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Failure Analysis of Biomass Reheater Tube

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In a 150 MW biomass power plant, severe damage occurred in a Reheater Tube of the main steam production system, leading to a emergency shutdown in power production. The damaged Reheater Tube, made of grade ASME TP347H seamless stainless steel, and shields guard had been installed to prevent erosion caused by flying ash from fuel combustion. The tube operated at 20 bars internal pressure and contact with steam at an unspecified temperature while the external environment was approximately 540°C. The tube's service life was about seven years.

After examining the patterns and mechanisms of damage through SEM/EDS corrosion product analysis, cross-section microstructure examination, chemical composition testing and hardness testing it was found that the Reheater Tube suffered from Intergranular Oxidation. The tube lost its thickness over the course of its use. Damages began at the external wall before spreading to the internal wall, leading to cracking along grain boundaries. It was also observed that the grains on the external wall had expanded, opposed to the densification of grains observed in the internal wall. Such a scenario stemmed from the accumulation of fuel combustion residue on the surface of the outer tube, which reduced the heat transfer efficiency between the exterior and interior walls of the tube. The installation of shield guards contributed to the buildup of residue and the tube displayed hot spots receiving temperatures higher than its design temperature, thus causing damage.

The mechanisms of failure and prevention methods for the TP347H Reheater tube were further studied. The tube failure resulted from prolonged exposure to excessive heat, coarse oxidation along grain boundaries, and grain growth.