NRB INDUSTRIAL

White Paper

Fatigue Life & Reliability

Where any part failure may result in damage to the entire system and repair of damage is not possible, in such application greatly increased reliability is demanded of each component. Aircraft, satellites, or missiles are good example. This concept is being applied generally to durable consumer goods and may also be utilized to achieve effective preventive maintenance of machines and equipment.

The rating fatigue life of a rolling bearing is the gross number of revolutions or the gross rotating period when the rotating speed is constant for which 90% of a group of similar bearings running individually under similar conditions can survive without suffering material damage due to rolling fatigue. In other words, fatigue life is normally defined at 90% reliability. There are other ways to describe the life. For example, the average value is employed frequently to describe the life span of human beings.

However, if the average value were used for bearings, then too many bearings would fail before reaching the average life value. On the other hand, if a low or minimum value is used as a criterion, then too many bearings would have a life much longer than the set value. In this view, the value 90% was chosen for common practice. The value 95% could have been taken as the statistical reliability, but nevertheless, the slightly lower reliability of 90% was taken for bearings empirically from the practical and economical viewpoint. However, 90% reliability is not acceptable for parts of aircraft or electronic computers or communication systems these days and a 99% or even 99.9% reliability is demanded in some of these cases.

The fatigue life distribution when a group of similar bearings are operated individually under similar conditions. The Weibull equation can be used to describe the fatigue life distribution within a damage ratio of 10 to 60% (residual probability of 90 to 40%).

Below the damage ratio of 10% (residual probability of 90% or more), however, the rolling fatigue life becomes longer than the theoretical curve of the Weibull distribution.

When bearing life with a failure ratio of 10% or less (for example, the 95% life or 98% life) is to be considered on the basis of the above concept, the reliability factor a1 as shown in the table 2.1 below is used to check the life. Assume here that the 98% life L2 is to be calculated for a bearing whose rating fatigue life L10 was calculated at 10 000 hours. The life can be calculated as L2=0.33´L10=3 300 hours. In this manner, the reliability of the bearing life can be matched to the degree of reliability required of the equipment and difficulty of overhaul and inspection.

Reliability, %	90	95	96	97	98	99
Life, *L*a	*L*10 rating life	*L*5	*L*4	*L*3	*L*2	*L*1
Reliability factor, *a*1	1	0.62	0.53	0.44	0.33	0.21

Table 2.1 Reliability factor

Apart from rolling fatigue, factors such as lubrication, wear, sound, and accuracy govern the durability of a bearing. These factors must be taken into account, but the endurance limit of these factors varies depending on application and conditions.