



CHAPTER I

INTRODUCTION

In the petrochemical industry, olefins are obtained mostly from thermal cracking and catalytic cracking processes which are performed by using only heat and catalysts respectively. The catalytic cracking is more favorable and more efficient because of its higher selectivity to olefins. However, both processes are endothermic which require high temperature to shift thermodynamic equilibrium to product side. In addition, the need for high temperature causes high energy consumption and high cost. Moreover, in the dehydrogenation process, coke can easily be formed over the active site on the catalyst surface at high temperature, causing the deactivation of the catalyst. Hence, the activity of the catalyst is declined and catalyst needs a frequent regeneration. Because of the above limitation, there are several studies [1-27] which aim to develop a process for the production of alkene that can overcome these limitations, for example [26]

- optimization of current dehydrogenation technologies to obtain more selective, stable and environmentally safe catalysts and to lower investments and utility costs.
- dehydrogenation coupled with hydrogen oxidation to supply the heat of reaction inside the catalytic bed while avoiding over heating and to shift the equilibrium toward the desired products.
- oxidative dehydrogenation (ODH), which operates at low temperature with an exothermic reaction, to overcome thermodynamic limitation and to avoid frequent catalyst regeneration.

- membrane-assisted dehydrogenation and oxidative dehydrogenation to obtain high conversion at low temperature and to conduct the reactions and separations in the same equipment.

For using the existing paraffins in the most worthwhile manner, these processes have to be more efficient. It is well known that the dehydrogenation process still has the problem about coke formation that usually occurs at high temperature, which results in frequent catalyst regeneration. Membrane technique has a problem about the mechanical strength of membranes which usually are made of ceramics. Thus, it is hard to make it in a large size. However, due to exothermic reaction of ODH, it can avoid the major problem of dehydrogenation reaction. ODH, therefore, has a high potential to be a new and better selection in the field of cracking process. Because of its exothermic reaction, then it can avoid the major dehydrogenation problems and mechanical strength of membrane technique.

In the past, several researchers [1-3,5-10,12,13,23] chose various compounds for testing as a catalyst in ODH of alkane. Among this, vanadium compounds such as V-P-O [13], V-Nb-O [5,12], and V-Mg-O [1,2,23] are the most widely used because of its low cost and high selectivity.

However, there are only few literature concerning about this process and proper catalysts for ODH still have not been found yet. Therefore, it is interesting to carry out a research on this reaction and to study the structure of catalyst that is suitable for this reaction including the relation between catalyst structure and their reactivity. Though, at present there is no suitable catalyst for this process, finding a proper one seems to be easier than solving the major problems of dehydrogenation and membrane technique processes. V-Mg-O is chosen as a model catalyst in this study because their structure is not complex, easily available,

cheap and there are many data about these compounds in literature [2,3,11,17,23-26,82].

In order to achieve the mentioned aims, some basic researches are needed to fulfil the lack of knowledge in this field. Therefore, this research was, then, set up to investigate:

1. the reactivity of oxidative dehydrogenation over MgO, V₂O₅, and V-Mg-O catalysts in different conditions.
2. the effect of vanadium-magnesium oxide-based catalyst being incorporated with alkali on propane (C₃H₈) oxidative dehydrogenation.
3. the relation between catalyst structure and their reactivity

The present work is arranged as follows, chapter II presents a literature review of investigation on oxidative dehydrogenation.

The theory of this work, studies about the oxidative dehydrogenation reaction, its possible mechanism, including the proper catalysts used in this process, and the surface oxide species concerning this reaction, are presented in chapter III.

In chapter IV, the experimental systems and the operational procedure are described.

The experimental results obtained from a laboratory scale reactor and standard measurement are reported and described in chapter V.

Chapter VI gives overall conclusion emerged from this work.

Finally, the sample of calculation of catalyst preparation, reactant flow rates including explosive limit checking, the knowledge about the chemisorption at oxide surfaces, the position of the vibrational bands for the Mg vanadate powders and data of experiments are included in appendix at the end of this thesis.