THE ASPECTS AND PERSPECTIVE VIEWS OF THE DIAGNOSTICS OF ELECTRIC DEVICES

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SUMMARY

The diagnostics is an indispensable part of all stages of electrical engineering industry. The diagnostics is a source of information, which also accompanies a product in the exploatation. This information influences on the construction based of the failure analysis regressively. The diagnostics with the results of running checks gives information about the diagnostic object's property and provides beddings for the predictive data. The ON-LINE diagnostics, which monitors the object continuously during its work, is essential for important and expensive objects. It is necessary to construct the diagnostic systems (diagnostic tools) with respect to the deposition ability and the economic demand. The structural approach to the solved problems is very perspective, because it has bigger deposition ability and it provides more complex information than the current phenomenological approach.

Keywords: *diagnosis, observer, fault, rotor, intensity, simulation*

1. INDRODUCTION

We cannot imagine the electrical engineering without enough information. The diagnostics plays an irreparable role in these areas. The gained pieces of information are essential in the area of elements, in the area of subsystems and in the area of electric devices. The diagnostics is becoming a connecting element among the other branches, which take part on the production of electrical machines in the electrical engineering industry. The material engineering provides needful elements for the specific purpose – material selection – alternatively the fundamental material's modification to be able to discharge the expectant function – the information is needed about parameters and their development. On the element input level into the next processing the further information is needed about whether all material properties are in the required limits. This all is a top-priority task for the electrical engineering technological diagnostics, because the diagnostics is getting to direct contact with the production here.

2. DIAGNOSTICS AND PRODUCTION

The diagnostics is also important in the technological process area – in the "know-how" area. In this area, the diagnostic examinations are important in several levels at once. At first the in-process control has a large economic influence, because this check can prevent the wrong product from the further processing on time. The check-out is a next area, where the diagnostics helps effectively – it is a test of the finished product. The producer in his factory makes the test. This check-out diagnostics has a big economic effect again, because the guarantee repairs are reduced to minimum or there are no guarantee repairs at all. In this aspect we can see massive power of the diagnostics with visible economic effects. It is necessary to see the impacts of the diagnostics in a wider context – especially in failure analysis. As it was said, these failures are recorded, assorted and archived in a database. We can gain many facts and information from the fault source analysis. These pieces of information are enormous worth. For example this is a question of the designs aiming at the changes of device's construction. Then the diagnostics brings improvement aimed at the elimination of the elements, which are the fault source frequently. It is possible to use the results of the failure analysis for a treatment of the working environment. We do this when the working environment affects the devices badly and the frequent failures show that the devices are overloaded because of bad working environment conditions. The diagnostics helps eliminating this negative factor.

When a failure is detected, the diagnostics has a possibility to suggest the fastest method eliminating this failure. It does means that the diagnostics localizes only the place of the failure, but also it gives operative instructions for the maintenance and it sets the optimal sequences of operations leading to elimination of the failure. This leads to the quick and direct repair without useless delay and operations.
If we imagine the diagnostics as a connecting link and inseparable element of the material engineering and technological processes, there is a huge and worth importance by the monitoring of the technical devices. In this area there is not important only the trend monitoring of the device's parameters, but also a data recording, a creation of worth databases describing own trend of system behaviour. It is possible to crate a prediction of the further system behaviour based on such information in the future. The electrical engineering technological prognosis is on the top of the diagnostics.

We showed the importance of the diagnostics in the electrical engineering practice and now let's pay attention to what the diagnostics needs to fill the expectation.

3. THE APPARATUS OF THE DIAGNOSTICS

The apparatus of the diagnostics is concentrated in the diagnostic system. This system includes:

- A necessary instrumental equipment for the diagnostics (measuring instruments with suitable converters – it means devices which convert the diagnostic signals on the recordable signals), necessary sensors, because the diagnostics should already be evident by the device design;
- A mathematical model of the diagnostic object. This model is able to simulate error-free situations and also all failure situations – representing failure situations of the diagnostic object, of course with all possibilities, which can happen. If we want to create the mathematical model, we have to collect all necessary characteristics and mathematic expressions of the parameter processing;
- A choice of the diagnostic process (the setting of the diagnostics: off-line or on-line diagnostics);
- A choice of the approach to the solution of the diagnostic problem: phenomenological (we are only interested in the diagnostic object reactions on the input signals) or structural (we are interested in the happening in the structure of the diagnostic object). The structural approach gives more information and has a smaller value variance. But it requires more expensive pieces of equipment and a special trained operator. The phenomenological approach is simpler. There are a lot of experience since it is used for a log time, does not need a specialist for operation, but has a wider value variance, naturally is less expensive – no special instruments are necessary. But its deposition ability is not so good;
- A knowledge and empirical potential – it means workers, which have got a relevant experience and knowledge on required level (this aspect seems to be very important for his possibility to realize the diagnostic on adequate level);
- A methodology assessment – a process of diagnostics, it means optimisation of diagnostic activities and assessment of particular steps of diagnosis – of course with the authority of economics aspects in general. Profundity of examination and exactness of diagnostic bears very closely on the price of the diagnosed device and its consequence in the working process.

4. CONNECTIONS IN THE DIAGNOSTICS

Connections in the diagnostic of electrical devices are very good marked in the Fig. 1. We can see there the fact, that diagnostics (just mentioned) intervenes in both existing stages – manufacturing and operating. Technical diagnostic gets through the preparative phase and then through the processing phase – the phase of diagnostic inquiry. Acquisitions and impacts of the results of diagnostic were just mentioned.

It is comprehensible, that in diagnostics of important electrical devices (e.g. high or low speed alternators of main power stations, transformers of important switching stations) exists higher form of connections between machines and their operators (especially at on-line diagnostic), consequently the expert systems, which use the fuzzy logic and all eventualities situated in this area.

We have made a mention of connections in diagnostics and then possibilities, how to make the diagnostic system. We also must notice the next very important point of view. It is a tactics of the right choice of the diagnostic problem. The most important fact is to find the key places, which are significant for the operation and the right function of the monitored devices. We have to pay attention to the subsystems or components, which are the most sensitive to making defects. These defects can cause the risk of life or the bad function of the device. There is paid attention to the insulation systems in the area of diagnostics of electrical devices. Insulation systems certainly belong to these very sensitive parts or subsystems. We can see the electrical device as a serial reliable system with the very sensitive part – just mentioned the insulation system. It is also evident that the fault source can be very exposed mechanical parts, e.g. bearings. We have to choose the process of diagnostic so as we get maximum of information about these monitored parts or subsystems.

To this point of view is very closely associated the moment of capacity to do statements of chosen method. The main fact is the structural approach. For the research of this problem (the study of property) seems to be optimal for example methods, which allow to describe enthalpy of materials [1]. This method is good for their direct view on momentary state of the material. If we monitor the trend of this quantity, we receive quality beddings for the required prognostic propositions.

5. ON-LINE DIAGNOSTICS

The next thing we must monitor is the demand on on-line examination. This area, which is also very sough-after, is especially difficult because of doing diagnostic examination. We can use only some methods and the whole system has to be connected to the direct data storage. And it is the most modern way of diagnostic [2] – the application of the expert system with the other special things like fuzzy logic and neuronal networks. This trend, which is based on direct use of these new methods of technical diagnostic, will need more and more research and effort. In addition we must assume that diagnostic will be applied because of its difficulty in the events, where it is really important and well founded, e.g. by the important electrical devices like high and low level alternators in the big power stations or transformers in the switching stations).

We also have to make reference to the perspective of technical diagnostics since there is no doubt about the increasing importance, especially at present. The quality is the priority program in many companies – necessity to accept the standard of

quality ISO 9000 and 14000 confirms its large importance.

The importance of the structural approach is still increasing in the area of diagnostic methods. The other methods may be next way – especially methods, which do not need extra expensive devices, for example the thermal analysis methods. We have enough good experience with the application of this method on our department [3-8]. There is also necessary to keep full detachment and economy of used methods.

In the area of the insulations systems of transformers (the system oil-paper) seems to be perspective to monitor the trend of characteristics of the solid part of the insulation system. But we are not able to take any test samples direct by the operation of transformers. For the detection its state – the material based on the cellulose – we must use the indirect methods. Possible methodology is the detection of the quantity of the furan compound – fissile products of cellulose with the dissidenced atom of carbon, which are good soluble and identifiable in the insulation oil of transformers. Furan components especially furfural and hydroxymethylfurfural – are the identifiers of the age level of the paper. The best parameter for ageing evaluation of insulation systems of transformers is the level of polymerisation of the cellulose paper in transformers during the operating conditions. We are able to define this level thanks to the method – liquid chromatography – HPLC (High Performance Liquid Chromatography) [9].

For the big rotating electrical machines seems to very useful the monitoring of these indicators: measuring of vibration based on analysis of deviation from the standard stage and their size, measuring of the level of acoustical capacity (noise), which advise imbalance and the level of operating quality, analysis of the thermal state of machines (monitoring of temperature on selected places), analysis of coolant (ozone concentration in the machine, test of the products of degradation), analysis of discharge activity. The next – additional – can be used: the application of the slot capacity tester for partial discharge measuring, analysis of the leakage, thermal record with relevant analysis.

6. CONCLUSION

The problem of diagnostics is very wide and complex discipline, which is formed from many fields of activity and is constantly developed. Its fluent development displays dynamics its major ideas.

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BIOGRAPHY

Prof. Ing. Václav Mentlík, CSc. was born in 1939. He defended his CSc. in the field of Elektrotechnologie at University of Czech Technical University in Prague in 1985, Doc. in the field of Elektrotechnologie at University of West Bohemia in Plzeň in 1990 and Prof. in the field of Elektrotechnologie at University of West Bohemia in Plzeň in 1998.

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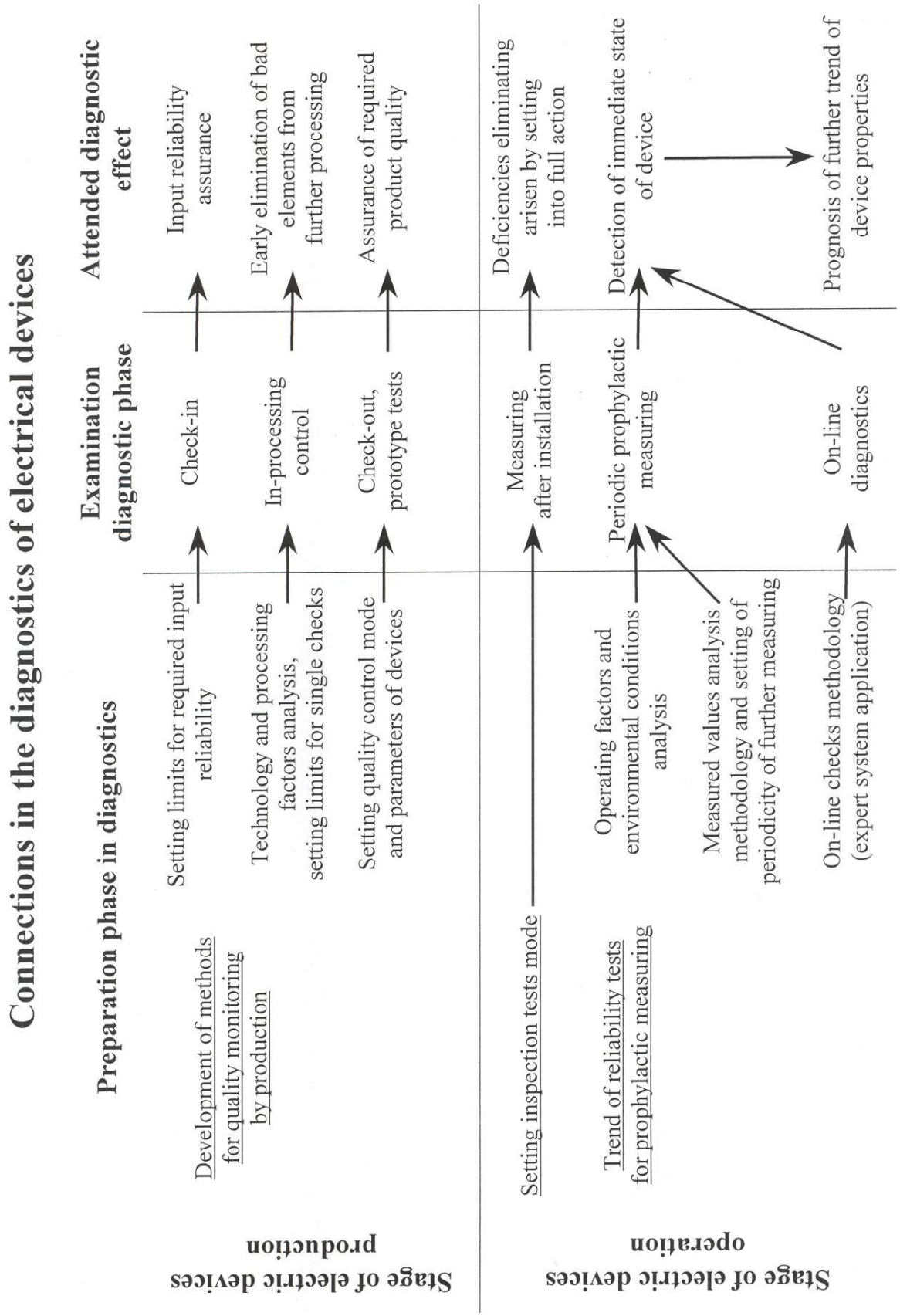

Fig. 1 Time behaviour in the middle area of fault