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Application of pyrolysis – Gas chromatography/mass spectrometry for the identification of polymeric materials in failure analysis in the automotive industry

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ABSTRACT

The application of analytical pyrolysis–gas chromatography mass spectrometry (Py–GC/MS) in the failure analysis of two hydraulic cylinders and their rubber membranes from the automotive industry were presented.

1. Introduction

The increasing use of polymeric materials in the automotive industry requires sensitive and reliable methods for its analysis. For the failure analysis in motor vehicles there is often lack of information about the component itself, such as chemical composition, temperature resistance, possible contaminants or mechanical properties. The damage range is usually limited and not always homogeneous. There are often only small amounts of samples available, which may be important for recognizing the cause of damage [1].

Traditional analytical techniques used for characterization of polymers/copolymers, such as thermal analysis (TA) and Fourier transform infrared spectroscopy (FTIR), are limited or not sufficiently sensitive to demonstrate the change of the structure and the resulting dysfunction of used materials.

Analytical pyrolysis technique hyphenated to gas chromatography/mass spectrometry (GC/MS) has extended the range of possible tools for characterization of synthetic polymers/copolymers [2–6]. Under controlled conditions at elevated temperature (500–1400 °C) in the presence of an inert gas, reproducible decomposition products characteristic for the original polymer/copolymer sample are formed. Pyrolysis methods eliminate the need for pre-treatment by performing analyses directly on the solid polymer/copolymer sample.

The pyrolysis unit is directly connected to the injector port of a gas chromatograph (Figs. 1 and 2). Flow of an inert carrier gas, such as helium, flushes the pyrolyzates into the fused silica capillary column, which is installed in the thermostat of the gas chromatograph (GC). The capillary column separates the complex mixture of the organic substances. The chromatographically separated substances are then detected with mass spectrometer (MS) and subsequently identified by interpretation of the obtained mass spectra or by using mass spectra libraries (e.g. *NIST*, *Wiley*). The detection technique of the

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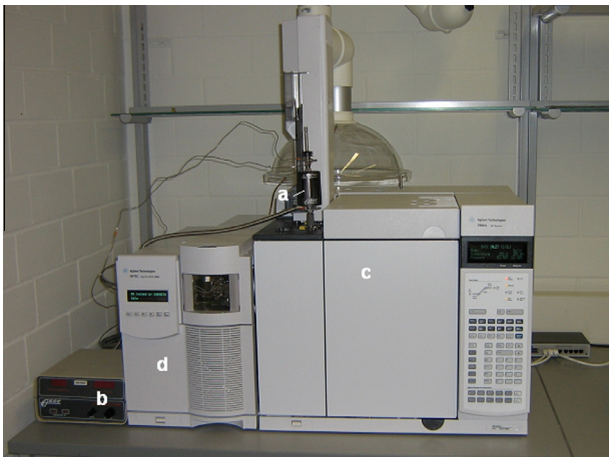

Fig. 1. Pyrolysis–GC/MS apparatus 2 consists of (a) furnace pyrolyzer *Pyrojector II*™ (S.G.E.), (b) control module (S.G.E.), (c) *7890A* gas chromatograph (Agilent Technologies) and (d) *5975C* quadrupole mass spectrometer (Agilent Technologies).

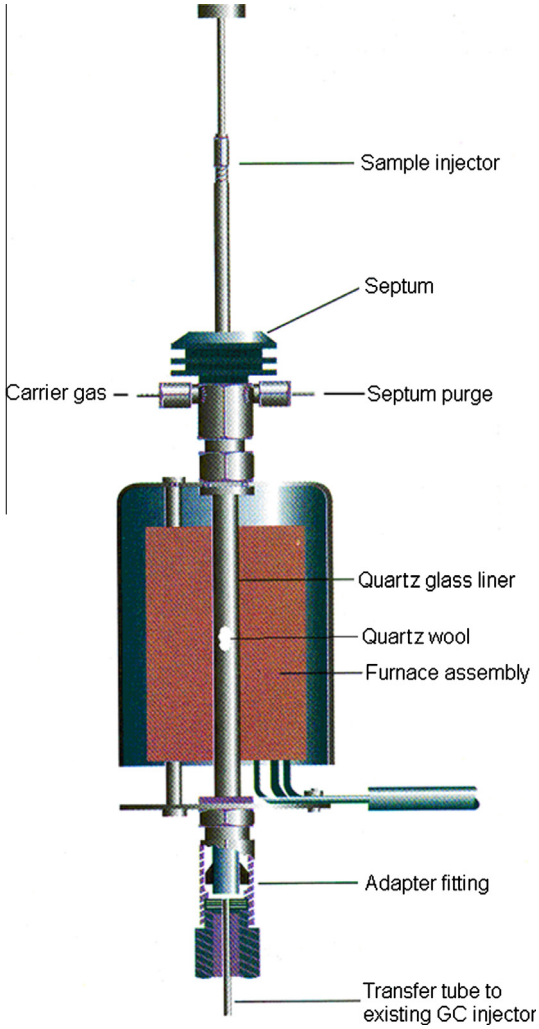

Fig. 2. Schematic view of the furnace pyrolyzer *Pyrojector II*™ (S.G.E).