EXPERIMENT NO:11

JOURNAL BEARING APPARATUS

Aim

To determine the present distribution of lubricating oil at various load and speed of a Journal Bearing.

INTRODUCTION

Journal Bearing Apparatus is designed on the bearing action used in practice. To formulate the bearing action accurately in mathematical terms is a more complex job. However, one can visualize the pattern of bearing pressure distribution due to the hydrodynamic action with the help of experimental rig. This helps to understand the subject properly.

The experimental rig consists of a small journal bearing as shown in Fig. This apparatus helps to demonstrate and study the effect of important variables such as speed, viscosity and load, on the pressure distribution in a Journal Bearing.

DESCRIPTION

The apparatus is illustrated in fig. It consists of a Brass bearing mounted freely on steel Journal shaft (A). This journal shaft is fixed directly on to a motor shaft (S). A Dimmer stat finely controls the speed of the DC motor. The Journal Bearing (E) has twelve (No.1 to 12) equispaced of 30° pressure tapings around its circumference, and two No, 13,14 additional **axial** pressure tapings are positioned on the topside of the journal bearing. The two sides of bearing are closed with two MS plates and sealed with gasket packing to avoid leakage. Balancing weights are provided to maintain the bearing in horizontal position while taking the readings. Both the weights can be adjusted freely along the rod.

Oil film pressures are indicated in 14-tubes manometer frame and readings directly in head of oil. Clear flexible tubes are fixed on the manometer frame and connected to the tapings spaced around bearing and thus permit the bearing to turn freely. The oil reservoir can be adjusted at required height and is connected to the bearing by a flexible plastic tube. From this reservoir oil enters the bearing through this plastic tube.

SPECIFICATIONS

1. Diameter of Journal = 2r = 52.5 mm.
2. Diameter of bearing = 2R=50mm (with 12 radial tapings and 2 axial tapings).
3. Bearing width (L) = 90mm.
4. Motor speed = 800 -1000rpm (variable speed – DC).
5. Motor control. Electronic DC Controller for motor speed control.
6. Manometer frame with 14 tubes of 240cm. Height with scales and adjustable oil supply tank.
7. Recommended oil = Lubricating oil SAE 30.
8. Supply required AC single phase 230v.50Hz stabilized.
9. r = Radius of Journal.
10. δ = Radial clearance (R-r) = (52.5-50) = 2.5 mm.
11. e = Eccentricity 00' between the center of the bearing & center of journal 2.5mm.
12. Eccentricity ratio = e/δ or $e=n\delta$ = 2.5/2.5 = 1
13. μ = Viscosity of oil.
14. R = Radius of journal bearing.
15. θ = Angle between the one of center and the position of which is to measured.
16. h = Film thickness =2.5 mm

THEORY OF JOURNAL BEARINGS

The mathematical analysis of the behavior of a journal in a bearing falls into two distinct categories:

1. Hydrodynamics of fluid flow between plates.
2. Journal bearing analysis where the motion of the journal in the oil films is considered.

According to the equation the Somerfield pressure function (when the velocity of the eccentricity and the whirl speed of the journal are both zero) is given by: (with seepage)

$$S_o = \left(\frac{r}{c}\right)^2 \left(\frac{\mu N}{P}\right) K_W \times 10^{-6}$$

when KW correction factor for side leakage from graph.

Where 'p' is the pressure of the oil film at the point measured anticlockwise from the line of common centers (00')

NOTE: Some books on lubrication give the Sommerfield function with a negative sign for 'n'. This is true if it is measured from the point of minimum thickness of the oil film.

RANGE OF EXPERIMENTS:

Determine the pressure distribution in the oil film of the bearing for various speeds and

a) Plot the polar pressure curve for various speeds by graphical method.
b) Calculate by using the Sommerfield pressure equation for each speed.
c)

$$S_o = \left(\frac{r}{c}\right)^2 \left(\frac{\mu N}{P}\right) K_W \times 10^{-6}$$

EXPERIMENTAL PROCEDURE:

1. Fill the oil tank by using SAE 30 lubricating oil under test and position the tank at the desired height **(up to 1.5 liter oil)**.
2. Drain out the air from the tubes on the manometer by removing the tubes from manometer.
3. Check that some oil sea page is there (Sea page of oil is necessary for cooling purpose).
4. Check the direction of rotation and increase the speed of the motor slowly.
5. Set the speed and let the journal run for about an 2 minutes until the oil in the bearing is warmed up and check the steady oil levels at various tapings.
6. Add the required loads and adjust the balancing weights, on the rod to maintain the horizontal levels position.

7. When the manometer levels are settled down, take the pressure readings on 1-14 manometer tubes. For circumferential and axial pressure distribution.
8. Repeat the experiment for various speed and loads.
9. After the test is over set dimmer to zero position and switch off the main supply.
10. Keep the oil tank at lower most position so that there will be no leakage in the idle period.

GRAPHS:

Graph to be plotted for pressure head of oil above supply head in cm of oil, at angular intervals of 30° of the oil film. The angular interval positions are measured in anticlockwise, commencing with position marked.

SAMPLE OF CALCULATIONS TO FIND SOMMERFIELD EQUATION

TABLE OF READINGS:

Tube No. Radial pressure point	LOAD in Kg	Speed	Supply head in mm of oil, Ps	Pressure at different points, Pa	Actual pressure (P_s-P_a)
1	1	800	40	45.4	-5.4
2	1	800	40	54.0	-14
3	1	800	40	57.6	-17.6
4	1	800	40	55.8	-15.8
5	1	800	40	53.1	-13.1
6	1	800	40	50.4	-10.4
7	1	800	40	47.3	-7.3
8	1	800	40	45.1	-5.1
9	1	800	40	42.7	-2.7
10	1	800	40	40.3	-0.3
11	1	800	40	37.3	2.7
12	1	800	40	38.1	1.9
13	1	800	40	45.2	-5.2
14	1	800	40	44.8	-4.8

Reading from observation table:

For speed = 800 rpm

Pressure at point 1 = 40 cm of oil

Sommerfeld equation is given by

So = $(r/c)^2$ (μ N/p) K_w x 10^{-6}

Where,

c = radial clearance = 3 mm = 0.0025 m

r = radius of journal = 27.5 mm = 0.02625 m

μ = viscosity of oil = 400 x 10^{-3} NS/m^2

N = Speed of the journal = 800 rpm

p = bearing pressure in kg/mm^2 (MN/m^2)

Kw = correction factor for side leakage

Calculation for p:

From manometer, Pressure = 40 cm of oil

Conversion into m of water = 400 x Specific gravity of oil

= 400 x 0.93 (from standard chart)

= 372 m of water

Conversion into Kg/cm^2 = 372 /10 =37.2 Kg/cm^2

{Where 1 kg/cm^2 = 10 m of water}

Conversion into Kg/mm^2 = 372 /100 = 3.72 Kg/ mm^2

{Where 1 Kg/mm^2 = 100 Kg/cm^2}

To obtain KW from graph,

Refer graph given (fig. 1)

Calculation for B/L:

From table B = 2 x π x r x (β/360)

(Where β = angle of radial point1 = 30)

= 2 x π x 0.02625 x (30/360)

= 0.0137 m

L = 0.090 m

Therefore B/L = 0.0137/0.09 = 0.152

From graph for B/L = 0.152 and ho/c= 0.6

Correction factor Kw = 0.85

Therefore substituting above in Sommerfeld equation

So = $(r/c)^2 (\mu N/p) K_w \times 10^{-6}$

$=(0.02625/0.0025)^2 \times \{(400 \times 10^{-3} \times 800)/0.372\} \times 0.85 \times 10^{-6}$

= $\underline{80{,}430 \times 10^{-6}}$ in s/min

Note: Similarly calculate for all the pressure points to get different Sommerfeld number.

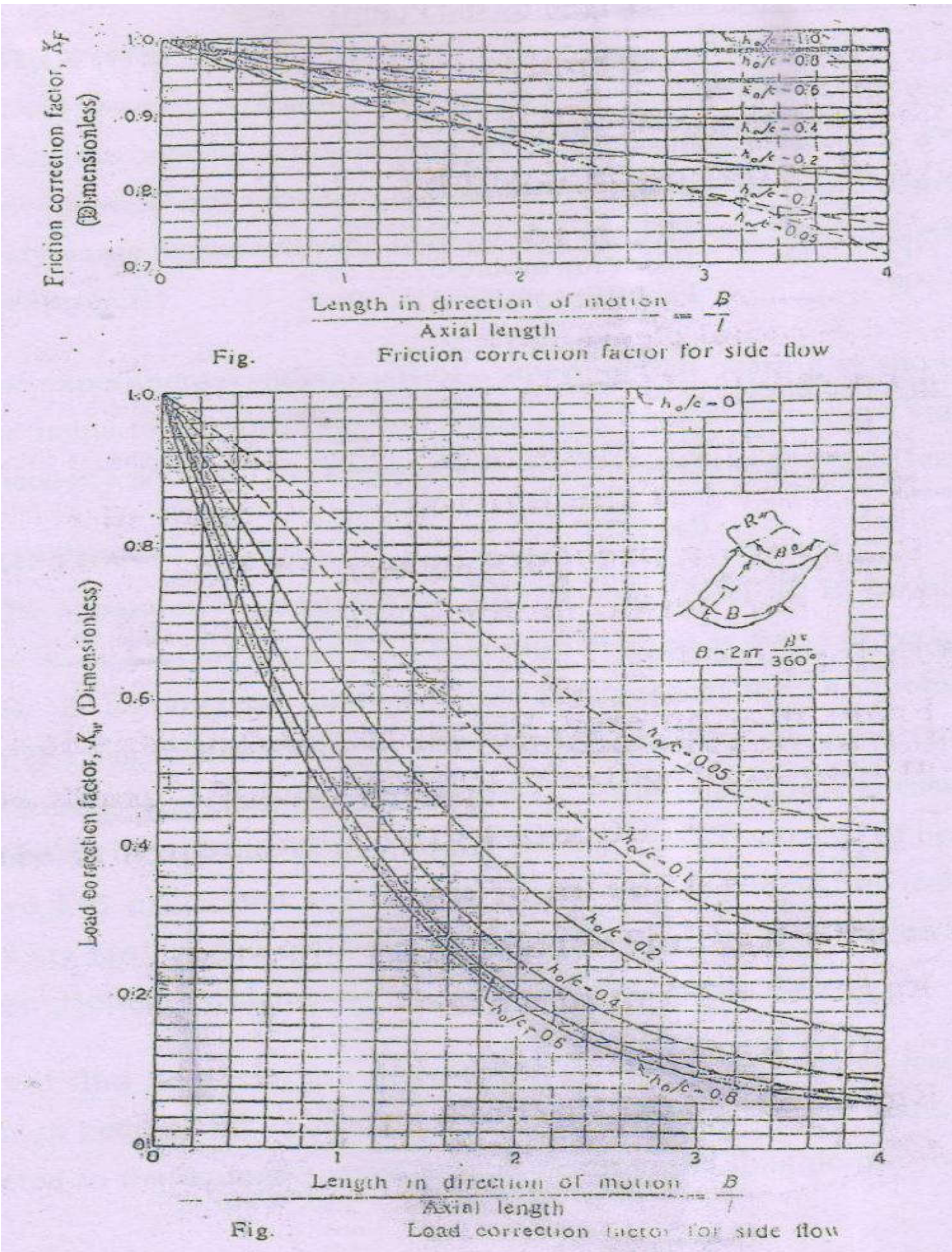
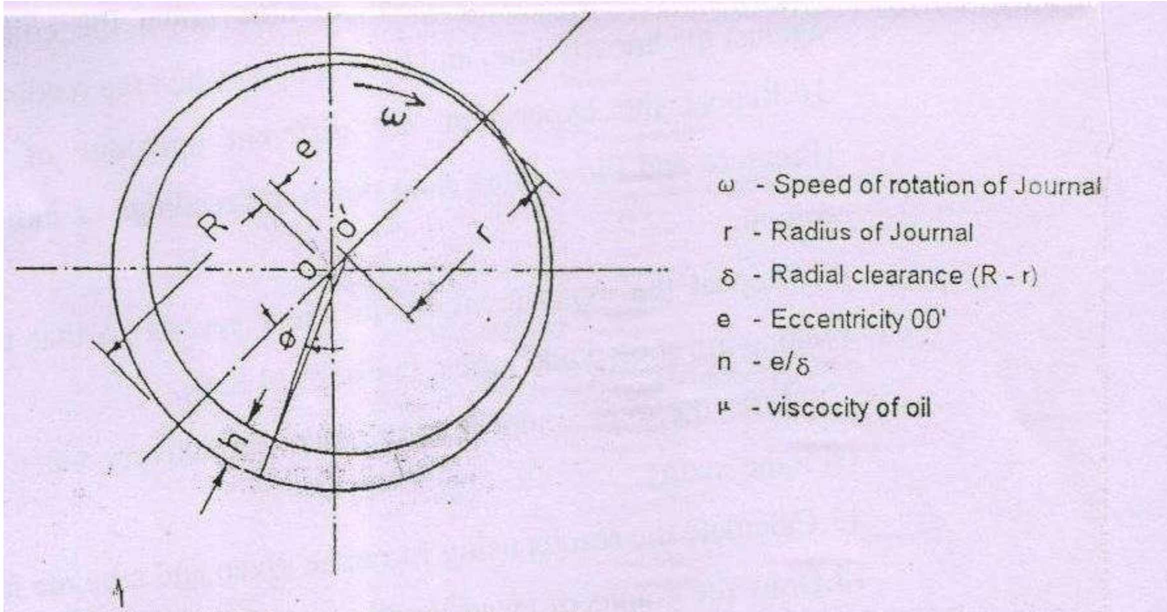


Fig. Friction correction factor for side flow

Fig. Load correction factor for side flow



GEOMETRY OF JOURNAL BEARING

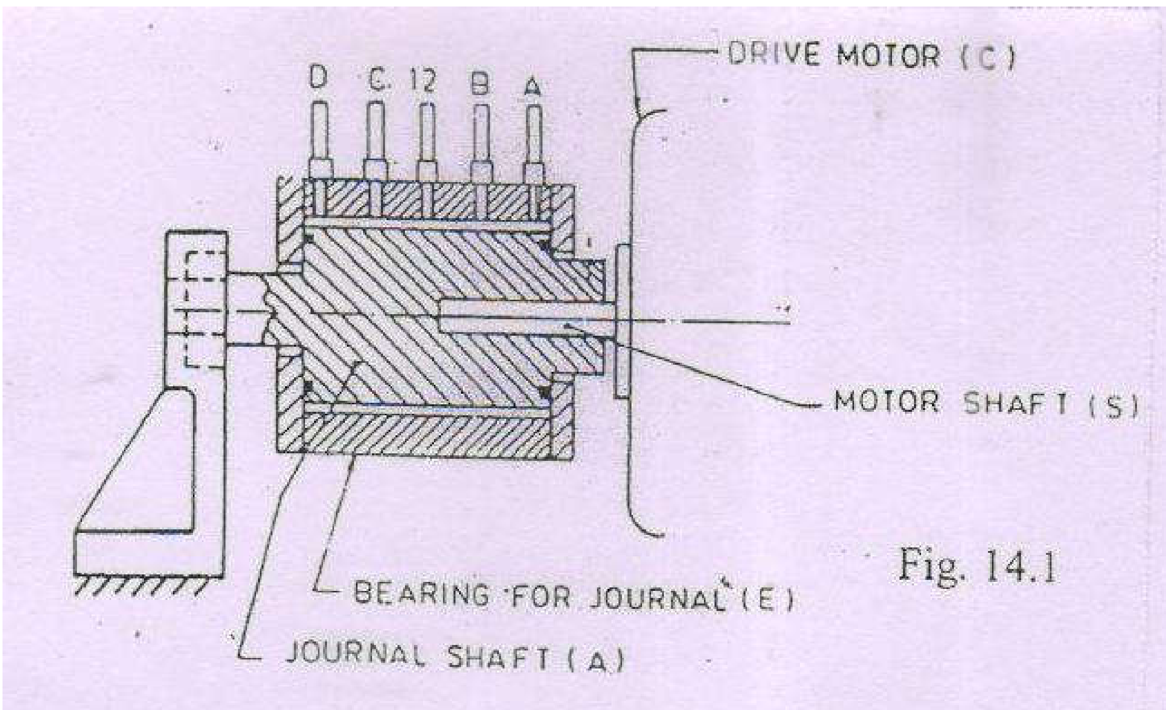


Fig. 14.1

RESULT: