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Short communication

Failure analysis of the impellers of coke plant

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ABSTRACT

Premature failure of the impeller blade of coke plant has been investigated. The component functioned during the CGC gas intake cycle. The component rotates at 1480 rpm with a volumetric flow of 720 m^3/min of flue gas with temperature about 200–300 °C. The failed component reveals exposed surface of a crack that extended slightly beyond the assembly weld. From macro-structural observation under-filled region in welding is observed which is detrimental because it acts as a stress concentration site. The microstructure from the weld zone showed severe intergranular corrosion degradation. Micro cracks and cracks have been observed at several locations, mostly originating from the weld zone. From the EDS analysis of the failed sample it is observed that there is a deposition of Cr along the grain boundary. From the mode of failure it indicates that probable reason for the premature failure is due to sensitization of the component. In this case, the precipitation of chromium carbides may be occurred during welding operation when the heat affected zone (HAZ) experiences a particular temperature range (550–850 °C). From the microstructure it is observed that the welding operation was not proper and there is every chance that there is heat generation in around sensitization range leading to precipitation of chromium carbides consumed the alloying element – chromium from a narrow band along the grain boundary and this makes the zone anodic to the unaffected grains. The chromium depleted zone becomes the preferential path for corrosion attack or crack propagation if under tensile stress. Thus it leads to premature failure of the component during service.
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1. Introduction

Centrifugal pumps are turbo machines used for transporting air or gas by raising a specified volume of the flow to a specified pressure level. The basic centrifugal pump components are: the casing, the bearing housing, the pump shaft and the impeller. As the impeller rotates, the gas is accelerated by the rotating element within the confined space created by the volume of the compressor's casing. The gas is compressed as more gas is forced into the volute by the impeller blades. The pressure of the gas increases as it is pushed through the reduced free space within the volute. In these studies premature failure investigation of impeller blade was carried out. The component functioned during the CGC gas intake cycle. The component rotates at 1480 rpm with a volumetric flow of 720 m^3/min of flue gas with temperature about 200–300 °C. The expected life of the component is 5 years while the component failed within 3 years of its service (Fig. 1).

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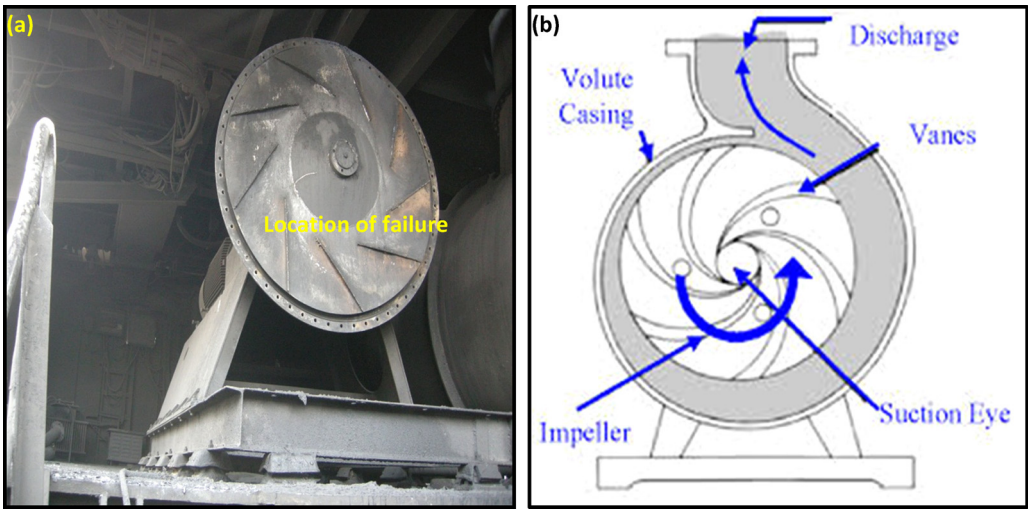

Fig. 1. (a) The assembly site of the failed impeller; (b) schematic drawing of the impeller.

2. Plant visit and visual observation:

Plant Visit was conducted to understand the problem. During plant visit it has been observed that after premature failure of the component several areas were detected on the blades and at the attachment zone of the blades and the hub where weld-repair work on the cast was performed. A triangular piece of the first centrifugal blower impeller blade was submitted for metallurgical analysis of the cause of cracking. The piece had been extracted from the rest of the blade, as referenced Fig. 2a. It contained an exposed surface of a crack that extended slightly beyond the assembly weld from the leading edge

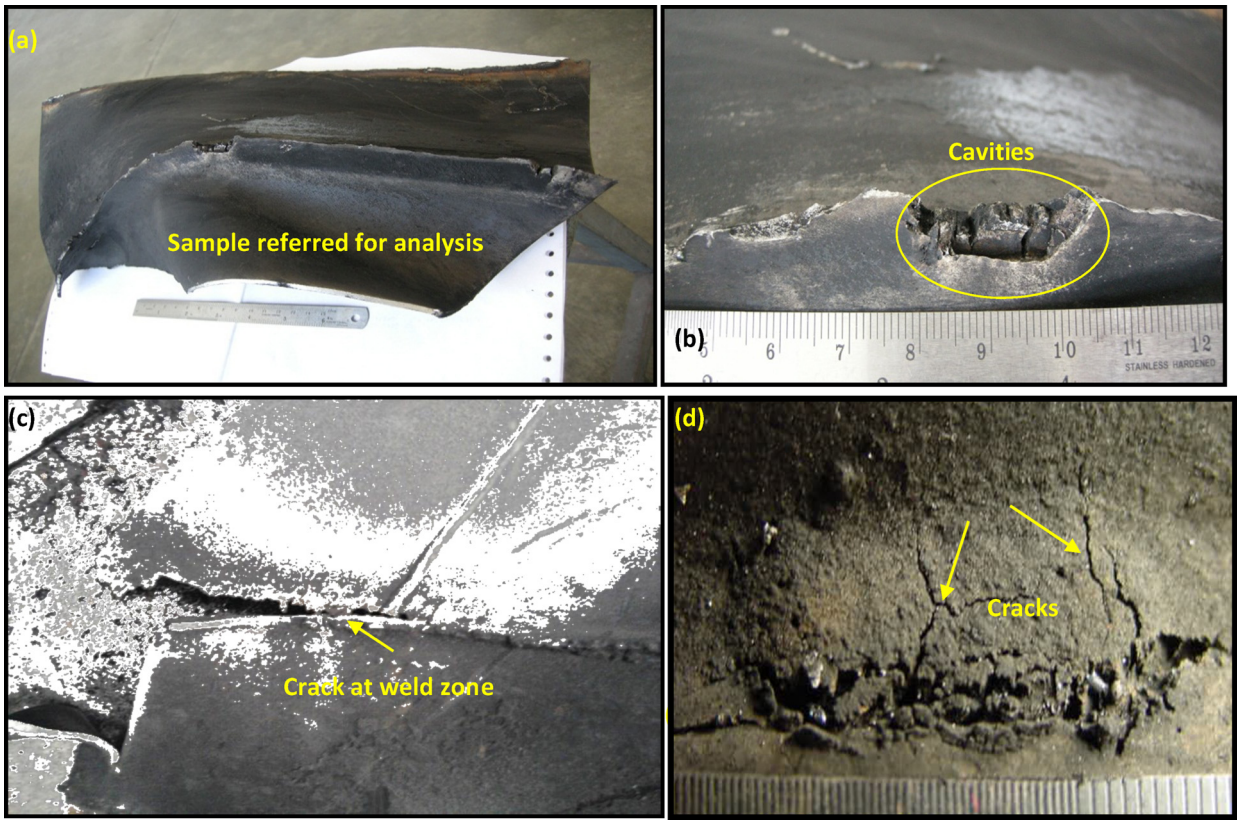

Fig. 2. (a) Full view of sample referred for analysis; (b–d) cracks at various location of the component.

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