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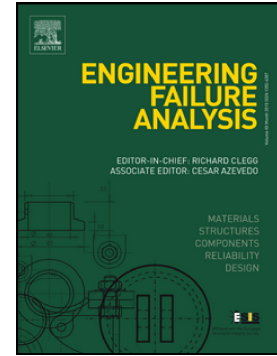
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Fracture of a Saddle Fusion (Weld) Joint in High Density Polyethylene (HDPE) Pipe

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Abstract

This article documents the materials evaluation of a fractured saddle fusion weld joint on high density polyethylene (HDPE) pipe. The fusion joint failed due to inadequate surface preparation or inadvertent contamination of pipe surfaces prior to fusion that led to a joint with incomplete fusion. Failure of a defective fusion joint at the service tee allowed natural gas to leak from the gas main and, in turn, the gas migrated into a building where it ignited. Optical, stereo microscope, and scanning electron microscope (SEM) were used to evaluate the fracture faces. Exemplar fusion joints were manufactured and subjected to drop weight testing. The fracture features from fusion joints subjected to drop weight testing provided invaluable guidance for determining the origin of the fracture and direction of fracture propagation. Fracture features from the fusion joint in HDPE pipe are displayed that are not readily available from open source reports.

Key words

HDPE, incomplete fusion, heat fusion, saddle fusion weld joint, Wallner lines, rib marks, fibril, dimples.

1. Introduction

On March 12, 2014, two adjacent multiuse five-story buildings, located in the East Harlem district of the Borough of Manhattan in New York City, were destroyed by a natural gas-fueled explosion and resulting fire. Eight people died, more than 50 people were injured, and more than 100 families were displaced from their homes as a result of this accident [1]. The National Transportation Safety Board (NTSB) investigated this accident. The source of the gas leak stemmed from a high density polyethylene (HDPE) gas service pipeline with a defective saddle fusion joint that contained an area of incomplete fusion. The purpose of writing this paper is to document and share the fractographic observations of fractures through incomplete fusion welds in HDPE gas pipeline.

1.1 Incomplete Fusion

“Incomplete fusion” is synonymous with reduced bond strength, indicating that the strength of the joint was below strength of a joint that would have been made under optimum heat fusion conditions [2, 3, 4]. This term has also been referred in the plastic pipeline industry as lack of fusion and cold fusion. Incomplete fusion is an internal weld defect. It cannot be detected by visual inspection methods and can be present in a weld joint having a normal external appearance. A weld with incomplete fusion can be strong enough to pass initial pressure testing of the piping system but could eventually fail or leak after the joint is placed in service.

1.2 Heat Fusion Process

The saddle fusion joint was made by the heat fusion process. The procedure used by the gas company for making a saddle fusion joint includes the following three essential steps: the two surfaces to be joined are roughened with emery cloth, both surfaces are heated simultaneously using a hot plate preheated to about 500 °F (260 °C) under pressure, and then the two surfaces are joined under pressure.

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