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Creep Wave Methodology for Critical Evaluation in RLA of Boilers

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Abstract

This paper explains the innovative approach of effectively evaluating the presence of root crack by Creep wave Methodology during RLA study. Residual Life Assessment of Boilers/Life extension programme of Boilers demands critical examination and evaluation of critical high temperature and high pressure welds of Boiler including examination of girth welds of Super Heater and Re-Heater headers and Main steam line where the pressure and temperature reaches maximum like 540 degree centigrade and 170kg/cm square. And the mechanism of cracking either by thermal fatigue or creep damage mechanism may happen.

Hence, more effective reliable ultrasonic examination and evaluation is a must for safety and reliability of continuous boiler operation. The crack oriented from OD can be detected by Magnetic Particle Examination or Liquid Penetrant Examination after proper surface preparation removing deposits, rust, scale formed etc. And to detect root oriented crack, formed whether during welding by hydrogen cracking or hot cracking mechanism ,or service induced crack by thermal fatigue or creep damage mechanism, the effective detection can be achieved by employing ultrasonic creep wave methodology. Though conventional shear wave probes of 45 degree or 60 degree also will reveal the root problem, the signals due to root geometry may create, complication for reliable evaluation. This problem can be easily solved by effective use of Creep Wave Methodology to detect the presence or root crack, which is the most hazardous defect.

Creeping waves can be considered as compressional surface waves contrary to what is the case with Rayleigh surface waves whose speed differ from that of shear waves by a factor of approximately 0.9. The propagation speed of creeping waves is equal to that of compressional waves. Therefore, creeping waves can be generated by a transducer of which the primary angle [angle in Perspex] is equal to the first critical angle, meaning that compressional waves are theoretically transmitted parallel to the surface. Creeping waves are generated parallel to the scanning surface, enabling detection of surface breaking defects. The range of these creeping waves is limited because they are continuously converted into shear waves.

Creeping waves travel just below the surface rather than in it, therefore they are not influenced by the presence of coupling liquids, and the influence of surface irregularities is less than with Rayleigh CCSS waves. Hence, the problem of echoes from root geometry belonging to critical boiler pipe line but welds of the Main Steam Line, Super Heater Headers, Re-Heater headers can be solved with the help of creep wave scan to detect and confirm the presence of root crack, if any. Creeping waves suffer less from a coarse material structure than Rayleigh CCSS. Compression waves are generated under angles of 75 degrees to 80 degrees enabling detection of sub surface defects.

Secondary creeping waves are generated at the opposite surface, enabling detection of surface breaking and near surface defects in that area - that means this same phenomena could be innovatively utilized to detect root crack in RLA study of boiler pipe critical welds. Creeping waves will not follow the surface contour, as is the case with Rayleigh CCSS waves. This enables a situation and offers possibilities to inspect weld caps without grinding the weld flush with parent metal. Creeping wave probes are like other compressional transducers usually of the "Separate transmitter and receiver" type.

The pioneers in RLA study of critical boilers, the Electric Power Research Institute/USA, uses the technique of ultrasonically plotting the cross sectional view of the butt joint, and locating the signal source at root to confirm whether there is any root crack or the signal is only due to root geometry. The evaluation of root signal is made clear and effective by the innovative application of creep waves methodology for safe reliable continuous operation of utilities