



# TOOTH TIPS

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There are a wide variety of inspection techniques available depending on what you're checking, and what you're checking for. Read on to learn more.

**CHEMICAL ETCH INSPECTION** is a standardized procedure for the detection and classification of localized overheating on ground surfaces. Damage may commence with the partial changing of beneficial compressive stresses at and below 500° C. When temperatures increase to nearly 600° C, B-class thermal damage (re-tempering burns) occurs. This has the effect of reducing the surface hardness and the onset of material stresses. When the temperatures rise above 720° C re-hardening burns with hard and brittle material appear, known as D-class thermal damage.

Prior to the issuing of standards there was a wide variation in the solution strengths and the time taken for the chemical etch inspection. This inspection method is more sensitive to hardness changes than most other hardness testing methods. The ISO standard applies to hardnesses higher than 40HRC, but does not apply to stainless steels or nitrided parts. The AGMA standard 2007-B92 is called "Surface Temper Etching after Grinding." There is also another popular specification ML-STD-867A.

Before inspection all surfaces have to be cleaned to ensure that they are free of all dirt, grease, and oil. When inspected the appearance indicates the part's condition. Localized tempered areas appear as dark gray or black, and the severity of the temper burns increase as the color darkens. Those parts that are considered problematic are usually subjected to a further magnetic particle inspection.

*Crack Inspection:* "Direct" and "indirect" methods are used for crack detection. The direct methods include visual, penetrant, magnetic particle, and x-ray. The indirect uses ultrasonic eddy current and acoustic emission. The visual is self explanatory, using the naked eye, magnifying glass, or microscope, etc.

*Liquid Penetrant:* This nondestructive method is used to find imperfections in the surface of a casting. The colored liquid covers the surface of the casting and penetrates any cavities. When the excess is cleaned, the presence and location of any discontinuities can be observed. The penetrant usually has an added bright-looking dye or a liquid that can be observed under ultraviolet light in its mix. To be acceptable the test requires trained personnel, and the part must be chemically cleaned. The dyed fine thin oil must remain on the surface for approximately 15 minutes. The test is simple, but it only detects surface defects. The process is wasteful of the dye and may require tanks, spraying, and drying equipment.


*Magnetic Particle:* This nondestructive test is designed to locate surface and near-surface flaws in ferrous magnetic materials. It is a very sensitive method of locating shallow surface cracks and those just beneath the surface. The basic requirement is that

the part must be properly magnetized so that the cracks attract the finely divided magnetic particles. The particles will align themselves on the surface in the direction of the defect. The test is not failsafe and must be carefully performed.

*Ultrasonic:* Ultrasonic determines the internal soundness and cleanliness of gearing by passing sound (ultrasound) through the gear. The returning sound waves are monitored and converted into voltage that can be monitored on an oscilloscope screen. The wave is reflected at the crack and its ends. This method detects distant internal and surface defects in sound conducting materials. One of the chief functions of acoustic micro-imaging is locating and analyzing very fine internal cracks. Recent developments allow the detection of crack widths in a range from 0.01 to 0.10 microns. Forgings for high power and high speed are susceptible to cracks and should be ultrasonic tested in seven positions to ensure against catastrophic failure. The detectors are fully solid state and can be battery powered and automated. The eddy current method besides determining cracks can measure conductivity, hardness, permeability, and coating thicknesses.

**"When using chemical etch inspection the appearance indicates the part's condition, with localized tempered areas appearing as dark gray or black, and the severity of the temper burns increase as the color darkens."**

*NDT Process:* Wayne State University has developed the NDT process to detect closed cracks. A test station is used in gear manufacturing to supplement or even replace other crack inspection methods. The station directs a high frequency sound to create a vibration in the part. The two sides of a crack will also vibrate, but not in unison. An infrared camera then detects the heat generated by the crack. The method detects cracks regardless of their orientation, vertical cracks being notoriously difficult to pin point by other methods.

*Fourier Transform Infrared (FT-IR) Spectroscopy:* Is the current analytical technique used for plastic materials. By measuring molecular vibrations the material being inspected can identify the resins, contaminants, chemical agents, and molecular degradation. Three other supporting analyses are Thermogravimetric (TGA), Thermomechanical (TMA), and Dynamic Mechanical (DMA). 

## ABOUT THE AUTHOR:

William P. Croser is former director of the National Conference on Power Transmission, as well as former chairman of the AGMA's Marketing Council and Enclosed Drive Committee. He was resident engineer-North America for Thyssen Gear Works, and later at Flender Graffenstaden. He is author of the book *Design and Application of the Worm Gear*.