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Synthesis of Hydroxypropyl Guar Gum by Phase Transfer Catalysis

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Abstract: HGG (Hydroxypropyl guar gum) was synthesized by phase transfer catalysis for the first time. The effects of alkalinity, phase transfer catalyst, etherification, pH value, temperature, reaction time and stirring speed were investigated. An optimal synthetic reaction technology was established, namely, dose of guar gum is 100 g, propylene oxide 40-50 g, HTAC (hexadecyl trimethyl ammonium chloride) 1.3-1.7 g, pH value 10-10.5, temperature 45-50℃, and reaction time 3-4 hours. The result shows that the improved HGG has high viscosity. Its dissolution speed, content of insoluble residue, colloid light transparency and stability are apparently superior to guar flour.

Keywords: Guar gum, hydroxypropyl guar gum, chemical modification, phase transfer catalysis.

Guar gum comes from endosperm of guar gum of herb. It is a kind of natural green product which has special physical and chemical property and is used as thickener, stabilizer, emulsifying agent, dispersant, suspending agent, water-retaining agent and coagulant, and applied to many fields such as oilfield. However, the application of unmodified guar gum is considerably limited by slow dissolution speed, high content of insoluble residue, weak and unstable solution light transparency[1-5]. Therefore, it is quite necessary to modify natural guar gum. Usually, chemical modification takes place in organic reagent, and needs large amount of methyl alcohol, ethyl alcohol, isopropyl alcohol or acetone and so on[1-5]. In the present research, HTAC is used as catalyst. HGG is prepared by phase transfer catalysis. About chemical modification of guar gum by phase transfer catalysis has no been reported up to now.

Basic thought about laying out synthetic route is that the reaction between propylene oxide and guar gum belongs to solid-liquid heterogeneous one. During reaction period, guar gum as solid suspends in the system and inorganic catalyst sodium hydroxide and etherification agent propylene oxide are used as soluent. In order to make reaction easier, the method of phase transfer catalysis can be utilized to bring reactants through two phase surface from one phase to another by means of phase transfer catalyst further to form tight electrons which have stronger nucleophilicity between cation and the anion of guar gum alkoxyl formed after leaving proton. The touch probability between propylene oxide and guar gum was increased and made the reaction rate to increase. The typical method is as follows: small amount of ethyl alcohol used as wetting agent was added to guar flour, then a certain amount of sodium hydroxide solution was added. After 1 hour alkalinifying, hydrochloric acid was

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dropped into the vessel in order to adjust the specific pH value. Then phase transfer catalyst was added, followed by adding a certain amount of propylene oxide. The reaction was processed at specific temperature for several hours. The product was washed and dried. The modified guar gum was obtained.

According to the research of the effects of alkalinity, phase transfer catalyst, etherification, pH value, temperature, reaction time and stirring speed, we find that phase transfer catalysis can make the synthetic reaction easier. For example, in order to assure diffusion of reactant in multiphasic system, reaction of modifying guar gum needs stirring, however, the stirring speed has no apparent influence on this reaction. The reason may be that the influence of phase transfer catalyst is dominant over the influence of stirring speed.

The results of the research indicated that the best synthetic conditions are as follows: the dose of guar gum 100 g, propylene oxide 40-50 g, HTAC 1.3-1.7 g, pH value 10-10.5, temperature 45-50℃, reaction time 3-4 hours. IR spectrum map measured by IR spectrum machine of Nicolet at 360 model indicated that main absorption spectrum of the target product is coincidence with that of guar flour.

Appearance of ν_{as}, -CH_3(2970cm^{-1}), δ-CH_3 (1378.09 cm^{-1}) in the IR spectrum proved that between guar flour and propylene oxide occurs etherification reaction. The molecules of product contain methyl group and the synthetic product belongs to hydroxypropyl polygalactomannan. These data indicate that the chemical modification of guar gum was successful. The SY/T5764-1995 standard test shows that the improved HGG has high viscosity. Its dissolution speed, content of insoluble residue, colloid light transparency and stability are apparently superior to guar flour (**Table 1**).

Table 1 Comparison of properties between modified guar gum and guar gum

Index appellation	guar gum	modified guar gum produced
appearance	light yellow	light yellow
dissolution speed/min	⩾120	10-15
light transparency of 0.5% aqueous solution /%	50-60	69.5
content of insoluble residue /%	20.06	8.93
Viscosity of1%aqueous solution /mPa.s	3000-3500	4300
colloid stability	＜24h	⩾20d
stable pH value range	6-9	5-11

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