Ethane Dehydrogenation to Ethylene Utilizing Catalytic Membrane Reactors

A. A. Al-Rabiah, M.E.E. Abashar, K. I. Al-Humaizi and A. Al-Hammad

Chemical Engineering Department, King Saud University, P.O. 800 Riyadh 11421, Kingdom of Saudi Arabia, arabiah@ksu.edu.sa

Ethylene is considered as the most important petrochemical constituent in the word today. Worldwide demand for ethylene has grown steadily in the past, and is expected to reach 140 million metric tons by the year 2010. Currently Saudi Arabia is considered as one of the top five producers of ethylene worldwide.

In Saudi Arabia, ethylene is produced via the thermal cracking process using ethane or propane as the feedstock. The thermal cracking process is generally quite expensive both in terms of capital and operating expenses, provided a strong motivation for evaluating the impact of multifunctional catalytic membrane reactor and process flow sheeting on the ethylene production process.

Ethane dehydrogenation in the catalytic membrane reactor is highly endothermic and the thermodynamic equilibrium limits the conversion. For further displacement of the thermodynamic equilibrium, auxiliary hydrogenation reaction of the product hydrogen by the membrane is used to shift the main reaction, and increase the conversion.

The objectives of this study are to develop and optimize an ethylene process that utilizes catalytic membrane reactors as an alternative to the thermal cracking process. When the conversion and selectivity of ethylene is attained using this new technology, a reduction in both capital and energy costs is expected. The research will be divided into two stages. The first stage is the experimental work where sophisticated catalytic membrane reactors will be developed and operated under different conditions. The second stage will include modeling, design, simulation and optimization of the new catalytic membrane reactor process. Thorough comparisons between the experimental data and the developed model will be conducted in this study.