EMAT TRANSDUCERS

EMAT PRINCIPLE

Sonatest EMAT transducers consist of a Neodymium-Iron-Boron-Magnet and a specially designed field coil. The permanent magnet produces a vertically polarised constant magnetic field that penetrates the outer surface of the material. The Flaw Detector generates an alternating current in the coil, which in turn produces an eddy current field and a Lorentz Force in the material being tested. When used with ferromagnetic materials with oxidized coatings, the electromagnetic forces set up in the surface layer, using the magnetostrictive principle to transmit and receive an ultrasonic pulse.

APPLICATIONS

- ▶Boiler tubes with oxidised & corroded surfaces
- ▶Incinerators & refuse burners
- ▶Nickel/Permalloy plated ferrous metals
- ▶Superheated tubes with scale up to 5-7mm thick
- ▶High temperature operations

EMAT FEATURES

▶A non-contact shear wave Electro Magnetic Acoustic Transducer.
▶Construction consists of a plastic case with side entry cable and knurled grip, or rugged brass case with integral adjustable wear/distance ring.
▶Measures the thickness through oxidized and corroded surfaces.
▶Does not require any couplants (oil or water).
▶No surface grinding required and therefore no further damage to materials under inspection.
▶Accuracy of EMAT ± 0.1mm (if used with Sonatest MS 340 Digital Flaw Detector).
▶Neodymium-Iron-Boron Magnet for ultra high field strength.

SPECIFICATIONS

TYPE	EMAT 5-0.5 STD Plastic Case	EMAT 5-0.75 SO Brass Case
Size	18-22 mmØ x 20 mm long	28 mmØ x 58 mm long
Cable	1.8 meters long (side entry)	1.8 meters long (top entry) *cable bought separately
Frequency	5 Mhz ±10%	5 Mhz ±10%
Connector	BNC	BNC
Weight	62g	122g
Pulse Duration	1.0µs *(Sonatest MS340)	1.0µs *(Sonatest MS340)

MEASURING INSTRUMENTS & EMATS

EMATs are more difficult to drive than piezoelectric transducers, Sonatest recommend that these EMATs be used with its MS340 range of products that have been optimised to operate correctly with these devices.
▶*The MS340 ensures that the EMAT properties are fully exploited; other flaw detectors do not have the voltage gain or the fast TX pulse recovery when driving an EMAT*.
These EMATs have been designed for the measurement of ferromagnetic materials whose surfaces are oxidised due to exposure to very high temperatures, they will not operate on materials with clean surfaces.

EMAT Probes and the Sonatest MS340
Corrosion Testing of Power Generation Coal-Fired Boiler Tubes

EMAT & MS340 Applicat

Unscheduled shutdowns, repairs and power replacement, due to boilers in electric power generation plants, cost the utility industry over $5 billion per year in the US alone. NDT using A-scan flaw detectors with conventional piezoelectric transducers, used to measure the wall thickness and determine the degree of corrosion, is a long established technique to predict the life of boiler tubes. However, such tests require clean, rust free surfaces and all tubes must be sand-blasted and cleaned prior to the inspection. Since no other form of maintenance can be conducted inside the boiler while these tubes are being cleaned, then this process is directly adding to the outage duration, where just one extra day of shutdown can cost $500,000 for a typical 500MW plant. It is easy to see the cost benefits in using an NDT technique which does not require tube cleaning. This report outlines a fast growing technique in the coal fired power stations using EMATs.

It should be emphasized that this technique is only suitable for tubes which have a non-conductive layer, and the best application is testing of boiler tubes that are oxidised by exposure to high temperatures over 450C. Thick, crusty scale with strong magnetostrictive properties is produced at such temperatures making EMATs ideal for thickness measurement in water-wall, superheater, reheater and economiser sections of coal fired boilers. Tests have shown that the EMAT wave can be transmitted through as much as 5-7mm of rust and corrosion. They are not suitable for measurement of clean tubes or painted tubes.

Equipment

UK power generation companies have performed exhaustive trials in their quest to find the best combination of EMAT probe and digital ultrasonic flaw detector, this included the use of expensive pre-amplifiers needed to generate sufficient power with certain manufacturers flaw detectors. A leading UK power station operator has sourced EMATs which can be driven by a portable flaw detector alone. Furthermore they have determined that the EMAT can only be used with certain flaw detectors due to the recovery time of the initial pulse. Most flaw detectors do not have the facility to reduce the pulse width sufficiently to eliminate the standing echo caused by this recovery time, and cannot measure below 2mm.

The only equipment which is deemed suitable for this application are the Sonatest MS330, MS335 & MS340 instruments.

Calibration

Gate 1 +ve (30% height)
Measurement mode Depth, H-U-D on distance, Peak mode*
Single probe operation
Frequency 5MHz
Detect FWR
Set contour to 3
Set TX pulse width to minimum (20ns)
Adjust damping to achieve maximum amplitude from returned signal
200 volts (400V NOT suitable)
Velocity = 3230m/s
Range = 10mm
Adjust gain until echo height is about 80% (will be high gain about 100dB)
Adjust probe zero until thickness reads same as test tube thickness
**** Peak is the preferred measurement mode due to the nature of the EMAT waveform.***

Using the T-Min feature in the Measurement menu, the minimum thickness from each scan can be stored in T-Log in the Memory menu. Used with numeric rather than sequence mode the boiler tubes are easily identified in the standard format.

e.g. Batch 2 = Wall 2 Loc 3 = Level 3 No 234 = Boiler Tube 234

Stored readings can then be instantly downloaded into Microsoft Excel via Sonatest SDMS software.

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