Research Article

Kinetic Study of Synthesis of Sorbitol Based Polymer for Detergents

MU. Bambole[1*], BC. Burande[2] and BB. Gogte[3]

[1]Priyadarshini College of Engineering, Nagpur, Maharashtra, India.
[2]Department of Chemistry, Priyadarshini Indira Gandhi College of Engineering Nagpur, Maharashtra, India.
[3]Department of Oil Technology, Laxminarayan Institute of Technology, R.T.M. Nagpur University, Nagpur, Maharashtra, India.

ABSTRACT
Sorbitol along with other polyols has been used successfully to synthesis polymers which can be used as replacement of soft acid slurry and alpha olefin sulphonate in liquid, powder and cake detergents. These polymers have also been used in hand wash and dish washing liquid compositions. The Detail kinetic study of synthesis of polymer is very essential to decide the time of heating and other parameters to get most useful product. The present study indicates that three hours heating at 130^0 C give most useful polymer for formulations of detergents.

Keywords: Polymeric surfactants; sorbitol; citric acid; oxalic acid; maleic anhydride.

1. INTRODUCTION

In the last decade the world has moved forward to a new class of surfactants that are made of natural renewable materials. Most of the commercial detergents contain Linear Alkyl Benzene Sulphonate (LABS) and Alpha Olefin Sulphate as main ingredients. These are less biodegradable chemicals. They are harmful to aquatic animals and create water pollution. It is necessary to replace these chemicals by other biodegradable substances[1]. Polymeric surfactants based on natural products are of interest as alternatives of soft acid slurry and Alpha olefin sulphate[2]. It can be anticipated that an increased fraction of natural building blocks in the surfactant structure will be beneficial for reducing aquatic toxicity and increasing the rate of biodegradation. Sorbitol based polymers have been reported which can replace convetional acid slurry in making powder, liquid and cake detergents[3,4]. In the present paper kinetic study of synthesis of sorbitol based polymers has been reported[5-6].

2. Experimental

The preparation of sorbitol based polymer was carried out in a glass reactor. The reactor consists of two parts. Lower part of reactor is a round bottom flask with very wide mouth. Upper part of reactor is its lid having four necks with standard joint. Out of these central one opening is for inserting mechanical stirrer, second is for charging of raw materials, third is connected to water condenser and four is to fit thermometer. An electric heating mantle having special arrangement for smooth control of the temperature (-/+ 2) has been used. Mechanical stirrer is provided with speed regulator.

The reactions of sorbitol with organic acids was carried out at three different temperature viz. 110^0C, 120^0C and 130^0C.The time of heating was studied for a duration of 1 to 4 hours. Raw material used for the synthesis of polymer is given in Table -1

Table 1: Raw Material of Sorbitol based polymer A_3

S.No.	Ingredients	% by weight
1	Sorbitol (70%)	80
2	Maleic anhydride	05
3	Citric acid	05
4	Oxalic acid	05
5	Pthalic anhydride	05

Sodium bisulphate1.5% and Sodium bisulphite 0.5 % by weight were used as catalyst.

3. RESULT AND DISCUSSION

Table no.1 give composition of sorbitol based polymer. A combination of acids has been used in this formulation and 5% each of maleic, pthalic, citric and oxalic acid has been

used. Sodium bisulphate and sodium bisulphite acts as a catalyst.

Table no. 2 and 3 gives physicochemical analysis[7] of synthesized polymer at three different temperatures and for a reaction time of 1 to 4 hours. Maximum reduction in acid value[8] and surface tension is obtained after 3 hours duration at 130^0C. There is no significant change in values in fourth hours. Thus to get maximum reduction acid value and surface tension temperature of 130^0C and heating time of three hour is recommended. This sample after three hour has desirable H.L.B. ratio and viscosity[9].

Table 2: Physicochemical analysis of sorbitol based polymer

S.No.	Properties	After 1 hour			After 2 hours		
		110^0C	120^0C	130^0C	110^0C	120^0C	130^0C
1	% Solid	76.89	77.25	79.27	77	78.67	80.21
2	Acid Value	98.96	94.18	90.72	96.26	94.89	90.27
3	H.L.B. Ratio	15	15.25	15.95	15.14	15.39	16.19
4	Surface tension of neutralized samples (By Stalagmometre method in dyne/cm)	65.90	63.19	62.12	63.01	62.71	61.83
5	Colour	Faint Yellow	Faint Yellow	Faint Yellow	Faint Yellow	Faint Yellow	Faint Yellow
6	Viscosity(by Ford Cup No.4) in seconds at 30^0C	200	227	240	209	230	250

Table 3: Physicochemical analysis of sorbitol based polymer

S.No.	Properties	After 3 hours			After 4 hours		
		110^0C	120^0C	130^0C	110^0C	120^0C	130^0C
1	% Solid	76.49	78.98	80.01	80.35	81	84.23
2	Acid Value	98.40	88.95	88.35	97.8	88.80	88.35
3	H.L.B. Ratio	15.44	15.63	16.29	15.49	15.20	14.10
4	Surface tension of neutralized samples (By stalagmometre method in dyne/cm)	62.52	61.18	58.67	62.14	61.01	58.6
5	Colour	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
6	Viscosity(by Ford Cup No.4) in seconds at 30^0C	240	270	298	250	290	340

I.R. and 1H NMR spectra of polymer sample A_3 (polymeric sample which is obtained by heating raw material at 130^0C for three hour) is given in figure-1 and figure-2. The I.R. & NMR spectra suggest the presence of I) free acid groups II) Free OH groups III) Ester groups and ether [10-11].

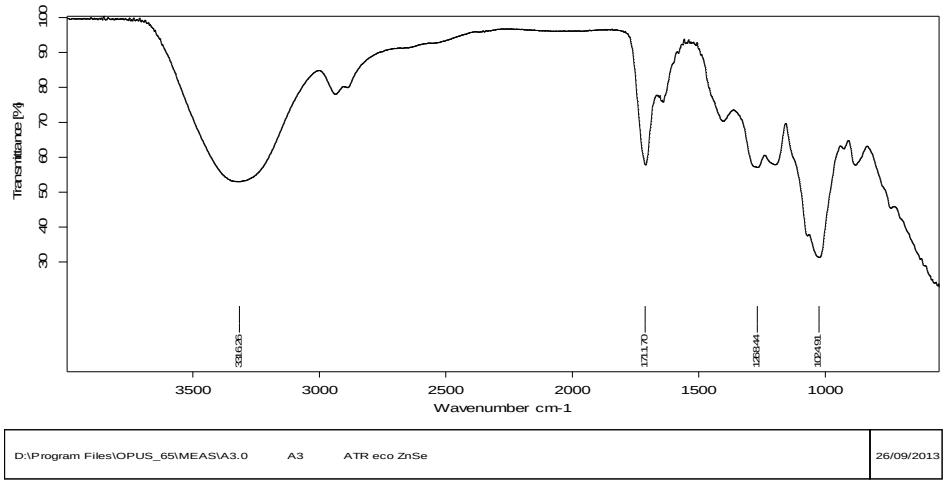

Fig. 1: Infra-red Spectra of A_3 Polymer

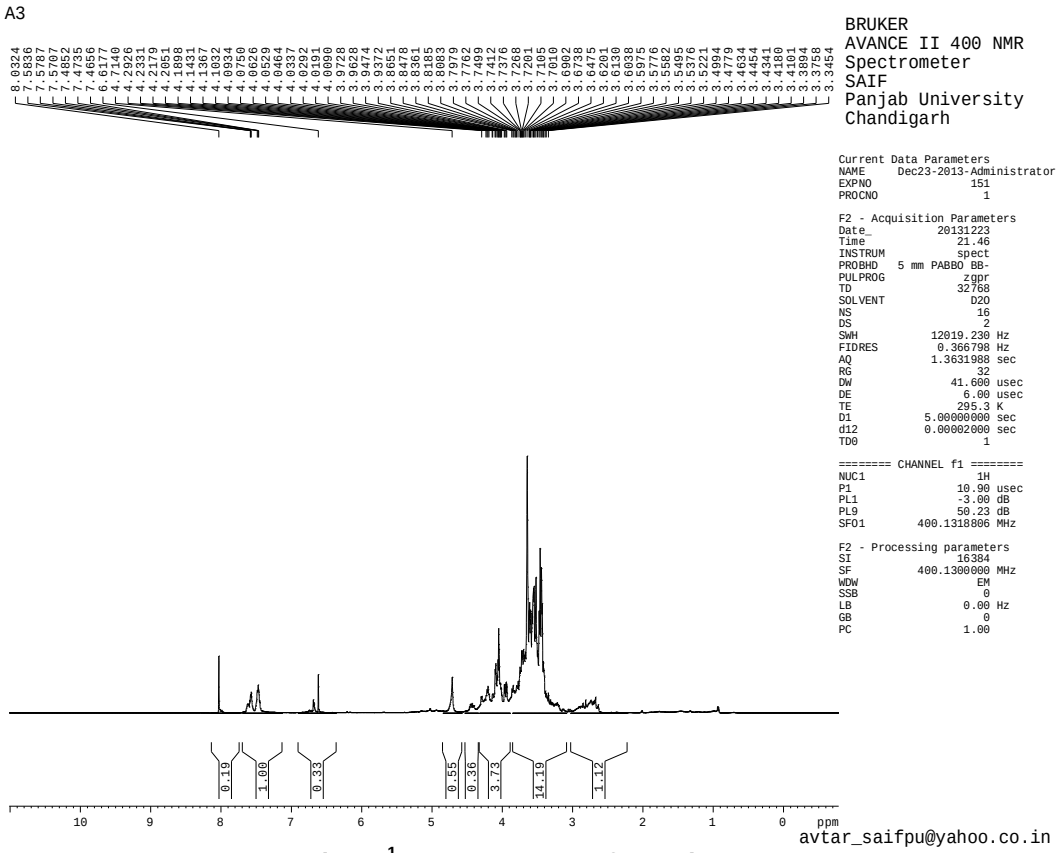

Fig. 2: ^{1}H NMR Spectra of A_3 Polymer

4. CONCLUSIONS

A. The Physicochemical analysis and spectral data indicate that following reactions are taking place.

I. Esterification between acid and alcohols group which are shown by peaks in I.R. and N.M.R.

$$RCOOH + R^1OH \rightarrow RCOOR^1 + H_2O$$

II. Etherification between –OH groups to give oxirane oxygen

$$R\text{-}OH + OH\text{-}R \rightarrow R\text{-}O\text{-}R + H_2O$$

B. The following parameters give best result in reference to reduction of acid value, surface tension and reasonably high viscosity.

I. Temperature of heating = 130^0C

II. Time of heating after attaining a temperature of 130^0C = 3 hours.

This kinetic study may help to produce this polymer on pilot and large scale productions.

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