CHAPTER V

CONCLUSION

5.1 Conclusion

Metal-amine complexes [M_1(tetraen)] and mixed metal-amine complexes [M_2(tetraen):M_3(tetraen)] (where M_1 = Cu, Zn, Ni, Co and Mn; M_2 = Cu and M_3 = Zn, Ni, Co and Mn) were synthesized for preparation RPUR foams. M_1(tetraen) prepared from metal (II) acetate:tetraen at the mole ratio of 1:1 showed good reaction times than those prepared at the mole ratio of 1:2. Metal-amine and mixed metal-amine complexes were characterized by means of FTIR spectroscopy, ultraviolet-visible spectroscopy, elemental analyses, flame atomic absorption spectroscopy and mass spectrometry.

RPUR foams catalyzed by Cu(tetraen) and Zn(tetraen) complexes showed good reaction times. Use of Cu(tetraen):Zn(tetraen), a mixed metal-amine complex, could improve flowability and reaction times of RPUR foams. RPUR foams catalyzed by Cu(tetraen):Zn(tetraen) showed better gel time and tack free time than those catalyzed by Zn(tetraen). Moreover, RPUR foams prepared by Cu(tetraen):Zn(tetraen) had higher foam rising than those prepared by Cu(tetraen). The optimum formulations of catalyst content and blowing agent (water) content were 0.5 pbw and 2 pbw, respectively. These formulations resulted in the desirable density, which ranged from 40 to 43 kg/m^3 at the NCO index of 100. RPUR foams catalyzed by DMCHA showed less density than those catalyzed by Cu(tetraen), Zn(tetraen) and Cu(tetraen):Zn(tetraen) complexes.

RPUR foams catalyzed by Cu(tetraen), Zn(tetraen) and Cu(tetraen):Zn(tetraen) complexes gave higher compressive strength than those catalyzed by DMCHA. Since compressive strength corresponded to density. Compressive strength of RPUR foams prepared from Cu(tetraen):Zn(tetraen) were 266.6, 341.9 and 414.8 kPa for NCO indexes of 100, 150 and 180, respectively. It was found that compressive strength increased with increasing of NCO indexes since the polymer matrix more highly crosslinked. Moreover,

Compressive strength of RPUR foams in parallel direction of foam rising was higher than that in perpendicular direction. RPUR foams were anisotropic materials, which confirmed by cell morphology. The cell structure of RPUR foams showed spherical cells and elliptical cells in parallel and perpendicular of foam rising, respectively.

Blowing agent (water) had an influence on the cell structure. The average cell size of RPUR foams catalyzed by Cu(tetraen):Zn(tetraen) increased from 370.2 to 521.3 μm with the increase of water from 1 to 3 pbw, respectively. Since the increase of water content generate more bubbles. Therefore, the cell size of RPUR foams increased with the increase of water content.

RPUR foams catalyzed by metal-amine complexes, mixed metal-amine complexes and DMCHA were characterized by FTIR spectroscopy. It was also used to determine the NCO conversion (%). The results indicated that NCO conversion of RPUR foams decreased with increasing of the NCO indexes. PIR formation increased with increasing of NCO indexes because the increasing of isocyanate resulted in trimerization. Moreover, the increasing of NCO indexes gave more unreacted isocyanate since metal-amine and mixed metal-amine complexes were not specific toward of PIR formation.

Foaming temperature profiles could confirm that the reactions of RPUR foams were exothermic reaction. The temperature profiles gradually increased after the starting materials were mixed. The maximum core temperature (T_{max}) increased with the increasing of NCO indexes. The excess amount of isocynate in the foaming system could react with amine and generated disubstituted urea. This chemical reaction is also exothermic reaction raising the foaming temperature. T_{max} of RPUR foams at NCO indexes of 100 and 150 showed in the range of 120 to 126 °C and 130 to 135 °C, respectively.

Thermal gravimetric analysis (TGA) was used to investigate decomposition temperature of RPUR foams. RPUR foams catalyzed by Cu(tetraen), Zn(tetraen), Cu(tetraen):Zn(tetraen) and DMCHA showed initial decomposition temperature at 278 to 287 °C for 5 to 6 % of foam weight loss (NCO index of 150). The initial decomposition temperatures related to the decomposition of urethane. It was indicated that RPUR foams

catalyzed by metal-amine and mixed metal- amine complexes showed similar thermal stability to the foams catalyzed by DMCHA.

5.2 Suggestion for Future Work

The suggestion for future work is to characterize metal-amine and mixed metal-amine complexes in water. The preparation of metal complexes in water spends less time and reduces toxic.