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SORBITOL AND ORGANIC ACID BASED POLYMERS FOR DETERGENTS

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Abstract. In this study, some eco-friendly polymers were synthesized by treating sorbitol and organic acids like citric acid, oxalic acid, and anhydrides such as pthalic and maleic anhydrides. Some specific linkages are found by FTIR. Polymers molecular weight range was determined by mass spectrometry. Some physicochemical properties like percent solid, viscosity, pH, HLB ratio, and surface tension and acid value were measured. We found that, these newly prepared polymers have a great potential to be used as surfactant in soap and detergents. It is easy to synthesized and cheaper than other commercially available surfactants.

Keywords. Sorbitol, Polymeric surfactant, Eco-Friendly Powder and Liquid Detergents.

1. Introduction

Sorbitol is a kind of sugar alcohol, a carbohydrate[1] that occurs in some fruits like pears, apples and cherries. Sorbitol has a wide application in different industries due to sweetening, humectants and stabilizing properties. In 2023, the market size [2] in India was 181.1 kilotons, with expectation to reach 221.2 kilotons by 2032. It is widely used in both the consumer and industrial applications such as liquid detergents[3], soaps, cosmetics, toiletries, textile, paper and pulp, machinery, food processing, rubber, plastics, coatings, medicine, pharmaceuticals. India has a strong base of agricultural products like starch, sorbitol, sugar and vegetable oils.

Many commercial detergents contain harmful ingredients. Phosphates[4] can pose risk to human and the environment. It promotes algae growth in water bodies and responsible for water pollution. Petroleum based ingredients are non-renewable and environmentally harmful. It can cause skin irritation and respiratory issues to humans [5]. Plant derived surfactants are renewable and better alternative for petroleum based surfactants and phosphates. Natural products are biodegradable [6], cheaper and cause less harm to the environment. As sorbitol are easily

available and useful chemicals in different sectors. Here we prepare some sorbitol based polymeric surfactants and its study shows that it has a great potential to be used in detergents and cleansing products.

2. Experimental.

Synthesis of polymeric surfactants

Initially previously weightingredients like Sorbitol, maleic anhydride, phthalic anhydride, oxalic acid, citric acid,sodium bisulphateand sodium bisulphite were added in a reactor.It is converted into a homogeneous dispersion by using electrically controlled homogenizer. This reaction mixturewas heated slowly up to it reach a temperature of 80^0C with continuous stirring. Then heating rate increased till it reaches temperature of 130^0C. The reaction was controlled by an accurate heating control system. At a constant temperature of 130^0C further heating were continued for three hour. Reaction mass was observe periodically for its consistency and colour. If necessary to maintain the flow and homogeneity additional amount of water is added. The product was cool to room temperature, and then stores it in an umbercolour air tight bottle.

In these polymers sorbitol was the main ingredient. We heat it with different proportion of organic acids and anhydride at 130^0C for three hours. We madefour different polymers. Compositions of polymers are shown in table 1.

Table 1: % Composition by weight of Sorbitol polymers

Ingredients	A_4	A_9	A_{11}	A_{12}
Sorbitol (70%)	78.4	84.6	83.2	73.6
Maleic anhydride	6.9	4.7	4.6	7.3
Phthalic anhydride	2.9	1.9	1.8	7.3
Oxalic Acid	4.9	1.4	1.5	4.9
Citric Acid	4.9	1.4	1.5	4.9
Sodium bisulphate	1.5	3.5	2.8	1.5
Sodium bisulphite	0.5	2.5	4.6	0.5

Table 2: Physico-chemical Analysis of Sorbitol based Polymers

Polymer	% Solid	Viscosity (Sec.)	Colour	pH value	H.L.B. ratio	Oxirane Oxygen value[7]	Surface Tension Dyne/cm	Acid Value
A_4	78	262	Yellow	4	16.58	0.33	67.19	35.86
A_9	77.23	197	Yellow	3.56	15.62	0.22	52.20	46.46
A_{11}	77.18	167	Yellow	3.76	16	0.22	59.20	42
A_{12}	77.5	95	Yellow	3.34	16.7	0.04	61.90	147.31

Spectra 1: Infra-Red Spectra of novel polymer (A_{12})

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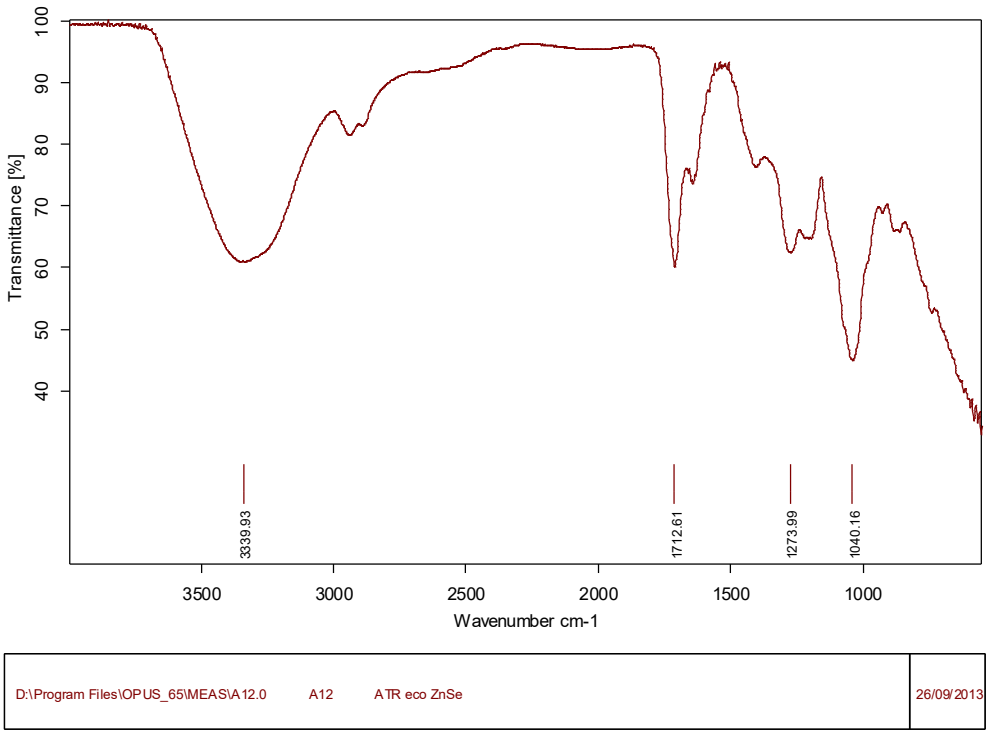
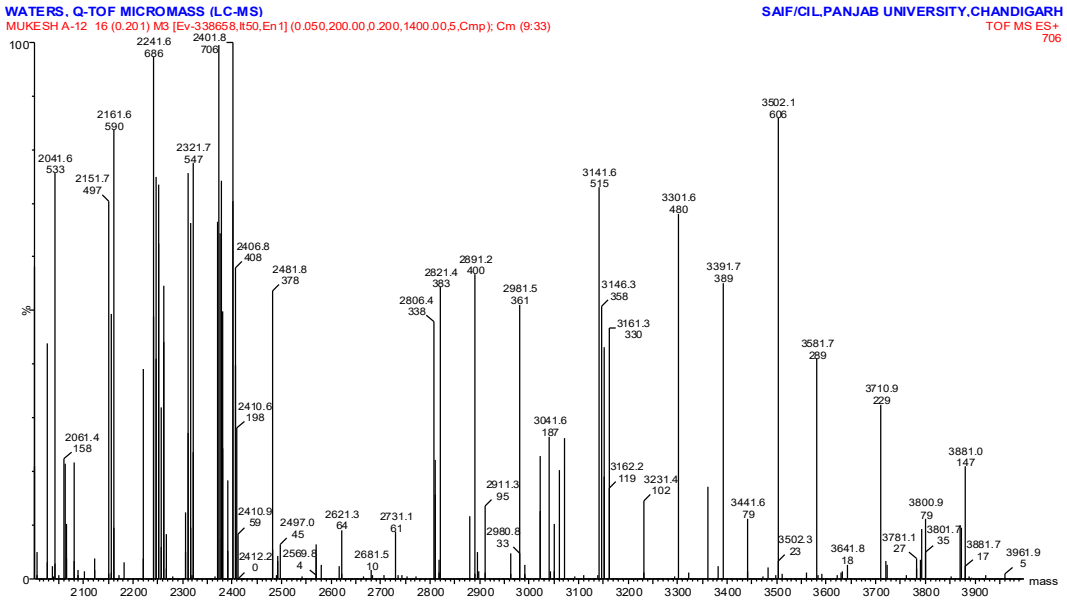


Table 3: FT-IR Spectroscopic analysis of Polymer A_{12}

Sr. No	Functional groups	Literature Wave number cm^{-1}	Observed Wave number cm^{-1}
1	Hydroxyl group (OH stretching)	3200-3600	3339.93
2	Ester group (C=O stretching)	1720-1708	1712.61
3	Ether group (C-O stretching)	1260-1000	1273.99, 1040.16

Spectra 2: Mass spectra of Novel Polymer A_{12}



3. Result and Discussion:

Table no.1 shows composition of different sorbitol based polymers. Sorbitol (70%) is a main ingredientof polymers. We take it 73 to 85 % by weight. In polymer A_{12}it is 73.6 while in A_9 contain 84.6 by weight. Different organic acids and anhydrides are taken in the range of 1.4 to 7.3 % by weight. Sodium bisulphate and sodium bisulphite is taken in the range of 0.5 to 4.9 by weight not greater than 7%.Sorbitol reacts with organic acids to form sorbitol esters and complexes. Hence during the course of reaction esterification reaction is proceeds. Further it undergoes polymerization. We get high molecular weight polymers having molecular weight in the range of 3000 to 3900.

Table no. 2 gives the physicochemical analysis of polymers. All polymers shows % solid of approximately 78 %.The polymers are yellow in colour. The viscosities of polymers are measured by ford cup method [8]. Polymer A_4 is thickest polymer having viscosity 262 s. Polymer A_{12} is thinnest among them. Viscosities of polymers are good enough to incorporate it in detergents formulations. All the polymers are acidic in nature having pH in the range of 3-4. While using polymers in detergents formulations it should be neutralized. HLB ratio of all the polymers clearly indicate there use in detergents. Polymer A_9 shows highest reduction in surface tension. All polymers have low surface tension than water.

Spectra -1 is Infra-red spectra of polymer A_{12}. Table no.3 gives different absorption band in IR spectrum [9,10]. It shows broad band for hydroxyl group at 3339.93, carbonyl group of ester at 1712.61 and for C-O at 1273.99, 1040.16. Spectra -2 is a mass spectra of polymer A_{12}. It gives information about different fragments as well as molecular weight of polymer A_{12}.

4. Conclusion

1) Polymer can besynthesized by heating sorbitol and organic acid at 130^0C.
2) The polyhydroxy groups from sorbitol with various organic acids like maleic, pthalic, citric, oxalic, etc. to form useful surfactant product. Basically it is esterification reaction.
3) Etherification reaction between two internal hydroxyl groups in carbohydrate entity has also been observed. The ether groups will make the polymer hydrophilic.
4) Infrared spectra of the polymer indicate that ester, ether and hydroxyl groups are present in the molecule.
5) The mass spectra of polymer indicate that average molecular weights of polymers are in between 3000 to 3900.
6) The mole ratio of reactants, temperature and properties of catalyst can be optimized to get polymer of desired molecular weight and physicochemical properties like surface tension, acid value and cleaning properties.
7) All samples have percent solid 77 to 79% and reasonable good viscosity. The HLB ratio, pH value and oxyrane oxygen value suggest strongly their used in detergents.

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II. Director, SAIF Panjab University, Chandigarh, Indiaproducesmass spectroscopic investigations.

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