PROCESS BULLETIN

Cellulose

Description

Cellulose, which makes up the skeletal structure of plant cell walls, is the main polysaccharide in living plants. This polysaccharide is made up of units of glucose. It has no nutritional value for a human, because the body lacks the necessary enzymes to digest cellulose.

Special forms of cellulose are used or have potential for use in many different products as thickening agents. Some forms of useful cellulose are as follows:

a. Microcrystalline Cellulose – This form of cellulose is generated by chemically treating the fibers to dissolve out of degrade the amorphous, accessible regions, leaving behind the less accessible crystalline regions.

b. Microfibrillated Cellulose – This is a material that has been mechanically treated to open the cellulose fibers which enlarges surface area, increases fiber accessibility and reduces fiber size 1-3.

c. Bacterial Cellulose – A fiber produced by fermented bacteria. This fiber is thinner than other forms of cellulose and has an intricately cross-linked fiber network 4-5.

Objective

Specially-treated cellulose could be used as a thickening agent in many products. The following applications are cited by references 5 and 6.

1. food ingredient for thickening, texturing and calorie reduction;
2. printing paper surface coating;
3. mineral processing froth-flotation depressant;
4. oil drilling and stimulation chemical;
5. paint or ink thickener;
6. latex adhesive or sealant thickener;
7. ingredient for thickening cosmetics;
8. ceramic or other metallic powder processing binder;
9. pharmaceutical applications such as excipient for medication, precipitation control agent;
10. thickener to stabilize dispersions, emulsions and suspensions.

Cellulose at low concentration can be used in place of gums or other thickening agents; and, in some cases, it may confer unique properties to the product not achieved with other additives. It accomplishes its thickening effect by the interaction of the fibrils with the suspending fluid, networking through the liquid, and it can produce gels even at low concentration.

Processing

As mentioned above, microcrystalline cellulose (MCC) is the product of chemically treated cellulose. However, this chemical process results in the loss of a portion of the starting material.

A mechanical beating of cellulose fibers, producing fibrillation or a splaying of submicron fibers, generates microfibrillated cellulose (MFC). This mechanically treated material requires no chemical treatment or loss of cellulose. MFC can be generated by high-pressure homogenization, passing the product several times through the homogenizer. Processing at elevated temperatures may improve fibrillation. When processing cellulose in the homogenizer, the cellulose concentration is usually low, less than 10%, sometimes only 2 to 4%, to avoid pumping problems. Longer fibers increase the possibility of pumping irregularities. This treatment can be performed on a cellulose dispersion only or on a combination of cellulose and other combined ingredients[2]. Processing the combined ingredients would result in a finished product; whereas, a separately treated cellulose would then have to be added to the other ingredients to generate the final product. The MFC is different from other types of cellulose, because it has a "vastly increased surface area, greater liquid absorption characteristics and greater reactivity"[2].

Microfibrillated cellulose may also have use in the paper industry, because MFC can improve the physical characteristics of paper such as tensile strength and water retention value.

The MFC is suspended in a liquid that can swell cellulose and is quite often combined with another hydrophilic polymer such as carboxymethylcellulose, guar gum, carrageenan, polyacrylic acid or hydroxypropyl cellulose. The added hydrophilic polymer keeps the fibers suspended for initial mechanical treatment and lessens the dewatering or matting that can occur when pumping untreated fibers. MFC suspensions are usually within the concentration range of 0.25% to 5%, depending on the application[3].

Cellulose produced by bacteria has a different physical three-dimensional structure than plant cellulose, because the fiber width is only 0.1 micrometer, as compared to 30 micrometers for plant cellulose. The bacterially generated fibers are long and thin, interlacing throughout the suspending medium; but this cellulose may also be enhanced by homogenization to open submicron fibrils. As with MFC, this cellulose can be combined with other thickening agents to improve the performance of the dispersion. Because these cellulose products are patented, these processes may require licensing from the inventors.

References

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ISSUED: 02/2009 3045-01-07-2008-US