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Food Ingredients For Bakery, Confectionery, Beverages, Brewing and Meat Processing

Carrageenan

Product Description

Carrageenan is extracted from many species of red seaweeds. The process begins with harvesting, followed by drying, cleaning, bagging or bailing. Once in the factory, the seaweeds are sorted, tested for quality and stored. Before being processed, they are hand-inspected, then washed to remove dirt and marine organisms, and then subjected to hot alkaline extraction. When the carrageenan is dissolved, it is clarified through conventional filtration and is then concentrated by membrane ultrafiltration. The carrageenan is precipitated by alcohol or potassium chloride to separate it from soluble impurities. This is followed by drying and grinding to appropriate particle size. The carrageenan powder is blended and standardized to customer specifications before shipment.

The carrageenan family has three main branches, kappa, iota and lambda, which are well differentiated in terms of their gelling properties and protein reactivity. Kappa carrageenans produce strong rigid gels, while those made with iota products are flaccid and compliant. Although lambda carrageenans do not gel in water, they interact strongly with proteins to stabilize a wide range of dairy products.

Carrageenan is a highly versatile ingredient suitable for use in food and nonfood products. As convenience food and household products proliferate, so do markets for carrageenan. Here is just a sampling of established applications and functionalities.

Processed Meat, Poultry and Seafood
Water binding, increased product yields, improved texture, fat replacement, meat/seafood analog binding.

Dairy Products (chocolate milk, frozen desserts, UHT milks, flans, puddings, low fat cheese, cheese analogs)
Provides cocoa suspension, milk stability, emulsion stability, milk gelling.

Cold Milk Powders (diet powder mixes, nutritional beverage mixes)
Provides body and mouthfeel, suspends solids.

Water Gel Desserts
Provides wide range of textures and flavor release, all without the need for refrigeration.

Toothpaste

Provides structure without masking flavors, resistant to enzymatic breakdown.

Pet Foods
Binds water, provides structure and prevents fat separation in canned, retorted products.

Controlled Release Products (air freshener gels)
Provides structure and controlled release of active ingredients such as perfume in a water-gel base.

Food Markets

Meat and Poultry
The meat and poultry industry is the fastest growing, and one of the most profitable, markets for carrageenan worldwide. In the USA, its use has grown exponentially since the standard used to identify meat and poultry products was changed to include carrageenan.

Pumping, massaging and emulsion systems require salt to cause the meat protein to unwind (denature) enabling these proteins to bind water, form a continuous network and solubilize and emulsify fat. Denatured protein is limited in its water-holding capacity and ability to stabilize fat emulsions. Various materials, from modified starches to oat flakes, have been used to increase water retention. All require a high-use level and degrade product quality, with only a marginal increase in yield which often does not cover the added costs. None provide emulsion stabilization or freeze-thaw stability.

Carrageenan is unique in its ability to bind considerable quantities for water to form a gel network which, in meat applications, complements rather than disrupts the protein network.

Furthermore, the charged nature of carrageenan stabilizes water/fat emulsions during preparation, cooking and storage. The net result is an increase in product quality and yield which more than offsets the cost of the carrageenan. Many meat producers report that their profit margins are now coming from the use of carrageenan to increase yield.

Bread
Carrageenan has a strong functional synergism with starches, which can be exploited in starch-based foods to improve product quality through moisture retention.

Carrageenan intended for farinaceous foods swells during the cooking cycles to form a gel matrix, binding moisture and providing additional structure. The carrageenan does not add to the viscosity of the dough during kneading. The soft-gel matrix blends with the dough and is invisible, even under microscopic examination. Carrageenan is unique in its ability to bind considerable quantities of water to form a gel network which reinforces the gluten structure for an improved air cell matrix. The net result is improved product quality and yield which more than offsets the cost of the carrageenan. Carrageenan gels are inert and do not affect yeast, and can be added to an existing formulation for immediate benefits in the form of products which retain a fresh texture and taste after storage. Even more benefits can be obtained by increasing the water content of the bread.

Noodles

Carrageenan's reinforced gluten structure allows the use of soft flour in place of high-gluten hard flours, providing considerable savings for the producer. For products containing egg solids, the use of carrageenan allows the producer to substantially cut the number of eggs used without a deterioration in product quality. All noodles made with carrageenan show improved resistance to over-cooking.

Other Farinaceous Foods

Starch is perhaps the most widely used thickener in the food industry. It is cheap but generally gives rise to pasty, poor-quality products, particularly when used at high levels. Mixed carrageenan/starch systems have unique properties which are a cost-effective answer to improving the quality of high starch formulations. The strong functional interaction between starch and carrageenan allows the starch content of soups, pie fillings and pudding to be reduced whilst improving the organoleptic properties of the system. Additionally, starch/carrgeenan combinations offer resistance to shear degradation and low processing viscosity while maintaining excellent stability during thermal cycling.

Surimi and Kamaboko

One of the major problems in formed fish products is how to use second-grade protein to produce products which match the quality of those made with expensive first-grade material. Carrageenan added to fish protein before processing supports and augments the mechanical properties of poorer quality raw materials to give products which look, feel and taste the same as their expensive counterparts.

Extruded Foods

Extrusion cooking is used extensively for the preparation of many different kinds of food, from breakfast cereal to confectionery. The high temperatures, pressures and shear conditions encountered in an extrusion cooker make it ideal for carrageenan which readily swells in the cooker. A major problem in extrusion processing (food and industrial) is to have the formed product rapidly attain structural integrity. The high gelling temperature of carrageenan's intended product is maintained by improving yield and quality.

Dressing

Traditionally, the dressings market has been dominated by Kelco's xanthan gum which displaced PGA (propylene glycol alginate) in the 1970s. Xanthan gum develops a weak structure in water, which enables it to thicken dressing systems and suspend spices. However, it also imparts a stringy texture to products and cannot be tailored to meet specific requirements. The market for carrageenan in traditional and low-fat dressing applications is expected to double within the next two years.

Low Fat Systems

Low fat systems act on the ability of a gum to provide the sensation of fat and oil emulsions. Carrageenan dispersions in water form collodial systems which can be designed with flow properties very similar to fat and oil in water emulsions. Typically, when fats are removed, carrageenan is added to maintain viscosity and mouthfeel.

Kappa and lambda carrageenan have unique interactions with protein. Kappa in particular, is indispensable in dairy applications, including processed cheeses, cheese analogs and cream cheese. The current market for these products is expanding rapidly, especially in Latin America.

Personal Care and Pharmaceuticals

Dentrifice

Carrageenan stabilizes toothpaste preparations through a combination of viscosity, continuous-phase gel formation and specific interactions with the abrasive. The continuous-phase gel matrix enhances viscosity stabilization and provides emulsion stability by trapping abrasive and flavor oil miscelles within the gel matrix. The gel structure also imparts a desirable short texture to the toothpaste providing a clean (non stringy) break on extrusion from the tube or pump. Specific interactions between carrageenan and the surface of abrasives both disperses and stabilizes the solids, preventing hardening, caking and drying out. Other binders that are now available have one or other of the properties of carrageenan but not the combination which makes carrageenan unique in the dentifrice industry. Coupled with this is the fact that carrageenan is stable to enzymes and can be used in areas of the world where binders such as CMC are not usable. It does not contain enzymes, and can safely be used in combination with CMC. Xanthan gum, an expensive binder for toothpaste preparations, contains enzymes which attack CMC, making it impossible to combine them.

The high cost of xanthan gum makes it prohibitive for new, smaller producers who naturally turn to carrageenan. The new producers of toothpaste fall into two categories, those which manufacture specialty, niche-market products such as "natural toothpaste," and those who produce cut-price products. Carrageenan is easier to work with than xanthan, and can be used with local water and without the careful handling that CMC systems demand. It is a natural ingredient and can be used in products bearing "All Natural" labels.

Drug Delivery Systems

Many pharmacologically active ingredients are destroyed in the stomach or gastrointestinal tract but can be safely absorbed through the buccal linings. Isoprenaline sulfate, an adrenaline-like compound, is one example. The problem is to maintain the drug in the mouth long enough for absorption to take place, which is exacerbated if the drug has a bad taste. There is a considerable body of patent literature on the use of gums, carrageenan in particular, for entrapping the active ingredients in a hydrocolloid matrix to provide a delivery system which will release the active ingredient in a prolonged and controlled fashion when incorporated into a variety of vehicles such as chewing gums. If the trapped material is tabletized, the technique can be used to administer drugs orally which would taste too bad to be given in conventional vehicles. This is particularly important for children and geriatric patients.

Wound Dressings

There is a high demand for stable, biodegradable wound dressing materials which can absorb body fluids and deliver medications to keep wounds clean and healthy. Although alginate fibers are used at the moment, they have severe limitations on their ability deliver medications and absorb body fluids.

Carrageenan forms a water-insoluble complex with an extract from the shell of crabs and other crustacea called chitosan. Insoluble carrageenan chitosan fibers can be spun with active pharmaceutical agents trapped within the fibers. The resulting systems, although water insoluble, will absorb considerable quantities of body fluids, enabling wounds to be kept clean and dry, thus speeding the healing process.

Cosmetics
The unique interactions between carrageenan and polyols can be exploited to control the textural properties of any formulation or preparation containing polyols. This is especially true of complex hand lotions and conditioners which are subject to considerable constraints on the ingredients and their concentration.

Hand Lotions and Shampoos
It has been known for centuries that fishermen who handle Irish moss tend to have soft skin. This folklore led scientists to discover that carrageenan interacts with human carotene to give soft skin and silky hair. In hand lotions and shampoos, carrageenan not only thickens the product but also promotes healthy skin and hair. In addition, carrageenan is a natural product and can be incorporated into formulations which rely on natural ingredients for their promotion.

Contraceptive Gels
Existing products suffer from a lack of gel structure and typically drain from the vagina causing embarrassment and reducing efficacy. Carrageenan gels in contrast, can be tailored to have rapid re-healing characteristics ideally suited to maintaining protection during intercourse. Spermicidal actives such as nonoxy-9 can be incorporated into the gel during manufacture. There is evidence that molecules such as carrageenan complex strongly with the protein coat of the HIV virus, suggesting that contraceptive gels made from carrageenan may reduce the probability of infection.

Industrial Markets

Industrial Suspension and Slurries
Carrageenan interacts strongly with pigments such as calcium carbonate, dicalcium phosphate, silica and alumina. In fact, oita carrageenan will act as a dispersant for calcium-based pigments at high solids (79-72%) and is a more effective dispersant than industrial standards such as Dispex N 40 (manufactured by Allied Colloids Ltd.) polyacrylate up to aqueous gum concentrations of around 0-3% w/w. At higher gum levels, a continuous-phase gel structure becomes apparent and the system resembles a well-stabilized soft-floc, with a low yield point. Iota carrageenan is well suited to the stabilization of pigment dispersions and slurries both for tank car and pipeline transportation.

The idea of tank car transportation of solids in the form of an aqueous high-solids slurry is not new. Currently, tank car transportation is a major distribution methods for chalk and ion oxides in the U.S. and Canada. Coal is pumped in slurry form through long pipe lines across the U.S., Canada and Siberia. The design of a slurry storage and distribution system is relatively straightforward, so long as the characteristics of slurry are taken into consideration. Slurries are centrifugal pumps that have a 400 liter/min capacity against a 15 m head through a 10 cm. loading line. Storage tanks are stirred intermittently, about 15 minutes each hour at 30 rev/min. Distribution to use point is done at a velocity of 0-5-2 m/s via recirculation loops with long radius bends and no vertical standpipes. Slurries are not allowed to stand in the circulation loops. The hydrocolloid used for viscosity reduction and stabilization must be shear stable during transfer and in the distribution loops. Carrageenan is an ideal dispersant and stabilizing polymer for a wide range of solid-in-water dispersions. It is resistant to shear degradation, lubricates particulates and has excellent shear-thinning characteristics.

Black iron oxide is currently transported in tank cars from the pigment manufacturers to the makers of black bricks and tiles. Carrageenan interacts very strongly with transition metals and more effectively coats and stabilizes than CMC which, though an industry standard for many years, has significant deficiencies, particularly during hot weather. Carrageenan systems can have an aqueous re-healing gel structure which, although resistant to vibration encountered in transportation, thins rapidly on pumping. The nature of the gel and thinning properties depends on the carrageenan and ionic environment, with sol-gel transitions well above the maximum temperature likely to be experienced in a tank car.

Many industrial applications require that polymer molecules be stable during pumping operations. Although all polysaccharides will undergo degradation at sufficiently high shear rates (for example, under the sonic shearing conditions of ASTM D2603-76), carrageenan is one of the most stable and is not degraded in centrifugal or displacement pumps.

Liquid Scouring Cleansers

There is an active interest on the part of major brand-name manufacturers and private-label houses in producing new liquid scouring cleanser products for use on fiberglass, plastics, tiles, and other easily abraded surfaces. The concept of such a cleanser dates from the late 1970's when Lever Brothers test-marketed 'Liquid Vim' and then withdrew the product. Since then, several other liquid cleansers have appeared. Liquid scouring cleansers are basically suspensions of a dense but mild abrasive such as calcite with detergents and suspending and dispersing agents. They are low-solids slurries and free of oxidizing, and agents can be stabilized with a polysaccharide such as a carrageenan. Iota-based carrageenan stabilizers impart good functional properties, such as temperature and storage stability, outperforming other gums such as CMC and xanthan. The Iota systems form thixotropic gels with a rapid buildup of structure after shearing which contrasts with the lower yield point of xanthan systems. The yield points of a carrageenan system result from disruption of the three-dimensional polymer network which serves to maintain particle separation, aiding stability. CMC slurries (including dentifrice) often show a yield point whose origin lies in the energy required to disrupt settled solids. With non-gelling polymers, the appearance of a yield point indicates instability and is most undesirable.

Ceramic Coatings and Extrusion Products

Carrageenan has been used by at least one major spark plug company as a carrier for ceramic coating during the manufacture of automotive spark plugs.

Catalytic converters for the automotive industry are currently manufactured using extrusion technology. The reject rate is very high due to collapse of the honeycomb ceramic after extrusion. Carrageenans designed for extrusion technology, with their high gelling temperature, are able to support the honeycomb, significantly decreasing the reject rate.

Anti-icers

Ethylene glycol and other polyols have long been used in aqueous solutions of various strengths for removing ice and snow accumulation from machinery and functional surfaces such as aircraft wings. In the absence of a thickening polymer, the glycol solutions soon drain from the surfaces and thus provide no long-term protection. An anti-icing fluid, on the other hand, contains a polymer to thicken the fluid so that it remains on the treated surface. Two types of fluid in current use for aviation applications are the non-thickened de-icer (type I fluids) and the thickened anti-icers (type II fluids). An anti-icer designed for aircraft should form an essentially continuous film coating after its application by conventional spraying devices, even on non-horizontal surfaces and should provide long-term protection against ice or snow accumulation. It is essential that the anti-icer fluid is blown off the wings during the aircraft's run-up to take off (prior to aircraft rotation). Carrageenan is fully soluble in the hot water/glycol mixes used for aviation machinery. It interacts with glycols to give a weak network with flow properties which make it an ideal thickener for type fluids. The shear field experienced during take off is more than enough to cause the carrageenan thickened fluid thin and drain from the wing. Carrageenan is compatible with all additives currently used in these fluids.

Protecting exposed heavy machinery requires a thick coating which is resistant to wind shear over long periods of time and yet will not clog or interfere with moving parts. Ideally, such a coating should also contain corrosion inhibitors and lubricants and be easy to apply and remove. Kappa carrageenan in water/ethylene glyco forms a gel with ideal characteristics for protecting exposed machinery.

For all anti-icing applications, the system must be non-toxic and harmless to the environment, which puts severe limitations on the types of thickening polymers which can be used. The carrageenan family is composed of non-toxic, food-grade materials which pose no threat or hazard to the environment and are thus ideally suited to thickening polyol systems. Technically, glycol-water-carrageenan systems are said to exhibit a definite yield point followed by marked shear thinning and thixotropy which can be utilized to give very effective industrial (spray-applied) de-icers. Carrageenan gel matrices readily entrap a wide variety of oils from heavy hydrocarbon to light and volatile food flavor systems, thus enabling the easy inclusion of corrosion inhibitors and lubricants.

Humidity Control

The concept of hermetically sealed packaging is somewhat of a misnomer since almost all commercially produced leaks to some extent. For most purposes, the loss of moisture is unimportant, but there are some applications where this is not the case as, for example, in advanced instant-film packages. When it is necessary to control the humidity within a package, a small nugget of carrageenan gel can be used. Moisture lost by leakage is replaced at the expense of the gel which merely shrinks in size.

Paper
Quality paper production requires the cellulose fibers to be strengthened and the surface sized for specific applications. Carrageenans are excellent film formers and will reinforce cellulose fibers to give added wet and tear strength and to control ink bleed. University tests have demonstrated the benefits of sizing and coating writing, printing and release papers with carrageenan.

A small but very profitable market is the production of specialty marbled papers. Marbling is probably one of the oldest techniques used for decorating, perhaps originating in the 15th century to prevent the forging of legal documents. In Turkish marbling, water-based inks or pigments are floated on a gelatinous surface and then moved around with picks and combs until a desired pattern is achieved. Mordant paper or fabric is laid on the surface of the solutions to absorb the color and is then lifted away. A gelatinous surface is made by sprinkling and mechanically dispersing a cold-water-swelling carrageenan powder in water. The inks, if added at the correct viscosity (which must be determined by trial and error), adhere to the soft, swollen gel particles and float to the surface of the bath allowing marbling to be achieved in a cost-effective fashion.

Textile and Carpet Printing
Although screen printing is used for both textile and carpet production, there is a trend to move (in the case of carpet printing) to jet printers. Both screen and jet printing technologies require the flow properties of the print paste to be closely controlled in order to achieve high definition and the required degree of penetration into the fabric or carpet pile. The wide thixotropic flow behavior of carrageenan makes it ideally suited for this purpose.

Within the next five years, jet printing technology is expected to advance into textiles, largely driven by the need to be able to produce short runs of fabric with complex patterns. Screen printing requires expensive screens – One screen per colour for process colour and four for half tone). Jet printing, on the other-hand, only requires computer instructions for controlling the jets, with considerable savings in down-time, cleaning and screen production. The development of jet printing machines capable of handling textiles fabrics is being carried out in cooperation with the producers of control agents, including carrageenan.

Flame Retardants and Foams
Aqueous fire-retardant fluids and foams require thickeners to ensure that the retardant adheres to the structures being sprayed. The ethixotropic and gel characteristics of carrageenan make it ideal for flame retardants and foams. During pumping, the fluids have very low viscosity but after application, the carrageenan builds structure so that treated surfaces remain coated.

Foams are also being used in the concrete industry for protecting freshly poured concrete from drying. The film properties of carrageenan stabilize the air-cell structure of foams to give systems which do not collapse even on partial drying. Tests on freshly poured concrete used in highway construction projects in California have shown the worth of using foams and foam stabilizers to prevent premature drying.

Oil Well Completion Fluids

To avoid damage to the production stratum, clear-water fluids, as distinguished from drilling muds, are used on completion and reworking operations as a standard oil-well drilling practice. Clear-water fluids consist of concentrated high density water solutions of ZnBr2 or another high density salt. The actual salt selected and concentration employed are determined by the desired density of the fluid. Additives are used with clear-water fluids to control and increase the viscosity. Increased viscosity enhances the carrying capacity of the fluid, reduces fluid loss and tends to promote the conditioning of the formation so as to minimize caving and water damage in water-sensitive formations. Polysaccharide gums are commonly employed for this purpose. It has been found that carrageenan can be more effective than HEC because of the ability of the carrageenan to form a network for drilling applications. The gel network must be sufficient to suspend the drilling lines but the weak enough to allow free passage to the surface. Research has demonstrated that carrageenan can be used effectively with high-density completion brines to maintain a predictable viscosity over the wide temperature ranges encountered during drilling completion operations, and is much more cost effective than xanthan gum

Carrageenan Refined E407

Description

General: carrageenans refined are quality fine powders manufactured from natural strains of red seaweeds of the Rhodophyceae family.

Application: carrageenan refined are suitable for use in a range of food applications where gelling, thickening and stabilising is required.

Physical and Functional Properties

Appearance: Fine, free flowing, off-white to cream powder

Moisture: Not greater than 12.0%

Colour: Conforms to standard

Solubility: Soluble in hot water

Viscosity: At least 5cps *1.5% @ 75℃, by Brookfield LVT*

PH of solution: 7.0 to 10.0

Particle Size : 120mesh or 160mesh.

Chemical Purity

Sulphate: 15% to 40%, on dry weight basis, as SO_4

Alcohol:Not greater than 0.1%

Ash : 15% to 40%, on dry weight basis, at 550°C

Acid-insoluble Ash: Not greater than 1%, on dry weight basis

Acid-insoluble Matter: Not greater than 2%, on dry weight basis

Arsenic: Not greater than 3 ppm

Lead: Not greater than 5 ppm

Mercury: Not greater than 1 ppm

Cadmium: Not greater than 1 ppm

Heavy metals (as Pb): Not greater than 20 ppm

Microbial Purity

Total Viable Count: Not greater than 5,000 cfu/g

Total Yeast and Mould Count: Not greater than 300 cfu/g

E coli: Negative in 5g

Salmonella: Negative in 25g

Staph aureus: Negative in 10g

Total Enterobacteriaceae Count: Not greater than 100 cfu/g

Carrageenan semi-refined E407a

Description

General: Pure Semi refined Kappa carrageenan – Eucheuma cottonii.

Physical and Functional

Properties

Appearance: Fine, free flowing, white to cream powder

Moisture: Max 12.0%

Viscosity: At least 5cps 1.5% @ 75°C, by Brookfield LVT

Purity: Min 98%

Salts: Max 2%

Added sugars: None

PH of solution: 8.0 to 10.0

Gel Strength: Minimum 400 g/cm2 1.2%, + 0.3% KCl @ 20°C

Particle Size Distribution

120mesh: At least 99.00% through

Chemical Purity

Nitrate: 30ppm Max

Nitrite: 3ppm Max

Arsenic: Not greater than 3 ppm

Lead: Not greater than 2 ppm

Mercury: Not greater than 1 ppm

Cadmium: Not greater than 1 ppm

Heavy metals (as Pb): Not greater than 20 ppm

Microbial Purity

Total Viable Count: Not greater than 5,000 cfu/g

Total Yeast and Mould Count: Not greater than 300 cfu/g

E coli: Negative in 5g

Salmonella: Negative in 25g

Total Enterobacteriaceae Count: Not greater than 100 cfu/g

Packaging and Labelling 25kg net multi ply paper sacks with moisture barrier or polythene inner