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DETERMINATION OF SERVICE LIFE FOR UNDAMAGED AND DAMAGED DELAYED COKER DRUMS

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ABSTRACT

A stated goal of governments in addressing climate warming and to transition to a low carbon future by the end of this century is to increase the proportion of energy supplied by alternative sources. For the hydrocarbon processing industry, the question of stranded assets will become significant as these alternative energy sources become more prevalent. Existing equipment will need to operate to the end of its useful life and new equipment may need to be avoided. In particular, coker drums are very expensive investments due to their size, materials and number required in the delayed coker unit of a processing facility. Because of the severe service environment in which coke drums operate, the service life of a drum is not well established.

Long term reliability of coker drums is impacted by thermo-mechanical damage mechanisms associated with self constraint of the drum shell and skirt during the formation of hot and cold temperature spots and patches. By assessing the imposed thermomechanical strains, a more precise determination of drum fatigue may be made, allowing better estimation of service life. This service life may be estimated for newly fabricated drums and those drums with shell damage, such as bulging.

Service life determination is of practical importance for operators since it provides a more realistic estimate of operational life as compared to the normally referenced Code design life. An accurate estimation of drum service life has not been available in the industry to date due to a number of deficiencies and conservatisms in the current calculation practices. Insight into the causal damage mechanism provides opportunities in identifying alternatives in design, material selection, fabrication, inspection, and maintenance for operating this equipment to a practical and optimal target service life.

INTRODUCTION

Delayed coker unit coke drums are a type of pressure vessel used in the hydrocarbon processing industry [HPI] to convert heavy molecule hydrocarbon fractions to lighter fractions, such as naphtha, kerosene and gas oil for product sale and further upgrading. Refinery and oil sands processing facilities are two primary users of this equipment.

An early independent survey revealed that these drums were susceptible to a number of problems which were attributed to the severe service environment [1]. These problems include

- bulging of shell
- skirt-to-shell joint cracking
- shell nozzle cracking

Cracking of the internal alloy lining was also listed, although general cracking of the drum shell was not listed.

The first industry trade survey provided by the American Petroleum Institute in 1968 highlighted shell bulging and through wall cracking as the major issue and this situation has remained so up to the current 4th industry survey completed in 2013 [2, 3]. The major reliability issues for coke drums remain

- shell cracking
- shell bulging
- skirt-to-shell cracking

Since the first survey in 1958, it has been recognized that coke drums operate in a severe service environment caused by high bitumen temperatures of up to 900 °F [482 °C] followed by rapid water quenching leading to large thermo-mechanical strains in the shell. In contemporary operations, this heating and quenching operation occurs on a repetitive basis of nominally one time (1x) per twenty four [24] hour period. The quantification of this thermo-mechanical loading and its impact in limiting the service life of coke drums has remained