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HOW CAN ARISE A RELEVANT FAILURE?

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Abstract: The suitable technical diagnostics with following measures resulting from real state is one from the decisive implements for increase of plants service ability. The technical diagnostics is defined as the process at that the topical technical state of objects is detected on the basic of objective evaluating symptoms determined with measuring technique means. Exerting diagnostics is possible with regard on a phase of machine or device life.

The aim of the diagnostics is not a measurement but disclosing machine failures in the state without dismounting. We can prevent so to failures and to realize repairs and to lower costs on the maintenance. At complicated technical machineries it need not go about degrading factors only devaluing a material structure and deteriorating operation of the machinery.

K e y w o r d s: Technical diagnostics, degrading factor, object, 3D .

1 INTRODUCTION

The failure is given by multitude of substantial points that create single functional parts of object elements and do not find on a prescribed place in a prescribed time. The place and the time is prescribed by tolerance field of elements. The prescription goes out from correct function of the object.

On the basis of failure removal work difficulty there are:

- Failures of permanent character. They are defined by static quantity. It is not possible to remove the failure by functional order not even by adjusting parts. It goes e.g. about wear of functional surface, about permanent deformation, about fracture of the part etc.
- Failures of adjustable character. They are defined by static quantity. It is not possible to remove the failure by functional order. It goes e.g. about shifting seating, about incorrect mounting part, about not taken up clearance etc.
- Failures of reversible character

They are defined by dynamic quantity. It is not possible to remove the failure by the function but it is possible to prohibit an unfavourable influence. By the unfavourable influence the temporary deteriorating function sets in and after its finishing the function points return into the prescribed right state. It goes e.g. about the unsuitable dynamic conditions, the thermal dilation of parts, the elastic deformation etc. The failures of information character are defined by dynamic quantity. It is possible to remove the failure by the function order. The incorrect position of the object function parts is given by the wrong managing order.

2 MECHANISMS OF FAILURE

If we go out from function definition of the failure then the failure state sets in then when mass points creating function surfaces are outside the prescribed tolerance. It is possible to be realized by the following mechanisms only:

1. Failure by permanent deformation, e.g. diminishing and deformation of supply piping section of machinery pump by influence of collision. This collision could arise during transport of heavy objects.
2. Failure by wear, We distinguish the following mechanisms of function surfaces wear: abrasive, erosive, cavitation, corrosive, adhesive, fatigue and vibrating.
3. Failure by separation, Separation of material can be due to various mechanisms. It goes mainly about separation of larger material pieces e.g. separation by cut, turn, pull etc.
4. Failure by choking (sticking) by additional material on function surfaces e.g. plugging hydraulic piping by mud.

Primary causes of failure are:

1. Failure by thermal radiation. It can result on change of mechanical and other material properties also separation and permanent deformation of parts.

2. Failure by electromagnetic radiation. The consequence can be degradation of material, the loss of information on memory media etc.
3. Failure by chemical effect of materials. The consequence can be shown by degradation of material properties, separation and wear of material respectively by choking function surfaces.
4. Failure by electrolysis and electric discharge results in mainly material wear.
5. Failure by fatigue, ageing and inadequate force overload of material. The consequence can be deformation, separation and wear of part.
6. In some cases it is possible to consider also about biologic activity e.g. failure of cables by rodents etc.

It is not possible to consider single mechanisms and causes of failures wholly apart. In practice we meet often with cases that one mechanism lets also other mechanisms of failure. Various causes alternate at in e.g. cavitation wear of piping on closed circuit can cause that crumbled material chokes other part of piping.

3 CLASSIFICATION OF FAILURES

A. Classification according to technical standards:

1) according to conditions of failure origin:

a) internal causes:

- the cause of the failure origin is a latent failure arisen e.g. at production of a semi product in material or by incorrect mounting etc.
- the cause of the failure origin is the incorrect design of an object. It results in discovering the relevant failure before the stated time of durability or life during normal working conditions.
- the cause of failure origin is a regular process after the stated service life of a part (wear, impression, choking, fatigue of material, ageing of material)

b) external causes:

- the cause of the failure origin is an non-performance of the stated technical conditions of working and maintenance
- the cause of the failure origin are unexpected appearances outside activity reach of an user (e.g. elemental calamities)

2) according to a failure extent:

a) total

b) partial

3) according to occurrence and regularity of occurrence:

a) casual (unexpected)
b) systematic(regularly occurring)

4) *according to temporal course of the failure with regard to human time perception:*

a) sudden
b) gradual

5) *according to demonstration of the failure with regard to human sensual perception:*

a) obvious
b) hidden

6) *according to a mutual relation of the failures*:

a) independent (primary failures)
b) dependent (monitored failures)

Between the mentioned standpoints there is the determined caused continuity that is represented in the following scheme.

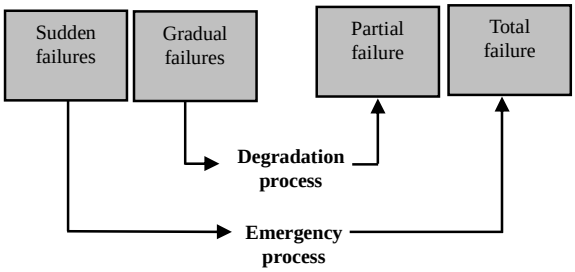

Fig. 1 Between the mentioned standpoints there is the determined caused continuity

7) *according to a measure of damages due to the failure:*

a) light

b) difficult

B. Classification according to technical diagnostics:

According to a main demonstration of the failures are:

a) the failure on the material level,

b) the failure on the energetic level,

c) the failure on the information level.

a) the failure on the material level:
The failure was shown on the material level. The failure can be e.g. the change of the form or the wear of the part. In this case the technical state of the object is judged on the basis of following changes of diagnostics quantities or diagnostics parameters. In essence three possible states are distinguished.

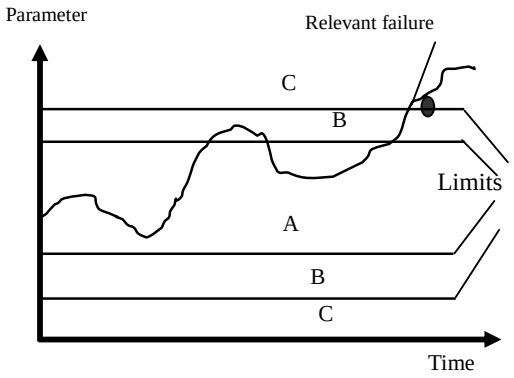

Fig. 2 Technical state of the object
A- normal state, B- state of limited serviceability, C- failure state

At representing diagnostics parameters the time axis is lost in some cases (frequency spectrum). Diagnostics aimed at this area are marked in the expert literature as methods of distinguishing images. Development of the failure is in every case dependent from time only. General disagreeable quality of a failures development is that the state of limited serviceable is shown often only in end time intervals. It troubles detection also creating failure substantially.

b) The failure on the energetic level:
The failure was shown on the energetic level e.g. the lowered power of the motor owing to incorrect supply of electric voltage or current or owing to absolute falling out energy.

c) The failure on the information level:
The failure was shown on the information level e.g. the failure could arise owing to an incorrect managing order that causes collision of function parts of the machine. The failure on the information level is shown on discreet form in low- output part of the machinery (e.g. in microprocessor). We judge on this level also correctness or incorrectness of the managing order. Detection of this failure runs over with help of simulation diagnostics programmes. If the failure will not be caught on this level then it will be shown on rough material level. It can result in material damages.

4 RELEVANCE OF THE FAILURE

The relevance of the failure is the agreed measure of admissible damage origin risk. Its height is determined individually according to philosophy of system user. The competent risk factor is determined form experimental, calculation also empirical producers. The main criterion stays the height of total cost on elimination of damages that can arise. According to it is necessary to distinguish by notion the type of the failure and to state limits considering total reliability. We distinguish the failures according to degree of relevance:

a) irrelevant

b) important

c) relevant

They are meanwhile non-standard notions diagnostics systems. They are inevitable for correct judging.

a) The relevant failure, is the failure to that we want to avoid with help of diagnostics system. It is numbered with greatness of arisen damages together with cost for introduction into original state without failure or it is determined with critical measure of risk number. It is important to realize that every relevant failure the less relevant failure precedes. We define it as the important failure. It is valid also in the cases of sudden and unexpected failures as a judging time is subjective and it reflects a human standpoint only. An action that is judged as fast one from human standpoint e.g. fracture of tool at machining it need not be fast from the standpoint of automatic diagnostics system. The processor that performs analysis of signal is able to perform thousands steps (measurements) in a second. The speed then depends from the technical level of diagnostics system. The aim of technical diagnostics and maintenance is in the first row to catch the important failure with the acceptable numbered damage smaller than the damage that arrives as follows and the corrected measure is not performed.

b) Important failure, is the failure that precedes the relevant failure and diagnostics system does not prevent from its origin. Simultaneously the important failure is also the monitored failure that is recorded by the diagnostics system or the maintenance man would record it.

c) ***The irrelevant failure,*** is the failure that precedes in time the important failure and partakes on origin of the important failure. The relation between heights of damages failure can be the important failure. The relation between height of damages and temporal development of failures is in Fig. 58.

Causes of failures origin STN 01 0102 defines the failure as an appearance resting in termination of serviceable state of the object. As we know also states of limited service ability it is suitable to define the failure also in wider conception of this notion activity. The most suitable is definition from standpoint of object function.

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5.1 Distribution and cumulating of failures

Model of origin and development of the failures can be complicated. The following diagrams present possible distribution of the failures at their development. The diagram (Fig. 3) presents principle of failures cumulating. The failures cumulating discovers on the end of complicated objects life and results in that in short time period number of failures and total deteriorating technical state (Fig. 4) grown rapidly. This type of failures distribution is typical for mechanical machineries. In practice also other types of failures distribution occur currently e.g. failures occurrence is most often in the beginning of an object using. Such a demonstration is mainly at the electronic parts. In the chapter „ failures intensity ” it will be dealt about mechanisms of other types of failures.

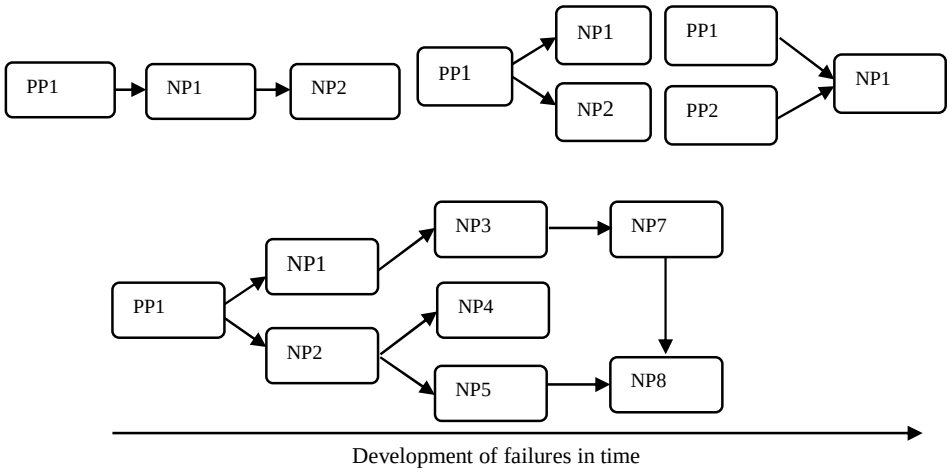

Fig.3 Block scheme of failure distribution and cumulating

PP- primary failure (primary cause)
NP- following failure

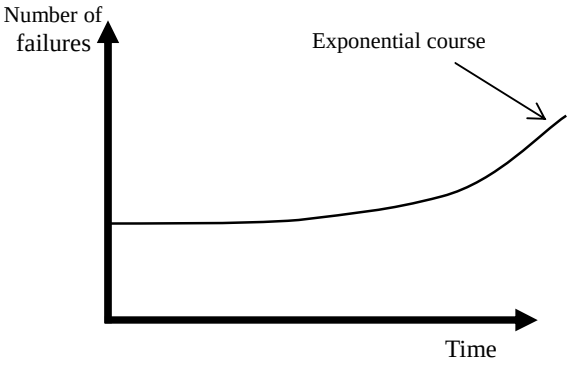

Fig.4 Exponential growth of the failures on the end of service time

5.2 Analysis of failures causes

General causes of the failures are following:

a) Nature wear, pressing-off, ageing or change of materials mechanical properties of single machinery parts at normal operation conditions. The failure of this type arises till after planned period of service life or durability.
b) The failure owing to weak construction solution of the machinery. In this case it comes regularly to the premature failure then still before the planned durability or the service life of the machinery.
c) The failure owing to enormously exposed parts. It is the type of the failure when it is difficult to solve the machinery nodal point by means of construction so that it reaches the demanded durability. In this case it is counted with the origin of the premature failure and it is taken it as a necessary wrong e.g. bearings of grinding rolls are overloaded enormously.
d) The failure owing to hidden manufacturing failures of the machinery.
    - The hidden failures of material arisen at production.
    - The improper dimension and form tolerances at production of machinery parts.

e) The failure owing to incorrect assembly of machinery parts.

    - The incorrect adjustment of couplings,
    - The incorrect adjustment of shafts,
    - The incorrect taking up clearances of functional units,
    - The improper fixing of machine foundation,
    - The interchange of parts,
    - The omitting of part,

f) The failure arises premature owing to incorrect or neglected maintenance e.g. insufficient lubrication of function bearings surface and slide-way, use of incorrect lubricating materials, omitting prescribed control etc.
g) The failure arose owing to incorrect attendance of the machinery.

    - Unsuitable choice of technological processes respectively incorrect

use of the machinery (e.g. machine overloading),

- Incorrect preparation of the machinery before work (e.g. incorrect adjustment of production machine),
- Wrong managing order owing to inattentiveness of service,
- Disorder in surroundings of the machinery and following collision with the objects that would have not be in presence of the machinery.

h) The failure arose owing to unexpected outside impulses e.g. falling out current, fire from surroundings, vibrations from surroundings at building arrangements, impact of the transported burden into the machine etc.

In essence at all causes a human factor shares as an author of the failures origin. At the causes “a, b, c” a human factor works at the machinery design. The causes “d, e” are bound to production and mounting machinery. The causes “f, g, h” are changed over with use respectively working machinery.

The modern maintenance methods RCM (Reliability Centred Maintenance) and TPM (Total Productive Maintenance) count with activity of the human factor as a man commits aware and unaware mistakes.

He is a fallible creature and then because of securing effectiveness and safety it is necessary to count with his failure. At the failures in some cases it is analysed also an intention of the man sharing on the failure origin. According to the literature (Moubray, I. RCM Reliability Centre Maintenance, ISBN 0 75063358 I, Butteworth Heinemann. Oxford, 1997, p. 1-128) it is possible to categorize certain human demonstrations.

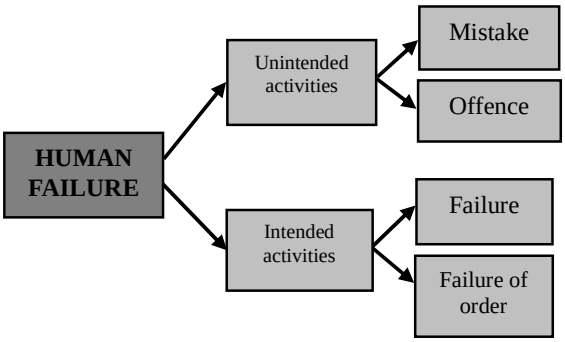

Fig. 5 Categorization of psychological failures

Mistake is a failure that arose from inattentiveness of a man.

Offence arose by omitting some steps of planned advance on account of oblivion; the man however had the intention to take away work of good- quality.

Failure arose by non-respecting on of verified rules and by compensating simplified advances. The intention from side of a man was to reach a higher effectiveness. The failure is charged by unconsciousness of activity.

Failure of orders arises from indifference to entrusted work, in worse case from deliberate sabotaged activity.

It is good to realize at analysis of failures that failure of the man can work in more levels and real causes can be covered by seeming ones e.g. the failure from side of machinery service arose but also working instructions were made incorrectly so that original failure is covered and it arose at creation of the technical documentation.

6 CONSULTION

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