



## CHAPTER I

### INTRODUCTION

Majority of the product volume from chemical process industries directly originates from catalytic technology. However, only in recent years has the catalysis been more regarded as a science than an art. Indeed, much art still remains, and imperfect understanding of catalysis has stimulated an increasing amount of research in the area, which extends over the entire field of chemistry to material science and chemical reaction engineering.

Particularly, most of the product volume that stems from chemical reactions utilizing catalysts which exhibit activity loss due to catalyst deactivation. Though the phenomena of catalyst deactivation have been observed for most of the history of catalysis, intensive studies extend back only a few decades. Furthermore, there have been recently an increasing number of studies of various deactivation problems. However, most deactivation problems still need further exploration.

Metal-based catalysts are widely used in industries to promote various types of reactions involving carbon-bearing feedstocks. One of the very useful applications is the dehydrogenation of hydrocarbons using the supported metallic catalysts. As with any other catalyst system, activity, selectivity, and life are the three most important aspects of the application of

these heterogeneous catalyst system. The life, or the stability of activity and selectivity, is dictated by the possibility of sintering, poisoning, or coking. The last two reasons, involving the adsorption and desorption of different species on catalyst surfaces, obviously depend on the physicochemical nature of the species and of the catalyst itself. In these cases, the nature of catalyst surface changes and the rate constant of the chemical reaction is altered.

Catalyst coking is a phenomenon which involves the deposition of carbonaceous species on the catalyst surface. Materials deposited may include elemental carbon, high molecular weight polycyclic aromatics and, high molecular weight polymers [1, 2].

Coke formation involves the metallic and acid functions of the catalyst [3] with steps of dehydrogenation, condensation, alkylation and cyclization. The poly-ring compounds produce a turbostratic structure which after a long period of operation could lead to a graphitic structure.

The surfaces on which coke is deposited, and their effects on coking, can also vary widely. Most metallic catalysts are supported and the metal, the support, and metal-support interaction can effect the phenomena.

The thermodynamics of the dehydrogenation reaction are such that it is desirable to work at high temperature and low pressure [4], but these are the conditions that favor coke formation. So, there are many studies trying to improve the performance of the present catalyst and to develop new catalysts that give the desired results.

The catalysts to be studied in this research comprise of platinum, the main metallic component, supported on alumina support, some of the other metals (tin and rhenium) and the alkaline (lithium), incorporated on the same platinum-based catalyst. The reaction used to test the activity of these catalysts is the dehydrogenation of propane.

### 1.1 The objectives of this study.

- 1.1.1 To study the preparation of dehydrogenation catalysts.
- 1.1.2 To characterize the prepared catalysts.
- 1.1.3 To study the catalysts deactivation.
- 1.1.4 To construct the Temperature Programmed Oxidation used for characterizing coked catalyst.
- 1.1.5 To characterize coked catalysts.

### 1.2 The scope of this study.

The reaction conditions for the dehydrogenation are chosen as follows :

Catalysts : (0.3 wt%)Pt/Al<sub>2</sub>O<sub>3</sub>,  
(0.3 wt%)Pt-(0.3 wt%)Sn/Al<sub>2</sub>O<sub>3</sub>,  
(0.3 wt%)Pt-(0.3 wt%)Re/Al<sub>2</sub>O<sub>3</sub>,  
(0.3 wt%)Pt-(0.3 wt%)Sn-(0.6 wt%)Li/Al<sub>2</sub>O<sub>3</sub>,  
(0.3 wt%)Pt-(0.3 wt%)Re-(0.6 wt%)Li/Al<sub>2</sub>O<sub>3</sub>,

Reaction Temperature : 500°C,

Pressure : 1 atm,

Gas Hourly Space Velocity of Reactant : about 25,525 hr<sup>-1</sup>,

Time on stream : 20 hr.