Nondestructive Testing to Help Prevent Equipment Breakdowns

Reliable mechanical and electrical equipment operations are essential for any business. Using predictive maintenance methods like nondestructive testing (NDT) can be especially helpful for reducing the risk of unexpected equipment breakdowns. These predictive maintenance techniques rely on non-invasive procedures to help identify abnormal conditions and faults before they result in equipment failures, making them an important part of an equipment maintenance program.

Nondestructive testing offers several advantages, including the opportunity to:

- Determine current equipment condition
- Compare results with previous inspections to help identify trends and predict remaining equipment life
- Evaluate conditions without damaging or altering equipment
- Discover defects and deficiencies that may be corrected before a breakdown occurs, thus avoiding costly unplanned outages
- Align corrective maintenance with scheduled shutdowns

This guide offers general information about common predictive maintenance methods that can be incorporated into your regular maintenance program. Nondestructive testing techniques should only be performed by qualified personnel.

Common NDT Methods

Visual Inspections, with or without the aid of tools such as mirrors, cameras, borescopes, magnifying lenses, etc., can be used to examine all types of equipment and surrounding areas. This is a quick and useful method that can be used during day-to-day operations or part of a routine checklist to identify abnormal conditions. Some of these include physical damage, cracks, excessive wear, signs of overheating, corrosion, leaking fluids, etc.

Dye Penetrant Inspections are useful for locating surface cracking. A dye penetrant inspection is a simple three-step process. The first step is to thoroughly clean the area to be tested in order to remove any paint, dirt, scale or grease. The second step is to apply a specialized penetrant that will soak into any surface defects through capillary action. The final step is to apply a developer, which draws the penetrant out from any defects, making them visible to the inspector. This inspection method can indicate the exact size, shape and location of surface defects.

This inspection method is low cost and can be used for a variety of applications to detect fatigue cracking in equipment such as, pressure vessels, pumps, blowers, internal combustion engines, boilers, and stress points on machinery. This inspection technique will not identify subsurface defects.

Magnetic Particle Examinations are used to detect surface and shallow subsurface defects in ferromagnetic materials such as iron and steel alloys. This examination requires creating a magnetic field through the object or material to be tested, usually by applying current through the examination area but can also use indirect magnetization. With the magnetic field present, wet or dry magnetic particle are applied to the examination area. If cracks or defects are present, this will cause a discontinuity in the magnetic field allowing the magnetic flux to extend past the surface of the material. The magnetic flux will attract the applied particles making the size and shape of the discontinuity visible.

Magnetic particle examination is relatively low cost and provides immediate results. It can be used for a variety of applications to detect surface and subsurface defects when other testing methods are unavailable. Equipment that can benefit from type of testing include DA tanks, welds, gears, manufactured parts, and metal surfaced that can have a magnetic field applied.

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Eddy Current testing can help detect surface and sub-surface flaws in conductive materials using the principal of electromagnetic induction. Eddy-current testing is commonly used to determine the condition of heat exchanger tubes in commercial refrigeration and air conditioning systems but can also be used to determine the condition of heat exchangers in a variety of applications. For example, the remaining life of a heat exchanger can be estimated based on trending eddy-current test results. Chill water treatment programs can also be evaluated to help ensure that tube material is properly protected from corrosion. Pitted, corroded, and thinning tubes found during this testing can be identified and repairs can be made before leaks occur. Proper use of eddy-current testing can help to prevent unplanned outages and determine the remaining life of heat exchangers.

Thermographic (Infrared) Inspections use an infrared camera to visually detect abnormal temperatures in operating equipment, such as electrical switchgear and panels, transformers, cables and bus, motors and thermal insulation. These abnormal temperatures can represent a variety of adverse conditions including, but not limited to lose electrical connections, dirty electrical equipment, deteriorating electrical insulation and failing mechanical bearings. An infrared camera detects the intensity of infrared radiation emitted by an object and the information is converted into an image. The image displayed represents the variation in temperatures of the object using different color intensities. Equipment can be scanned from a distance without contacting the object being inspected.

Vibration Analysis is a predictive technique where the operating frequency, or vibrations, of rotating equipment is measured and analyzed. Vibration analysis results can be compared to previous results in order to develop a base line and trend history. This data can be used to indicate adverse equipment conditions, such as imbalance or impending bearing failure. When vibration analysis indicates incipient failure, maintenance can be planned before a breakdown occurs, allowing the facility to avoid an unplanned outage.

Equipment that can benefit from vibration analysis includes electric motors, internal combustion engines, refrigeration and air conditioning compressors/chillers, pumps, fans, and rotating machinery such as motors and gear sets.

Ultrasonic Inspections are used to measure the thickness of materials and to detect subsurface defects in a wide variety of materials including metals, ceramics, plastics, glass, and rubber. In an ultrasonic inspection, high frequency and highly directional sound waves pass through an object and bounce back to the instrument that monitors, records and analyzes the wave patterns to document the test results. Equipment that can benefit from ultrasonic testing includes air receivers, ammonia refrigeration piping and pressure vessels, boiler tubes, pressure vessels and piping, and mechanical and hydraulic presses.

Another common use for ultrasonic testing is in the predictive maintenance of rotating machinery, such as motors, fans and pumps. Ultrasonic testing can be used to detect a variety of conditions including bearing problems, imbalance issues, rubbing, etc. Ultrasonic testing used in this way can be especially helpful for identifying problems in slowly rotating machinery where vibration analysis is less effective.

When considering nondestructive testing as part of your maintenance program, it is beneficial to evaluate all methods available. This can help you determine the best option for your specific equipment.