8.軸受の寿命
Bearing Life

8.1 軸受の寿命

転がり軸受をある用途に正しく使用しても、ある時間が経過すると、音響・振動の増加、摩耗による精度低下、潤滑グリースの劣化、転がり面の疲労はくりなどによって使用に耐えなくなる。このように使用不能になるまでの期間が広義の軸受寿命であり、それぞれ音響寿命、摩耗寿命、グリース寿命、転がり疲れ寿命などと呼ばれている。

軸受の疲れ寿命は、材料の疲れそのものに本質的なばらつきがあるため、この寿命のばらつきを統計的現象として取扱い、次のように定義された定格疲れ寿命を用いる。

定格疲れ寿命とは、一群の同一呼び番号の軸受を、同一運転条件で個々に回転させたとき、そのうちの90%の軸受が、転がり疲れによるフレーキングを起こすことなく回転できる総回転数をいう。一定回転速度で運転される場合には、定格疲れ寿命を総回転時間で表わすことも多い。

8.2 基本動定格荷重と疲れ寿命

軸受の負荷能力を表す基本動定格荷重とは、内輪を回転させ、外輪を静止させた条件で、定格疲れ寿命が、100万回転になるような、方向と大きさとが変動しない荷重をいう。

基本動定格荷重Cは、ラジアル軸受ではCr、スラスト軸受ではCaとして軸受寸法表に記載されている。軸受の基本動定格荷重、軸受荷重と定格疲れ寿命との間には、次のような関係がある。

$$L = \left(\frac{C}{P}\right)^3$$

ここで、L = 定格疲れ寿命　(100万回転単位)
P = 軸受荷重　(動等価荷重)　(N),{kgf}
C = 基本動定格荷重　(N),{kgf}

軸受が一定回転速度で使用される場合、軸受の疲れ寿命を時間で表したほうが便利である。回転速度をn(min^{-1})とすれば、次のような関係が得られる。

$$L = \frac{10^6}{60n}\left(\frac{C}{P}\right)^3$$

8.1 Bearing Life

The various functions required of rolling bearings vary according to the bearing application. These functions must be performed for a prolonged period. Even if bearings are properly mounted and correctly operated, they will eventually fail to perform satisfactorily due to an increase in noise and vibration, loss of running accuracy, deterioration of grease, or fatigue flaking of the rolling surfaces.

Bearing life, in the broad sense of the term, is the period during which bearings continue to operate and satisfy their required functions. This bearing life may be defined as noise life, abrasion life, grease life, or rolling fatigue life, depending on which one causes loss of bearing service.

Rolling fatigue life is represented by the total number of rotations at which time the bearing surface will start flaking due to stress. This is called fatigue life. Even for seemingly identical bearings, which are of the same type, size, and material and receive the same heat treatment and other processing, the rolling fatigue life varies greatly even under identical operating conditions. This is because the flaking of materials due to fatigue is subject to many other variables. Consequently, "rating fatigue life", in which rolling fatigue life is treated as a statistical phenomenon, is used in preference to actual rolling fatigue life.

Suppose a number of bearings of the same type are operated individually under the same conditions. After a certain period of time, 10% of them fail as a result of flaking caused by rolling fatigue. The total number of rotations at this point is defined as the rating fatigue life or, if the speed is constant, the rating fatigue life is often expressed by the total number of operating hours completed when 10% of the bearings become inoperable due to flaking.

8.2 Basic Dynamic Load Rating and Fatigue Life

The basic load rating is defined as the constant load applied on bearings with stationary outer rings that the inner rings can endure for a rating life of one million revolutions. The basic load rating of radial bearings is defined as a central radial load of constant direction and magnitude.

The basic dynamic load ratings C are listed under Cr for radial bearings and Ca for thrust bearings in the bearing tables. The following relation exists between beairng load and rating fatigue life:

$$L = \left(\frac{C}{P}\right)^3$$

where L= Rating fatigue life (10^6 rev.)
P= Bearing load (equivalent load) (N), {kgf}
C= Basic load rating (N), {kgf}

In the case of bearings that run at a constant speed, it is convenient to express the fatigue life in terms of hours. By designating bearing speed as n (min^{-1}), the relation is obtained as follows.

$$L = \frac{10^6}{60n}\left(\frac{C}{P}\right)^3$$