Engineering Failure Analysis 18 (2011) 192–201

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Failure assessment of composite cooler tubes in a gas boosting station

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ARTICLE INFO

Article history:
Received 17 August 2010
Received in revised form 25 August 2010
Accepted 25 August 2010
Available online 17 September 2010

Keywords:
Failure assessment
Hydrocarbon gas
Sweet corrosion
Composite cooler

ABSTRACT

The present study describes origin and failure mechanisms of air cooled heat exchangers tubes, in a gas pressure boosting station. Hydrocarbon gas was circulating within aluminum finned tubes and cooling was done by forcing ambient air over the exterior of the tubes, made of carbon steel A-214 material. The hydrocarbon gas was contained traces of H_2S and substantial level of CO_2. The investigation was carried out in a station located in southern part of Iran. The process involved condensation of water and hydrocarbon along the length of tubes, resulting in a wet gas multiphase flow situation. Such type of coolers is also called composite coolers. The failure of tubes was characterized on the bases of all the available evidences and metallurgical examinations, such as analysis of tube materials, feeding gas, condensate water, and the residue inside the tubes. The processing was also simulated by Hysis-3.1 software, in order to evaluate and compare various parameters such as gas flow rate, liquid water and hydrocarbon formation, in actual and design condition. The air cooled tubes showed highest corrosion rate and was experienced leakage regularly. The results indicated that, low velocity assisted sweet corrosion caused severe pitting inside the tubes, and led to failure.

1. Introduction

A gas boosting station includes separation facilities to remove liquids (water and hydrocarbons), a compression unit to increase pressure, a cooling system, controlling system and auxiliaries. Usually boosting station is installed at variable distances to compensate for loss in gas pressure that occurs along the pipeline. This will ensure adequate flow at the delivery end of the pipeline. While pressure is increased in stages by compressor, the temperature raised need to be cooled by coolers.

Air cooled heat exchangers use finned tubes in which a pressurized fluid at high temperature is circulated. Ambient air is forced over tube bundles to dissipate the heat. This is done by placing fans beneath the tube bundles. In this way no cooling water and therefore no chemical treatment is required. This type of cooler is (finned) tubing usually suited for natural gas process applications.

Based upon temperature, pressure and the chemical composition of the gas being circulated, air cooler material is selected. There is an extensive use of carbon steels as construction material for cooler tubes in the oil and gas industries. The widespread use of these alloys in petroleum industry is mainly due to economic reasons. However, they exhibit poor corrosion resistance [1]. Besides the failure mechanism, the other important parameter to be considered for air coolers performance is the gas velocity. Erosion is controlled by fluid velocity circulating inside the air cooler tubes. High fluid velocity leads to severe erosion and thinning of tubes, whereas low velocity, causes sedimentation of residues and corrosion products. In latter case, not only under deposit corrosion (pitting) takes place, but also corrosion inhibiting materials, if injected, do not reach the bare surface of the tubes. The flow induced corrosion–erosion [2] is often used to describe this type of failure

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doi:10.1016/j.engfailanal.2010.08.021