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Experimental and theoretical investigation of coke formation in steam cracking reaction

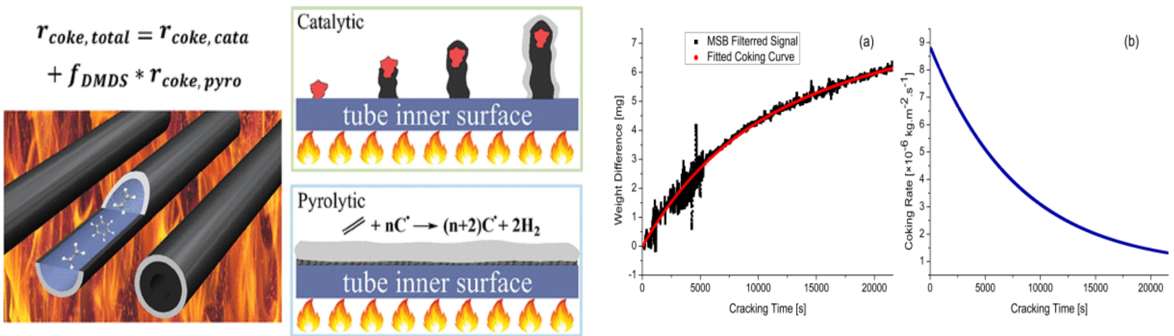
Aim

The objective of this master's thesis is to experimentally and theoretically investigate the coking behavior of feedstocks at various steam cracking operational temperatures. This research aims to offer insights into coke byproduct production behavior for kinetic modeling purposes.

Justification

Light olefins such as ethylene and propylene are the most important basic chemicals for the petrochemical industry. The dominant process to manufacture them is thermal cracking in the presence of steam. Coke deposition on the inner wall of the tubular cracking reactors is the main drawback of this process. The resulting coke layer reduces the cross-sectional area of the tubular reactors, causing a continuously increasing pressure drop. Thus, bi-molecular reactions gain ground, leading to lower olefin selectivity. In addition, the resistance to heat transfer from the furnace to the feed is increased. All the above lead to higher tube metal temperatures and eventually, to process shutdown in order to decoke the reactors. This negatively affects the desirable production and the economics of the process.

This research endeavors to comprehensively understand the intricate mechanisms behind fouling, with a specific focus on the paramount role of operational temperature. By emphasizing kinetic modeling, the primary objective is to quantify and model how temperature variations directly impact coke formation. This investigation will be pivotal for accurate predictions and precise modeling of fouling. Developing robust analytical, statistical, or mathematical methodologies stands as a crucial step toward effectively estimating and comparing fouling risks arising from varying operational temperatures.



Program

- Conduct an in-depth review focusing on fouling within steam cracking furnaces.
- Measure catalytic and asymptotic coking rates via experiments conducted at diverse temperature settings.
- Utilize established kinetic models from literature to model coking rates.
- Further developing a predictive model for coke formation based on obtained catalytic, asymptotic rates, and product distribution from steam cracking.