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An Experimental Study on the Friction Characteristics of Oil Hydraulic Vane Pump

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The friction characteristics of contact region between vane tip and cam-ring is studied with an experimental device model. The radius of vane tip is less than 1 mm and sliding speed is lower than 10 m/s. The friction characteristics of the actual oil hydraulic vane pump is estimated on the basis of coefficient of friction. The coefficient of friction can be obtained by measuring the frictional forces in the contact region. The lubrication condition between vane and disk is modeled after the actual condition between the vane and cam-ring.

Keywords : Friction Coefficient, Lubrication, Contact Region, Cam-ring, Vane, Disk

1. INTRODUCTION

An oil hydraulic vane pump used in automobiles requires high power-to-weight ratio, excellent steady/ dynamic characteristics under severe condition. Because the high pressurization is urgently required for the acquisition of large output with a miniaturized vane pump, a tribological design is demanded for vane pump which consist in a lot of contact regions. And as a radial acting force of the vane becomes unstable hydro- dynamically in the suction port region, it is expected that the acting load of the vane on the cam-ring is so severe that the surface of cam-ring can be damaged.

Therefore, this study shows that the friction characteristics between the vane tip and the cam-ring by the experimental apparatus. And the device is made on the basis of the contact model between the vane-tip and the cam-ring of a vane pump.

2. EXPERIMENT

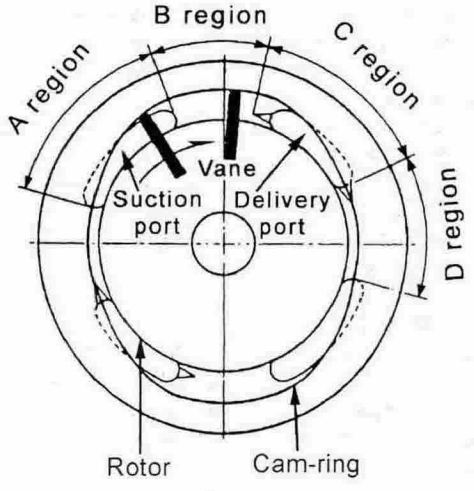


Fig. 1 Structure of oil hydraulic vane pump

Fig. 1 shows the structure of oil hydraulic vane pump.

In this paper, the condition of lubrication between the vane and disk is modeled after the actual condition between vane and cam-ring. And the friction characteristics of contact region between vane tip and cam-ring is studied with an experimental apparatus.

The measurement system of dynamic friction force was modeled the contact region between vane and cam-ring for the satiable reproduction of crucial factors affecting the lubrication characteristics of real vane and for the precisive measurement of friction force.

The schematic diagram of friction apparatus is shown in Fig. 2.

The radial force of the vane was computed. The force pushed up vertically from the vane to the disk represents the fluctuating radial force of the vane. The load is produced by oil hydraulic actuator controlled by electro-hydraulic servo valve.

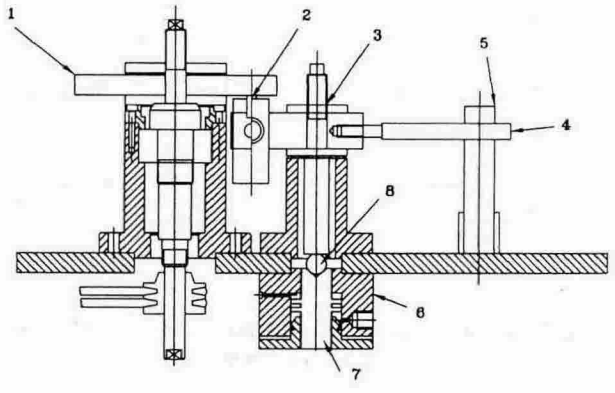
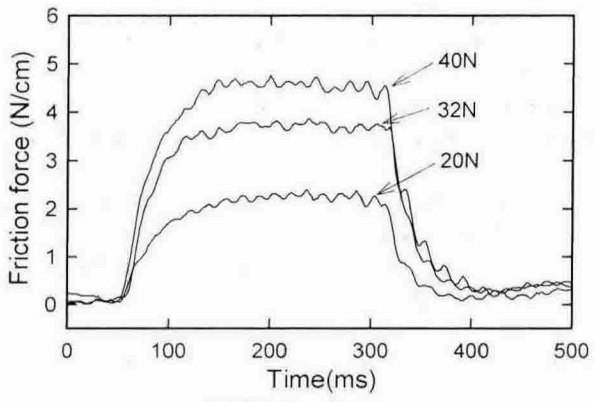


Fig. 2 Schematic representation of the friction apparatus

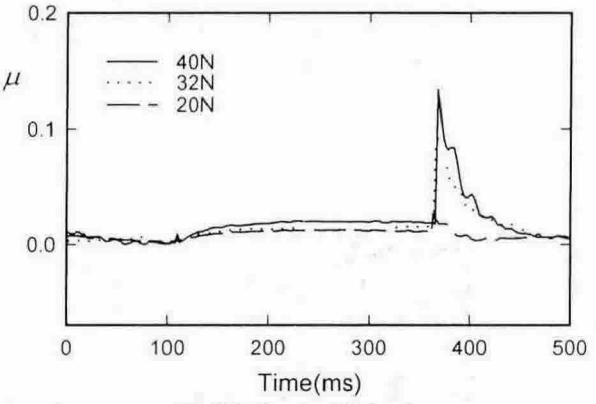
A circular flat disk is driven by 3 kw DC motor coupled indirectly. And to provide the same lubrication condition as in real vane pump, oil which is used in a real vane pump as a test oil is supplied through a gear pump for the lubrication of vane and Disk. The shape of Disk and vane are made to be similar to that of cam-ring and vane of real vane pump. Friction forces are measured by the load cell attached to the load lever. Signals detected by the sensors go through A/D converter and then are processed by PC processor.

3. RESULTS

Figure 3 shows the distribution of friction forces and friction coefficients for the variation of load. In these graphs, we can know that with the increase of load, the friction force increases, but the friction coefficients is almost the same. Certainly, when the suction is started, the value of friction coefficient is maximum. The curved line of the friction force wave is due to the response characteristics of the servo valve and the actuator used to push up the vane.



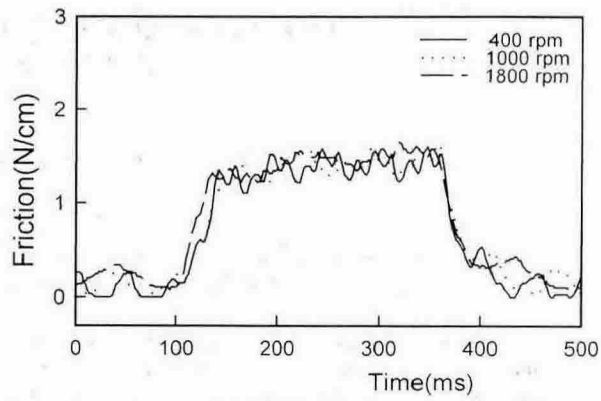
(a) friction forces



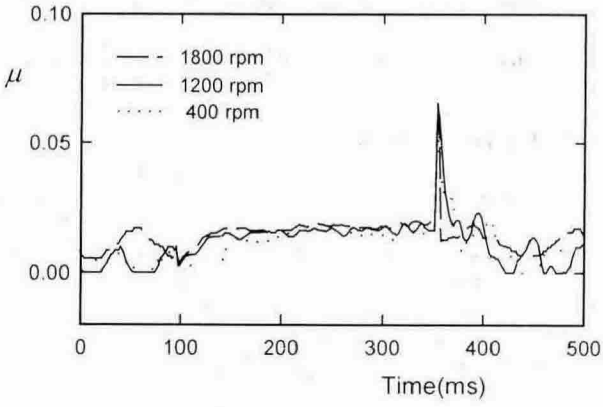
(b) Friction coefficients

Fig. 3 Variation of friction forces and friction coefficients with input loads

Figure 4 shows the variation of friction forces and friction coefficients with the change of rotating speed in the constant load. These graphs show that with the increase of rotating speed, the friction forces and friction coefficients are almost the same.



(a) friction forces



(b) Friction coefficients

Fig. 4 Variation of friction forces and friction coefficients with rotating speed

4. CONCLUSIONS

From the experimental results, following results are obtained:

(1) With the increase of load, the friction force increases, but the friction coefficients are almost the same.

(2) With the increase of rotating speed, the friction forces and friction forces are almost the same.

In the case of mixed lubrication or elasto- hydrodynamic lubrication regime, It was known that the friction coefficient does not affect to the load and the speed. Therefore, from these experimental results, we can know that power steering vane pump derives to elasto-hydrodynamic lubrication and mixed lubrication regime.

5. REFERENCES

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