

Failure and Stress Analysis of Super Heater Tubes of a 67 TPH Coke Dry Quenching Boiler

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Abstract : The steam superheater (SH) is a coil type heat exchanger which is used to produce superheated steam or to convert the wet steam to dry steam (69.6 kg/cm² and 495°C), generated by a boiler. There were two superheaters in the system, SH I and SH II. SH II is a set of tubes that faces the initial interaction with flue gas at high temperature followed by SH I tubes. After a service life of 2100 hours, a tube in the SH II found to be punctured. Dye penetrant test revealed that out of 50 such tubes, 14 more tubes had severe cracks at a similar location. The failure was investigated in detail. The materials and scale were characterized by optical microscope and advance characterization technique. Scale, observed on fracture surface, was characterized under scanning electron microscope and Raman spectroscopy. Stresses acting on the tubes in working condition were analyzed by finite element method software, ANSYS. Cyclic stresses were observed in the simulation at the same prone location due to restriction in expansion of tubes. Based on scale characterization and stress analysis, it was concluded that the tube failed in thermo-mechanical fatigue. Finally, prevention and control measures were taken to avoid such failure in the future.

Keywords : finite element analysis, oxide scale, superheater tube, thermomechanical fatigue

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