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Industrial Applications of Guar Gum

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Abstract: Guar gum is a novel agrochemical processed from endosperm of cluster bean. It is mainly used in the form of guar gum powder as an additive in food, pharmaceuticals, paper, textile, explosive, oil well drilling and cosmetics industry. Industrial applications of guar gum are potential because of its ability to form hydrogen bonding with water. Hence it is essentially used as thickener and stabilizer. This article focuses on history and many industrial applications of Guar gum.

Keywords: Cluster bean, Dietary fiber .Guar gum .Hydration rate, deflocculent.

I. INTRODUCTION

Guar gum is synthesised from the seeds of the drought tolerant plant *Cyamopsis tetragonoloba*, a member of Leguminosae family. The universal names used in the scientific literature for the bean, guar gum flour and the galactomannan fraction are Indian cluster bean, guar and guaran, respectively. There is lack of general consent with regard to the origins of this plant. At that time, the supply of locust bean gum, which was widely used in the paper and textile industries and imported from Europe and North Africa had declined and was difficult to get. In order to obtain the gum it is necessary to separate the gum-containing endosperm of the seed from the outer and largely fibrous portions. Consumption of guar gum rapidly increased but it was the development of anionic and cationic guar gum derivatives and their use in oil and gas well stimulation that gave guar gum its present commercial importance. In textile and carpet printing, guar gum thickens the dye solutions which allow more sharply printed patterns to be produced.

A. History

Guar is a member of the pea family which is cultivated both as fodder and as a green veggie. Over the years, the actual vegetable has gained added significance despite not being part of the staple diet. The reason for this is the emergence of guar gum. Yes, the gum extracted from this plant is being used all over the world in a wide range of industries. This multipurpose substance is in high demand. Guar was used primarily for feeding cattle.

The vegetable is a rich source of protein and fodder and cooking were its two main uses. It was in the mid 1940s, just as the Second World War drew to a close, that guar gum came into common use.

At that time, the paper and textile industries used gum which was extracted from locust bean. However, the war had diminished reserves of the gum and the industries sought an alternative. Guar gum was suggested as a replacement and it was in 1953 that the technology for extracting it became commercially available in the US as well as India. This means that it took close to a decade for technology to catch up with the demand. Over the past six decades in a bit, guar gum has grown in popularity and is one of the most widely used substances today. Owing to its wide range of applications, it is used in industries as diverse as food and textile. Even the slightly niche items in the food industry, including baked goods and ice creams, use guar gum as an agent for thickening or enhance the texture.

Despite there being no major breakthroughs in the substance itself, guar gum continues to enjoy tremendous popularity and there is no reason why this demand shouldn't stay high in the future. In recent years, it has become the primary gelling agent in water based slurry explosives. The production of paper is enhanced by an addition of small amounts of guar gum to the pulp. It serves as a fiber deflocculent and dry-strength additive.

B. Structure

The molecular structure reveals that GUAR GUM is a straight chain galactomannan with galactose on every other mannose unit. Beta 1-4 Glycosidic linkages couple the mannose units and the galactose side chains are linked through alpha 1-6. The mannose to galactose ratio has been estimated at 1.8 : 1 to 2: 1. The molecular weight of Guar has reported as $1-2 \times 10^6$. Further studies indicate that Guar Gum is a rigid rod like polymer because of the beta linkage between the monomer units. Guar hydroxyls are in the CIS position. The CIS position is important since adjacent hydroxyl groups reinforce each other in hydrogen bonding reactions. The typical diagram of Guargum is shown in figure-1

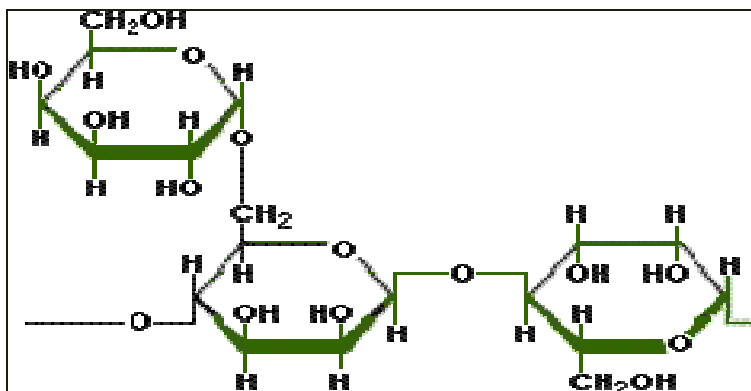


Figure-1: Chemical structure of Guar gum

Source: https://www.guargum.biz/guargum_chemical_structure.html

II. INDUSTRIAL APPLICATIONS

A. Food Industry

Guar gum is one of the best thickening additives, emulsifying additives and stabilizing additives. In Food Industry Guar gum is used as gelling, viscosifying, thickening, clouding, and binding agent as well as used for stabilization, emulsification, preservation, water retention, enhancement of water soluble fiber content etc.

Some food products in which guar gum powder is used:

- 1) Ice Cream, soft drinks & concentrates, puddings
 - 2) Chocolate milk, flavoured milks
 - 3) Jams, jellies, fruit spreads, jelly sweets
 - 4) Bread, biscuit and other baked foods
 - 5) Ham and sausages
 - 6) Soft cheese and cheese spreads
 - 7) Canned or retorted food of fish and meat
 - 8) Myonnaise, ketchup, sauce and dressings
 - 9) Noodles and pasta
- a) *In Frozen Food Products:* Guar gum reduces crystal formation, act as a binder & stabilizer to extend shelf life of Ice-cream.
 - b) *In Baked Food Products:* Guar gum provides unparallel moisture preservation to the dough and retards fat penetration in baked foods
 - c) *In Dairy Products:* Guar Gum improves texture, maintains uniform viscosity and color
 - d) *In Sauces & Salad preparations:* Guar gum acts as a water binder in sauces & salad dressings and reduces water & oil separation
 - e) *In Confections:* Guar gum controls viscosity, bloom, gel creation, glazing & moisture retention to produce the highest grade confectionary.
 - f) *In Beverages:* Guar gum provides outstanding viscosity control and reduces calories value in low calories beverages
 - g) *In Pet Food:* Guar gum forms gels & retains moisture, acts as a thickening, stabilizer and suspending agent for veterinary preparations.

B. Pharmaceutical Industries

Guar gum powder is used in pharmaceutical industries as Gelling/ Viscosifying/Thickening, Suspension, Stabilization, Emulsification, Preservation, Water Retention/Water Phase control, Binding, Clouding/Bodying, Process aid, Pour control for following applications.

In tablet manufacturing it is used as a binder and disintegrating agent and in micro-encapsulation of drugs.

- 1) Suspensions
- 2) Anti-acid formulations
- 3) Tablet binding and disintegration agent

- 4) Controlled drug delivery systems
- 5) Slimming aids
- 6) Nutritional foods

Guar Gum is an important non-caloric source of soluble dietary fiber. Guar gum powder is widely used in capsules as dietary fiber. Fiber is a very important element of any healthy diet. It is useful in clear and cleanses the intestinal system since fiber can not be digested. This keeps the intestines functioning properly and also improves certain disorders and ailments. All natural fiber diet works with body to achieve a feeling of fullness and to reduce hunger. Its synergistic mix of guar gum and fiber mixture when taken with water expands in stomach to produce a feeling of fullness.

C. *Cosmetic Industries*

- 1) Used as a thickener, protective colloid in Skin care products, creams and lotions.
- 2) Also used in toothpaste, and shaving cream for easy extruding from the container tube.

D. *Industrial Grade Guar Gum Powder*

In Industrial Applications guar gum powder is a very versatile product and finds its different applications, as thickening, sizing agent, wet-end strength additive, gelling agent and water barrier, flocculation aid, for waste water treatment, as emulsifier, binder. Also used for mud formulations, enhanced oil recovery, polymer flooding, well treatment, lost circulation plugging etc. Mining grade guar gum is used in mining industry as a floatation agent flocculating or setting better quality agent. Fast hydration guar gum powder for oil drilling applications is an important advantage of guar gum. Ultrafine Gums in India supply oil drilling grade guar gum, guar gum for paper industry, guar gum as an emulsifying, guaran and sickle pod.

Guar Gum Industrial grade powder is used in textile Printing & Sizing, Fire Fighting, Ceramics, Pharmaceuticals, Printing Inks, Mosquito Mats, Synthetic Resins, Paper Industry, Battery Electrolytes, Water Treatment, Floatation Agent, Water Paint, Carpet Printing, Oil Well Drilling, Explosives etc.,

E. *Paper Industry*

Guar Gum provides better properties compared to substitutes. It gives denser surface to the paper used for printing. Guar Gum imparts improved erasive and writing properties, better bonding strength and increased hardness. Due to improved adhesion, it gives better breaking, mullen and folding strengths.

F. *Textile Industry*

Guar Gum gives excellent film forming and thickening properties when used for textile sizing, finishing and printing. It reduces warp breakage, reduces dusting while sizing and gives better efficiency in production.

G. *Oil Industry*

Industrial grade Guar gum powder are use in oil well fracturing, oil well stimulation, mud drilling and industrial applications and preparations as a stabilizer, thickener and suspending agent.

- 1) It is a natural, fast hydrating dispersible guar gum and is diesel slurriable.
- 2) In the oil field industry, guar gum is used as a surfactant, synthetic polymer and deformer ideally suited for all rheological requirements of water-based and brine-based drilling fluids.
- 3) High viscosity Guar Gum products are used as drilling aids in oil well drilling, geological drilling and water drilling.
- 4) These products are used as viscosifiers to maintain drilling mud viscosities that enable drilling fluids to remove drill waste from deep holes.
- 5) Guar gum products also reduce friction in the holes, and so minimising power requirements. Some Guar Gum products act to minimise water loss should occur in broken geological formations.

H. *Metallurgical And Mining Industry*

Guar gum is widely used as a flocculants to produce liquid solid separation. Guar gum is also used in flotation. It acts as a depressant for talc or insoluble gangue mined along with the valuable minerals

I. Explosives Applications

Gelling agents for gel sausage type explosives and pumpable slurry explosives. Cross linking agents for gel and slurry explosives systems

J. Grass Growing / Erosion Control

Guar Gum has a major application in the grass growing and erosion control industry where it is used as a water binder to retain moisture on the soil surface, particularly on slopes where the addition of Guar Gum to the water systems will help to anchor the hydro seeding mixture to the slopes and seal in the moisture. It is used in systems that protect against hydraulic lift and shear forces created by high-volume discharges, so whether grass is grown on slopes, channels, or straight-aways, from roadside to residential lawns, golf users to athletic fields to parks, using Guar Gum prevents soil erosion and enhances grass growing.

K. Health Benefits

Guar gum shows cholesterol and glucose lowering effects because of its gel forming properties. It also helps in weight loss and obesity prevention. Due to gel forming capacity of guar gum soluble fiber, an increased satiation is achieved because of slow gastric emptying. Diet supplemented with guar gum decreased the appetite, hunger and desire for eating. Mechanism behind cholesterol lowering by guar gum is due to increase in excretion of bile acids in faeces and decrease in enterohepatic bile acid which may enhance the production of bile acids from cholesterol and thus hepatic free cholesterol concentration is reduced. Hypotriacylglycerolaemic effects are due to decrease in absorption of dietary lipids and reduced activity of fatty acid synthase in liver. Toxicity study on partially hydrolyzed guar gum has revealed that it is not mutagenic upto dose level of 2500 mg/day). Adequate intake of guar gum as dietary fiber helps in the maintenance of bowel regularity, significant reductions in total and LDL-cholesterol, control of diabetes, enhancement of mineral absorption and prevention of digestive problems like constipation.

III. CONCLUSION

Guar gum is an important agrochemical derived from the seed endosperm of guar plant i.e. *Cymopsis tetragonolobus* which is cultivated in India and Pakistan from ancient times. Guar gum is a useful material to look into. It has a strong hydrogen bond forming tendency in water which makes it a novel thickener and stabilizer. Aqueous solutions of guar gum are very viscous in nature. Because of these properties it has wide applications in the industries like food, pharmaceutical, textile, oil, paint, paper, explosive and cosmetics. Another reason for its popularity in the industry is its low cost. Its economical nature makes it popular in gums and stabilizers industry. In food industry, it has wide applications in ice cream, sauce, beverages, bakery and meat industry. It is also used in food products for supplementation as dietary fiber. Its consumption reduces the risk of heart diseases by reducing the cholesterol level in body, control diabetes and maintains the bowel movement in human beings.

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