

Combined Anomalies Prediction Using the Bayesian Theory

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The industry world uses machines and plants that are increasingly powerful and complex. The requirements of high safety, the reduction of the exploitation costs, and the control of the equipment availability give to maintenance a dominating role. The industrialists attach a great importance to the conditional maintenance of the revolving machines that use primarily the vibrations of their rotors. The temperature measurements in the stages can bring additional information to vibrations.

In conditional preventive maintenance, the diagnosis of failures of the industrial systems, if it is carried out with effectiveness, represents one of the means to gain points of productivity. It consists in observing the symptoms of a failure and then identifying the cause using a logical reasoning founded on observations, that is, to dismount a deterministic mechanism between the cause and its effect.

This research presents and discusses the decision making that is practically exerted with each stage in the procedure of industrial diagnosis and tool of assistance to the decision making. The approach used is Bayesian theory to reveal a defect masked by another in the low frequency (combined defect). The turbo compressor as an object of research, vibratory analyses, and thermography are the techniques used in this work. Copyright © 2011 John Wiley & Sons, Ltd.

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1. Introduction

The monitoring by vibration analysis remains the dominant technique and is more used in a program of conditional preventive maintenance. It is in this maintenance concept that the monitoring must not only fulfill its function of safety, but especially, it must allow the early defects detection.

The monitoring based on the follow-up of evolution of scalar indicators presents several steps; the main thing is the mask effect¹; unfortunately, these indicators are insensitive with the appearance of a new defect in the case or a defect already exist.

Research tasks were completed with the objective of determining and defining indicators in the presence of combined defects² in high frequency (defect of bearings and gears). However, the experimentation showed a low effectiveness of these indicators, and until now, the engineer of maintenance remains always anxious to ensure an optimal machine availability.

Within the framework of a diagnosis, taking into account operating conditions processing is essential in the case of installations monitoring. A weak rate of correlation between the evolution of the vibration and the passage of the limiting values of viscosity makes it possible to exclude the increase or the loss from viscosity as cause's anomaly³.

Several methods are used for the decision making, such as the binary tests (Bayes, minimax, Neyman–Pearson) and the tests with multiple assumptions⁴. In an estimated context, one example of great interest is the Bayesian method, which will be discussed in the course of this article. This method is used to envisage the number of apparatuses that could break down in the future⁵, an approach that facilitates planning within a framework of systematic preventive maintenance. Moreover, studies showed the role which the Bayesian models can play for the establishment of a criterion of warning to reveal deteriorations⁶. The Bayesian approach, like a tool of assistance to the decision making in the case of a combined defect at low frequency, is used to prevent such anomalies.

2. Methodology

The Bayesian network has a characteristic to combine two different fields from mathematics with an aim of representing uncertainty: the graph theory, on one hand, which provides the framework necessary for a qualitative modeling of knowledge, and the probability

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