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# Failure analysis on abnormal corrosion of economizer tubes in a waste heat boiler

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**Abstract:** Repeated shell side corrosion occurred on economizer tubes of a waste heat boiler. In order to find out the root cause of the corrosion, a series of characterization methods were conducted. First of all, the tubes were proved to be qualified A106 Gr.A steel in chemical compositions and metallographic structures. Then, both macroscopic and microscopic characteristics of the failed tube were observed thoroughly. After that, phase compositions of the deposits collected from failed tubes were analyzed. Content of sulfur and nitrogen of deposits was determined precisely as well. The results revealed that repeated failures were primarily owing to sulfuric acid dew point corrosion and the sulfur mainly came from waste liquid of methyl methacrylate (MMA). Finally, mechanisms of the failure were discussed in detail and practical countermeasures were put forward.

**Keywords:** Waste heat boiler, Economizer, Dew point corrosion, Failure analysis

## 1. Introduction

As the world has had a rude awakening from its abuse of exhaustible natural resources since the mid 20th century, implementation of waste heat boiler has played an increasingly significant role in industries. Nowadays, waste heat boilers are widely applied in chemical, petroleum, medicine and power industries to recover residual heat from flue gas and save companies millions of dollars. In a waste heat boiler, heat exchanger tubes are very critical components. Exposed to complicated operation conditions, such as high temperature, high pressure, corrosive flue gas, alkaline fly ash and so on, heat exchanger tubes of a waste heat boiler may often encounter severe failures. Common failure causes found in waste heat boilers can be classified into the following categories: material defects [1], high temperature corrosion [2, 3], stress corrosion cracking (SCC) [4, 5], dew point corrosion [6, 7], etc.

In this paper, a famous German chemical company utilized a waste heat boiler to deal with the waste liquid of methyl methacrylate (MMA) from upstream factories, not only taking advantage of exhaust gas, but also ensuring that emissions were environmentally friendly. Appearance of the waste heat boiler is shown in Fig.1. It was put into service in 2009. Unfortunately, the boiler suffered successive leakage and had to be shut down for repair four times in next five years, resulting in huge economic losses. Fig.2 shows the industrial process of the waste-to-energy conversation. In detail, the liquid waste collected by S-1930, atomized and mixed with natural gas, is sprayed into the thermal oxidizer where the gas mixture burns with preheated air, producing high-temperature exhaust gas. Then the hot flue gas is neutralized by aqueous ammonia to get rid of hazardous nitrogen oxides and make it green. After that, the gas flows through the waste heat boiler, which is composed of evaporator X-1981, super-heater X-1984, evaporator X-1982, evaporator X-1983 and economizer X-1985, making feed water absorb latent enthalpy of the hot gas. Finally, the low-temperature flue gas can be discharged into atmosphere directly with minimal impacts on the environment and the high-pressure steam is transferred to downstream plants to be used.

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