Chapter 1 : Nondestructive Testing Handbook

Nondestructive Testing Handbook, Third Edition: Volume 7, Ultrasonic Testing (UT) A collaborative effort of Ultrasonic Testing (UT) experts. Editorial emphasis on practicality with information useful to Level II and Level III inspectors.

History[edit] On May 27, , U. Floyd Firestone of the University of Michigan applies for a U. The patent is granted on April 21, as U. Extracts from the first two paragraphs of the patent for this entirely new nondestructive testing method succinctly describe the basics of such ultrasonic testing. For instance if a casting has a hole or a crack within it, my device allows the presence of the flaw to be detected and its position located, even though the flaw lies entirely within the casting and no portion of it extends out to the surface. The general principle of my device consists of sending high frequency vibrations into the part to be inspected, and the determination of the time intervals of arrival of the direct and reflected vibrations at one or more stations on the surface of the part. The crystal vibrates at the ultrasonic frequency and is mechanically coupled to the surface of the specimen to be tested. This coupling may be effected by immersion of both the transducer and the specimen in a body of liquid or by actual contact through a thin film of liquid such as oil. The ultrasonic vibrations pass through the specimen and are reflected by any discontinuities which may be encountered. The echo pulses that are reflected are received by the same or by a different transducer and are converted into electrical signals which indicate the presence of the defect. These nonlinear methods are based on the fact that an intensive ultrasonic wave is getting distorted as it faces micro damages in the material. These amplitudes can be measured by harmonic decomposition of the ultrasonic signal through fast Fourier transformation or wavelet transformation. The scanner, which consists of a frame with magnetic wheels, holds the probe in contact with the pipe by a spring. The wet area is the ultrasonic couplant that allows the sound to pass into the pipe wall. Non-destructive testing of a swing shaft showing spline cracking In ultrasonic testing, an ultrasound transducer connected to a diagnostic machine is passed over the object being inspected. The transducer is typically separated from the test object by a couplant such as oil or by water, as in immersion testing. There are two methods of receiving the ultrasound waveform: In reflection or pulse-echo mode, the transducer performs both the sending and the receiving of the pulsed waves as the "sound" is reflected back to the device. Reflected ultrasound comes from an interface, such as the back wall of the object or from an imperfection within the object. The diagnostic machine displays these results in the form of a signal with an amplitude representing the intensity of the reflection and the distance, representing the arrival time of the reflection. In attenuation or through-transmission mode, a transmitter sends ultrasound through one surface, and a separate receiver detects the amount that has reached it on another surface after traveling through the medium. Imperfections or other conditions in the space between the transmitter and receiver reduce the amount of sound transmitted, thus revealing their presence. Using the couplant increases the efficiency of the process by reducing the losses in the ultrasonic wave energy due to separation between the surfaces.

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Chapter 2 : ASNT Level III Refresher Courses

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Ultrasonic Test Techniques Part 3. Immersion Coupling Devices Part 4. Water Couplant Characteristics Part 5. Immersion Testing of Composite Materials Part 8. Angle Beam Immersion Techniques Part 9. Focused Beam Immersion Techniques Part Acoustical Holography Chapter 8. Ultrasonic Characterization of Material Properties Part 1. Fundamentals of Material Property Characterization Part 2. Material Characterization Methods Part 3. Measurement of Elastic Properties Part 4. Microstructure and Diffuse Discontinuities Part 5. Ultrasonic Testing for Mechanical Properties Part 6. Ultrasonic Testing of Advanced Materials Part 1. Ultrasonic Testing of Adhesive Bonds Part 3. Metals Applications of Ultrasonic Testing Part 1. Ultrasonic Testing of Primary Aluminum Part 3. Chemical and Petroleum Industry Part 2. Ultrasonic Testing in Processing Plants Part 3. Storage Tanks Part 5. Inservice Inspection in Power Plants Part 2. Nuclear Power Plants Part 3. Fossil Power Plants References Chapter Infrastructure Applications of Ultrasonic Testing Part 1. Aerospace Applications of Ultrasonic Testing Part 1. Aerospace Material Production Inspection Part 3. Inservice Inspection of Aircraft Part 4. Special Applications of Ultrasonic Testing Part 1. Reliability of Nondestructive Testing Part 2. Ultrasonic Testing in Railroad Industry Part 3. Ultrasonic Testing in Marine Industry Part 4. Acoustic Microscopy Chapter Ultrasonic Testing Glossary Part 1.

Chapter 3 : Ultrasonic testing - Wikipedia

Ultrasonic Handbook Features: A collaborative effort of Ultrasonic Testing experts Editorial emphasis on practicality with information useful to Level II and Level III inspectors Applications arranged according to industry: aerospace,chemical-petroleum, electric power, infrastructure, metals Chapters on applications in material.

The values of these coefficients are presented in Table 1. Acoustic impedances are taken from [2] and are for babbitt From the data presented in Table 1 follows that in the case of delamination the pulses reflected inside the babbitt layer are decaying much less. The second difference is that the pulses reflected by a delamination are of an opposite polarity than the pulse reflected by the inner surface of a bearing. In the case of a good adhesion only even multireflected signals are of the opposite polarity. Of course, if only the amplitude will be taken into account in both cases we shall loose the information about the sign of the reflection coefficient. Evaluation of the delamination area Fig. The dependence of the integral reflection coefficient from the ratio of delaminated area and ultrasonic beam crossection area The minimal detectable area, coverage and accuracy of a total delamination area evaluation are critical parameters in NDT of bearings. If the area of delaminated zone is less than the beam crossection area, the total reflected signal is the result of interference of the signals reflected from delaminated and perfectly bonded zones. Note, that the reflection coefficients K1d and K1 can be positive or negative depending on the acoustic impedances of media at the particular point of the boundary. The dependence of the from the ratio of delaminated and perfectly bonded covered by an ultrasonic beam is presented in Fig. The minimal detectable area can be determined setting threshold level equal to 2I1 for the first reflected pulse I1 when a polarity of the signal is not taken into account. The minimal detectable area in this case will be approximately 0. Using the second reflected signal I2 the sensitivity can be higher and, correspondingly, minimal detectable area is approximately 0. When the delaminated area covers only a part of the beam crossection region the amplitude of the first reflected pulse I1 can be less then the amplitude of the second reflected pulse I2. This can be used as an indication that the delaminated zone does not cover the beam crossection completely. A coverage can be evaluated taking into account that in the case of a disk transducer the ultrasonic beam spot on the boundary has a circular shape with the diameter very close to the diameter of transducer. So the maximal scanning step allowing to cover a whole surface of a bearing is equal to , where dt is the transducer diameter. The most conservative approach in the calculations of a total delamination area is to assume that at each scanner position, where the delamination was detected, the area of the delamination is equal to the area of the rectangle with the sides corresponding to scanning steps in both directions. In order to achieve a higher accuracy of the estimation of delaminated areas it is necessary to perform scanning with a smaller step and to take into account that on the delamination edges only a part of ultrasonic beam crossection is covered by the delamination zone[2]. Structure of the system Fig. Structure of ultrasonic system for NDT of journal bearings The developed ultrasonic system for NDT of journal bearings consists of the electronic unit, the scanner, the testing tank, set of the ultrasonic transducers and IBM PC type computer with a specialized software. The structure of the system is presented in Fig. The two coordinate scanner possess two stepping motors. The minimal scanning step in the vertical direction along the axis of a bearing is 0. The test tank filled with water is used to place bearings during testing. The tank has special holders and centering mechanism enabling positioning of the bearings with an accuracy about 1 mm. Heavily damped ultrasonic transducers with the central frequency 10MHz and the diameter 5mm are used for radiation and reception of short ultrasonic pulses. The duration of emitted ultrasonic signals is about one period. The original software have been developed to control the whole testing process. It is implemented in multiwindows mode enabling to create a convenient user interface form. The test results can be presented in the usual A,B,C scan modes with a selected option of signal processing. The bearing testing report contains a spatial distribution of delaminated zones and their total area. C-scan image of the bearing with delaminated zones denoted as dark areas red in colour coding Fig. B-scan image of the bearing containing delaminated zones. At these zones long reverberations of the signal inside the babbitt layer exist. Location of the B-scan is shown in Fig. C-scan image of the steel shaft containing delaminated zones indicated as red on colour image The test results are presented in Fig. The dark areas correspond to delamination zones. There is one large defective zone near the upper edge of the bearing which shows that this bearing can not be used. The few smaller delaminated spots, shown in the middle of the image, most likely occurred during manufacturing of the bearing. The B-scan presented in Fig. Ultrasonic testing of materials. Springer- Verlag, Berlin- Heidelberg, Nondestructive Testing Handbook, 2nd edition, vol. American Society for Nondestructive Testing, Kaunas University of Technology http:

Chapter 4 : Ultrasonic non-destructive testing system of journal bearings

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Chapter 5 : Nondestructive Testing Handbook Third Edition Volume 7 Ultrasonic Testing (Ut) Pdf

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Chapter 7 : Nondestructive Testing Handbook, Third Edition: Volume 7, Ultrasonic Testing (UT)

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