CHAPTER I

INTRODUCTION

The removal of sulfur from transportation fuels which are gasoline and diesel fuels is an important aspect of the global's effort to reduce sulfur oxides that contribute to pollution of the atmosphere. During combustion, sulfur compound contained in fuel is oxidized to sulfur oxides, primarily sulfur dioxide (SO_2) with small amounts of sulfur trioxide (SO_3) that are known to inhibit the catalytic function of catalytic converters. The requirement of sulfur reduction in transportation fuels is enhancing because of increasingly stringent restriction on the sulfur content of these fuels. For instance, the U.S. Environmental Protection A gency announced new regulations that require refineries to reduce sulfur levels to 30 ppmw in gasoline and 15 ppmw in diesel by 2006 (Ma *et al.*, 2003). Thus, refineries in the U.S. and worldwide face the challenge of producing very low sulfur highway and non-road fuels, even though the sulfur content of crude oils refined is getting higher and the feedstocks are getting heavier. Therefore, the efficient removal of sulfur compound is crucial for refineries. The requirements for the deep desulfurization of transportation fuels may become even more stringent because of the possibility that these fuels can be used on-board or on site.

Currently, deep desulfurization is achieved by a multi-step process including, hydrodesulfurization (HDS) over catalysts and subsequent removal of H_2S with an adsorbent. However, the HDS process is not suited well to produce ultra-clean (essentially sulfur free) transportation fuels, particularly for fuel cell applications. At the severe reaction conditions required for effective sulfur removal, the olefins and aromatics in the gasoline are saturated, decreasing the octane number. In addition, the current HDS process can not adequately remove the refractory sulfur compounds present in the diesel since there is a high cost in hydrogen consumption. However, the cetane is improved. This hydrogen is consumed by both hydrodesulfurization and aromatic hydrogenation reactions and it has been shown that the size of the HDS reactor needs to be increased by a factor of 7 to reduce the sulfur content of the diesel from 500 to 15 ppmw (Khare, 2001). Clearly, more effective and affordable methods which have minimal effect of octane number are required to reduce the sulfur content of the transportation fuels to ultra-low levels.

Recently, there is an increasing interest in the development of desulfurization process which can operate at ambient temperature and pressure. The new challenge is to use adsorption to selectively remove refractory sulfur compounds from transportation fuels. This process is particularly effective in the removal of low concentration of sulfur compounds from fuels. As a result, this research was set to study the adsorptive desulfurization to remove refractory sulfur compounds from transportation fuels by using Na-X in a continuous process. Effects of several factors such as type and initial concentration of sulfur compounds on the adsorption and desorption time were examined. In addition, a simple mathematical model was developed as a valuable tool to describe the adsorption phenomena of sulfur compounds in the adsorber.