

Preparation of a New Waterborne Polyurethane Emulsion and its Properties Investigation

GUO Xue-li, WANG Zheng-xiang, ZHAO Shu-hui, DU Jing-jing, HOU Qing-li, HE Quan-guo

(1. Green Packaging and Biological Nanotechnology Laboratory, Hunan University of Technology

Zhuzhou 412008, China; 2. Department of Chemistry, Zhengzhou University, Zhengzhou 450052, China)

Abstract A new waterborne polyurethane emulsion is synthesized by prepolymerization. The effecting factors including the ratio of isocyanate content to hydroxyl group's ($-NCO/-OH$), the reaction temperature and the carboxyl group content on target prepared emulsion's viscosity, particle diameter and the water absorption are experimentally investigated during the reaction processes. The results show that: (1) The emulsion viscosity and water absorption are decreased when the $-NCO/-OH$ ratio is increased, but the particle diameter is increased. (2) The reaction rate is increased when the temperature is increased, but the side reaction is more easily arisen. (3) The emulsion viscosity and water absorption are increased, but the particle diameter is decreased when the carboxyl content the carboxyl group content is increased.

Key words waterborne polyurethane; viscosity; particle diameter; water absorption; preparation

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Lots of waterborne polyurethanes have been developed and applied in various fields due to their excellent characteristics. In the preparation of most waterborne polyurethanes, the chain extender is dissolved mostly in the organic solvent before use. Furthermore, the organic solvent could hardly be removed completely once used. As an attempt improvement for new waterborne polyurethane preparation and better candidate for conventional replacement, we presented a new waterborne polyurethane emulsion preparation via prepolymerization.

1 Experimental

(1) TDI, PPG ($M_n=1000$), dibutyltin dilaurate were charged in a round-bottomed flask. The mixture was heated. (2) DMPA was added and the mixture was heated. (3) TEA was added and the mixture was incubated. (4) The water was added to the emulsion under mechanically stirring. Some experimental parameters were investigated in Section 2.

2 Results and Discussions

2.1 The $-NCO/-OH$ ratio's effect

Fig 1 (curve 1) showed that the viscosity was decreased as the $-NCO/-OH$ ratio's increasing. It was

because the ability of entwining with each other was decreased. Fig 1 (curve 2) showed that the particle diameter was increased when the $-NCO/-OH$ ratio was increased, since the molecular weight was larger when the $-NCO$ content was more^[1].

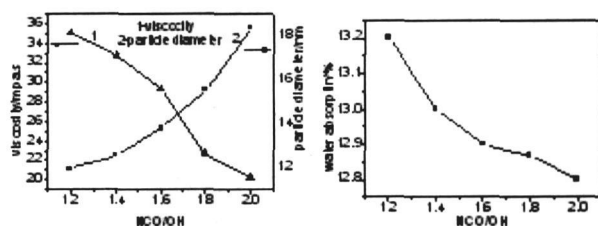


Fig 1 The $-NCO/-OH$ ratio effect on emulsion's viscosity and particle diameter (Left)

Fig 2 The $-NCO/-OH$ ratio effect on film's water absorption (Right)

Fig 2 showed that the water absorption was decreased when the $-NCO/-OH$ ratio was increased. It was because the total surface areas of particles were decreased when the particle diameter was increased^[2].

2.2 The reaction temperature's effect

The reaction temperature's effect on prepolymerization reaction was shown in Fig 3. It showed the carbamate content was rapidly decreased when the reaction

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作者简介: 郭雪梨 (1981年生), 女, 硕士研究生; 通讯联系人: 贺全国; E-mail: hequanguo@163.com

temperature was 80°C . But the reaction was uncontrollable because of the side reaction. The reaction was gentle at 60°C , but the reaction time was 120 minutes. Therefore, the optimized reaction temperature was 70°C .

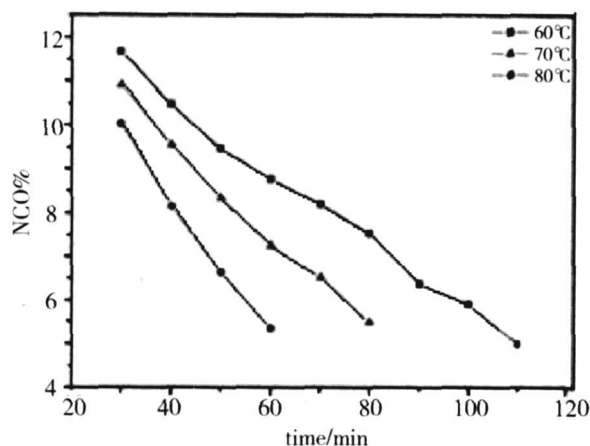


Fig 3 The reaction temperature's effecting

2.3 The carboxyl group content's effect

Fig 4 (curve 1) showed that the viscosity was increased when the carboxyl group content was increased. The charge number of ion was increased when the carboxyl group content was increased. Fig 4 (a) (curve 2) showed that the particle diameter was decreased rapidly in the first and then leveled off. One hand, the polyurethane was easily dispersed when the carboxyl group content was increased. On the other hand, the particle's hydroexpansivity was produced when the carboxyl group content was increased^[3]. Fig 4 (b) showed the water absorption was increased when the carboxyl group content was increased. The particle's

hydrophilicity was increased when the carboxyl group content was increased. After coating, the water was easily absorbed by hydrophilic groups^[4].

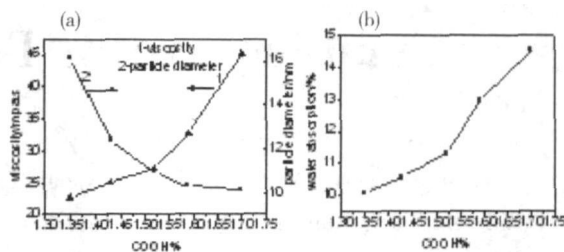


Fig 4 The carboxyl group content's effect on emulsion's viscosity and particle diameter (a) and film's water absorption (b)

3 Conclusions

A new waterborne polyurethane emulsion preparation via pre-polymerization was described in the article. The performances of the emulsion prepared as above method were fine.

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新型水性聚氨酯乳液的合成及其性能影响因素的研究

郭雪梨¹, 王正祥¹, 赵淑蕙², 杜晶晶¹, 侯清麟¹, 贺全国¹

(1. 湖南工业大学绿色包装与生物纳米技术应用实验室, 湖南 株洲 412008

2. 郑州大学化学系, 河南 郑州 450052)

摘要: 采用预聚法合成了一新型的水性聚氨酯乳液, 研究了配方中异氰酸酯基和羟基的物质的量的比 ($-\text{NCO}/-\text{OH}$)、反应温度、羧基含量对水性聚氨酯的粘度、粒径和吸水率等性能的影响。表明, 随着 $-\text{NCO}/-\text{OH}$ 比的增大, 粘度下降, 粒径增加, 吸水率下降; 预聚反应温度越高, 越快达到异氰酸酯基的理论值, 但是温度越高越易发生副反应; 随着羧基含量的增加, 粘度升高, 粒径起初下降, 最终趋于平衡, 吸水率升高。

关键词: 水性聚氨酯; 粘度; 粒径; 吸水率; 合成

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