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Synergistic Combination of Carbohydrate Polymer with Conventional Active Materials for Detergent Formulations

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Abstract: - Novel ecofriendly polymeric surfactant based on Sorbitol and Maleic anhydride has been synthesized and used successfully in detergent composition. Sorbitol is obtained majorly as a vegetable product. In present research work a small quantity of Maleic anhydride and Benzoic acid along with major quantity of Sorbitol has been used in synthesis of polymer. The mole ratio of ingredients and cooking schedule has been standardized to get desired molecular weight, HLB ratio and surfactant properties. Powder detergents have been formulated based on these novel polymer and conventional active ingredients such as alpha olefin sulphonate, sodium lauryl sulphate. And linear alkyl benzene sulphonate. This synergistic combination of novel polymer has been used as a 60 to 80% replacement of conventional linear alkyl benzene sulphonate in detergent powder formulation. The preparation of this polymer is ecofriendly and has a potential for commercial use as an ecofriendly detergent in powder form. The surface tension, foam height, % detergency and stain removing characteristics have been evaluated and compared with commercially available powder detergent sample. The petroleum resources are soaring in price and their replacement with novel polymer of vegetable origin will certainly promote the cause of Green Chemistry and Green Environment.

Key word: - Novel polymer, Sorbitol, Detergents, Surfactants, Maleic anhydride, Synergistic combination.
HLB- Hydrophilic–lipophilic balance.

Introduction: In recent year much attention has been directed towards natural surfactants owing to their different advantages such as lower toxicity, higher biodegradability, better environmental capability, higher foaming, high selectivity, specific activity at extreme temperature, PH and salinity and ability to be synthesized from renewable feedstock. Many natural surfactant have been treated at the lab scale only. The discovery of new natural surfactant may open a new door to the petroleum industry to explore the use of low cost and environmental friendly natural materials for enhanced oil recovery (EOR) during the chemical flooding.

A novel polymeric surfactant based on Sorbitol and maleic anhydride has been synthesized[1]. In this synthesis Benzoic acid has been used as a chain stopper, sodium bisulphate and sodium bisulphite have been used as a catalyst. In this research work, the mole ratio, catalyst and heating schedule has been standardized to get novel polymer with molecular weight in the range of 1800 to 3000. The conditions have been worked out to get desired acid value[2] hydrophilic-lipophilic balance[3], viscosity and solubility characteristics. An efforts has been made to replace crude petroleum based acid slurry and sodium lauryl sulphate (SLS) with novel polymer. The combined used of conventional active material and novel polymer gives good foaming and cleaning properties. This composition based on 11 to 13% Novel resin and varying % of alpha olefin sulphonate, Sodium lauryl sulphate (1 to 15%) are giving excellent result in % detergency. The sample can remove soil, coffee and Tea stain effectively.

Experimental:

The Reactor: - The preparation of resin was carried out in glass reactor. The reactor consists of two parts. Lower part of the reactor is a round bottom vessel with very wide mouth. The upper part of the reactor is its lid, having four necks with standard joints.

A major driven stirrer was inserted in the reactor through the central neck, while another neck was used for thermometer. A condenser was fitted with the reactor through the third neck. And the fourth neck was used for dropping the chemicals in to the reactor. The reactor was heated by an electric heating mantle having a special arrangement for smooth control of the temperature of the reactor. A regulator controlled the speed of the stirrer. The reaction vessel and its lid were tried together with the help of clamp.

Preparation of Novel Resin: - The polymer was prepared in an above reactor. The composition of novel resin mainly based on Sorbitol and Maleic anhydride. sodium bisulphate and sodium bisulphite has been

used as catalyst and Benzoin acid used as chain stopper The preparation and cooking schedule of Novel resin is given in table no 1 and 2.

Neutralization of Novel Resin: 100 gm. of Novel polymer was heated to 70℃ the calculated amount of 30% KOH was added to novel polymer with constant stirring so as get slightly alkaline solution of polymer with pH of 8.

Preparation of powder detergent: The composition of various powder detergent based on novel resin are given in the Table No. 4 The given ingredient in the powder form are weighed and mixed thoroughly in a tray. Then add liquid ingredient like Alpha olefin sulphonate and neutralized resin. Whole mass is then homogenized thoroughly. This mixture then added in a homogenizer pot. After mixing, homogeneous mass thus obtained is taken out in a tray and kept out in a open air for drying.

Physicochemical Analysis of powder Detergent:

Stain preparation

The soil medium of following composition was prepared.

Component Weight %-carbon black (28.4%), coconut oil (35.8%), lauric acid (17.9%), mineral oil (17.9%). The mixture of carbon black and lauric acid along with mineral oil was taken in a pastel mortar. Coconut oil was added slowly to form a thick paste. All the components were ground in pastel for 1-2 hours to obtain fine paste.

Soil solution

This was prepared by adding 2gms of above paste in 500ml of carbon tetrachloride. Mix it well and use for staining cloth sample preparation. The solution was kept in packed bottles.

Tea stain solution

The tea was prepared with following composition. Tea (Taj Mahal) (2.2%), sugar (8.0%), milk (38.4%), water (51.4%). 25gms of water was warmed to 35 to 40℃ then add Tajmahal brand tea and sugar heated up to 80℃ milk was added then heating continued at boil for next 5 minutes, stop heating and pass the tea through a Steiner. Use this as tea medium.

Preparation of coffee medium

The Coffee of following composition was prepared, coffee (1.0%), sugar (8.1%), milk (51.9%), water (39.0%), 25gms of milk and water in a beaker warmed to 35-40℃, coffee and sugar were added and heating continued to the boil for 5 minutes.

Method of application of soil

The cloth of size 24 × 32 cm^2 were prepared. Took 50ml of soil solution in a beaker, the cloth sample was soaked in for 5 minutes. This is kept outside for drying in open atmosphere for 2 hours. Then this cloth was cut in size of 6× 8 cm^2 and samples were used for the washing test.

Method of washing

The solution of different concentration were prepared. Heated to 60℃. Soiled cloth sample was dipped in it for 5 minutes and given to and fro 10 hand washes.

Method of application of (tea and coffee)

The cotton cloths of size 24 × 32 cm^2 were taken and drawn checks of size 6× 8 cm^2. Then took the above staining solution in a pipette and added in a center of checks one drop and then kept the stain cloth sample in an oven at 55-60℃ for ½ hr. then this stain cloth was cut into test sample size and these were used for stain removal testing. Same method is used for washing.

After washing, the percent detergency[4] was found out by using Lambert and Sanders formula.

$$\% \text{ Detergency} = \frac{(Rw-Rs)\times 100}{(Ro-Rs)}$$

Where R_w, Rs and Ro are the reflectance measured on washed fabrics, stained fabrics (before washing) and clean fabrics respectively. The reflectance was measured with an elrepho reflection photometer with filter R-46 against an MgO-standard.

Composition of Novel Resin (% by Weight)

Table 1. Composition of novel Polymer based on Sorbitol.

Serial No.	Raw materials	Concentration (% by weight)	
		A	B
1.	Sorbitol (70% solid)	77.42	98.04
2.	Maleic anhydride	18.05	-
3.	Benzoic acid	2.57	2.57
4	Sodium bisulphate	1.47	1.47
5	Sodium bisuphite	0.49	0.49

Table 2.Cooking schedule of Novel polymer

Sr. No.	Time (Hour)	Temp(^{0}C)
1	0.00—1.00	120
2	1.00---2.30	130
3	2.30--- 5.30	150

(Maintain the paste like consistency add 75 to 100 ml water)

Table 3. Analysis of Novel polymer

Sr.no.	Analysis	Result	
		R_A	R_B
1	Solubility	Alcohol & water	Alcohol & water
2	% solid	93.34	77.52
3	Acid value	122	1.27
4	Saponification value	255.94	48.02
5	HLB Ratio	15.10	15.01
6	pH	1.28	2.12
7	Color	Reddish brown	yellowish
8	Molecular weight	2,653	1817
9	Viscosity in ethyl alcohol(70:30)	180 sec.	240 Sec.

(Synergistic combination of powder detergent based on novel polymer $R_{A)}$

Table 4. Composition of Powder Detergent (Sodium Lauryl Sulphate)

Serial No.	Raw materials	Concentration (% by weight)					
		PDs_1	PDs_2	PDs_3	PDs_4	PDs_5	PDs_6
1.	Sodium carbonate	48.02	47.29	46.08	44.87	43.66	41.23
2.	Sodium sulphate	8.73	8.60	8.38	8.16	7.94	7.50
3.	STPP	4.37	4.30	4.19	4.09	3.97	3.75
4	Dolomite	13.09	12.90	12.57	12.24	11.91	11.25
5	SLS	1.0	2.50	5.00	7.50	10.00	15.00
6	Neutralize Resin	13.09	12.90	12.57	12.24	11.91	11.25
7	Moisture Content	11.70	12.11	11.21	10.90	10.61	10.02

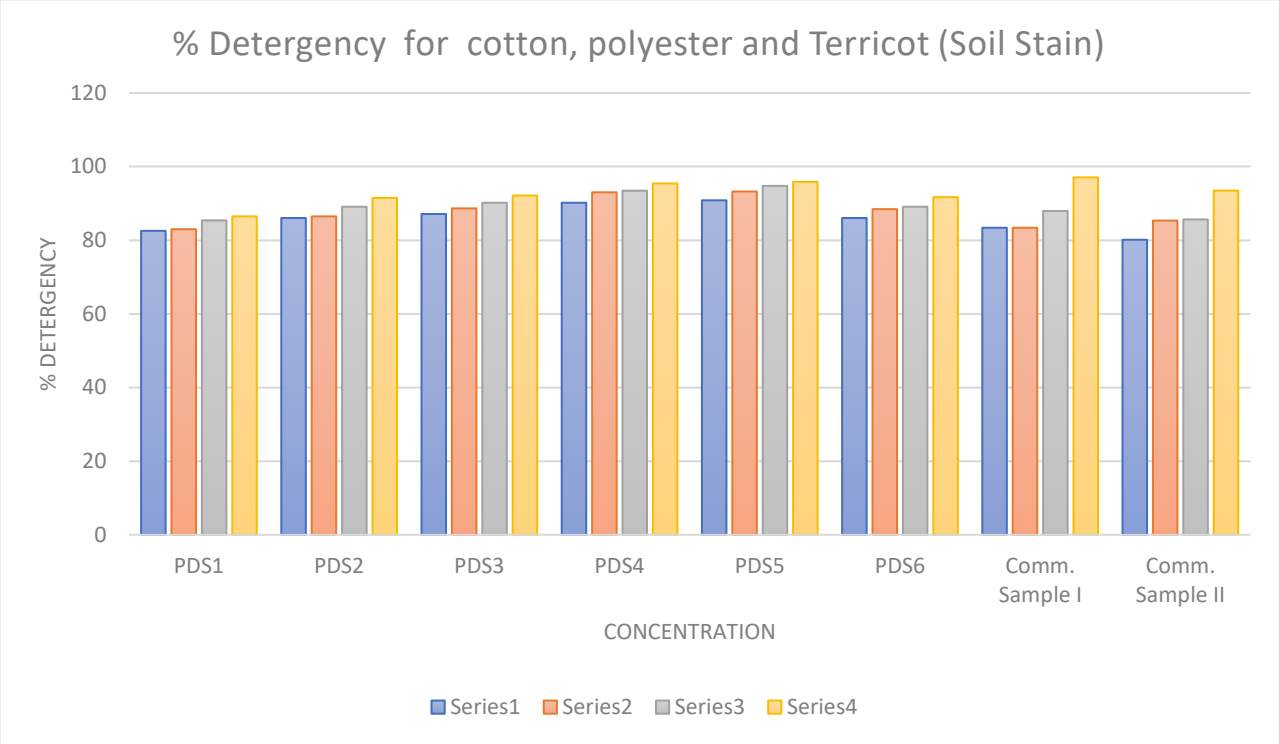
Physicochemical Properties of Powder detergent based on novel polymer and Commercial Powder Detergent:

Table 5. Analysis of Powder detergents at 0.5% concentration by weight

Detergent sample	Density (g/cc)	Surface Tension(dynes /cm)	PH	Foam height (cc)	% Reduction in surface tension
PDs_1	0.9962	40.15	9.62	120	44.37
PDs_2	0.9993	29.21	9.62	250	59.53
PDs_3	1.0004	24.86	9.62	400	65.55
PDs_4	0.9956	24.07	9.62	520	66.65
PDs_5	0.9934	28.72	9.62	560	60.21
PDs_6	0.9934	28.72	9.62	570	60.21
Commercial sample	0.9988	25.67	8.59	250	64.33
Commercial sample	0.9945	24.14	8.34	550	66.46

Table No. 6 Effect of Powder detergents based on novel polymer on % detergency

Cloth	Medium Staining	Conc.	% Detergency						Comm. Sample I	Comm. Sample II
			PD_{S1}	PD_{S2}	PD_{S3}	PD_{S4}	PD_{S5}	PD_{S6}		
Cotton	Soil solution	0.1	82.55	86.04	87.13	90.18	90.84	86.04	83.39	80.13
		0.25	82.99	86.48	88.66	93.02	93.24	88.44	83.39	85.34
		0.5	85.39	89.09	90.18	93.45	94.76	89.09	87.95	85.64
		1.0	86.48	91.49	92.15	95.42	95.85	91.71	97.07	93.48
	Tea solution	0.1	82.79	84.40	86.02	87.36	83.87	83.33	83.06	89.78
		0.25	83.87	88.09	88.44	89.78	86.82	83.87	87.09	86.28
		0.5	88.44	88.70	89.24	92.74	88.17	89.24	77.68	78.22
		1.0	89.24	89.78	91.93	94.08	89.24	90.05	84.94	80.91
	Coffee solution	0.1	85.29	88.76	88.23	91.47	92.94	88.23	93.82	86.76
		0.25	86.76	87.64	90.58	91.76	94.11	91.47	98.23	87.94
		0.5	88.23	88.23	90.17	94.11	94.41	92.94	99.70	91.76
		1.0	89.70	90.58	94.41	94.70	94.41	94.11	97.35	90.20
Polyester	Soil solution	0.1	80.03	83.39	84.23	89.91	88.23	81.92	93.11	80.86
		0.25	80.45	84.02	85.70	90.33	89.28	84.44	91.33	88.27
		0.5	84.33	86.33	86.12	91.80	90.33	85.49	94.39	93.36
		1.0	84.02	87.38	88.65	92.43	92.64	88.23	97.70	92.34
	Tea solution	0.1	71.95	73.17	74.39	81.30	73.17	70.32	76.82	93.90
		0.25	73.98	76.42	77.23	84.55	75.60	72.35	90.65	98.78
		0.5	76.42	78.45	80.08	85.36	77.84	73.17	99.18	95.33
		1.0	78.04	83.73	82.52	87.39	80.48	77.64	74.39	100.00
	Coffee solution	0.1	79.09	79.09	79.09	85.90	79.09	74.54	96.90	93.63
		0.25	81.81	80.00	81.81	88.18	84.54	79.54	96.90	66.81
		0.5	83.63	83.63	84.54	90.00	87.27	82.72	96.46	70.18
		1.0	85.90	88.18	86.36	93.89	88.18	84.54	96.46	76.18
Terricot	Soil solution	0.1	78.27	78.48	79.57	84.57	82.39	78.70	87.14	78.74
		0.25	78.70	80.44	79.79	87.17	84.13	81.74	88.71	80.31
		0.5	80.22	82.39	80.44	88.48	86.09	83.70	85.83	85.56
		1.0	82.33	84.13	83.48	89.35	89.35	87.17	74.54	87.40
	Tea solution	0.1	79.28	74.42	81.84	87.28	81.84	74.16	82.09	90.03
		0.25	79.53	78.26	83.37	88.49	82.60	78.77	82.39	95.64
		0.5	82.35	84.39	84.39	89.51	84.39	79.53	94.37	94.85
		1.0	83.63	86.44	85.67	90.02	85.93	82.35	93.09	94.35
	Coffee solution	0.1	71.71	72.50	79.68	83.66	79.68	70.50	93.23	89.24
		0.25	76.49	76.49	82.07	84.46	82.07	75.69	93.23	87.64
		0.5	78.88	80.47	83.66	88.04	83.66	80.07	91.23	94.02
		1.0	79.68	84.06	84.46	88.44	86.05	83.66	80.44	91.63



Result and Discussion:

1. Table No.1 gives the composition of selected novel polymer with desired properties. The major ingredient of novel polymer is Sorbitol while minor ingredient is Maleic anhydride and benzoic acid used as chain stopper. The catalyst used are sodium bisulphite and sodium bisulpate. The total time of heating is 5 to 6 hrs. At 150^0C.
2. The analysis of these polymer are given in Table No. 2. The color and consistency of the novel polymer is acceptable for commercial use. The polymers are soluble in alcohol and water. The HLB ratio of products indicate it utility as ingredient in powder and liquid composition
3. The synergistic combination of powder detergent are given in table No.3 The polymer R_A has been used in the powder detergent composition in the ratio of 11 to 13% with varying SLS from 1 to 15%
4. The samples having foaming characteristics equivalent to commercial sample, the reduction in surface tension is also appreciable and comparable to commercial sample. The special features of formulation are free from petroleum actives and less use of sodium tripolyphosphate.
5. The result of % detergency on different cloths is given in table no. 5. The % detergency obtain for cotton is highest of the order of 84 to 98 %. While for similar concentration the % detergency of commercial product is slightly lower than our sample which is nearer to the commercial sample. The tea, coffee on different clothe also show same trade in many sample 82 to 100% detergency is reported. The results are comparable with commercial powder detergent.

Conclusion:

1. On the basis of this study it can be concluded that the vegetable based Sorbitol has great potential as raw material for the production of surfactants.
2. Polymeric surfactant synthesized using the Sorbitol and maleic anhydride has huge potential and can be used as substitute petroleum based actives like LABS and AOS.
3. The higher acid value of polymeric surfactant (R_A) is helpful in making water thin able composition. We can neutralize polymeric surfactant with sodium hydroxide.
4. In this formulation sodium lauryl sulphate has been progressively increases from 1% to 15%. It is observe that 2.5 to 7.5% SLS gives optimum result.
5. Incorporation of novel polymer and SLS (5%) shows best result in surface tension and % detergency are better than commercial sample. Particularly this combination do not contain any petroleum based active material and % of STTP is also low. Therefore they are ecofriendly and safe composition.

References:

1. B.W. Phate and B.B. Gogte paint India LV(3), 71 (2005)
2. P.G.Gajbhiye and B.B. Gogte Chemical Engg. World 48 (5), 92 (2005)
3. R. Lambourne paint and surface watinghs: Theory of practice, Elis Horwood Limited, New York 440(1987)
4. S.K. Kharkate and B.B. Gogte, Surface waiting Austrilia 42(4,91)(2005)
5. V.D. Sawant paint India LV(50),79-80 (2000)
6. Gogte BB, Agrawal RS. Starch-sorbitol based co-polymer (a Substitute for LABS), Soaps, Detergents and toiletries Review. 2003;34(2):25-28.
7. Dontulwar JR, Gogte BB. Synthesis of eco-friendly Detergents by using white Dextrin sorbitol maleic anhydreide. Asian Journal of Chemistry. 2004;16(3-4):1385-1390.
8. Agrawal RS, Kakdkar G, Gogte BB. Sorbitol based polymeric surfactant for detergent formulation. Soaps, Detergents and Toiletries Review. 2003; 19:20-25.
9. BIS methods for the test for detergency for household detergent, BIS 4995; 2000.
10. Bacher Melhen VC. The analysis of fats and oils, Garrard publication, Champaigxllinois, 299-308(for sap. Value, for acid value, 103-108, for Oxirane oxygen, 558-560); 1960.
11. ASTM standard method. 6.01, D 1639-70, (for acid value of organic coating materials) published by the American society for testing materials, Philadelphia; 1981.
12. ASTM standard method. 6.03, D 1952-67, (saponification value of drying oils); 1979.
13. I.S. 5785, methods for performance tests for surface-active agents, part (Indian standards, New Delhi); 1976.