GUAR GUM POWDER POSSESSING IMPROVED HYDRATION CHARACTERISTICS

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ABSTRACT
A guar gum powder product whose manufacturing process includes the additional step of extruding hydrated and flaked guar splits prior to grinding and drying. The extruding step may be included before or after the step of flaking the splits. The inclusion of the extruding step, along with the flaking step, has been found to create a guar gum powder product which has advantageous properties over the prior art. These advantageous properties include (1) increasing the hydration rate and the hydration acceleration rate of the guar gum powder without any corresponding change in particle size, and (2) providing a hydration acceleration rate that is less affected by cold temperatures.
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BACKGROUND OF THE INVENTION

[0001] Guar gum comes from a plant that is grown primarily in India and Pakistan, although other climates are also friendly to its cultivation. Guar is a legume-type plant that produces a pod, much like a green bean. In the pod there are seeds that, upon heating, split open exposing the endosperm and meal. The resulting product is then differentially ground to purify the endosperm. Such purified endosperm is referred to as a “split.”

[0002] The exposed endosperm contains a polymer of great use for thickening industrial and commercial fluids. The polymer is a polysaccharide material known as polygalactomannan. This material develops a high viscosity via hydration of the fluid to be thickened, similar to the action of starch. The guar endosperm polymer is much more efficient than starch in developing viscosity, however.

[0003] Guar gum has numerous applications in the oil industry as an additive to drilling and fracturing fluids. Other industrial and commercial applications abound. For example, it is used in the explosives industry to thicken gelled explosives. It is used as a food additive as a thickener. It is used in paper manufacturing to increase the water-absorption and wet strength characteristics of paper. It is used in textiles in carpeting as part of the colorizing or shading process. Another use is in animal litter to enhance clumping characteristics. Further uses include synthetic fuel briquette manufacture, and in firefighting to deliver thickened water to smother fires.

[0004] Guar gum powder is known in the art to be manufactured primarily by flaking the hydrated splits, then grinding the flakes, and then drying the resulting powder. Just like any powder, guar gum’s hydration characteristics are related to the particle size of the powder. The smaller the particles, generally the better the hydration characteristics (and principally the faster the hydration) because the surface area of the powder has increased.

[0005] Fast hydration is a goal of many of the industrial and commercial applications set forth above. In particular, in oilfield stimulation, the technique is to hydrate to full hydration as quickly as possible so as to waste as little product as possible. Rapid hydration also enhances fluid pumping performance.

[0006] In animal litter applications, rapid hydration allows the litter to clump faster and thereby makes for a better, more efficient product. For example, cat fluids do not drop to the bottom of the pan, they stay at the top.

[0007] In synthetic fuel applications, a better pellet or briquette results if the product is fully hydrated as it is dried. In explosives, the product is typically ruined if it takes on water when, for example, it is buried in the ground. If the product contains an agent that hydrates quickly, it seals the water from the explosive.

[0008] Reducing particle size to improve hydration is not always advantageous, however. Reducing particle size requires additional manufacturing costs in grinding and screening the product. It also creates additional fines which are hard to manage, package, and cause wasted product.

[0009] There is therefore a need in the industry to develop a guar gum powder whose hydration rate is increased while maintaining optimum particle size.

[0010] Hydration rate is not the only characteristic of guar gum powder that is of interest to the industrial and commercial applications described above. Hydration acceleration rate is also important. If hydration cannot reach, say, 50% hydration fast enough, the guar powder may be unsuitable for the application, even though the overall hydration rate may be acceptable.

[0011] There is therefore also a need in the industry to develop a guar gum powder having both faster hydration and faster hydration acceleration rates.

[0012] Responsiveness of the hydration rate to lower temperatures is also important. Typically, the lower the ambient temperature, the slower the hydration acceleration rate, even when the absolute time for 100% full hydration is acceptable. For example, in oil fracturing fluids applications in cold places such as the Rockies, Alaska, Canada, Russia and Scandinavia, the use of guar gum powder may not always be optimal when the hydration acceleration rate is slowed by the cold.

[0013] There is therefore also a need in the industry to develop a guar gum powder whose hydration acceleration rate is not as adversely affected by low ambient temperatures.

SUMMARY OF THE INVENTION

[0014] These and other objects, features and technical advantages are achieved by a method in which the manufacturer of guar gum powder includes the step of extruding the hydrated splits prior to drying. The extruding step may be included before or after the step of flaking the splits.

[0015] The inclusion of the step of extruding the hydrated splits in the manufacturing process has been found to create a guar gum powder product which has advantageous properties over the prior art. These advantageous properties include (1) increasing the hydration rate and hydration acceleration rate of the guar gum powder without any corresponding change in particle size, and (2) providing a hydration acceleration rate that is less affected by cold temperatures.

[0016] Extrusion is known to be a part of the manufacturing process of products from other crops such as wheat or corn. Where extrusion is used in such processes, however, its purpose is known to be for objectives totally unrelated to improving hydration characteristics of the product. Generally its purpose is to shape the product into a desired physical profile.

[0017] It is therefore a technical advantage of the present invention to provide a process of making guar gum powder that hydrates faster and whose hydration accelerates faster, than prior art powders of corresponding particle size. The potential benefits of such a product to industrial and commercial applications are described in detail in the “background” section of this disclosure.

[0018] A further technical advantage of the present invention is that the inventive process provides a guar gum powder product whose hydration acceleration rate is less affected by cold temperatures. The potential benefits of such a product in cold environments are also described in detail in the “background” section.

[0019] A yet further technical advantage of the present invention is that the resulting guar gum powder product has numerous applications as a high-performance hydrating or thickening agent when mixed, integrated or suspended with
host products. These products include, in addition to the ones discussed in the "background" section of this disclosure:

- shampoo, body wash, lotions and other personal care
- household cleaner;
- catalytic converter catalyst;
- electroplating solutions;
- diapers and sanitary towels;
- super-adsorbents in food packaging;
- sticking plasters for skin abrasions (“band-aids”);
- water-adsorbing bandages;
- foliar spray for plant leaves;
- suspension for spraying plant seeds or nutrients; and
- flotation aid or flocculent in particulate separation or water treatment processes.

The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and the specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGS. 1 and 2 illustrate guar gum powder manufacturing processes known in the art;
FIGS. 3 and 4 illustrate alternative exemplary guar gum powder manufacturing processes according to the present invention;
FIG. 5 illustrates the hydration performance at 70 degrees F. of guar gum powder made according to a known process such as is illustrated in FIG. 1;
FIG. 6 illustrates the hydration performance at 40 degrees F. of guar gum powder made according to a known process such as is illustrated in FIG. 1;
FIG. 7 illustrates the hydration performance at 70 degrees F. of guar gum powder made according to the present invention; and
FIG. 8 illustrates the hydration performance at 40 degrees F. of guar gum powder made according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1 and 2 illustrate processes known in the art to manufacture guar gum powder. These processes typically include hydrating guar gum splits as an initial step (101, 201). Popular techniques hydrate the splits to about a 20%-80% moisture content. The hydrated splits may then be flaked using milling techniques or other flaking operations known in the art (102). Alternatively, the prior art is known to simply omit the flaking process, as seen on FIG. 2. The splits then proceed to a grinding operation (103, 202) and a drying operation (104, 203) to yield a guar gum powder. This powder is then screened (105, 204), and then packaged for distribution (106, 205).

A manufactured powder particle size is generally selected by artisans in this field to optimize the hydration characteristics of the powder. Finer powder will generally produce a product that hydrates faster. However, finer powder also costs more to produce and is harder to handle. Also, finer powder is more susceptible to loss through waste.

FIGS. 3 and 4 illustrate alternative embodiments of the process of present invention. It will be seen that, by comparison to FIGS. 1 and 2, the inventive process in FIGS. 3 and 4 includes an extrusion step (302, 402). The extrusion step is advantageously carried out after hydration of the splits (301, 401) and before grinding (304, 404). According to the invention, however, the extrusion step (302, 402) may be performed either before or after flaking (303, 403).

Extrusion as shown in FIGS. 3 and 4 may be accomplished by using a single screw extruder or by other means known in the art.

Adding the extruding step according to the present invention has been found to improve the hydration characteristics of guar gum powder without affecting particle size. These improved characteristics include (1) increasing both the hydration rate and the hydration acceleration rate, and (2) providing a hydration acceleration rate that is less affected by cold temperatures.

The improved hydration characteristics of a guar gum powder made according to the inventive process are disclosed herein by example.

EXAMPLE 1

FIGS. 5 and 6 illustrate the hydration performance of guar gum powder made according to a known process as illustrated in FIG. 1, whereas FIGS. 7 and 8 illustrate the corresponding hydration performance of guar gum powder made according to the inventive process as shown on FIG. 4. It will be understood, however, that similar hydration performance to FIGS. 7 and 8 has been achieved according to the process of FIG. 3, in which extrusion step 302 precedes flaking step 303 instead of following it.

Specifically, the samples whose hydration performance is shown on FIGS. 5, 6, 7, and 8 were made as follows. Guar gum splits from the same batch were hydrated to about a 20-80% moisture content at about 50-200 degrees F. The splits were then converted to flakes using a Farrell-Ross flaker. About half of the flaked splits were then
extruded through a Bonnot Corporation extrusion machine having a 2" - 8" barrel diameter. The other half of the flaked splits were not extruded. All splits were then ground to a powder, dried to about a 1-10% moisture content, and then screened so that the entire powder sample passed through a 100 mesh sieve.

[0049] The comparative rates of hydration of the samples were then measured and plotted as set forth on FIGS. 5, 6, 7 and 8. On FIGS. 5 and 7, the comparative hydration performance of the samples at 70 degrees F. is shown. On FIGS. 6 and 8, the comparative hydration performance of the samples at 40 degrees F. is shown.

[0050] FIG. 7, when compared to FIG. 5, shows that the hydration rate at 70 degrees F. is appreciably faster for the guar gum powder made according to the inventive process with the extrusion on step. For example, the sample in FIG. 7 is 90% hydrated after 9 minutes, whereas the sample in FIG. 5 does not achieve 90% hydration until about 20 minutes. Further, it will be seen that the hydration acceleration rate of the sample in FIG. 7 is appreciably faster than in the sample of FIG. 5.

[0051] Moreover, FIG. 8, when compared to FIG. 6, shows that the hydration rate of the sample made according to the inventive process is less affected by lower temperatures. For example, the inventive sample in FIG. 8 is at least 50% hydrated after about 90 seconds at 40 degrees F., and about 90% hydrated after 5 minutes. This is in comparison to FIG. 7, illustrating the hydration performance of the same inventive sample at 70 degrees F., in which 50% hydration occurred at about 60 seconds and 90% hydration occurred after about 5 minutes. Thus, 50% hydration occurred only 30 seconds later in the inventive sample when hydrated at 30 degrees F. lower temperature.

[0052] In contrast, the prior art sample in FIG. 6 achieves 50% hydration at 40 degrees F. after about 3 minutes, and achieves 90% hydration after about 20 minutes. This is in comparison to FIG. 5, illustrating the hydration performance of the same prior art sample at 70 degrees F., in which 50% hydration occurred after about 90 seconds, and 90% hydration occurred after about 20 minutes. Therefore, 50% hydration occurred 90 seconds later in the prior art sample when hydrated at 30 degrees F. lower temperature.

[0053] The foregoing disclosure relates to a process of manufacturing guar gum powder with improved hydration characteristics. As noted above, the polymer of interest in guar gum is polygalactomannan, a polysaccharide. It will be understood that the improved hydration characteristics of guar gum powder are likely to be exhibited by other polymers found in plant seed endosperms, including other polysaccharide-like polymers, when manufactured in powder form according to the inventive process.

[0054] It is also known in the art to chemically modify guar gum to achieve other characteristics. For example, it is known to add hydroxypropyl group polymers or carboxymethyl group polymers to the hydrated splits to enhance the achievable final viscosity of the guar gum powder. It will be understood that chemically modified hydrated guar gum splits are also likely to exhibit improved hydration characteristics when manufactured in powder form according to the inventive process.

[0055] It is also known in the art to genetically modify plants so as to achieve desired characteristics. For example, it is known to genetically modify guar gum seeds to alter the plant’s climatic requirements so that the crop may be grown in a wider geographic territory. In the case of genetic modification of guar to alter the active polymer provided by the endosperm, it will be understood that powder from the endosperms of such genetically modified guar is also likely to exhibit improved hydration characteristics when manufactured according to the inventive process.

[0056] It will be further understood that minimal experimentation would be required by those of skill in this art to identify other plant seed endosperms (whether unmodified, chemically modified or genetically modified) that exhibit improved hydration characteristics when manufactured according to the inventive process. It will be appreciated that once set up, a manufacturing process built according to the invention can easily process many types of plant seed endosperms with minimal modification, if any. Further, hydration performance of the powder product can be easily measured using well-known testing techniques.

[0057] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.

We claim:

1. A guar gum powder product of the process comprising:
   (a) hydrating guar gum splits;
   (b) processing the hydrated splits, said processing step including the substeps, in either order, of flaking the splits and extruding the splits;
   (c) grinding said processed splits into a powder; and
   (d) drying the powder.

2. The guar gum powder product of claim 1, in which the guar gum splits comprise polygalactomannan.

3. The guar gum powder product of claim 1, in which the guar gum splits have been chemically modified.

4. The guar gum powder product of claim 1, in which the guar gum splits have been genetically modified.

5. The guar gum powder product of claim 1, in which the extruding substep in step (b) encourages said powder product to hydrate faster.

6. The guar gum powder product of claim 1, in which the extruding substep in step (b) encourages said powder product to hydrate at a faster rate of acceleration.

7. The guar gum powder product of claim 1, in which the extruding substep in step (b) encourages said powder product to hydrate faster and with a faster hydration acceleration rate.

8. The guar gum powder product of claim 1, in which the extruding substep in step (b) causes said powder product to hydrate at a rate that is affected less by lower temperatures.

9. The guar gum powder product of claim 1, in which the extruding substep in step (b) causes said powder product to hydrate at a rate of acceleration that is affected less by lower temperatures.

10. The guar gum powder product of claim 1, in which the extruding substep in step (b) causes said powder product to hydrate at a rate of acceleration that is affected less by lower temperatures, and

11. The guar gum powder product of claim 1, in which said powder product achieves about 90% hydration after about 5 minutes at about 70 degrees F.
12. The guar gum powder product of claim 1, in which said powder product achieves about 90% hydration after about 5 minutes at about 40 degrees F.

13. The guar gum powder product of claim 1, in which said powder product achieves about 50% hydration after about 60 seconds at about 70 degrees F.

14. The guar gum powder product of claim 1, in which said powder product achieves about 90% hydration after about 90 seconds at about 40 degrees F.

15. The guar gum powder product of claim 1, in which said powder product achieves about 50% hydration after about 5 minutes at about 70 degrees F and after about 5 minutes at about 40 degrees F, and in which said powder product further achieves about 50% hydration after about 60 seconds at about 70 degrees F and after about 90 seconds at about 40 degrees F.

16. The guar gum powder product of claim 1, in which:

   a. the splits are hydrated in step (a) to about a 20%-80% moisture content at about 80-200 degrees F;

   b. the hydrated splits are extruded in step (b) through about a 2”-8” diameter barrel; and

   c. the powder is first dried in step (d) to about a 1%-10% moisture content and then screened through a 100 mesh sieve.

17. The guar gum powder product of claim 15, in which:

   a. the splits are hydrated in step (a) to about a 20%-80% moisture content at about 80-200 degrees F;

   b. the hydrated splits are extruded in step (b) through about a 2”-8” diameter barrel; and

   c. the powder is first dried in step (d) to about a 1%-10% moisture content and then screened through a 100 mesh sieve.

18. The guar gum powder product of claim 1, in which said powder product is an agent in a host product selected from the group consisting of:

   (a) drilling fluid;
   (b) fracturing fluid;
   (c) animal litter;
   (d) explosive;
   (e) foodstuff;
   (f) paperstock;
   (g) floor covering;
   (h) synthetic fuel briquettes;
   (i) water thickener for firefighting;
   (j) shampoo;
   (k) personal care lotion;
   (l) household cleaner;
   (m) catalytic converter catalyst;
   (n) electroplating solution;
   (o) disperser;
   (p) sanitary towels;
   (q) super-absorbent in food packaging;
   (r) sticking plaster for skin abrasions;
   (s) water-adsorbing bandages;
   (t) topical spray for plants;
   (u) suspension for spraying plant nutrients;
   (v) suspension for spraying plant seeds;
   (w) flotation aid; and
   (x) flocculent.

19. A guar gum powder product of the process comprising:

   (a) hydrating guar gum splits;
   (b) flaking the splits;
   (c) extruding the splits;
   (d) grinding said processed splits into a powder; and
   (e) drying the powder.

20. The guar gum powder product of claim 19, in which said powder product is an agent in a host product selected from the group consisting of:

   (a) drilling fluid;
   (b) fracturing fluid;
   (c) animal litter;
   (d) explosive;
   (e) foodstuff;
   (f) paperstock;
   (g) floor covering;
   (h) synthetic fuel briquettes;
   (i) water thickener for firefighting;
   (j) shampoo;
   (k) personal care lotion;
   (l) household cleaner;
   (m) catalytic converter catalyst;
   (n) electroplating solution;
   (o) disperser;
   (p) sanitary towels;
   (q) super-absorbent in food packaging;
   (r) sticking plaster for skin abrasions;
   (s) water-adsorbing bandages;
   (t) foliar spray for plants;
   (u) suspension for spraying plant seeds;
   (v) suspension for spraying plant nutrients;
   (w) flotation aid; and
   (x) flocculent.

21. The guar gum powder product of the process comprising:

   (a) hydrating guar gum splits to about a 20%-80% moisture content at about 80-200 degrees F;
   (b) flaking the splits;
   (c) extruding the splits through about a 2”-8” diameter barrel;
   (d) grinding the splits into a powder; and
   (e) drying the powder to about a 1%-10% moisture content.

22. The guar gum powder product of claim 21, in which said powder product is screened through about 100 mesh sieve.

23. An improved guar gum powder product formed by a method including the steps of hydrating guar gum splits, processing the hydrated splits, grinding the processed splits into a powder, and then drying the powder, wherein said processing step includes the substep of flaking the splits, the improvement comprising:

   also extruding the splits in said processing step.

24. The improved guar gum powder product of claim 23, in which the guar gum splits comprise polygalactomannan.

25. The improved guar gum powder product of claim 23, in which the guar gum splits have been chemically modified.

26. The improved guar gum powder product of claim 23, in which the guar gum splits have been genetically modified.