Effect of Sound Velocity on Frictional and Wear Behavior of Lubricating Oils

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ABSTRACT

Friction and wear are the key term in the field of tribology. For a desired performance and life of a component, its friction and wear needs to be minimized or optimized for a given application. Lubrication is used to reduce friction and wear of interacting parts of machine elements. For the better performance of machineries, lubricants' frictional and wear behavior is important in boundary lubrication regime. Friction and wear experiments were carried out using a conventional four-ball wear tester and a soda pendulum test machine. All experiments in four-ball wear test were conducted at load 1.39 kN and at upper rotating ball speed 60 rpm, corresponding to a sliding speed of 0.035m/s. Duration for each experiment was 1 h, and thus total sliding distance was 124.6 m. Load of each pair was 564 N, corresponding mean Hertzian pressure = 2.6 GPa, and Hertzian diameter d_H = 0.521 mm. Experiments were carried out at room temperature. Wear scar area in bearing steel balls (19.05 mm in diameter and 5.7 nm in mean surface roughness) was measured using different lubricating oil. Friction coefficient of the same samples was measured using the pendulum test machine. Soda pendulum test machine is fixed on a column of steel with the T-pattern pendulum in the center. The pendulum is supported on four bearing steel balls by a roller pin. It is the device, which measures the frictional coefficient from the degree of decline in the free swing of the pendulum. Steel ball diameter was 4.75 mm and roller pin diameter is 3.0 mm with hardness number RC 60-66. This study then tried to find out the relations between the sound velocity and these experimental results. Sound velocity in lubricating oil is a property by which we can predict the tribological and rheological properties of lubricating oils. In this research sound velocity in lubricating oil was measured using Sing around technique. Adiabatic bulk modulus was calculated from the measured sound velocity using the Wood equation: $U=(K/\rho)^{1/2}$, where U is the sound velocity in m/s, K is the adiabatic bulk modulus in Pa and ρ is the density in kg/m^3. Adiabatic bulk modulus was compared with the wear scar area and friction coefficient using different lubricating oils including mineral oil, perfluoropolyether (PFPE) oil, traction oil, etc. From the relations, it has been found that the adiabatic bulk modulus influence on the wear and frictional behavior of lubricating oil. Fluid having low adiabatic bulk modulus indicated the higher wear scar on materials. It also found that low adiabatic bulk modulus fluid pointed out lower friction coefficient. Finally, it can be concluded that the frictional and wear behavior of lubricating oils can be predicted from the sound velocity in the lubricating oils.

Key Words

Sound velocity, Adiabatic bulk modulus, Wear scar, Friction coefficient, Lubricating oil.

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