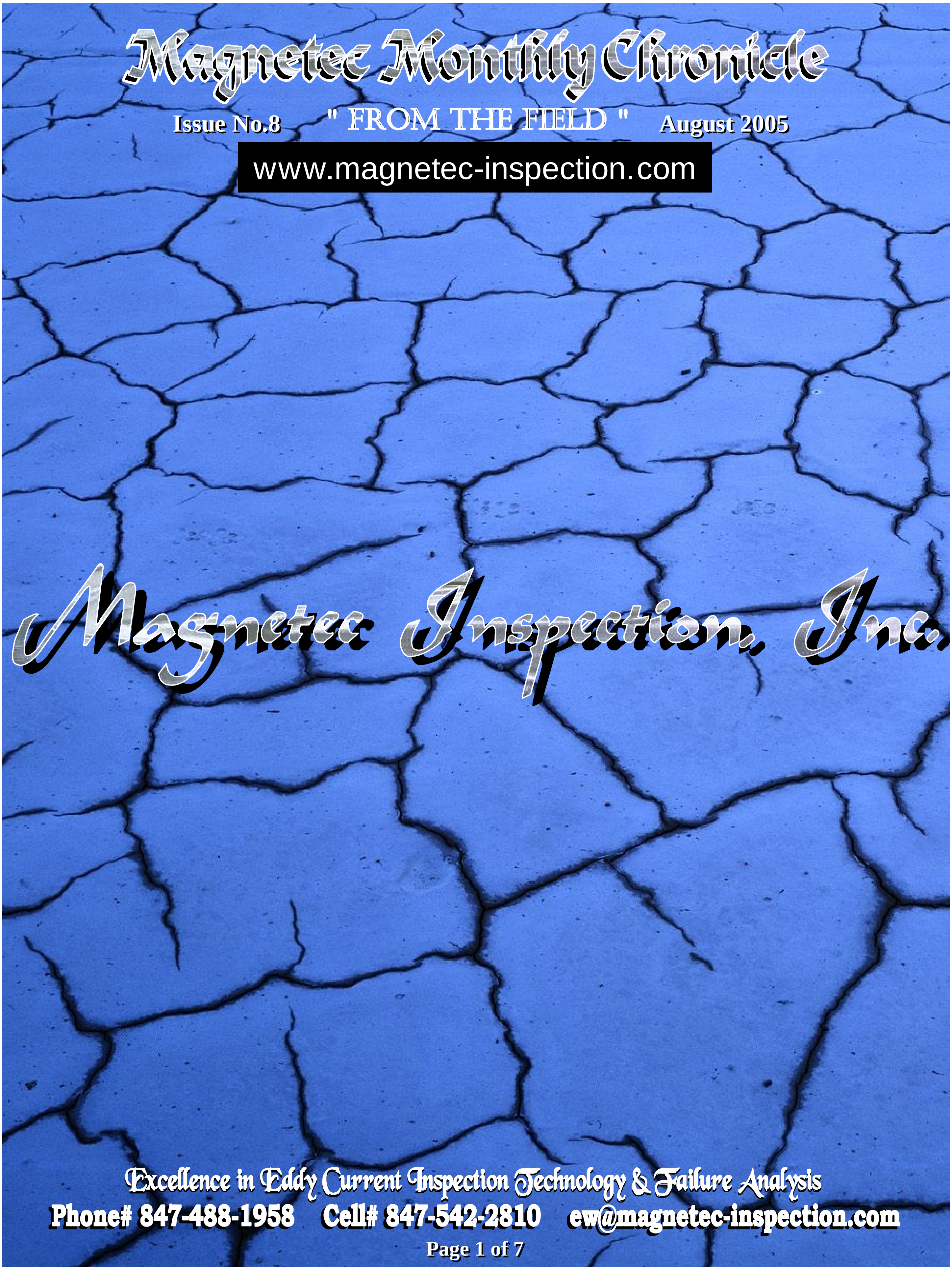

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Excellence in Eddy Current Inspection Technology & Failure Analysis

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RJG (Ring Joint Groove) Inspection Technique Does this Work !?!

Subject: New technique to Inspect RJG Grooves

The Nozzle and blind were found in a large Gulf coast refinery. The nozzle acts as a Catalyst unloading port on the third level tray of a Hydro-cracking reactor

The surface Eddy Current Test was performed in combination with a Penetrant type inspection to determine effectiveness of technique and to aid in depth determination and repair. The RJG joint was 10" in diameter and of standard design. There was no previous inspection/eddy current inspection history for the nozzle and the past visual inspections found/reported no adverse conditions. The Condition of the surface and discoloration of the groove tended to mask the presence of any cracking mechanism. The inspection scheme was performed on the bottom land and angled vertical edges of the RJG grooves. The Penetrant test was performed prior to the Eddy Current Test which found 5 single defects aligned at the bottom of the groove and extending from angles edge to edge of the groove configuration. The Eddy Current test detected the cracks and noted they were inter-connected with inter-granular cracks which affect the material from the 3rd to 5th crack face. The Eddy Current Test inspection noted the cracks into/up the side of the angled surfaces with depths

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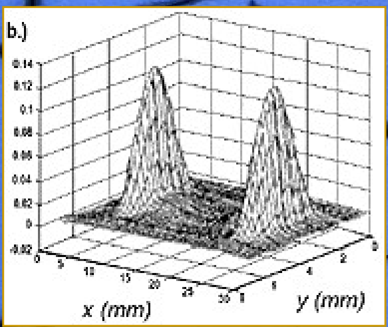
greater than .050 and total crack coverage of 5” across the groove surface. The groove was machined to prepare for repair which highlighted the cracks and the inter-granular extension of the crack face. Post machining Eddy Current Test inspections were performed to determine the extent of the repair required which finally removed ½” of the parent material in the affected area. The groove was repaired by weld material build-up and machining to return groove to original condition. The Eddy Current Test inspection required no surface prep or cleaning was performed in ½ the time of the Penetrant technique and provided more information on the cracking mechanism.



The following is a discussion of ACFM & Eddy Current Test techniques which can be utilized for the inspection of surface breaking cracks in Ferrous & Non-Ferrous Materials

Crack Depth Measurement Using ACFM

AC field measurement (ACFM) is a recently developed electromagnetic technique which offers the capability of detection and sizing of surface-breaking cracks without the need for calibration or cleaning to bare metal. ACFM is in effect a natural extension of Eddy Current inspection techniques with the uniform injected current replaced by a uniform field induced by a driver coil and the contact electrodes replaced by a set of orthogonal pick-up coils. The measurements are performed by scanning the probe along the crack face.

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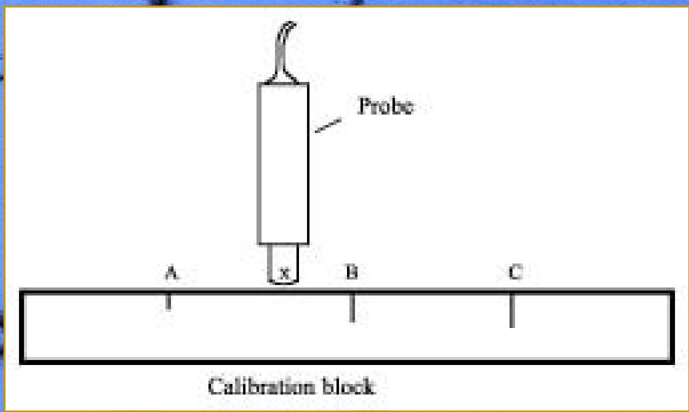
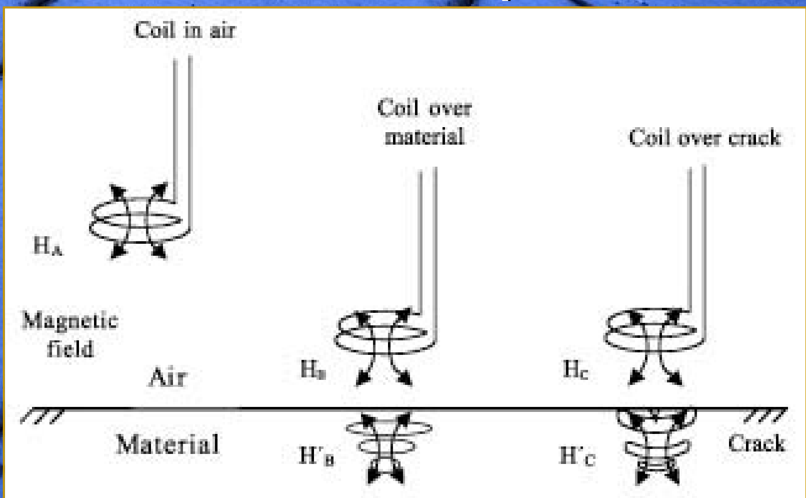
Eddy-Current Crack Depth Measurement

The detection of surface and slightly sub-surface cracks by the Eddy Current Technique has been successively utilized by many different industries (aerospace, automotive, etc.) for over 20 years. The ability of detecting surface breaking cracks basically involves passing a coil(s) of correct design and orientation over a defect where the operating characteristics change and are presented to the equipment operator.



The Eddy Current response is based on the inter-action of the parent material and the electrical condition of the probe as it passes material with no defect or in the presence of a crack/ corrosion.



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As the inspection probe encounters a defect the probe delivers a response, a signal which contains both amplitude and phase information which can be correlated to the defect in question. Interpretations of these components provides the inspector with information of the defect type, orientation, extent, & depth.

Current methods for practical crack-sizing using ACFM or Eddy Current techniques are based either on the use of calibration cracks or on the estimation of crack depth from measurements of the surface crack length assuming that the crack has a known aspect ratio. Both approaches have limitations.

A major drawback in using the surface crack length (whether determined from the eddy-current probe response or directly from in-situ metallography) to infer crack depth is that the assumed length-to-depth ratio may be incorrect for the particular crack under investigation. For example, the crack depth will be overestimated if the crack has grown through coalescence of shallow cracks having multiple origins rather than through the growth of a single crack, or may be underestimated if the crack has initiated from an unexpected sub-surface defect. A further question is what length-to-depth ratio should be assumed in the absence of any fractographic or detailed fracture mechanics information. Such problems are less severe in the case of quadrant or corner cracks, where the crack intersects two surfaces and abnormal crack geometry can be more easily ruled out.

In principle it is possible to estimate crack depth by comparing the eddy-current signal from an unknown crack against data from a calibration crack of the same surface length in the same component, presuming the depth of the calibration crack is already known and that materials factors such as crack closure, crack branching and crack-face contact are equivalent. In practice, such a library of calibration cracks is rarely available, however defect response and signal presentation can be utilized in conjunction to give fairly accurate crack configuration, depth and extension information.

NOZZLE #3

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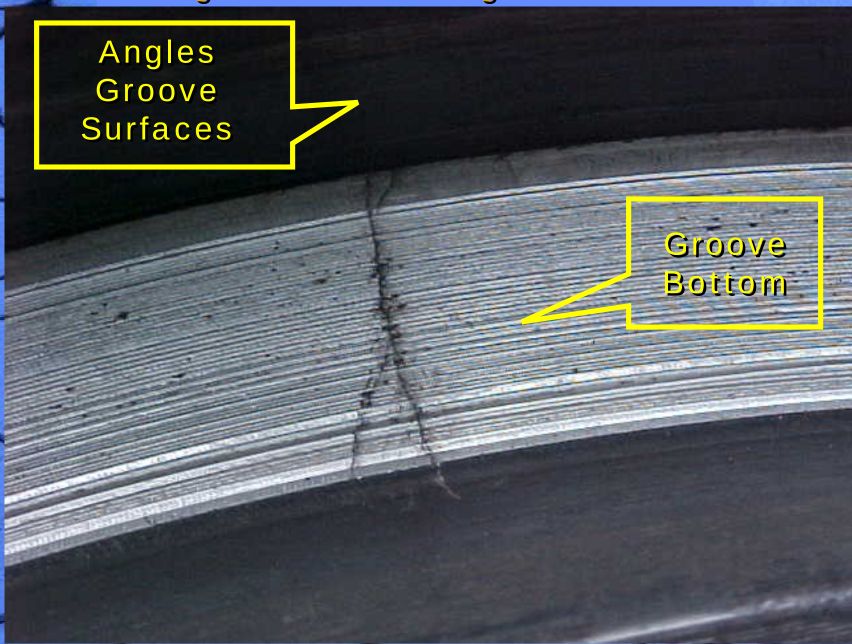
Enlarged Photo of Single Crack Face



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