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Statistical Study on the Bearings's Degradation

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Abstract: The study relates to a problem concerning the excessive consumption of the bearings. On the basis of data-gathering (bearings installed on a fan centrifugal with the iron and steel complex), relating to only the nature and the causes of the failures of the bearings with double lines of rollers, we proceeded has a statistical analysis. We could deduce per degree from importance the causes from fast deterioration. This allowed us in the first time to cure in a direct way the problem and consequently to increase the lifespan appreciably. Following this analysis it was established that the results correspond on the whole to the distribution according to the law normal of Gauss and this for all the studied parameters: Assembly, constraints, environments and lubrication. To know the function of distribution allows in the event of a probability of confidence of determining the limits and confidence the interval of any parameter. With the base of the fiducial limits one can question at the point the possibilities of the quality control of the bearings about the studied factor. One can deduce his failure rate, and its reliability, to take into account the parameters of the medium in which it works and to correct has new its lifespan reality. The computation results become very different then compared to those recommended by the manufacturers. One cannot any time not give an exact definition of the normal operating conditions. It is very desirable thus to acquire a practical experiment and with this showing particularly vigilant, if one wants to correct the lifespan, in order to be able to satisfy a policy of conditional preventive maintenance based more particularly on the vibratory analysis and this in order to reduce any problem involved in the operation of the bearing. The study is carried out on bearings of type: 22309CK, installed on a ventilator centrifugal on the level of an iron and steel complex.

Key words: Maintenance, diagnosis, degradation, bearings rollers

INTRODUCTION

The various functions which one requests from bearings vary according to the kind of use of those (SKF, 1980). These functions must be provided the one prolonged period old court of continuous or intermittent operation. Even if the bearings were correctly assembled and are correctly used, they are likely to cease functioning correctly at a certain time, in consequence of an increase in the level of noise and vibration, of a loss of precision of operation, of a deterioration of grease, or a chipping of tiredness of the riding surfaces (Spenle, 1985; Lefevre, 1990; Bigert, 1992).

In addition to the damages resulting from a natural deterioration, a bearing can cease functioning correctly under the effect of a seizing per heating, or the damage of a ring, such as a crack, a rupture, or a deep scratch, or in consequence of a damage of its system of sealing. The conditions of this kind of failure are not regarded as component of the damages specific to the bearing itself, because they are often the result of an error made in the choice of the bearing, of an error of design or realization of the adjacent bodies to the bearing, or of a fault of assembly or maintenance (SKF, 1989; Boitel, 1994).

A statistical analysis was elaborate in order to dissociate per degree of importance the causes of the failure. This allowed us in the first time to cure in a direct way the problem and consequently to increase the lifespan appreciably.

Following this analysis it was established that the results correspond on the whole to the distribution according to the law normal of Gauss and this for all the studied parameters: Assembly, constraints, environments, and lubrication.

While limiting itself to the study of the new technique of the manufacturer SKF who covers the principal parameters and allows to measure and control the state of a machine (compound of two or several bearings) against the various phenomena which can influence directly these parts such as (noise, the

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temperature, speed, the vibration, the alignment and the state of the lubricant), in order to obtain optimal performances.

ANALYZE DETERIORATION OF THE BEARINGS

To come to a conclusion, validly about the direct cause of the deterioration of a bearing, it is significant above all to know the type of defect affecting this sensitive body, and this thanks to the analysis of the resulting symptoms is:

- Analysis of the parts of bearing (traveling rings, elements and cage).
- Opération (noise, vibration, heating........).

By associating the various techniques of control, the experiment of the personnel of maintenance as well as the history of the machines equipped by the type with the bearing in question, we can quote the types of deterioration most often met, and which are as follows:

- **Chipping has:** They are the particles which are detached from the tracks (way of the travelling elements).
- **Seizing:** It is characterized by microphone-wrenchings of the metal particles.

Table 1: Standards and causes of the deterioration of the bearings

Type\Cause	Assembly	Constraints	Lubrication	Environment
Chipping	*			*
Seizing	*		*	
Fissure	*			
Contact corrosion		*		
Deterioration of the cage	*	*		
Wear			*	*
Corrosion				*
Abrasion	*		*	
Coloring		*	*	

- **Cracks (breaks):** It is appeared it cracks and small breaks on the elements of the bearing.
- **Contact corrosion:** It is the wear of surfaces in contact and the forgeries brineling.
- **Deterioration of the cages:** It is even of the deformation and the rupture of the cage of the bearing.
- **Wear:** It is the wear of the tracks, which causes a modification on the geometrical precision (matter loss and presence of stripes).
- **Corrosion:** Characterized by a reddish coloring.
- **Abrasion:** It is the grinding of the tracks, characterized by surface prints and shoulder of guidance (matter without wear pushes back).
- **Coloring:** it is the change of color of the bearing.

By exploiting Table 1, we can thus identify the immediate causes of the deterioration of the bearings (SKF, 1981; Timken, 2002; NSK, 2003) and which are as follows:

- The assembly.
- The constraints (conditions of operating).
- Lubrication.
- Environment (environment).

STATISTICAL STUDY

The studied sample comprises 83 conical cylindrical bearings (rolled with double lines). The studied unidimensional statistical characteristic is the age of the bearings initially, then a whole of statistical characteristics of a two-dimensional random vector among these characteristics one has the damages by age and causes like their probability. Table 2 has the treatment and the computation results. The listed causes are the assembly, the constraints, environment and lubrication. Table 3 has the outputs. Table 4 present the average age due to the constraints.

Table 2: Statistical processing and results

A	B	C	D	E	F	G	H	I	J
2-4	3	0	0	0	0	1	-	83	0
4-6	5	14	14	0.169	0.169	0.831	0.169	69	0.845
6-8	7	12	26	0.145	0.314	0.686	0.174	57	1.015
8-10	9	10	36	0.120	0.434	0.566	0.174	47	1.08
10-12	11	9	45	0.108	0.542	0.458	0.190	38	1.19
12-14	13	8	53	0.096	0.0638	0.362	0.209	30	1.248
14-16	15	7	60	0.084	0.722	0.278	0.232	23	1.26
16-18	17	6	66	0.072	0.794	0.206	0.264	17	1.224
18-20	19	5	71	0.06	0.854	0.146	0.292	12	1.14
20-22	21	4	75	0.048	0.902	0.098	0.331	8	1.76
22-24	23	4	79	0.048	0.95	0.049	0.490	4	1.104
24-26	25	2	81	0.024	0.974	0.026	0.490	2	0.60
26-28	27	2	83	0.024	1	0	1	0	0.65
Total									13.116

Table 3: Numbers and Probability of damage per age and causes bearings

	Assembly		Constraint		Environment		Lubrication		Total	
X	ni	pi	ni	pi	ni	pi	ni	pi	ni	pi
2-4	0								0	
4-6	14	0.169							14	0.169
6-8	12	1.145							12	0.145
8-10			10	0.121					10	0.121
10-12			9	0.108					9	0.108
12-14			5	0.060					5	0.060
14-16					7	0.084			7	0.084
16-18					6	0.073			6	0.073
18-20					5	0.060			5	0.060
20-22					1	0.012	4	0.048	5	0.060
22-24							4	0.048	4	0.048
24-26							4	0.048	4	0.048
26-28							2	0.024	2	0.024
Total	26	0.314	24	0.289	19	0.229	14	0.168	83	1

Table 4: Average age of damage due to (Assembly, Constraint, Environment, Lubrication)

	Assembly			Constraint			Environment			Lubrication		
	xi	fi	xi.fi	xi	fi	xi.fi	xi	fi	xi.fi	xi	fi	xi.fi
2-4												
4-6	5	0.54	2.7									
6-8	7	0.46	3.22									
8-10				9	0.42	3.75						
10-12				10	0.375	4.125						
12-14				11	0.208	2.7						
14-16							15	0.37	5.55			
16-18							17	0.31	5.27			
18-20							19	0.26	4.94			
20-22							21	0.052	1.1	21	0.29	6.09
22-24										23	0.29	6.67
24-26										25	0.29	7.25
26-28										27	0.14	4.06
Total			11.92			10.6			16.86			24.07

Designation:

A : Age group (month).
B : Average of the age group (Class mark)
C : Manpower of the damaged bearings.
D : Cumulated manpower of the damaged bearings.
E : Probability of damage at age X.
F : Probability of damage of age 0 at age X.
G : Probability of survival at age X.
H : Probability of damage of the bearing at time T provided that it is intact in the time T-1.
I : Numbers surviving bearing.
J : Average of damage of the bearings.

RESULTS

- Probability of damage (Fig. 1). It is noticed that the function of density of probability marries the theoretical form, one deduces whereas the data follow the law normal.
- Probability of survival at ages X (Fig. 2). It is not other than the reliability of the bearings, one the basis of which we can affirm that the bearings are bad quality.

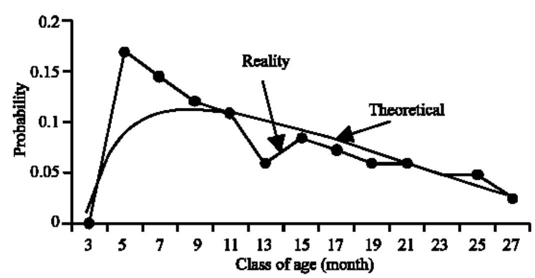

Fig. 1: Function of density of probability

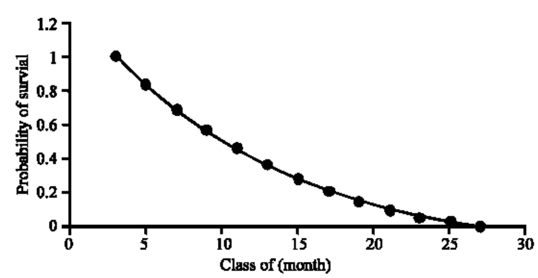

Fig. 2: Probability of survival at age X

- Conditional probability (Table 2). The latter is expressed by the fact that a bearing can be damaged

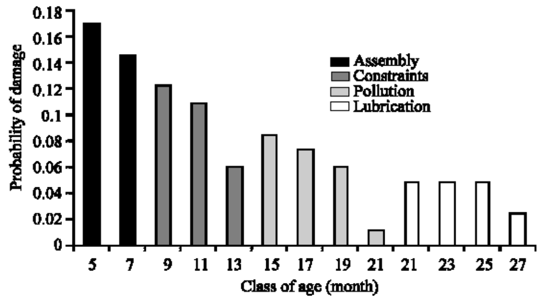

Fig. 3: Probability of damage per age and cause

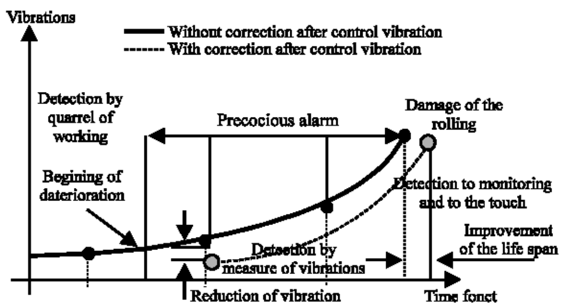

Fig. 4: Evolution of the bearings deterioration

in the time T, whereas it was still intact in the time (T-1); in comparison with other type of bearing one deduces that the bearings with double line have one less lifespan.

- A Number of surviving bearing (Table 3). The evolution of this indicator is subjected to the same conditions as the probability of survival but expressed in a number.
- Average Age of the damage (Table 4). It is retained that the bearings with cylinders have a short lifespan (13,116 months) compared to that recommended by the manufacturer.
- A Number of damage per age and boxes (Table 3). It is clear that the causes of damages occur in a progressive order of age. One count the number of bearing weakening due to the assembly is 26, the constraints 24, environment 19 then lubrication 14.
- Probability of tamping per ages and reasons (Fig. 3). One notes in has similar way 31.4% are owed to the assembly, the constraints 28.9%, environment 22.9% then lubrication 16.8% ¶.

ROLE OF THE CONDITIONAL PREVENTIVE MAINTENANCE

Determination of the state of the bearings: The objective is to guarantee a long lifespan of the bearings, for that it is necessary to determine the state of these parts in particular and the machines in general during their operations. Knowing q' a good preventive maintenance will reduce the costs of maintenance.

While limiting itself on the study of the new technique of the manufacturer (SKF, 2001) who covers the principal parameters and allows to measure and control the state of a machine (compound of two or several bearings) (Fig. 4) against the various phenomena which can influence directly these parts such as (noise, the temperature, speed, the vibration, the alignment and the state of the lubricant), in order to obtain optimal performances.

Conditional maintenance not only makes it possible to establish the diagnosis on the state of a machine at a given moment, but more especially, it gives the elements necessary to envisage the evolution of it.

Table 5: Deterioration of a bearing per vibratory measurement

	Designation of the bearing: 4510/3H/Displacement		
Designation	No	C,C measure in µm	Admissible vibration (10 : 70) µm
Ventilator :	1	64.0	Tightening of the landing
Radial	2	72.0	
Power:	3	76.0	
18.5 Kw	4	79.0	
Speed:	5	116.1	
2950 tr/mn	6	116.7	Excess of grease
	7	115.6	Renewal of grs
	8	58.1	
	9	60.2	
	10	57.5	

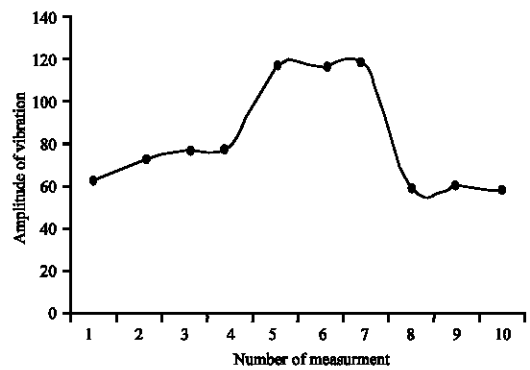

Fig. 5: Curve of tendency

Followed deterioration of a bearing per vibratory measurement: Reference of the bearing: 22309CK, with double lines of rollers, taper bore. The curve of evolution of the vibration is given by the Fig. 5 and Table 5.

CONCLUSION

The bearings are sensitive elements in the machines, which do not allow an excessive fluctuation of the load, temperature, speed, vibration.

Too fast wear is expensive with our companies, encouraged us to lean in a way closer on the study to this phenomenon, in order to improve the duration the life. This led us has to consider:

- Probability of survival of the bearings.
- Reconsider the loads applied.
- Influence of the type of greasing.

The statistical study revealed initially, that the damages are due mainly to the assembly, one deduces non qualification from the workmen and the inexistence of the material specific to the assembly and disassembling of the bearings. Non respect of the greasing type to the bearing also decreases by the life. Finally, one can say through this work that there are other means of evaluation of the life in a practical way by calling upon the statistical tool. The vibratory study on the level of the stages highlighted the origin of the failure by examining the spectrum and thus to lay down the lifespan.

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