CHAPTER I

INTRODUCTION

As a positive attempt to cope with the alarming degradation of air quality in today's industrialized world, many environmental regulations have been issued, exerting a great deal of control over the enormous emissions discharged from the relentless operation of billions of transportation means and factories, in which sulfur oxides remain a major concern. In 1998, the European Union first mandated new sulfur specifications for drastically reduced levels that started to be phased in from the year 2001 (Hernandez et al., 2003a). Not long after that, in January 2005, the US Environmental Protection Agency Tier II (USEPA) regulations required reductions of sulfur in gasoline from the current average of 350 ppmw to 30 ppmw and a reduction of sulfur in diesel from 500 ppmw to 15 ppmw by June 2006 (Babich et al., 2003). Another reason for deeply lowering sulfur content in transportation fuels is for state-of-the-art application in fuel cells – one of the most promising and convenient energy conversion devices for generating electricity. Unfortunately, sulfur compounds in liquid hydrocarbon fuels for fuel cells, including gasoline, diesel fuel, and jet fuel, can lead to a poisoned catalyst for the water gas-shift reaction and the electrode (anode) catalyst in the fuel cell stack. Ideally, the sulfur concentration should be below 0.1 – 0.2 ppmw for such applications.

Nowadays, most of the sulfur compounds are removed from petroleum-based feedstock by the hydrodesulfurization (HDS) process which usually operates at severe conditions, such as elevated temperature (300 – 340°C) and high pressure (20 – 100 atm). This process can reduce the sulfur content in gasoline to less than 30 ppmw, but it is difficult to reduce the sulfur content in diesel to less than 15 ppmw. In addition, in order to enhance the efficiency of the sulfur removal process to meet the required standards, the reactor volume or the catalyst activity must be at least three times larger than those currently used in refineries (Ma et al., 2005b), which will unfavorably affect operating cost and capital. Moreover, another major problem associated with the deep hydrodesulfurization of gasoline is the significant reduction of octane number due to the saturation of aromatics and olefins in naphtha from fluid