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Predictive Maintenance

Introduction

The goal of predictive maintenance is to reduce unscheduled outages created by equipment failures and to improve the overall availability of an operating plant. Traditional maintenance programs rely on routine equipment servicing to reduce plant outages, but predictive maintenance programs schedule specific maintenance tasks as they are actually required based on equipment operating conditions. Predictive maintenance is not a substitute for traditional maintenance programs, but if executed properly it can significantly increase plant availability. Comprehensive predictive maintenance programs shall include monitoring and diagnostic techniques such as vibration monitoring, thermography, tribology, ultrasonic and other nondestructive testing techniques.

Vibration Monitoring

Vibration monitoring is the most critical predictive maintenance tool as most plants have a large number of electromechanical equipment. Many of the vibration monitoring systems employed today collect single channel, steady state data that are only suitable for simple machines operating at a relatively constant speed. Therefore, frequency domain vibration monitoring tools as well as analytical tools are required to accurately predict machine failure. Furthermore, vibration monitoring systems must be used for all critical systems, not only simple rotating systems, to increase plant availability.

Thermography

Thermal imaging tools can be used to monitor the conditions of machinery, structures, and plant systems. These tools detect infrared energy emitted by equipment in order to identify thermal anomaly i.e. areas that are hotter or colder than the normal operating condition. Thermal image analysis can locate a multitude of incipient problems within the plant. Because there is a wide selection of thermal imaging equipment available, proper equipment selection is critical for predictive maintenance applications. Thermal imaging systems can also be valuable for monitoring the thermal efficiency of critical processes that rely on heat transfer or retention, electrical equipment, and other process parameters.

Tribology

Tribology refers to the analysis of surfaces in relative motion and studies how wear, friction and lubrication, and other tribo-elements behave in relative motion in natural and artificial systems. Two of the most important tribology techniques used for predictive maintenance are lubricating oil analysis and wear particle analysis. Lubrication analysis can only be used to schedule oil change intervals based on the actual condition of the oil and to analyze effectiveness of the oil in lubricating the equipment. Lubrication analysis can't be effectively used to determine the operating condition of equipment or detect potential equipment failures. Wear particle analysis, on the other hand, provides wear conditions of equipment. Wear particle size, shape, composition, and quantity can be used to predict potential equipment failures. Wear particle analysis can also be useful for understanding the root cause of catastrophic equipment failures. To effectively employ wear particle analysis in predictive maintenance programs, sampling frequency must be chosen based on the equipment mean time between failures (MTBF).

Ultrasonic

Like vibration analysis, ultrasonic is a subset of noise analysis. The only difference between the two measurements is the frequency of interest. Ultrasonic measures noise frequencies above 30 KHz, whereas vibration analysis measures frequencies between 1 Hz to 30 KHz. Ultrasonic measurement is useful for detecting leaks that generally create high frequency noise because of the expansion or compression of air, gases, or liquids as they flow through an orifice or leak in either pressure or vacuum vessels.

Visual Inspection

Visual inspection is one of the most critical components of predictive maintenance. Daily walk-throughs and check routines are vital for identifying potential failures or maintenance issues that can impact plant availability. Visual inspection shall be included in any effective predictive maintenance program.

Electrical Testing

Periodic electrical testing shall be used in predictive maintenance programs along with the aforementioned techniques to increase plant availability. These electrical tests should include: resistance testing, megger testing, HiPot testing, impedance testing, transformer oil sampling, etc.

Conclusion

Predictive maintenance programs can significantly improve plant availability by reducing unplanned outages. Predictive maintenance tools can be used for maintenance management, plant optimization, and reliability improvement. Predictive maintenance programs have been proven to lead to significant performance gains. Successful implementation of a predictive maintenance program must start with proper identification of the program objective, proper selection of technologies, successful implementation, and continuous improvement plans.

References and Further Reading

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2. Practical Machinery Vibration Analysis and predictive maintenance, Paresh Girdhar, 2004.
3. State-of-the-Art Predictive Maintenance Techniques, Published in: IEEE Transactions on Instrumentation and Measurement (Volume: 60, Issue: 1, Jan. 2011)