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Reformer Tube Internal Diameter Measuring System

A Thesis in the partial fulfilment of the requirements for the Degree of

Master of Engineering

In

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Morio Fukuoka
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ABSTRACT

A Reformer Tube is a device used in chemical engineering, commonly in the fuel cell technology, used to perform chemical reactions to produce chemicals products. Commonly the process involves heating the introduced chemicals in the tube to ultra-high temperatures at pressures around 20 bars encouraging rapid reactions. Reformer tube construction is described within which both the desired endothermic catalysed chemical reaction and heat transfer from the reaction products to the incoming reactants are accomplished [10]. The service life of these devices is primary ended when Creeps Shear damage is detected. Due to the complex combination of multiple factors between temperature, stress and aggressive environment during service influencing the generation of Creep damage, it is of significant benefit for process companies using condition-based assessment rather than time-based estimation to judge the retirement of reformer tubes.

The aim of this research is to investigate a low-cost, mechatronic reformer tube inspection system that can replace the conventional expensive laser based system employed by New Zealand Methanex Ltd. The system must be a non-destructive examination (NDT) instrument capable of making a full inspection of a vertically standing, 110mm bore, 14m reformer tube within 5 minutes duration. Specification requirements set by the company state that the new system must be able to make measurement of at least 2 diametrical axes at axial increments of 25mm. The measurements are to be of 0.5mm accuracy or better. The nature of the tube stands to handle processing of Methanol stored at temperature of 500 degrees Celsius, gathering internal pressure of up to 20 bars. Due the cyclic repetition of these thermal and pressure changes, the tube will overtime result in internal cavity adaption causing tube failure through Creeping Shear. The device will be used to inspect the internal diameter change caused by creep damage and thus forecast the remaining service life of the tubes to help schedule the retirement of the reformer tubes at the most efficient timing.

The project commended with a research investigating the variety of reformer tube inspection techniques available for modern furnaces and reviewed the application methodologies and limitations. Based on the findings, the project proceeded to develop a low cost, mechanical reformer tube inspection system. The new system is branded Reformer Tube Internal Diameter Measuring (RTIDM) system. In the final part of this research, field testing was conducted at the Methanex Ltd furnace to examine the RTIDM systems performance. Analysis performed on the collected data from the field test revealed that the RTIDM system is a working system capable of making diametrical measurement at the precision of +/-0.1668mm.

Documented in this thesis is an in-depth discussion on the development of the Reformer Tube Internal Diameter Measuring (FTIDM) system. Conclusively, the RTIDM system developed in this research provided new method for reformer tube inspection. With the cost of the prototype is under $2000 NZD, the design is a much cost friendly instrument compared with its rival devices while capable of making diametrical inspection at competitive precision and accuracy.

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