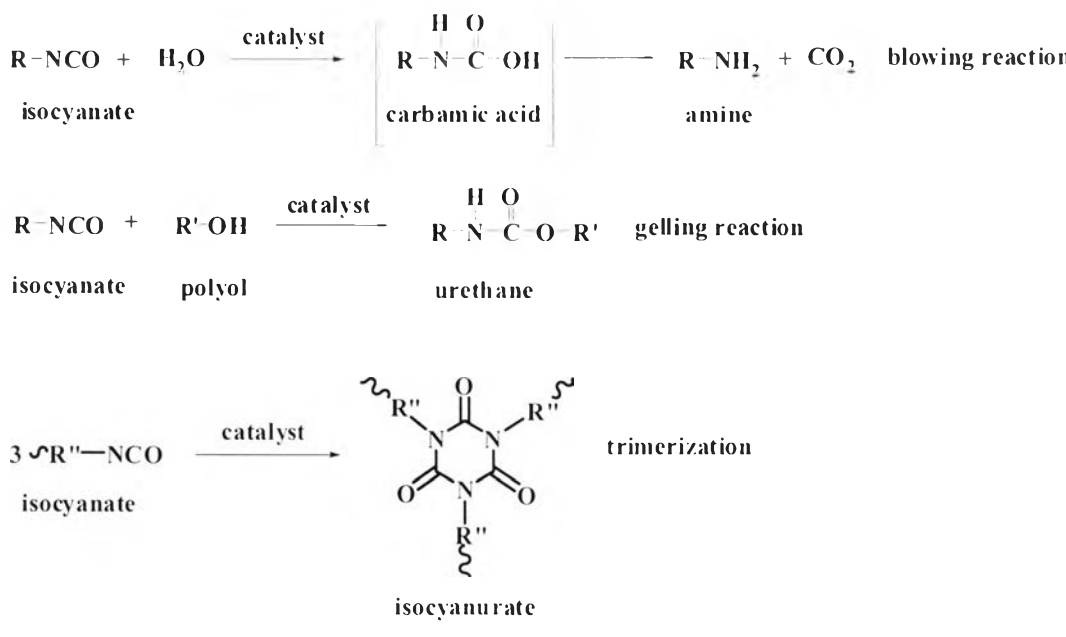
CHAPTER I

INTRODUCTION

1.1 Introduction

Polyurethane foams have been commercially used in wide variety of applications since 1940s. These foams play an important role in many industries and our daily lives. Especially rigid polyurethane foam (RPUR foam) is the most important thermal insulating materials used today for constructions, refrigerators and freezers [1]. Traditional RPUR foam is made by the reaction of polyol, isocyanate, blowing agent and a variety of additives such as catalyst, surfactant and fire retardant. The main reactions are presented in Scheme 1.1.



Scheme 1.1 The main reactions of rigid polyurethane formation

Blowing, gelling and trimerization reactions are the important reactions of RPUR foam. They indicate that catalyst has an influence on RPUR foam formation because

those reactions are slow. Therefore, catalyst can control and accelerate the reactions. Tertiary amine and organometallic are commercial catalysts such as N,N-dimetylcyclohexylamine (DMCHA) and dibutyltin dilaurate (DBTDL) [3]. They show excellent catalytic activity but have strong smell and toxicity. Therefore, new catalysts are needed for replacing the commercial catalysts. Metal-amine complexes have been studied in our research group as catalysts for preparing RPUR foams. They are easy to synthesize and do not have strong smell. Metal-amine complexes can be prepared from the reaction between metal (II) acetates and aliphatic amines. These catalysts show good catalytic activity.

1.2 Objectives and Scope of the Research

The objectives of this research were to prepare RPUR foams catalyzed by metal-amine complexes and mixed metal-amine complexes. It was expected that these metal-amine complex catalysts showed good catalytic activity and improved properties of RPUR foams. The reaction times, physical, mechanical and thermal properties of RPUR foams were compared with those prepared from commercial catalyst, DMCHA.

This research was divided into two steps. In the first step, metal-amine complexes [M_1(tetraen)] and mixed metal-amine complexes [M_2(tetraen):M_3(tetraen)] (Figure 1.1) were synthesized from the reaction between metal (II) acetate and tetraethylenepentamine (tetraen) in different solvents. Acetone and water were used as solvents in the synthesis. Metal-amine complexes could catalyze RPUR foams but the foams had low volume. The mixed metal-amine complexes were synthesized in order to improve the flowability and reaction times of RPUR foams. Moreover, mixed metal-amine complexes showed good solubility in RPUR foam starting materials. The mole ratio of metal (II) acetate:tetraen in M_1(tetraen) was determined. RPUR foams accelerated with M_1(tetraen) prepared from metal (II) acetate:tetraen at the mole ratio of 1:2 showed longer reaction times than those prepared at the mole ratio of 1:1. Since the steric hindrance of tetraen had the effect on catalytic activity. M_1(tetraen) obtained from metal (II) acetate:tetraen at the mole ratio of 1:2 had more steric hindrance than those obtained from metal (II) acetate:tetraen at the mole ratio of 1:1. Metal complexes were characterized by FTIR spectroscopy, ultraviolet-

visible spectroscopy, elemental analyses, flame atomic absorption spectroscopy and mass spectrometry.

In the second step, RPUR foams were prepared by using M_1(tetraen) and M_2(tetraen):M_3(tetraen) as catalysts. Foam morphology and cell size were studied by scanning electron microscope. Physical and mechanical properties of RPUR foams studied were density and compressive strength, respectively. Thermal stability of the foams was determined by thermogravimetric analysis.

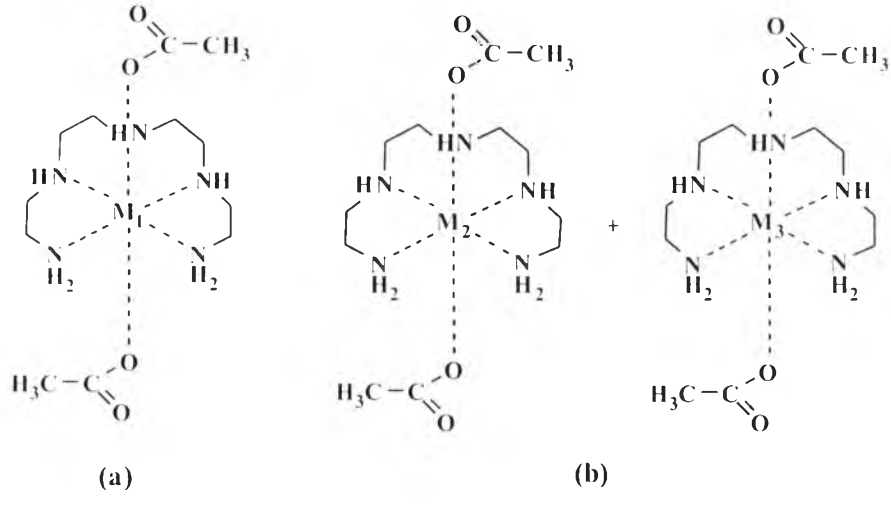


Figure 1.1 Structures of (a) metal-amine and (b) mixed metal-amine complexes

(M_1 = Cu, Zn, Ni, Co and Mn; M_2=Cu; M_3 = Zn, Ni, Co and Mn)