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Sugar -Sorbitol Based Polymeric Surfactants for Detergents

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Abstract: Novel polymers based on sorbitol, sugar, and maleic anhydride have been synthesized. Various parameters such as time of reaction, temperature, and mole ratio have been studied. Novel catalysts have also been used for these experiments some compositions have been selected for further studies. Polymeric surfactants are known to contribute towards soil suspension, soil removal, and reduction in surface tension. Selected novel compositions of polymers have been used in powder detergent formulations as active ingredients. About 10-12 % incorporation gives excellent results. The petroleum actives such as soft acid slurry, alpha olefin sulphonate can be replaced in parts with these novel polymers. The petroleum resources are souring in price and availability their replacement with novel polymers of vegetable origin will certainly promote green environment.
Key words: Sugar -Sorbitol ,Polymeric Surfactants, , Detergents.

INTRODUCTION:

The commercial liquid, powder, and cake detergents normally contain 15-20% petroleum based actives such as linear alkyl benzene sulphonate and alpha olefin sulphonate .the scarcity and price fluctuation of petroleum based products compel us to think about products of vegetable origin such as sugar, starch, and sorbitol .In our earlier research work we have developed polymeric surfactants based on natural products like vegetable oil[4], rosin[3], starch[1], sorbitol[2].These products have been successfully used in liquid and powder detergent compositions. We were able to replace about 50-70% of petroleum based actives with natural products. In this present work we are using combinations of sugar, sorbitol, starch, and anhydrides to get a novel polymer.

The following chemical reactions are possible,

1. Sugar will be hydrolyzing to glucose and fructose.
2. Esterification reaction of OH group coming from sugar and sorbitol with acid group of phthalic anhydride, oxalic acid and maleic anhydride.
3. Etherification reaction between two OH groups in sorbitol and sugar .The catalyst used in B1, B3, and B4 are HCl and Tween80. In formulation B2 we have used a combination of sodium bisulphite and sodium bisulphate.

EXPERIMENTAL:

The procedure adopted for mixing of ingredients was as follows, First prepared a sugar solution in distilled water to get 80% solution, this sugar solution was added to sorbitol base and homogenize thoroughly if recommended a small amount of starch powder is included. The synthesis was carried out in glass reactor of two liter capacity with four outlets. A condenser was used to cool the reaction mixture. This combination is heated slowly and steadily to a temperature of 130-140° c and then the reaction was continued at this temperature for next 4 hrs. The samples were withdrawn and stored in refrigerator.

TABLE NO.1: Composition of Sugar Sorbitol Based Novel Polymers, temperature=140°c & time of reaction=4 hrs.

Ingredient	Composition % by weight			
	B1	**B2**	**B3**	**B4**
Sorbitol (70%)	55.25	52.64	55.71	60.00
Sugar Soln(80%)	29.84	31.60	30.26	30.00
Starch Powder	4.97	-	5.52	-
Phthalic anhydride	4.97	5.25	11.6	10.00
Maleic anhydride	4.97	10.51	-	-
Catalyst used	H Cl = 0.5%	Sodium bisulphate = 0.5% Sodium bisulphate = 1.0%	Tween80=2%.	HCl=1%

The reaction temperature was controlled within +/- 2°c accurate temperature control in heating mantle.

The composition of powder detergent based on B3 and B4 are given in Table no.2

TABLE NO.2: Physico chemical properties of sugar sorbitol base novel polymers

Sr. No.	Physical property	B1	B2	B3	B4
1	Acid Value	4.47	4.20	4.61	12.48
2	Solid (%)	82%	93.5	63	84.5
3	Color	Dark Brown	Dark Brown	Dark Brown	Dark Brown
4	Consistency	thick	thick	thick	thick
5	Solubility				
5	1) hot water	soluble	soluble	soluble	soluble
	2) alcohol	Soluble	Soluble	Soluble	Soluble
	3) NaOH	soluble	Soluble	soluble	soluble
6	Surface Tension of 1%soln. dyne/cm.	32.47	34.61	35.93	36.45

Samples B3 and B4 were chosen based on their color, viscosity, and surface tension reducing characteristics. The special features of these detergent compositions are as follows –

1. Sodium lauryl sulphate has been used to extent of 2-9%. This substance is purely of vegetable origin and expected to give good detergency characteristics.
2. Samples PD1 and PD2 use conventional actives based on petroleum products These compositions have been prepared with a view to compare them with our products.
3. A special whitener has been developed based on titanium dioxide and sorbitol which contain about 60%titanium dioxide this optical whitener gives an asthetic appeal to our product. Titanium Dioxide gives a very white appearance to cloth.

TABLE NO.3: Composition of powder detergents based on novel polymer B3 (%by weight)

Ingredient	PD1	PD2	PD3	PD4	PD5
SLS	2	5	7.62	5	7.62
Salt	20	20	19.50	20	19.50
Dolomite	34	28	29.65	28	29.65
Sodium sulphate	10	10	6.0	10	6.0
STPP	3	3	4.23	3	4.23
Sodium perborate	1	1	0.84	1	0.84
Sodium carbonates	20	20	16.94	20	16.94
Acid slurry	7	-	-	-	-
AOS	-	10	12.71	-	-
Whitener	3	3	2.54	3	2.54
POLYMER B3	-	-	-	10	12.71

Whitener: Titanium dioxide and sorbitol are taken in 1:1 ratio.

TABLE NO.4

Sr. No.	Sample	% moisture	P H
1	PD1	8.73	8.72
2	PD2	10.19	9.17
3	PD3	11.17	8.37
4	PD4	10.02	9.21
5	PD5	10.52	8.42

Table no. 4 gives moisture content and PH of 1% solution .The moisture content is between 8-10.5%while PH is in the range 8-9.

PREPRATION OF DETERGENT COMPOSITIONS:-

A small laboratory blender mixer was used, first sodium carbonate ,polymer ,petroleum actives ingredient were mixed thoroughly for twenty minutes after this period other were mixed by rotating the drum for 30 minutes. Finally perfume was added and blending continued for five minutes. The sample was place in plastic, bags.

ANAYLISE OF DETERGENT POWER:

The detergent power was analyzed for moisture contest[5], PH[6], surface tension[7], foaming[8,] and detergency[9] on soil cloths by standard techniques described in the literature.

TABLE NO.5:

Physico Chemical Properties of detergents based on novel polymeric surfactant and commercial detergents from market (CD1 &CD2).

Conc	Sample	Foam Volume in CM3 C Time in				Density (gm /cc)	Surface Tension (dyne/cm)
		0	5	10	15		
0.1%	PD1	300	300	300	300	0.907	25.77
	PD2	750	700	650	650	0.935	31.24
	PD3	350	350	300	300	1.18	29.24
	PD4	500	500	500	450	1.20	38.71
	PD5	650	650	600	600	1.18	35.28
	CD1	1000	800	750	700	1.21	38.31
	CD2	1000	800	750	700	1.21	36.66
0.25%	PD1	400	350	350	350	0.912	25.91
	PD2	800	750	750	700	0.983	31.82
	PD3	400	400	350	350	1.20	29.94
	PD4	550	500	500	500	1.20	38.78
	PD5	700	700	700	650	1.19	35.41
	CD1	1000	800	750	700	1.22	33.49
	CD2	1000	800	750	700	1.23	37.37
0.5%	PD1	450	450	400	400	0.972	16.37
	PD2	850	850	800	800	1.012	32.12
	PD3	450	450	400	400	1.25	30.05
	PD4	600	600	550	550	1.21	38.92
	PD5	750	750	750	700	1.20	3537
	CD1	1000	800	750	700	1.27	68.29
	CD2	1000	800	750	700	1.29	67.70
1%	PD1	500	500	500	450	1.013	16.52
	PD2	900	900	900	850	1.12	32.55
	PD3	650	650	650	650	1.27	30.17
	PD4	650	650	650	650	1.23	39.04
	PD5	800	800	800	790	1.22	35.71
	CD1	1000	800	750	700	1.31	72.61
	CD2	1000	800	750	700	1.33	70.88

TABLE NO.6

Cloth	Medium for Staining	Conc.	PD1	PD2	PD3	PD4	PD5	CD1	CD2
Cotton	Soil Solution	0.1%	66	63	78	69	76	78	74
		0.25%	71	72	82	79	84	86	82
		0.5%	82	79	86	83	89	90	84
		1%	88	86	90	89	91	95	86

The cloths were soiled by standard technique and washed as per literature methods.

There is considerable lowering of surface tension by using different concentrations of powder in our samples the lowering of surface tension is significant at low concentration of 0.1% this is better than the two commercial samples tested simultaneously the following characteristics of our sample are up to the mark and are comparable to commercial products The satisfactory foaming is observed from 0.1 to 1%concentration. The foam stability is also excellent.

The following compositions PD4 &PD5 are found to be technically and economically viable alternatives for commercial detergents available in the market.

RESULTS AND DISCUSSIONS:

Several experiment were performed to get a desired polymer of low acid value, desired molecular weight, and pale color . Four polymers with desire characteristics are reported in table NO 1. .major ingredient was sorbitol (47-58%) and sugar solution has been used (28-20%). The higher proportion of sugar result in charring so the limit to which sugar can be tolerated is found to be 28-30%. A small amount of starch power has been used in composition B1and B3. A variety of catalyst have been tried which include hydrochloric acid, tween 80, sodium bisulphite and sodium bisulphate .Hydrochloric acid appear to give desirable result .

The preliminary physicochemical analysis is given in table no. 3 the acid values are quiet low in the range of 4-12 this indicate esterification reaction between acidic group of phthalic & maleic anhydride and OH group of starch, sorbitol, and sugar. The cooking schedule and composition is given in table no.1

Table no.1 gives compositions, cooking schedule , and order of addition of reaction the compounds giving OH groups are sorbitol, sugar, and starch while component phthalic anhydride and maleic anhydride gives acid groups. it is a esterification reaction the other possible chemical reaction is etherification between two OH groups to give a epoxy group the physicochemical properties are given in table no.3 The acid value is very low in the range of 4-12 this indicate that acid group have reacted almost completely with alcohol group to form esters all the samples are highly soluble in water ,alcohol, and sodium hydroxide. There is a significant lowering of surface tension.

Five detergent samples have been prepared based on novel polymer B3 developed in the synthesis. sample PD1 is based on acid slurry while PD2and PD3 are based on alpha olefin sulphonate and special whitener based on sorbitol and titanium dioxide has been used. This imparts additional whitening effect on the cloth samples PD4 and PD5used 10-15% of polymer B3 .The special features of PD4 and PD5 compositions are freedom from acid slurry or alpha olefin sulphonate vegetable product like sodium lauryl sulphate and novel polymer have been used instead of petroleum products. Amount of sodium tripolyphosphate is kept at minimum3-5% The analysis of sample is given in table no. 5. On an average the moisture content of samples are between 9-12%while pH varies between 8-9. The foaming characteristics and surface tension are given in table no. 6. The sample PD4and PD5 based on 10-15%novel polymer shows excellent foaming comparable to commercial sample as indicated in table no.6. The surface tension data also indicate significant lowering of surface tension in samples based on novel polymers. The results are comparable to commercial samples CD1 and CD2 tested simultaneously. Detergency testing carried out on detergents based on novel polymers and commercial products obtain from market indicate excellent soil removing characteristics.

CONCLUSION:

THE FOLLOWING CONCLUSIONS STAND CONFIRM IN THE LIGHT OF ABOVE EXPERIMENTAL RESULTS.

1. Carbohydrate polymer of desired viscosity, flow, molecular weight can be prepared by using combination of sorbitol, sugar, and starch. Acids such as maleic and phthalic anhydrides can be incorporated in to the composition Hydrochloric acid is giving excellent results as a catalyst .The heating schedule is of 4 hrs at 140°c.
2. The preliminary analysis indicates that polymer B_3 and B_4 should be used for powder detergent compositions based on color, viscosity, surface tension reduction and soil removing characteristics.
3. Powder detergent composition containing 10-15% of novel polymer without using conventional petroleum based actives can be used in powder detergent formulation without significant change in performance characteristics of detergent.
4. Cost of the polymer comes around 60/- per Kg. which is lower than conventional active ingredient like LABS and AOS which are available at 100-110/- per Kg .in the market.
5. Our sample based on sodium lauryl sulphate and 10-15% Novel polymer gives foaming, surface tension and detergency almost equivalent some time better than commercial sample CD1 and CD2 which were tested simultaneously.
6. The experimental compositions should be tried on pilot plant scale and market on commercial scale. This will certainly promote "green environment".
7. The raw material cost of our composition comes around 32/- per Kg. which is certainly attractive preposition for commercial product.
8. The product can be marked as free from petroleum, ecofriendly which will certainly attract global market.
9. The whitener is very important additive as it gives whiteness to the cloth.
10. Conventionally sodium chloride and dolomite are used inversely small quantity. We have practically proved that their higher property does not affect physicochemical properties and detergency.

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