INVESTIGATION OF THE INDUCTION MOTOR BEARING AGING BY MEANS OF COMPUTER SIMULATION OPERATING DUTY

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The bearings of the electric machines with horizontal shaft serve for carrying supports. They are subject to the influence of the rotor weight, the unilateral magnetic attractive force, rotor unbalance forces and additional driving mechanism loading. For machines with comparatively small capacity the bearings are mounted in bearing shields placed at the machine front parts.

For machines with big capacity with external diameters above 1 m the bearings are placed out of the body and mounted on special stands. The bearing stands are fixed by bolts to the same foundation plate on which the body is mounted. In order to avoid bearing currents one of the stands is insulated from the foundation plate by insulating pad. The fixing bolts and pins are insulated by insulating pipes and washers.

The bearing currents which close on the contour shaft- bearing stand – foundation plate – bearing stand – shaft cause corrosion to the bearing surfaces and shaft pins, as well as aging of the lubrication oil. The reason for these currents is E.M.F. inducted in the shaft by the stream that changes with time. It is caused by magnetic asymmetry (joints between parts of the stator and the segments of the magnetic circuit, key way, eccentric, the eccentric condition of rotor etc. The bearing currents occur mainly with machines with comparatively big capacities.

As far as construction is concerned the bearings are divided in anti friction bearings (roller and ball bearings) and friction bearings. According to the load type there are thrust bearings with radial load and stop bearings with axial load and according to the functional use there are carrying and guide bearings.

Keywords: electrical machines, bearings, diagnostic, computer modeling

Investigation:

For selection of construction, type and dimensions of bearings it is necessary to know as follows:

- the size and direction of loads acting on bearings
- type of loading
- machine rotation frequency
- desired operation term

In general case the bearing is subject to the influence of radial and axial load .The diagram presenting the location of bearings and different loads is given on figure 1.

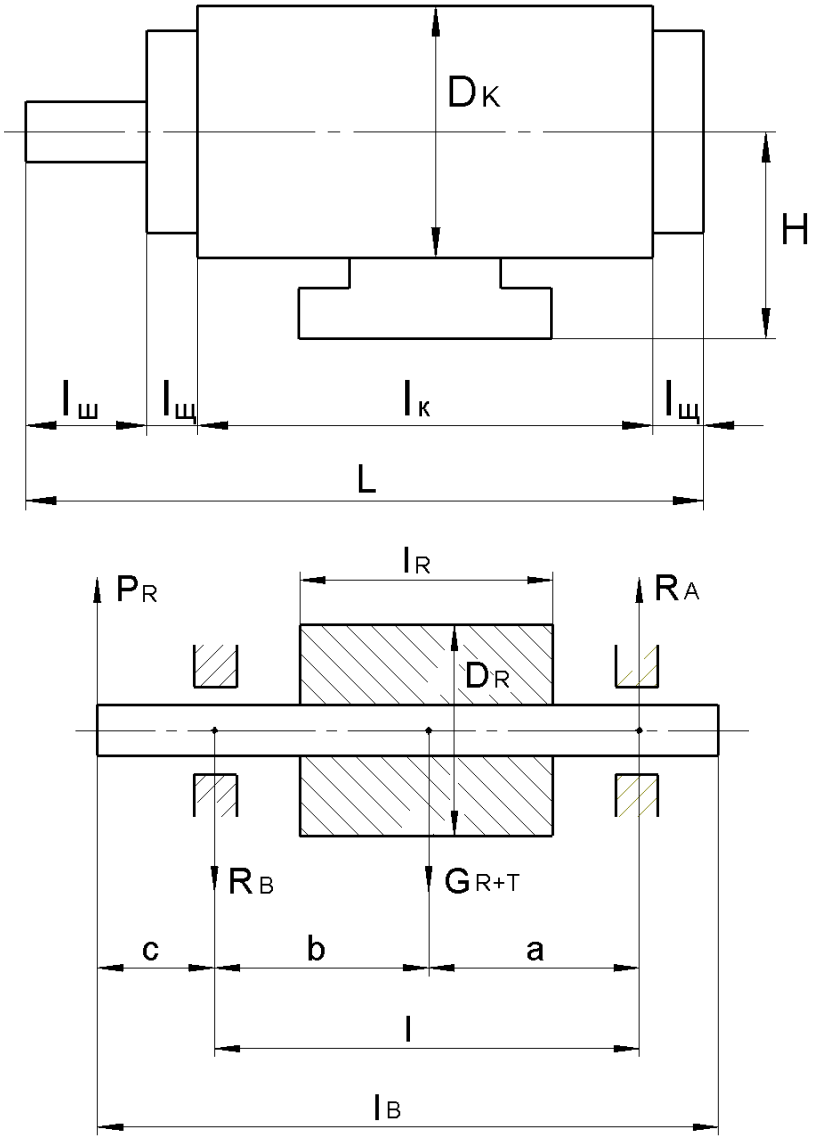


Fig.1 Loads acting on bearings

The selection is made according to dynamic load Q and the motor is examined for rated duty.

Exposition:

For single-row ball bearings the load is determined according to the following formula:

$$Q_{ai}=1.15.R_{ai}.k_{\delta} \quad (1)$$

$$Q_{ві}=1.15.R_{ві}.k_{\delta} \quad (2)$$

where $k_{\delta}=1$; $k_{\delta}=1{,}5$ – for load with moderate pushes , $k_{\delta}=2$ – for load with impacts and strong shoves. R_{ai} and R_{bi} are radial loads, acting on the bearings. The most unfavorable case is taken for their determination. In order to determine $R_{ві}$ at

unilateral transmission it is assumed that the force P_{ri} is directed downwards and for R_{ai} is directed upwards. Then:

$$P_r = k_n.\frac{M_i}{R}, \text{ where } k_п=0.3. \quad (3)$$

The radial loads of the bearings:

$$R_{ai} = (G_r + T).\frac{b}{l} + P_{ri}.\frac{c}{l} \quad (4)$$

$$R_{вi} = (G_r + T).\frac{a}{l} + P_{ri}.\frac{c+l}{l}, \quad (5)$$

where P_{ri} is determined for work in rated duty.

G_R - the rotor weight ,

where: $G_r = 6.3.D_r^2.l_r.10^{-3}$ (6)

T- unilateral magnetic attractive force

$$T = 3.D_r.l_r.\frac{l}{b} \quad (7)$$

Determining the load Q and considering the rotation frequency n and the necessary operation term in hours h, we find the dynamic load capacity of bearing C, [N] for:

- ball bearings:

$$C = \frac{Q}{25.6}.\sqrt[3]{h.n} \quad (8)$$

$$C = \frac{Q}{18.5}.(h.n)^{0.3} \quad (9)$$

The operation term can be assigned or selected: $h=\geq(15\text{-}20).10^3$ hours

The mechanical moment M_I is determined by the dependence:

$$M_n = 97500.\frac{P_n}{n_n}(\text{кг.см}) \quad (10)$$

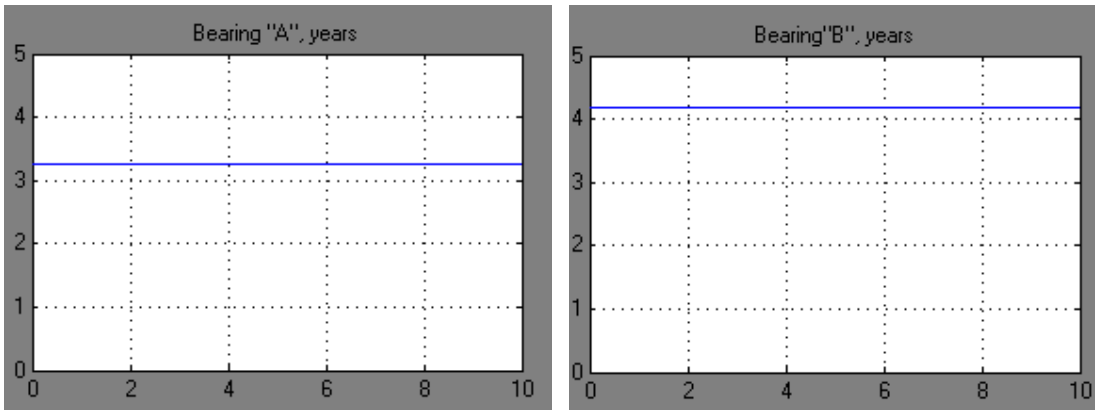
$$M_i = \frac{I_i - I_0}{I_n - I_0}.M_n(\text{кг.см}) \quad (11)$$

After determination of all loads there follows calculation of operation term and residual resource of bearings:

$$h = \frac{1}{n}.\left(\frac{c}{Q}\right)^{3.333}, [h]\text{- bearing life} \quad (12)$$

$$T_{pi} = \frac{1}{\sum_{i=1}^{n}\frac{n}{1}.\left(\frac{Q_i}{c}\right)^{3..333}} \text{ residual recourse} \quad (13)$$

The graphically obtained results are presented on fig.2 and the computer model realized by MATLAB 6.5 program product are presented on fig.3.



a) b)

a) bearing A b) bearing B

fig.2 *The graphically results*

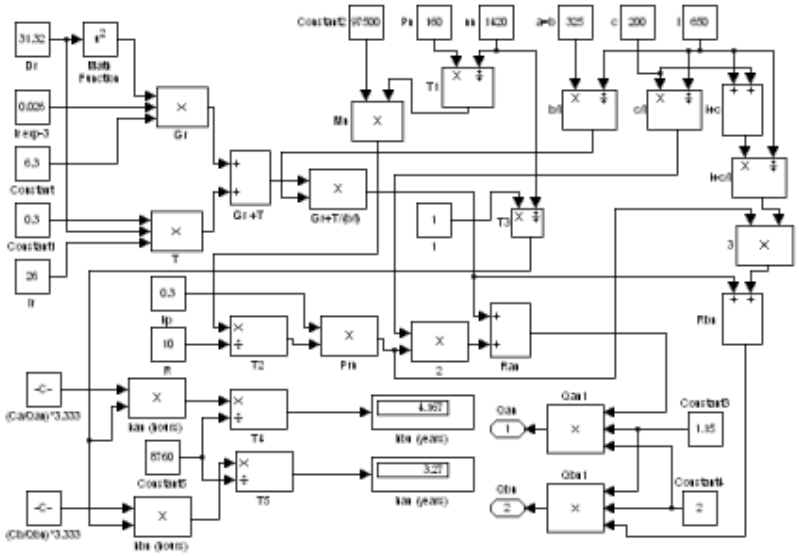


Fig.3 The computer model realized by MATLAB 6.5

Conclusion: We can conclude that a method have been developed for determination of induction motor bearing life even at the machine design stage considering the operating duty. The results obtained are within the limits of admissible values and this is a precondition for the accuracy of the developed method.

Appendix: AM type 4A3563YS

Un=380/660V;2p=4;Pn=160kW;n_n=1420min^{-1};In=284/166.5A;Ir=210A;I_0=118A;Mn=1076Nm;a=b=325mm;c=200mm;l=650mm;$l_в$=910mm

Reference books:

1. Kopilov I. – *Electric Machines Engineering* – Technica, Sofia 1980
2. Sergeev I., Vinogradov K., Goranov H.- *Electric Machines Engineering*-GE-Moskva 1962