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Guar Gum Grafting and Its Application in Textile

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Abstract : It is a common belief that "natural" meterials are more enviromentally friendly than "artificial" or man made materials. Guar gum is naturally occurring non-ionic polysaccharide which is derived from the Guar seed *"Gyamposis tetragonolobus"*. Guar is commonly called as "gawar phalli". This leguminous plant has been grown for centuries in India Guar is being grown in Madhya Pradesh in plently and is mainly being used as food material for both man and animals. It is also used as viscosity builder and water binder in various industries. Guar gum forms viscous colloidal dispersion when hydrated in cold water. These are not very stable due to biodegradation that is why guar gum is rarely used in its natural forms. Drawback of guar gum may be minimized by grafting on to it water soluble polyacrylamide using new redox initiating system. We have developed a new redox initiating system to examine the grafted solubility and viscosity of graft co-polymer.

To add the knowledge of polymer science, either we can develop a new polymer from low-molecular weight compound by a known method or by modifying the existing natural and synthetic polymers either by derivation of their functional groups or grafting of different polymers or by blending\alloying with different materials. Existing natural and synthetic polymers are also modified by graft co-polymerization of various polymers onto their backbone.

Eco-Print System is water based printing system designed to meet standard with soft handle, bright **colour** and excellent fastness. The grafted guar gum was grinded to make powder and mixed with hot water. This product was tested with the dye "Reactive Brilliant Red H8B" against the usual gum paste. The product was used in printing of cotton fabric. The print so obtained from usual guar gum paste and from grafted guar gum paste have been verified as regards to their colour fastness by different tests from Hukumchand Mills Indore (M.P.)

Introduction :

In the textile, jargon printing is considered as the surface enrichment of the fabric. It is common belief that "natural" materials are more environmentally friendly than "artificial" or man made materials. Guar gum is naturally occurring non-ionic polysaccharide which is derived from the guar seed *"Gyamposis tetragonolobus"*. Guar is commonly called as "gawar phalli" . This leguminous plant is grown plenty in Madhya Pradesh and is mainly being used as food material for both man and animals. It is also used

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as viscosity builder and water binder in various industries. Guar gum forms viscous colloidal dispersion when hydrated in cold water. These are not very stable due to biodegradation that is why guar gum is rarely used in its natural froms. Drawback of guar gum may be minimized by grafting on to it, water soluble polycrylamide using new redox initiating system. We proposed to examine the solubility and viscosity of grafted co-polymer.

Polymer science owes its importance to the fact that polymers are essential and manifold components of aminate nature; also out of substances derived from them new industrial materials have appeared, such as synthetic fibres, rubber and plastics, which form an economical significant sector and an influential factor both cultural and civilizing in our lives. To add the knowledge of polymer science, either we can develop a new polymer from low-molecular weight compound by a known method or can develop a new technique mechanism for synthesizing the existing polymers or by modifying the existing natural and synthetic polymers either by derivatisation of their functional groups of grafting of different polymers or by blending/alloying with different materials.

1. Polymerization of water-souble monomers : A few water-soluble monomers when polymerized produce water soluble polymers e.g poly acrylamides which find wide industrial applications as flocculants in waste-disposal; oil recovery, paper, textile and sugar industries. We have developed processes in which acrylamides are polymerized by new redox initiating systems. An oxidant-reductant containing system, first generates a free redical and that free redical initiates the polymerization of vinyl monomer. A wide variety of redox initating systems have been developed but still there is much scope to work with inorganic material containing redox systems. Redox systems are preferred over thermal polymerization because they work at low temperature, good field of polymer is obtained, side reactions which occur at higher temperature, are negligible. We have studied the aqueous polymerization of vinyl monomers *viz.*, acrylamide, methylacrylamide using a new redox initiating systems. The effect of different organic solvents, inorganic salts, surfactants have also been studied in order to find out the optimum conditions for the polymerization reaction. Rate expression for the polymerization was deducted based on experimental conditions.

2. Existing natural and synthetic polymers are also modified by graft co-polymerization of various polymers onto their backbone. Guar is being grown in Madhya Pradesh in plenty and is mainly being used as food material for both man and animals. Guar gum is being used as viscosity-builder and water-binder in various industries, the mining pharmaceuticals, paper, petroleum, explosives, food and textiles. Raw guar gum is being exported at a very low price to USA and Japan and again is being imported as the modified material at exorbitant rates. Guar gum is soluble in water and forms highly viscous solutions even at 1% concentration which are not very stable due to biodegradation. It is fermented and enzymatically hydrolyzed by microorganisms. Drawbacks of guar gum may be minimized by grafting on to it, water-soluble polyarylamide onto guar-gum using redox initiating systems. Chemically initiated vinyl graft co-polymerization is easier than photochemical, thermal and other methods of initiation and involves less costly equipments which can be adopted by industry with minimum involvement of money. Rate of graft co-polymerization will be deducted in order to get the optimum experimental conditions. Different reaction parameters are varied and their effects in percentage grafting and grafting efficiency have been studied.

% of grafting = W1-W0/W0*100

W1 = Weight of grafted Guar gum

W0 = Weight of Guar gum initially

[Wt. of grafted Guar gum = Wt. of grafted guar gum + crucible-Wt. of crucible]

Percentage grafting s.m.s/p.p. system with varying concentration of acrylamide

Acrylamide/gms.	0.355	0.4441	0.5329	0.6216	0.7108
Percentage grafting (%)	38.7 39.0 40.0 40.4	49.5 49.8 50.9 51.8	84.7 85.0 86.3 87.8	100.0 102.9 103.8 104.2	140.2 142.0 143.3 144.0

With Varying Concentration of Guar Gum

Guar gum/gms.	0.05	0.07	0.100	0.120	0.150
Percentage grafting (%)	15.2 16.1 18.8 20.4	31.2 32.8 34.3 35.7	38.7 39.0 40.0 40.4	56.0 56.9 57.5 58.3	35.5 36.8 37.0 38.4

With Varying Concentration of Potasium Persulphate

Potassium Persulphate (ml.)	3.0	4.0	5.0
Percentage grafting (%)	38.7 39.0 40.0 40.4	43.2 43.8 44.4 45.4	47.6 48.4 49.6 49.8

Ecoprint system is water based printing system designed to meet standard with soft handle, bright colour and excellent fastness. The grafted guar gum was grinded to make powder and mixed with hot water and stirred with glass rod or “Remi Motor Strirrer” in water bath. This was done to get swelling of gum properly. This product was tested with the dye “Reactive Brilliant Red H8B” against the usual gum paste. the paste consists of the product-Urea granules + resist salt + Kerosene. In the usual paste modified gum suitable for reactive dyes was used in place of sample product for comparing with grafted guar gum. The product thus obtained was used in printing of cotton fabric. colour fixation was done by “silicate method concentration” in which urea was used to increase solubility of colour and resist salt (Sodium meta nitro benzene sulphomate) was used for reactivity control, stability and for colour paste control or tailing. The end product must meet certain “fitness for use” criteria relating to:

- Dimensional changes during washing and drying (e.g.-shrinkage)
- Colour fastness (to washing, perspiration, rubbing and light).

Colour fastness of textile materials is of considerable importance to the consumer. The fastness depends not only upon the nature and depth of shade of the dyestuff used but also upon the nature of the fibre and the method of dyeing and printing employed; the same coloring matter when used in dyeing or printing different results. The print so obtained from usual guar gum paste and from grafted guar gum paste have verified as regards to their colour fastness from Hukumchand Mills Indore. The following tests have been applied for the same:

- colour fastness test for artificial light Xenon arc lamp test.
- colour strength test by spectrophotometer.
- colour fastness to perspiration by Prespirometer.
- colour fastness to rubbing by crockmeter.
- colour fastness to washing byb Launder-O-Meter.

All the above tests have confirmed that the printed textile material with grafted guar gum paste as a binder for the printing was found faster to colour than usual guar gum paste. Colour prepared with usual guar gum paste (without grafting) for the printing of fabric was not stable due to biodegradation.

Guar Gum

Commentary

Guar gum (also called guaran) is extracted from the seed of the leguminous shrub *Cyamopsis tetragonoloba*, where it acts as a food and water store. Many leguminous plant seeds contain Galactomannans. Guar Gum is known for its thickening properties. It is obtained from the seeds of *Cyamopsis tetragonolobus*, an annual leguminous plant originating from India and Pakistan. It is also cultivated in the United States. Guar fruit is a pod; its seeds have an average diameter of about 5 mm. They contain a reserve substance, the albumen. From the outside to the interior, we have:the hull, the albumen or endosperm, which is light cream in colour. It is made up of two hemispherical segments (splits) which surround the germ. Its major constituent is the polysaccharide, the germ, rich in protein.

Interest for Guar Gum is fairly recent: its initial development was due to a lack of Locust Bean Gum in the 1940s. Its large scale industrial production dates from the 1950s.

Structural unit: Guar gum is a galactomannan similar to locust bean gum consisting of a (1®4)-linked b-D-mannopyranose backbone with branchpoints from their 6-positions linked to a-D-galactose (*i.e.* 1®6-linked-a-D-galactopyranose). There are between 1.5 - 2 mannose residues for every galactose residue. Another galactomannan with lower substitution (with a mannose to galactose ratio of about 3:1) is tara gum, obtained from *Cesalpinia spinosa*. It has properties between those of guar gum and locust bean gum. Higher substituted galactomannans are found in fenugreek gum (*Trigonella foenum-graecum*) and **mesquite gum** (*Prosopis juliflora*), with mannose to galactose ratio of about 1:1 (but possibly as high as 5:4) and 5:4 respectively. The higher substitution of these gums gives them improved solubility, dispersiveness and emulsification (although it appears that this emulsification activity is absent in the polysacchaharide but due to protein impurities).

Functionality: Guar gum is an economical thickener and stabilizer. It hydrates fairly rapidly in cold water to give highly viscous pseudoplastic solutions of generally greater low-shear viscosity when compared with other hydrocolloids and much greater than that of **locust bean gum**. High concentrations (~ 1%) are very thixotropic but lower concentrations (~ 0.3%) are far less so. Guar gum is more soluble than **locust bean gum** and a better emulsifier as it has more galactose branch points. Unlike **locust bean gum**, it does not form gels but does show good stability to freeze-thaw cycles. Guar gum shows high low-shear viscosity but is strongly shear-thinning. Being non-ionic, it is not affected by ionic strength or pH but will degrade at pH extremes at temperature (*e.g.* pH 3 at 50°C). It shows viscosity synergy with xanthan gum. With casein, it becomes slightly thixotropic forming a biphasic system containing casein micelles.

Guar gum retards ice crystal growth non-specifically by slowing mass transfer across solid/liquid interface.

Interactive structures are available (COW [**Plug-in**, **ActiveX**], 43 KB; **Chime**, 19 KB, includes crystal structure).

Guar Gum is generally used as an excellent and reasonable stabilizer as well as gelling agent in many aqueous systems.

The main uses are :

Food

1. Guar Gum for Bakery : One of the major applications for Guar Gum Powder is the production of bread. Even small quantities of Guar Gum powder added to the dough increase the yield, give greater resiliency, improve texture and give longer shelf life.

2. Guar Gum for Dairy : In this field Guar Gum is used as an excellent binder of water and a stabilizer. It is used in the production of ice-creams, sherbets, cheese, liquid milk products, and others. It is also widely used as a gelling agent.

3. Guar Gum for Meat : Guar can be used as lubricants and excellent binder for various meat products. It allows storing with less loss of weight and can decrease the filling time for cans.

4. Guar Gum for Dressing and sauces : Guar can be used as lubricant and excellent thickener to improve the stability appearance of salad dressings, barbecue sauces, relishes, ketchups and others. It is quite compatible with highly acidic emulsions.

5. Guar Gum for Beverages : Guar can be used as stabilizer for chocolate drinks, fruit nectars, and juices.

1. **Guar Gum for Miscellaneous food applications :** Dry soups, sweet dessert, canned fish in sauce, frozen food item and others.
2. **Guar Gum for Pharmaceutical & cosmetics :** Guar Gum can be used as a thickener for various cosmetics and pharmaceutical. In compressed tablets Guar Gum can be used as a binder and disintegrator.

Several studies have found significant decrease in cholesterol levels after administration of Guar Gum in human consumption.

Further important applications

- Textile printing
- Water treatment
- Tobacco Industry
- Mining
- Oil-drilling
- Explosives and others