Cationic Guar Gum – A Binding Force in Paper Manufacturing

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Seed gums (galactomannans) undoubtedly provide a rich and renewable reservoir of structurally and functionally different biopolymers. However, the possibility of functional groups in seed galactomannans to undergo a wide range of chemical reactions is an additional advantage for the extension of their applications. The availability of a spectrum of seed gums thus provides an excellent opportunity for the development of fine tuned products by chemical modification for broader applications.

Why chemical modification?

Generally, the monotonous physicochemical properties of native gum solutions are the limiting factors for their wide application in industries. The growing industrial utility of these gums and/or their chemically modified derivatives in the field of paper, textile, petroleum recovery, pharmaceutical etc. has resulted in an impetus in India for intensified research on new applications of gums and their chemically modified products.

Chemical modifications are intended to impart some very peculiar behaviors in solution, according to the needs of the particular final application. Significant changes in properties occur when the galactomannan is substituted with the new functional groups.

Examples of such seed gums are locust bean gum, fenugreek gum, cassia gum, guar gum etc. Among various commercially utilizable seed gums, guar gum and its derivatives occupy a very important place, as it is a rich source of high quality galactomannan polysaccharide. Due to its unique rheology modifying properties, guar gum and its derivatives are widely used across a broad spectrum of industries — food, cosmetics, textile, paints, mining, oil-well drilling, construction etc.

Guar gum is derived from the seeds of plant *Cyamopsis tetragonolobus*, a pod bearing legume (Fig.1) grown commercially in India, Pakistan and the southwestern United States. The seed (Fig. 2) is composed of hull (15%), germ (45%), and endosperm (40%). The endosperm (Fig. 3) contains 75-85% of the hydrocolloid, has a chain of (1→4)-linked-β-D-mannopyranosyl units with single β-D-galactopyranosyl units connected by (1→6) linkages to, on the average, every second main chain unit. The ratio of D-mannopyranosyl to D-galactopyranosyl units is about 1.8:1. The average molecular weight of the galactomannan is in the range of 1-2 x 10^6 dalton(1).

Preparation of cationic guar gum (SUNCOS-PG)

With a view that cationic guar gum may be used as a better wet end additive

Fig. 1 - Guar plant

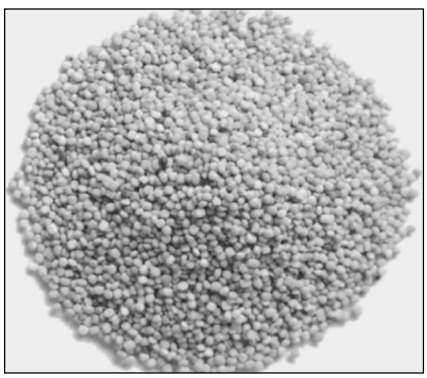

Fig. 2: Guar seed

Fig. 3: Guar endosperm

and can provide binding strength to cellulose fibres, chemical modification of guar gum via quaternization reaction was carried out at lab/commercial level by using our state-of-the-art technology to achieve the desired substitution and viscosity.

In this method, cationic guar gum is prepared by the etherification reaction of 3-chloro-2-hydroxypropyl trimethylammonium chloride (cationic reagent) with guar gum under alkaline conditions (Fig. 4). Such modification greatly improves specific properties of native guar galactomannan like stability, solubility, affinity to cellulose fibres and the rheological characteristics in context of their utilization in various types of paper manufacturing processes.

Table 1
Properties of SUNCOS-PG

Product series name	**SUNCOS-PG**
Chemical name	Guar-2-hydroxy-3-(trimethylamino) propyl ether chloride
CAS No	65497-29-2
Physical appearance	Free flowing yellow powder
Particle size	Through US ASTM 100 mesh (150µ): 99%
Ash	Not more than 5%
Moisture	Not more than10%
Apparent viscosity (1% aq. solution, 25°C, 20 rpm, 2 h)	**SUNCOS-PGLV**=800-1200 cps **SUNCOS-PG1**=1500-2000 cps **SUNCOS-PG2**=2000-2500 cps **SUNCOS-PG3**=2500-3000 cps **SUNCOS-PG Super**=3500-4500 cps
Products are easily dispersible in water. Viscosity will develop after adjusting pH between 5.5-6.5	9.0-10.5
pH (as is)	0.9 - 1.0%
Nitrogen content	

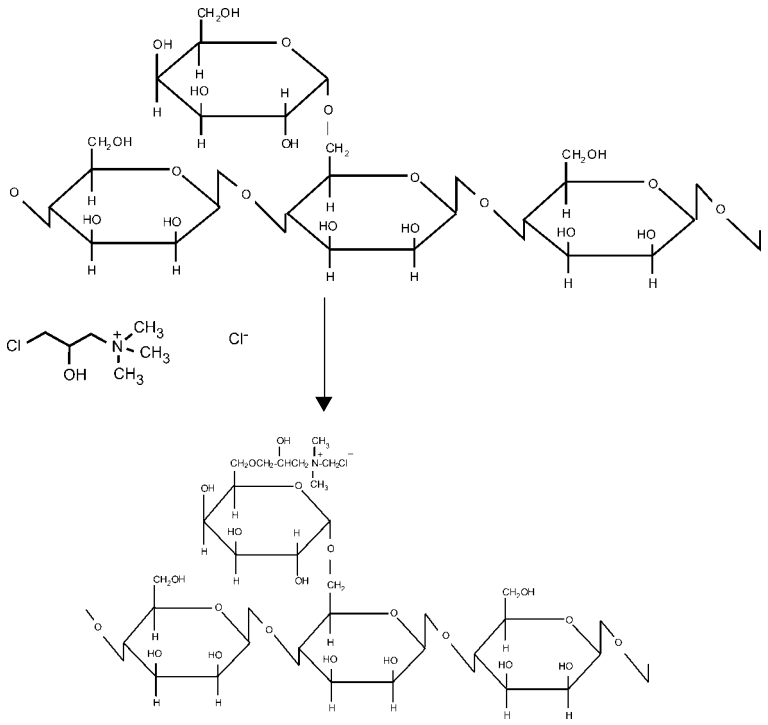

Fig. 4: Reaction of cationic reagent with guar gum

Properties of cationic guar gum (SUNCOS-PG)

SUNCOS-PG is quaternized ether of guar galactomannan, which is cationic in nature.

Uses of cationic guar gum (SUNCOS-PG)

For many years, the paper industry has been the major user of native guar gum, but since a couple of years native guar gum is mostly replaced by cationic guar gum. The major use of cationic guar gum in paper making is at the wet end of the process.

The pulping process in paper manufacturing, which is designed to remove lignin and produce a fibrous cellulose pulp, also removes large parts of the hemicelluloses normally present in the raw material. Cationic guar gum replaces or supplements the natural hemicelluloses needed in paper bonding.

Some of the other advantages of cationic guar gum in the paper manufacturing are:

- Increased tensile strength;
- Increased bursting strength;
- Increased ease of pulp hydration; and
- Increased retention of fines.

One of the properties of cationic guar gum is its hydrogen bonding effect, an effect which is known to be one of the major factors affecting fibre-fibre bonding(2, 3).

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