



## CHAPTER I

### INTRODUCTION

#### GENERAL

It is estimated that at least 80 % of the product volume from reactions in the chemical process industries directly involves catalytic technology. However, only in recent years has catalysis been regarded more as a science than an art. Indeed, much art still remains and imperfect understanding of catalysts has stimulated an increasing amount of research in this area, which extends over the entire field of chemistry and to material science and chemical reaction engineering.

Particularly, it is estimated that 70 % of the product volume within that 80 % 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 an increasing number of studies of various deactivation problems recently. However, most deactivation problems still need exploration.

The fundamental categories of catalyst deactivation are sintering, poisoning and fouling (coking) . The last two of these, 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 the catalyst surface changes and the rate constant of the chemical reaction is altered.

Coking is a common deactivation mode in hydrocarbon conversion processes, involving the deposition of carbonaceous materials on the catalyst surface. Materials deposit may include elemental carbon, high molecular weight, polycyclic aromatics and high molecular weight polymer (1,2).

Coke formation involves the metallic and acidic functions of the catalyst (3) with steps of dehydrogenation, condensation, alkylation and cyclization. Coke has a complex structure containing several different growth forms, which can be grouped into amorphous, filamentous and graphitic platelets (4,5,6).

The surface 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 affect the phenomena.

The thermodynamics of the dehydrogenation reaction are such that it is desirable to work at high temperature and low pressure (7) but these are the conditions that favour coke formation. Therefore, 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, the metal (tin) and the alkalines (lithium, sodium), incorporated on the same platinum - based catalyst. The reaction used to test the performance of these catalysts is the dehydrogenation of propane.

## OBJECTIVES

1. To study the synergistic effect of promoters for dehydrogenation of propane.
2. To study the nature of irreversible coke by catalyst regeneration technique.
3. To suggest the model of irreversible coke formation .

## SCOPE OF WORKS

1. Preparing the platinum , platinum-tin and platinum-tin-lithium catalysts by dry impregnation method. The catalyst compositions are as follows :
  - 1.1 The prepared platinum catalyst which platinum loading on  $\text{Al}_2\text{O}_3$  support was varies as 0.30, 0.60 , 0.75 and 1.00 %.
  - 1.2 The prepared platinum -tin catalyst which tin loading on 0.3 %  $\text{Pt}/\text{Al}_2\text{O}_3$  catalyst was varies as 0.10, 0.30, 0.60 and 1.00 %.
  - 1.3 The prepared platinum - tin - lithium catalyst which lithium loading on 0.3 % Pt - 0.3 % Sn/ $\text{Al}_2\text{O}_3$  catalyst was varies as 0.10, 0.30, 0.60 and 1.00 % .
2. Testing of all prepared catalysts by feeding 20 % propane in nitrogen gas with gas hourly space velocity of reactant about  $25,525 \text{ hr}^{-1}$  , operating temperature between  $500 \text{ }^\circ\text{C}$  -  $650 \text{ }^\circ\text{C}$  , analyzed the result by gas

chromatograph.

3. Studying the characterize of coke on catalyst by temperature programmed oxidation method.

4. Studying the nature of revervisble and irreversible coke formation by regenerating catalyst with 1 % oxygen in helium. Metal active site regeneration method was selected.

5. Developing the model of irreversible, reversible coke formation.

### **BENEFIT ESPECTED**

The understanding of coke formation for dehydrogenation of propane may be applied for catalyst design in order to increase the catalyst life and decrease the expenses in catalyst regeneration.