Department of Mechanical Engineering

MD – II: Tutorial sheet for Bearings

1. A 360° hydrodynamic bearing operates under the following conditions: radial load = 50 kN; journal diameter = 150 mm; bearing length = 150 mm; radial clearance = 0.15 mm; minimum film thickness = 0.03 mm; viscosity of lubricant = 8cp. What is the minimum speed of operation for the journal to work under hydrodynamic condition? (Ans: 2973 rpm)

2. Following data is given for a 360° hydrodynamic bearing: journal diameter = 100 mm; bearing length = 100 mm; radial load = 50 kN; journal speed = 1440 rpm; radial clearance = 0.12 mm; viscosity of lubricant = 16 cp. Calculate: (i) minimum film thickness (ii) coefficient of friction and (iii) power lost in friction. (Ans: 0.0087 mm; 0.002; 0.76 kW)

3. Following data is given for a full hydrodynamic bearing: radial load = 25 kN; journal speed = 900 rpm; unit bearing pressure = 2.5 MPa; l/d = 1.0; viscosity of lubricant = 20 cp; class of fit = H7e7. Calculate: (i) dimensions of the bearing (ii) minimum film thickness and (iii) requirement of oil flow. (Ans: 100 mm; 100 mm; 0.0191 mm; 1.057 litre/min)

4. The following data is given for a 360° hydrodynamic bearing: bearing diameter = 50.02 mm; journal diameter = 49.93 mm; bearing length = 50 mm; journal speed = 1440 rpm; radial load = 8 kN; viscosity of lubricant = 12 cp. The bearing is machined on the lathe from bronze casting while the steel journal is hardened and ground. The surface roughness values for turning and grinding are 0.8 and 0.4 microns. For thick film hydrodynamic lubrication, the minimum film thickness should be 5 times the sum of surface roughness values for the journal and the bearing. Calculate: (i) the permissible minimum film thickness (ii) the actual film thickness under the operating conditions and (iii) power lost in friction. (Ans: 6 microns; 6.07 microns; 0.069 kW)

5. Select a suitable bearing which is to operate at 1500 rpm and is acted upon by 8000 N radial load and 5000 N axial load. The inner ring rotates, load is steady and service is continuous. Shaft diameter is 45 mm and life expectancy is 500 hours. (Ans: 6309 SRDGBB)

6. A 30 second work cycle consists of following two parts: Part I is for 10 seconds, has 45 kN radial and 12.5 kN axial load at rpm of 720. Part II is for 20 seconds and has 15 kN radial and 6.25 kN axial load at rpm of 1440. For this application, the static and dynamic load capacities of a SRDGBB are 50 kN and 68 kN respectively. Calculate life of bearing in hours. (Ans: 195.4 hours)

7. A cylindrical roller bearing with bore diameter of 40 mm is subjected to a radial force of 25000N. The coefficient of friction is 0.0012 and speed of rotation is 1440 rpm. Calculate power lost in friction. (Ans: 0.09 kW)

8. A ball bearing is subjected to a radial force of 2500 N and an axial force of 1000 N. The dynamic load carrying capacity of the bearing is 7350 N. The values of X and Y factors are 0.56 and 1.6 respectively. The shaft is rotating at 720 rpm. Calculate life of the bearing. (Ans: 340.42 hrs)

9. The radial load acting on a ball bearing is 2500 N for the first five revolutions and reduces to 1500 N for the next ten revolutions. The load variation then repeats itself. The expected life of the bearing is 20 million revolutions. Determine dynamic load carrying capacity of the bearing. (Ans: 5303.43 N)

10. A ball bearing subjected to a radial load of 3000 N is expected to have a satisfactory life of 10000 hrs at 720 rpm with a reliability of 95%. Calculate dynamic load carrying capacity of the bearing so that it can be selected from the manufacturer's catalogue based on 90% reliability. If there are four such bearings each with a reliability of 95% in a system, what is the reliability of the complete system? (Ans: 27840.94 N; 81.45%)

(Dr. Chandan Sharma)