

INTISARI

Vortex finder merupakan komponen penting pada *cyclone boiler Circulating Fluidized Bed* (CFB) yang bekerja pada temperatur tinggi 850–950 °C dan terpapar partikel padat berkecepatan tinggi secara kontinu. Kondisi operasi tersebut menyebabkan komponen rentan mengalami degradasi material dan kegagalan. Penelitian ini bertujuan mengidentifikasi karakteristik kerusakan, menganalisis penyebab, serta menjelaskan mekanisme kegagalan *vortex finder* berbahan 253MA pada *boiler* CFB PLTU.

Metodologi penelitian meliputi pengamatan visual dan makroskopik, pengujian *Positive Material Identification* (PMI), uji tarik, uji kekerasan mikro, pengamatan struktur mikro metalografi, serta analisis *Scanning Electron Microscope–Energy Dispersive Spectroscopy* (SEM–EDS) dan *X-Ray Diffraction* (XRD). Pengujian dilakukan untuk mengevaluasi perubahan sifat material, degradasi mikrostruktur, serta karakteristik deposit yang terbentuk pada permukaan *vortex finder*.

Hasil penelitian menunjukkan bahwa kerusakan ditandai oleh deformasi plastis, penipisan dinding akibat erosi, oksidasi temperatur tinggi, dan terbentuknya deposit material asing yang berasal dari *refractory* dan *fly ash*. Analisis mikrostruktur menunjukkan pembesaran butir dan indikasi *creep* akibat paparan temperatur tinggi berkepanjangan. Mekanisme kegagalan terjadi secara bertahap dimulai dari erosi partikel padat, pembentukan deposit *refractory*, hingga munculnya *hotspot* lokal akibat hambatan perpindahan panas. Rekomendasi yang diusulkan meliputi pengendalian erosi, peningkatan kualitas *refractory*, penggunaan material atau *coating* yang lebih tahan temperatur tinggi dan erosi, serta penerapan pemeliharaan berbasis kondisi.

Kata kunci: *vortex finder*, kegagalan material, *hotspot*, SEM-EDS, XRD, *boiler* CFB

ABSTRACT

The vortex finder is a critical component in a Circulating Fluidized Bed (CFB) cyclone boiler operating at high temperatures of 850–950 °C and continuously exposed to high-velocity solid particles. These operating conditions make the component susceptible to material degradation and failure. This study aims to identify the damage characteristics, analyze the causes, and explain the failure mechanism of a 253MA vortex finder used in a CFB boiler at a coal-fired power plant.

The research methodology included visual and macroscopic examinations, Positive Material Identification (PMI), tensile testing, microhardness testing, metallographic microstructure observation, and analyses using Scanning Electron Microscope–Energy Dispersive Spectroscopy (SEM–EDS) and X-Ray Diffraction (XRD). These tests were conducted to evaluate changes in material properties, microstructural degradation, and deposit characteristics formed on the vortex finder surface.

The results showed that the failure was characterized by plastic deformation, wall thinning due to erosion, high-temperature oxidation, and the formation of foreign material deposits originating from refractory materials and fly ash. Microstructural analysis revealed grain coarsening and indications of creep caused by prolonged exposure to elevated temperatures. The failure mechanism occurred progressively, beginning with solid particle erosion, followed by refractory deposit formation and localized hotspot generation due to restricted heat transfer. Recommended actions include erosion control, improvement of refractory quality, the use of more heat- and erosion-resistant materials or coatings, and the implementation of condition-based maintenance.

Keywords: *vortex finder, material failure, hotspot, SEM-EDS, XRD, CFB boiler.*