4. Speed limit

The speed limit can be defined as the speed reached by a bearing if the following conditions are observed:

- the bearing load should correspond to a rating life L_{10h} = 150 000 operating hours
- the inner ring rotates
- the operational clearance should be properly chosen, considering the fit and the operating temperature
- the maximum operating temperature is of +70°C without other heating sources.
- proper lubrication and sealing are provided
- proper stiffness of the shaft and housing

The speed limit of bearing depends on many factors such as: bearing type, magnitude of load, tolerance class, cage design, operational clearance, lubricant, lubrication and cooling conditions etc.

In case of oil lubrication, the speed limit can be approximately determined for radial bearings as a function of the mean bearing diameter from the diagram fig. 10 and for thrust bearings as a function of the product $\sqrt{D H}$ (where H = mounting height of thrust bearings) from the diagram fig. 11.

The diagrams show both the speed limit for normal manufacturing and operating conditions, and maximum speed that can be reached only in special conditions:

- bearings that have a high accuracy (tolerance class P5, P4) should be used
- special design and material for the cage
- special lubrication and cooling conditions
- radial clearance larger than normal
- proper manufacturing of the adjoint parts of the bearing (shaft and housing)
- minimum pre-load $P_{min} \geq 0{,}002\ C_{0r}$, for roller bearings and $P_{min} \geq 0{,}001\ C_{0r}$ for ball bearings.

In bearing tables, the values of speed limit are given both for grease and oil lubrication.

If the bearing operating conditions and the lubricant quality are not well enough known, the effective speed is recommended not to exceed 75% of the speeds indicated in this catalogue.

In case of heavy loads when the rating life is shorter than 75 000 operating hours and bearing mean diameter is larger than 100 mm, the speed from the catalogue should be multiplied by factor f in the fig. 12:

$$n_{adm} = f\, n,\ \text{r/min}$$

For a bearing combined load, the speed from the catalogue should be multiplied by factor f_1 in the diagram - fig.13:

$$n_{adm} = f_1\, n,\ \text{r/min}$$

Special cases

Low speeds

At very low speeds it is impossible for an elasto-hydrodynamic lubricant film to be built up in the contacts between the rolling element and raceway. In such cases, lubricants with special additives should be used.

Oscillating movements

Since the rotational speed is zero at the point where the direction of rotation is reversed, an elasto-hydrodynamic lubricant film cannot be maintained in the contact areas. In such cases, lubricants with special additives should be used.

It is also necessary to analyse the inertia forces which occur and can cause damages on the raceway by temporary sliding of rolling elements at each reversal of direction.

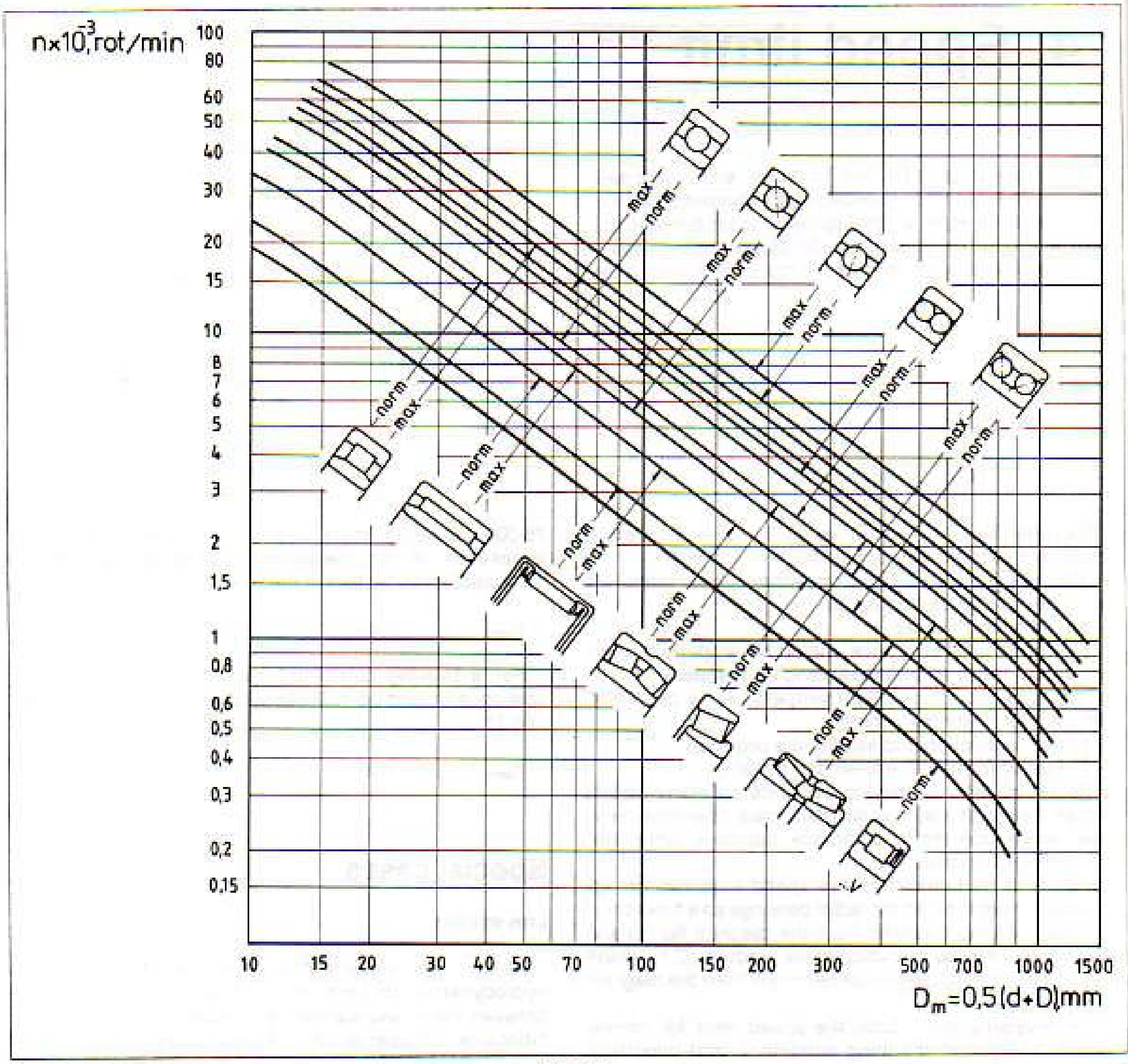


Fig. 10

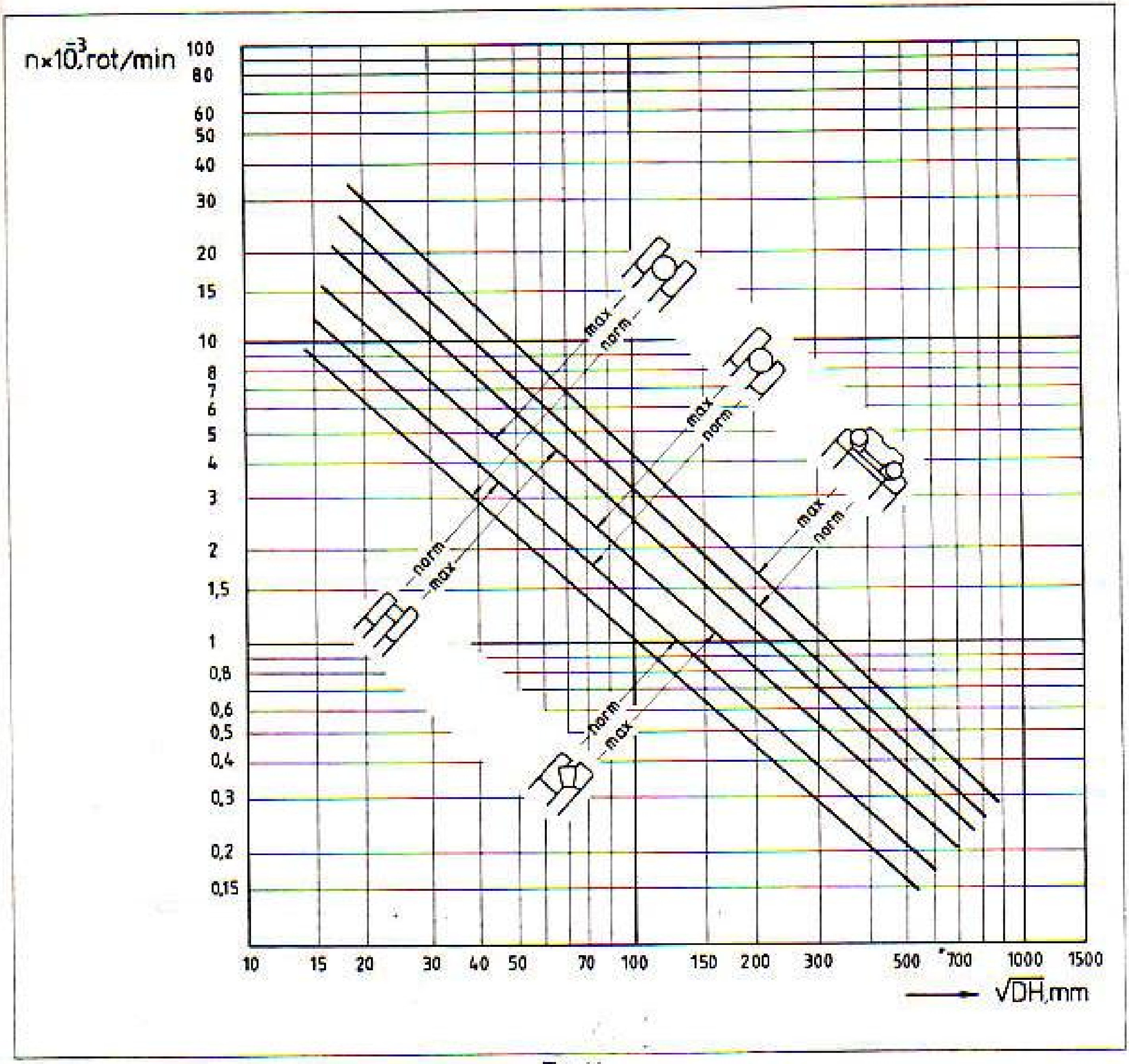
Stationary conditions

If in long term stationary conditions rolling bearings vibrate, the micro-movements at the rolling element/raceway contacts produce damages on the contact surfaces.

This produces an increase in vibration level or even a shorter life.

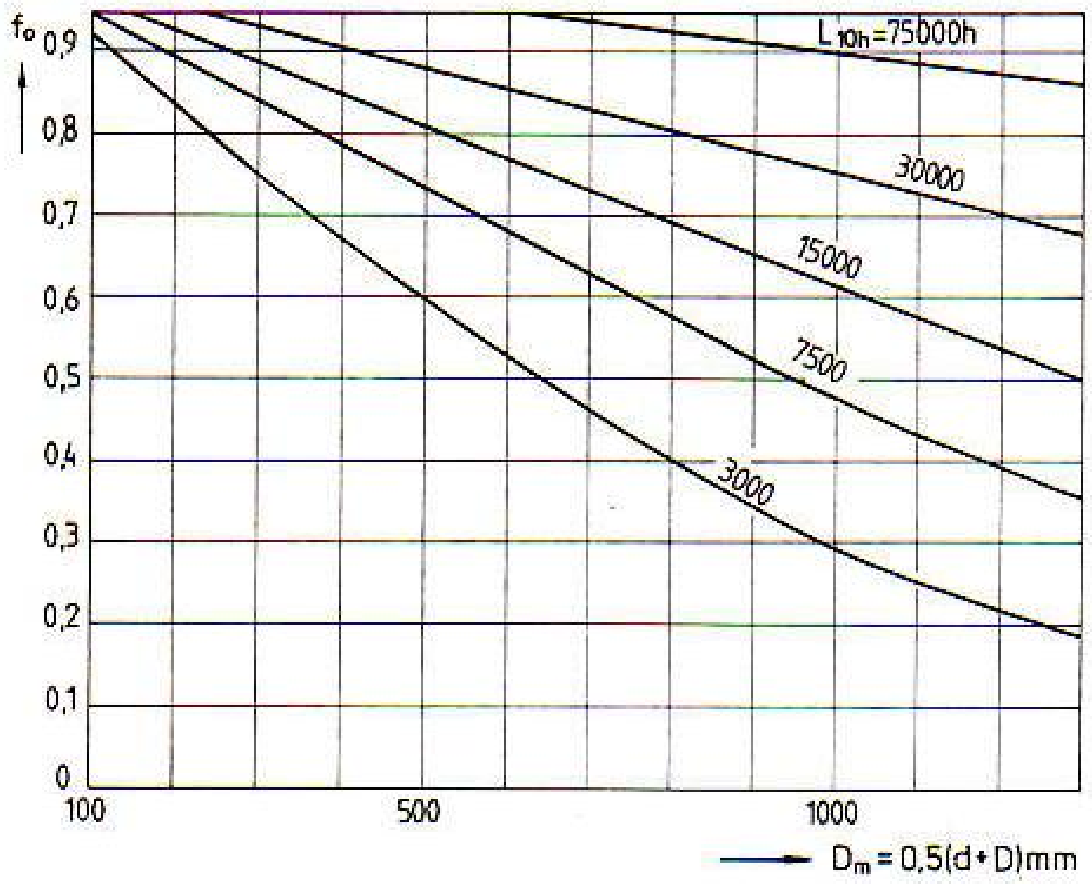
Such damage can be avoided by insulating the bearing from external vibrations. A similar situation can also occur during bearing transport, particularly in case of large-sized bearings. Such damage can be avoided by fastening the elements.

Oil lubrication is also preferable to grease lubrication.



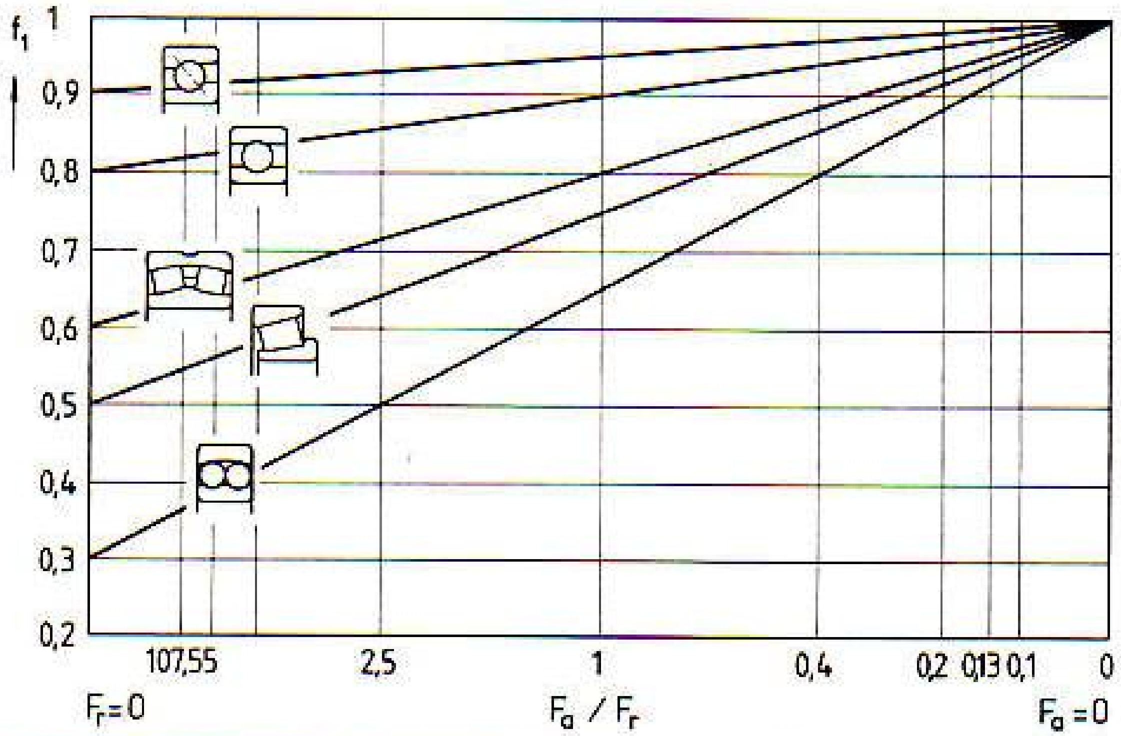
n×10⁻³ rot/min
100
80
60
50
40
30
20
15
10
8
7
6
5
4
3
2
1,5
1
0,8
0,6
0,5
0,4
0,3
0,2
0,15
max
norm
10
15
20
30
40
50
70
100
150
200
300
500
700
1000
1500
√DH,mm

Fig. 11



f_o
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
100
500
1000
L_{10h}=75000h
30000
15000
7500
3000
D_m = 0,5(d + D)mm

Fig. 12



f_1
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
107,55
2,5
1
0,4
0,2 0,13 0,1
0
F_r = 0
F_a / F_r
F_a = 0

Fig. 13