Step 1: Convert Mass Load to Force (Radial Load)

A mass expressed in kilograms represents inertia, whereas bearing equations require the gravitational force (load) acting on the journal. The radial load (W) is obtained by multiplying the mass by the acceleration due to gravity (g_o = 9.81m/s^2):

$$W = m\left(\frac{g_O}{g_C}\right) = (1400\ kg)\left(\frac{9.81\ m/s^2}{1\ \frac{kg-m}{N-s^2}}\right) = 13,734\ N$$

Step 2: Calculate the Frictional Force

The coefficient of friction (f) represents the ratio between the tangential frictional resistance and the normal radial load acting on the shaft. The total tangential frictional force (F_f) acting along the surface of the journal is calculated as:

$$F_f = fW = (0.12)(13,734\ N) = 164.808\ N$$

Step 3: Determine the Frictional Torque

Frictional torque (T) is the resisting moment that the engine or motor must overcome to keep the shaft rotating at a constant speed. It is equal to the frictional force multiplied by the radius of the journal (r = D/2): $T = F_f\left(\frac{D}{2}\right) = (164.808\ N)\left(\frac{0.055\ m}{2}\right) = 4.5322\ N - m$

Step 4: Calculate the Power Loss and Convert to Horsepower

The power dissipated as heat due to friction (P) is the product of the frictional torque and the angular velocity of the shaft. When speed is given in revolutions per minute (N), the standard rotational power formula in Watts is:

$$P = \frac{2\pi TN}{60} = \frac{2\pi(4.5322\ N-m)(1000\ rpm)}{60} = 0.6362\ hp$$

A power loss of **0.636 hp** may seem minor, but it represents approximately **475 Watts** of continuous energy dissipation. In thermodynamics and heat transfer, this mechanical energy loss does not vanish; it converts entirely into thermal energy within the thin oil film separating the journal and the bearing sleeve. As the oil temperature rises, its dynamic viscosity drops drastically, which can collapse the hydrodynamic oil film and lead to metal-to-metal contact. This highlights why high-load journal bearings require dedicated oil circulation systems or cooling jackets.