CHAPTER I

INTRODUCTION

Supported transition metal oxides can exhibit interesting catalytic properties depending on the composition of catalysts and on the nature of support. It forms a group of industrially important catalysts for the selective oxidation reactions. One important oxides is V_2O_5 which is utilized in several partial oxidation reaction such as selective oxidation of *o*-xylene to phthalic anhydride, selective catalytic reduction of NO_x with NH_3, oxidation of butane to maleic anhydride and selective oxidation of methanol to formaldehyde. Despite the fact that bulk V_2O_5 has poor thermal stability and mechanical strength, its stability can be greatly enhanced when vanadium oxide is impregnated on a suitable support *e.g.* Al_2O_3, SiO_2, TiO_2, MgO, etc. Vanadium oxide has been known to show strong interaction between several supports. [Chaar *et al.* (1988), Khodakov *et al.* (1999) Nieto *et al.* (1990) and Okuhara (1993)]. In addition, the interaction of vanadia with the support can dramatically modify the catalytic properties. Among several supports, TiO_2 (anatase) is a good support for the selective oxidation of hydrocarbons. The superior behavior of anatase-supported vanadia catalysts as compared to other systems is attributed to the formation of a highly disperse, amorphous vanadia layer on the anatase surface. The successful application of the vanadia-titania system is the synthesis of phthalic anhydride by the oxidation of *o*-xylene.

Unlike the above titania supported vanadia catalyst, vanadium oxide supported on basic support, MgO, does not form a surface vanadia monolayer because of the acid-base reaction between acidic vanadia and basic magnesium oxide. The strong interaction between vanadia and magnesium oxide results in the formation of mixed oxide compounds, V-Mg-O, rather than a stable surface vanadia overlayer on the magnesium oxide supports. The exact structure of the new compounds depends on V/Mg ration *e.g.* $Mg_3(VO_4)_2$ (orthovanadate), $Mg_2V_2O_7$ (pyrovanadate) and MgV_2O_6 (metavanadate). Recently, it has been reported that V-Mg-O based catalysts

are active and selective in the oxidative dehydrogenation (ODH) of alkanes to alkenes. These catalysts are basic, which enhance the desorption of basic alkene molecules from the catalyst surface, preventing them to react further into carbon oxides and water.

As mentioned above, the nature of support used such as acidity-basicity can control the structure of vanadium oxide species on the support surface, leading to different catalytic properties. The vanadia interactions between TiO_2 (anatase) and MgO are very interesting and numerous works have been performed to study the catalytic behavior of both V_2O_5/TiO_2 and V-Mg-O systems. However, no information is given in the literature about the catalytic performance of V-Mg-Ti-O system. Therefore, for this research, the V-Mg-O/TiO_2 system is prepared to study the oxidation property of the catalyst. This work was set up to investigate:

1. The effect of vanadium oxide content on the oxidation property of V-Mg-O/TiO_2 catalyst.
2. The effect of magnesium content on the oxidation property of V-Mg-O/TiO_2 catalyst.
3. The oxidation property of V-Mg-O/TiO_2 catalyst for the oxidation of propane, propene, 1-propanol and carbon monoxide.

The present work is arranged as follows;

Chapter II presents a literature review of investigation over related supported vanadia system on the selective oxidation.

The theory related to this work, studies about the structure and reactivity of vanadium oxide species on oxide support especially TiO_2 and MgO are described in chapter III.

Chapter IV presents the experimental systems and the operational procedure.

Chapter V shows the experimental results of the characterization of catalysts and the propane, propene, 1-propanol and carbon monoxide oxidation reactions on V-Mg-O/TiO_2 catalyst.

In the last chapter, the overall conclusion emerged from this research is given.

Finally, the sample of calculation of catalyst preparation, diffusional limitation effect, the details of gas chromatograph including the operating conditions, the calibration curves and the samples of chromatogram, data of experiments and a published paper which has emerged from this study are included in appendices at the end of this thesis.