

金属管线高温环境下的断裂失效分析

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摘要: 某实验台采用了煤油进行高温壳体的冷却, 在实验过程中发生了输油管线断裂并引发燃烧的现象, 对此开展了断裂失效分析。首先采用体视显微镜与扫描电镜进行了断口观察与分析, 结果表明: 管线的开裂起源于焊缝根部, 具有典型的多源起源特征; 裂纹源区色泽为蓝色, 表明存在明显的氧化; 断口上呈现明显的疲劳辉纹, 间距为亚微米量级。进一步的根据辉纹间距与管材壁厚以及工作时间可确定出疲劳载荷的频率范围, 并根据理论公式对管线的共振频率进行了估算, 理论分析值与断口分析的结果吻合良好, 表明管线的断裂失效是典型的振动疲劳失效。为此, 建议对管线的安装进行约束以改变共振频率, 并改进焊接安装工艺, 问题得到了有效解决。

关键词: 金属管, 振动疲劳, 断口分析, 疲劳辉纹, 焊缝

Failure analysis on the fracture of a metallic pipe in high temperature

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Abstract: Kerosene was used to cool structure in high temperature in lab at Institute of Mechanics. In the course of an experiment, some of the kerosene pipes were broken and induced fire disaster. This paper investigate the failure of the pipes. At first, the fractograph were analyzed with stereomicroscope and SEM. The results indicated cracks initiated from the outside surface of the pipe near the welding line, and were of classical multisource type. The color of the crack initiation area is blue, which indicated the oxidation in these area. Fatigue striations were observed on the fracture surface with the submicro interval between each other. Then, the fatigue load frequency were estimated with the striations interval, the pipe thickness and the working time in the experiment. Which is in agreement with the natural vibration frequency estimated with the elastic theory. Based on these analysis, some fix point were added to change the natural vibration frequency of the pipe and decrease the vibration amplitude. And the welding process and the installation of the pipe were also improved to avoid initial injury. After this, there are no pipe failure again.

Keywords: metallic pipe, vibration fatigue, fractograph, fatigue striation, welding line