

## EDDY CURRENT TESTING OF ZIRCALOY WIRES (\*)

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Fuel bundles for Rajasthan Atomic Power Reactor, consist of a cluster of 19 elements held together by zircaloy and plates and spaced by wire helices on the six elements of the inner ring and alternate elements of the outer ring. As in the case of all other reactor materials, the zircaloy wire also need be inspected 100% to avoid any defective part entering the reactor system. The zircaloy wire must be free from defects such as seams, internal voids, welded spots etc apart from the dimensional and metallurgical requirements.

The eddy current test is an electromagnetic test applicable to the examination of electrically conducting test specimens for detecting any flaw.

In eddy current testing high frequency alternating currents is caused to flow in the test coil which in consequence produces magnetic field in the vicinity of the coil. If a conducting test specimen is introduced into this field, currents known as Foucault or eddy currents are induced in the specimen by electromagnetic induction. Variations in eddy currents are caused by flaws and so cause variations in the impedance of the coil. These impedance variations can be analysed, and their magnitude and phase can give information concerning the identification and severity of the flaw.

#### Test Procedure and Results

a) Description of the unit - The eddy current wire tester model FW 201 supplied by M/s Magnaflux Corpn, has been used in our preliminary studies on zircaloy wire. The unit has a fixed frequency oscillator tuned to 625 kc/s.

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The feed through differential coil set having the two coils in different axes is plugged into the unit. Special teflon guides have been made to suit the zircaloy wires under investigation.

b) Defect standards - The normal defect standards suggested are drilled holes, surface notches and welded and filed joints. The unit can be standardized with any specified defect standard and the threshold level can then be adjusted such that in the actual wire testing any defect indication more than that of the defect standard can be made to trigger an alarm. The indications can also be continuously recorded while the wire is pushed through the coils.

c) Preliminary investigation - The eddy current unit is put on and is allowed for stabilization. Proper connections are made for the recorder and the recorder also is put on. Through one of the coils, a sound (defect free) sample of 1.25 mm wire is kept and through the other defect standard is passed. Initially a sound portion of the defect standard is balanced against the other wire.

The artificial defects are then passed through the second coil and the corresponding oscilloscope indications and recorder charts are studied.

The pattern of indications on oscilloscope are different for different type of defects. In a normal production line, wire is fabricated starting from a given ingot through different main stages of processing such as extruding and/or rolling into smaller sections which are further drawn to the specific sizes. In our particular cases, the standard flaws that can be expected are dimensional variations, and defects like cracks, voids or seams. Since the type of coils we are using are of differential type, other variables (that could affect eddy current distribution) such as hardness, composition, heat treatment conditions are balanced out. As such it will be easier to a good extent to resolve the type of defects depending on the type of patterns indicated on the oscilloscope. The magnitude of the defect can only be recorded on the chart and it is not possible to differentiate the type of defect from the recording trace.

For production line inspection, the zircaloy wire to be inspected will be mechanically driven through the test coil from one intake spool to the other spool, keeping a short length of standard and acceptable type of wire (same dimensions as that of the test wire expected to be) in the other test coil. Good reproducible results have been obtained when the speed of the testing is of order 50 mm/sec and there is a scope for improvement.