



Examination of a failure detected in the convection zone of a cracking furnace

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ABSTRACT

Heat-transfer investigation and a failure analysis of a cracking furnace are presented. The cracking furnace, in which thermal decomposition of hydrocarbons occurs in its radiant section, represents a plug-flow reactor placed in a firebox in point of fluid mechanics and heat-transfer processes. The reacting mixture that consists of hydrocarbons and dilution steam is heated up by means of natural gas in the burners of radiant section.

The aim of the investigation was to characterize the mechanical, chemical, and corrosion transformation processes occurring inside the convection zone and to examine a specific failure (leakage) process and damage. The geometrical model of the convection zone of the furnace was established by FLUENT software as well as the fluid mechanical model of the heating stage which covered the calculation of the flow characteristics and the temperature field resulted by the corresponding heat flow processes.

Samples were taken from the different positions of the pipe made of different types of steel (A106, A335, A312, B407). The causes of the failure were investigated on the base of the results of composition and fine structure examinations. The outer surfaces of the samples of the pipes were examined using optical emission spectrometry (ARL 3460 OES instrument), while the main metallic components were determined with atom absorption spectrometry (device: PYE UNICAM PU 9100).

After taking the samples signs for failure and changes in the structure were looked for. For these investigations, optical microscopy, scanning electron microscopy, point or small area microprobe (EDAX) and X-ray diffraction methods were used.

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1. Introduction

The cracking furnace producing stock for petrol chemistry is a gas–gas type counter flow heat exchanger. The gas to be cracked enters the pack of four tubes at the top part of the convection zone of the furnace. The gas flows downwards in the tubes where it is heated up by the counterflow flue gas flowing between the tubes. The upper zone is the so called preheating section. At the bottom of this section the tubes exit the furnace so the technological steam and the admixture containing sulphur can be added. The tube containing the hydrocarbon–steam mixture returns into the furnace where it keeps heating the mixture flowing downwards. As the mixture leaves the convection zone, its temperature reaches the 700 °C, which is the temperature the cracking process starts at. However, cracking is avoided in this segment of the furnace, because the material of the tubes in this section is not suitable for the temperature of the cracking process. The most common failure of the

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