

The changing of dynamic viscosity with temperature and shear rate is important not only for the sake of theoretical analysis but also regarding the practical application to the real hydraulic systems in which temperature and shear rate are changing continuously [8-10].

MATERIAL AND METHOD

The hydraulic oil H32 were purchased from the Slobozia from a specialized distribution chain. To study the rheological behavior of hydraulic oil it was Haake VT 550 viscometer equipped with HV1 sensor. For the rheological behavior study there were tested the hydraulic oil grade H32. The value of dynamic viscosity for hydraulic oil grade H32 was determined for shear rates, ranging between 3.3 to 120 s^{-1} and the testing temperatures between 40^{0}C, 50^{0}C, 60^{0}C, 70^{0}C, 80^{0}C and 90^{0}C.

RESULTS AND DISCUSSION

The results are presented in figures 1, 2 and 3. From analyzing three figures it is noticed that a dynamic viscosity has the some decrease with the increase shear rate and temperature for hydraulic oil H32 studied at different temperatures. This viscosity decreases with the increase of the shear rate shows hydraulic oil has the properties of pseudo plastic non-Newtonian fluid.

In figures 2 and 3 it was represented, according to the experimental determination, the variation of the viscosity with temperature for seven shear rate 3.3, 6, 10.6, 30, 52.95, 80, 120s^{-1}, respectively. Analyzing the three figures we can see that the viscosity decreases with the temperature for all the seven shear rates for studied hydraulic oil.

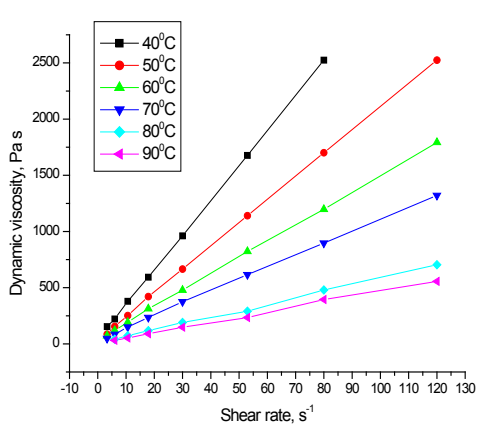

Figure 1: The variation of dynamic viscosity with shear rate at temperature for hydraulic oil H32

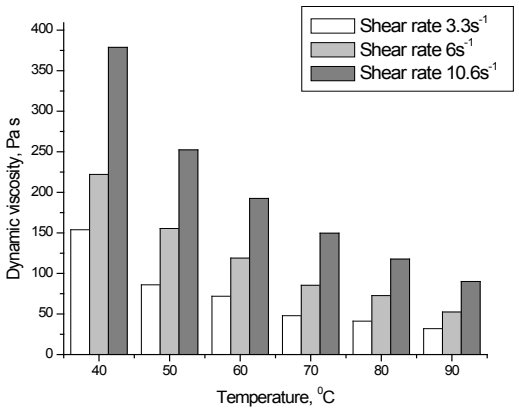

Figure 2: The variation of dynamic viscosity with temperature for shear rate

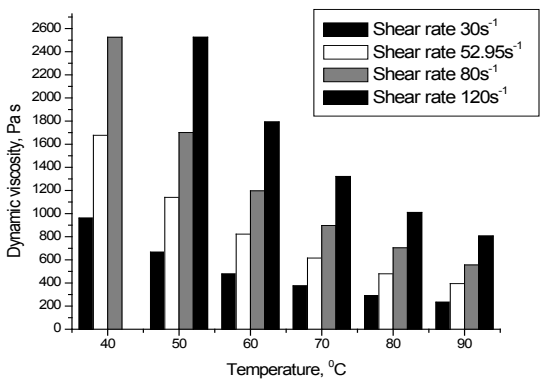

Figure 3: The variation of dynamic viscosity with temperature for shear rate for hydraulic oil H32

The decrease of dynamic viscosity for hydraulic oil H32, when the shear rate increases, can be explained by the orienting of oil molecules in the shear direction, which is reducing the thickening effect produced when the molecules are randomly distributed. Dynamic viscosity value decrease with the increasing shear rate for hydraulic oil has the characteristics of non-Newtonian pseudo-plastic fluids.

CONCLUSIONS

This paper presents the variation of dynamic viscosity with shear rate for hydraulic oil H32. It was noticed that the dynamic viscosity decreases with increasing shear rate, for tested hydraulic oil, at all temperatures at which determinations were done. The dynamic viscosity of hydraulic oil H32 is lower than at all shear rates and at all temperatures.

The decreasing dynamic viscosity with increasing shear rate for hydraulic oil has the characteristics of non-Newtonian pseudo-plastic fluids.

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