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Study on Predictive Maintenance Strategy

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Abstract

Predictive Maintenance is the catchword in the present times. First ,the paper analyze the feature of the Predictive Maintenance, include scientific, approximation, timeliness, condition monitoring, fault diagnostic and so on, second the technology system for Predictive maintenance has been studied, including: condition monitoring technology, fault diagnosis technology, state prediction and maintenance decision support and maintenance activities. Finally, the Strategies of Predictive maintenance is given.

Key*words: Predictive Maintenance, fault diagnosis,State prediction*

1. Introduction

According to reports, the annual equipment maintenance costs up to 40%, so the development of new technologies and effective maintenance service strategies which can improve productivity and economic efficiency equipment is essential, which has an important influence not only for the economic benefits of the equipment, but also system reliability, availability, and security.

Maintenance Technology development has gone through three stages: corrective maintenance, preventive maintenance and predictive maintenance. The corrective maintenance is "only fault repair" approach, which is the early maintenance mode; the preventive maintenance is performed at predetermined time intervals down to check, replacement of parts, in order to prevent damage, destruction secondary loss; the predictability maintenance is a condition-based maintenance, according to the system condition decide whether to repair. The corrective maintenance and preventive maintenance are the traditional way of maintenance, which will result in lower equipment reliability and high maintenance costs. The predictive maintenance integrate in the equipment condition monitoring, fault diagnosis, fault state predicted maintenance decision support and maintenance activities, that is a new way of maintenance and can enhance economic efficiency and availability.

Predictive maintenance concepts can be divided into narrow and broad. Narrowly predictive maintenance refers to irregular or continuous condition monitoring of equipment, based on the results, to identify whether the state is abnormal or faulty equipment trend, and then to arrange for service, which is based on "condition monitoring" and stresses the "Troubleshooting". Narrowly predictive maintenance period is not fixed, only to arrange timely maintenance programs by monitoring and diagnostics the result, it emphasized that the process of monitoring, diagnosis and repair of the trinity, this idea applies mass production equipment maintenance.

Broadly predictive maintenance emphasized that the process of condition monitoring, fault diagnosis, state forecasting and repair decision of the trinity, based on the condition monitoring and fault diagnosis, the system state is predicted, and then the maintenance decision is established to obtain the final requirements for maintenance activities. Broadly predictive maintenance is a systematic process, the maintenance management is affiliated into a predictive maintenance areas, taking

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into consideration the entire repair process, until the results associated with the maintenance activities is gained.

2. Predictive Maintenance Features

According to reports, the annual equipment maintenance costs up to 40%, so the development of new technologies and effective maintenance service strategies which can improve productivity and economic efficiency equipment is essential, which has an important influence not only for the economic benefits of the equipment, but also system reliability, availability, and security.

(1)Scientific

The predictive maintenance for equipment use the performance monitoring mode of the equipment (manually or automatically monitor online monitoring), combining the correlative information of the device, considering the work experience of the relevant personnel to use and repair the equipment , and by means of diagnostic systems the development and change of equipment operation has been analyzed, the future status of the equipment can be predicted, and according as the prediction result ,the equipment is managed and repaired. The predictive maintenance takes on scientific. In order to further improve the efficiency and accuracy of maintenance management, to ensure work efficiency and accuracy of the equipment and to ensure the quality of the equipment, usually using advanced forecasting techniques and monitoring equipment, to establish the online monitoring system and the diagnostic system, the predictive maintenance system is established and perfected based on the technological transformation and on-line monitoring of existing equipment to obtain available diagnostic data.

(2)Approximation

Since the state prediction of the device is to predict the future state of the device or operating trends, in practice, the factors affecting the prediction have many, such as: the accuracy of monitoring instrument, technical level of relevant use and maintenance personnel. The more accurate monitoring of instrument error is smaller. At the same time, the impact on the accuracy of the equipment in possession and external factors, the changes will also affect the forecast results. Thus, on the one hand, the scientific practices, operating standards, maintenance standards precise and rigorous examination and testing system need be formulated so that device management is standardization and institutionalization, while strengthening infrastructure management provide strict device management system platform for the establishment and perfection of a predictive maintenance system. The other hand, the personnel related production management, equipment management, quality control, equipment operation and maintenance have been trained to hold suitability and effectiveness of new techniques and new systems education, so that they can master the methods and skills, the predictive maintenance flexibility has been improved based on emphasizing the role of people, the people's flexibility, mobility mobilized to. To the people's initiative and learning to compensate for mechanical instruments and unity, to avoid excess repair or inadequate maintenance, the prediction approximation has tried to overcome.

(3)Timeliness

Predictive maintenance timeliness reflected in its real-time monitoring of equipment status and full data acquisition. Fault diagnosis is make and the maintenance strategy, spare parts inventory policy and procurement plans is provided based on state monitor. The predictive maintenance can improve the accuracy of equipment maintenance, spare parts management to improve accuracy. Since predictive maintenance can make an accurate guide for the repair time and method, the type and the amount of the spare parts needed, which is timely. It is expected to achieve "zero inventory" management.

(4)Condition monitoring

Condition monitoring is one core technology of the predictive maintenance, which is the basis for fault diagnosis technology. Condition monitoring can be divided into on-line monitoring and off-line monitoring. The off-line monitoring techniques is convenient, practical, fast and intuitive, which is mainly used for routine inspection and regular inspection of equipment; The on-line monitoring technology is accurate, timely, and data can be stored, which is mainly used for in the key components. The condition monitoring system monitor equipment and surveillance data is provided to fault Diagnosis.

(5)Fault Diagnostic

Fault diagnosis is another core technology of the predictive maintenance, which decide the repair mode. Fault diagnosis based on the device running information and status monitoring information identifies the various characteristic parameters and then the device status by data analysis, processing and extraction technology. Dynamic information of the devices running data can be performed through the collection, collation and storage timely, accurately and completely. The data support is provided by information and data sharing for fault diagnosis. Currently, the intelligent fault diagnosis systems, equipment intelligent diagnosis and predictive maintenance systems theory has in-depth research, and there is a wide range of applications.

3. Predictive Maintenance Technology System

Predictive maintenance basically formed its own technology system at present, including: condition monitoring technology, fault diagnosis technology, state prediction and maintenance decision support and maintenance activities.

3.1. Condition Monitoring Technology

Condition monitoring technology have formed their own monitoring methods in all engineering fields, based on different state detecting means the condition monitoring methods has divide into the vibration monitoring method, the noise monitoring method, the temperature monitoring method, the pressure monitoring method, the oil analysis monitoring method and the acoustic emission monitoring method.

3.2. Fault Diagnosis Techniques

Fault diagnosis is very important for equipment maintenance, and it gets more and more attention. Accordance with German international Frank professor of view, which is authority in fault diagnosis field, all the fault diagnosis method can be divided into three kinds: based on a mathematical model, based on signal processing and based on artificial intelligence methods. The method based on a mathematical model includes physical model, state observer, Kalman filtering, auto-regressive moving average, The method based signal processing includes wavelet analysis, principal component analysis, Hilbert transform, spectral analysis, The methods based on artificial intelligence includes Bayesian networks, case-based reasoning, fuzzy logic, artificial neural networks, expert systems.

3.3. State Prediction Technology

The state prediction assesses the current status and expected future member state based on the operating information equipment. Commonly the used methods include: forecasting method based on the traditional reliability, forecasting method based on data-driven and statistical, forecasting method based on failure physics. The prediction accuracy and the costs of the three methods improve and increase successively.

3.4. Maintenance Decision Support and Maintenance Activities

The state prediction assesses the current status and expected future member state based on the operating information equipment. Commonly the used methods include: forecasting method based on the traditional reliability, forecasting method based on data-driven and statistical, forecasting method based on failure physics. The prediction accuracy and the costs of the three methods improve and increase successively.

According to condition monitoring, fault diagnosis and status predictable results, from the people, resources, time, cost, efficiency, and many, many angles, maintenance decision put up maintenance feasibility analysis, set maintenance plan, determine maintenance support resources, given time, place, and content maintenance activities. Developing methodologies generally maintenance decision includes faulty tree reasoning, mathematical model analysis method, Bayesian network method and intelligent maintenance decision method.

From the top of the domestic and foreign research present situation, we can see that the life prediction method provides estimates of the residual life of the equipment, and maintenance planning is on the basis of further define the proper execution of maintenance time. Compared with the life prediction, maintenance planning decides the maintenance strategy more directly and directly influences the performance of the equipment. However, maintenance planning problems are more complex than life prediction.

The key technology of predictive maintenance planning as follows:

(1) Study on life prediction method.

Most remaining life prediction method based on similarity using only failure sample history the recession process information, and failure history sample application occasions is limited, therefore it may advance maintenance or termination of the operation of the equipment. In practice, the recent recession indicators of equipment are more likely to reflect the current state of the component than the historical recession indicators of similar equipment. So, taking into account the historical recession indicators, the actual recession indicators and other information, and their respective weights, develop a forecast life plan.

(2) The analysis of the "new" and "non new" system of the repair.

"As good as new after repair" system is undergoing maintenance, which can be considered as the state of the system completely restored as a new, system of age simply calculated as: system accepts recently restoration after the start of the run time to the current time period length. However, after the maintenance of the non new system, the system has accumulated the damage, and it is difficult to calculate the age of the system, and the degradation index of the system can not be restored to the level of the new system. Therefore, "repair non new system" accept maintenance component failure rate estimation of subsequent stages of life prediction will be crucial, it need intends to combine the reliability theory and life prediction method for estimation of the growth rate of the failure rate and failure rate.

(3) Dynamic maintenance planning model.

The only difference between predictive maintenance planning model and preventive / monitoring based maintenance planning is the recession and recovery module. Prevention / based on condition monitoring maintenance planning model of recession and recovery module used for all the regression models to calculate the static component failure probabilities and predictive maintenance planning model of recession and recovery module used for individual regression models to calculate and at each sampling point dynamic update components failure probability. Therefore, the failure probability of the component is constructed by using the dynamic update to construct the predictive maintenance programming model.

(4) The predictive maintenance planning model for the "repair of non new" system.

The maintenance of non new maintenance is very common, but the optimization of maintenance strategy for the maintenance of the system considered as the maintenance of non new maintenance is limited. Because of the difference between the maintenance and the new maintenance of the new maintenance, the effect of the instantaneous effect and the sustained effect of the maintenance on the maintenance of the maintenance and the instantaneous effect of the maintenance are considered. The predictive maintenance planning model is constructed for the target to minimize the maintenance cost or the maximum average availability of long-term expectation.

(5) The maintenance program for the development of comprehensive life forecasts and predictive planning.

The research results of various key technologies are integrated with the forecast maintenance plan model, and formulate the maintenance plan which is suitable for the actual equipments, and form the complete theoretical system.

4. Predictive Maintenance Strategies

(1)Determine the parameters

The first step of the predictive maintenance is to confirm condition monitoring parameter, confirm parameter measurement method (visual, general instrument measurements and special instruments measurements) as the current and voltage of the electrical equipment, the oil temperature, current and pressure of the crusher, the speed and vibration of the rotation device, and those parameter limits is used as a criterion to monitor.

(2)Detection, monitoring

After determining the parameters, the periodic (eg, weekly, monthly, *etc*.) or aperiodic (such as online random monitoring) approach can be adopted to detect and monitor the process. Also, the monitoring methodology and the used instruments is importance, different parameters for different devices and monitoring instrumentation, its monitoring methods are also different. When the measured value exceeds the parameter limits of engineering standards, it is necessary for further analysis and diagnosis.

(3)Fault diagnosis

There are many fault diagnosis method, using fault diagnosis technology of spare parts and equipment fault has been diagnosis.

(4)Maintenance work orders

After the results of the diagnosis, the maintenance program has developed, including maintenance personnel, maintenance tooling, maintenance resources, maintenance procedures, and spare parts and so on.

(5)Project Maintenance

According to maintenance program, Project Leader organizes relevant personnel to service and adjust malfunction status parameter value to the normal range. After adjustment or repair equipment, if the equipment have been tested and meet the project the standard range, which can enter a new predictive maintenance cycle.

5. Conclusion

The proposed predictive maintenance experiences the time short, by monitoring and diagnostic, the equipment status has been estimated, and then the scientific and reasonable

maintenance strategy has been developed, which overcome a lot of the current maintenance problems. Although predictive maintenance is a capable and effective method to improve system reliability, because uncertainty of fault data during equipment operation, The implementation of this new technology has a certain degree of difficulty. Implementation of predictive maintenance should be starting from the grasp of their characteristics and comprehensive use of various core technologies, to give full play to its scientific and timeliness advantages, to overcome the lack of approximation, to establish equipment management information system for the predictive maintenance.

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