Thesis Title Stability of ZSM-5 Catalyst Used for Production of Light Olefins from Mixed C4 Hydrocarbon

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ABSTRACT

In this thesis, the catalytic cracking of mixed C4 hydrocarbons is studied for light olefins production over ZSM-5 catalysts. Impregnation technique is chosen to prepare metals, namely, gallium, platinum and silver, loaded HZSM-5 catalysts. The catalysts are characterized by X-ray Powder Diffractometer, X-ray Fluorescence Spectroscope, Scanning Electron Microscope, Energy Dispersion Spectroscope, Thermal Gravimetric Analyzer and Gas Adsorption Analyzer. Catalytic cracking reaction is carried out in a fixed bed flow reactor with a feed flow rate of 30 ml/min without carrier gas over 6 hours on stream, determining on stability and activity. The products from the reaction are analyzed by on-line Gas Chromatography. It was found that high conversion (>90%) is obtained over high acidity catalyst (HZSM-5(1) and HZSM-5(2)). However, a rapid deactivation is observed. Using zeolite with high silicon to aluminium ratio as catalyst provides a lower activity (~60% conversion) but high stability and selectivity for light olefins (~75%). Moreover, using catalyst with small crystal size particularly enhances the catalyst stability. Cracking of paraffin-rich feed leads to a much longer catalyst stability up to 200 hours on stream. Incorporation of metal namely, gallium, platinum and silver, into a conventional acid catalyst induces oligomerization and aromatization of light olefins products, resulting in a relatively low selectivity for light olefins (~65%). The hydrogen transfer preferred at high reaction temperature, cause a coke deposit on the catalyst active sites, leading a rapid catalyst deactivation when the reaction temperature is increased to 600 ^{o}C. In addition, an increase in contact time (0.0375-0.6 grams catalyst) improves the reaction conversion, however, the excessive contact time reduces the light olefins selectivity, due to the further side reactions. The regenerated catalyst shows the catalyst activity similar to the fresh one.