

## Microcrystalline Cellulose - An Anti-Caking Agent for Grated Cheese

CLT-06

by E.J. McGinley and W.R. Thomas

*The following paper was presented by Mr. William R. Thomas, Food Marketing Manager, FMC BioPolymer, Philadelphia, Pennsylvania, especially for the 17th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on september 10 and 11, 1980.*

Caking and flow difficulties are common problems in industries producing or utilizing grated and shredded cheese. High temperature stability, changes in relative humidity, pressure packing, and the composition and particle configuration of the cheese itself are some of the important factors affecting flowability.

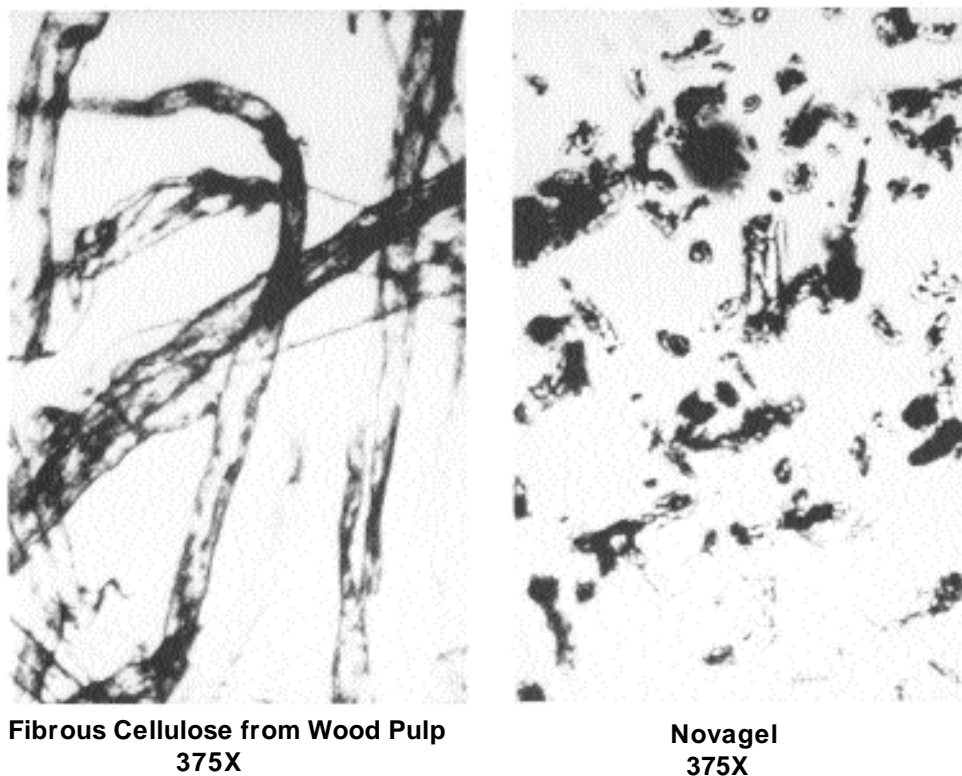
A number of ways of overcoming flow problems, to some extent, are employed commercially. These include: selection of cheese by composition, controlling particle size, drying to allow moisture content, and the addition of anit-caking agents.

The purpose of this study was to characterize the use of microcrystalline cellulose (MCC) as an anti-caking agent and flow aid for grated and shredded cheeses.

Cellulose, and particularly microcrystalline cellulose, may not be familiar to you. MCC is a non-fibrous form of cellulose in which the cell wall of the plant fiber has been broken into fragments ranging in size from a few hundred microns to a few tenths of a micron in length (Figure 1). MCC is chemically identical to native cellulose and has the same x-ray diffraction pattern. Only the physical form of the cellulose raw material is changed in the course of manufacture of MCC; cellulose in fiber form is converted to cellulose in particle form. It occurs as bland, white, odorless, crystalline flour.

The unique ability of MCC to convert cheese and other pasty oleaginous materials to a granular free-flowing form was demonstrated in 1959. The Swift Company, with the support of the National Cheese Institute, Inc., petitioned the federal government to allow the use of MCC as a flow aid for grated cheeses. The Federal Standard of Identity for grated cheese was formally amended on June 11, 1973 to include the optional use of MCC as an anti-caking agent not to exceed two percent by weight of the finished food (21 CFR 19.798)

### Structure of Fibrous Cellulose and Novagel GP 1281



**Figure 1**

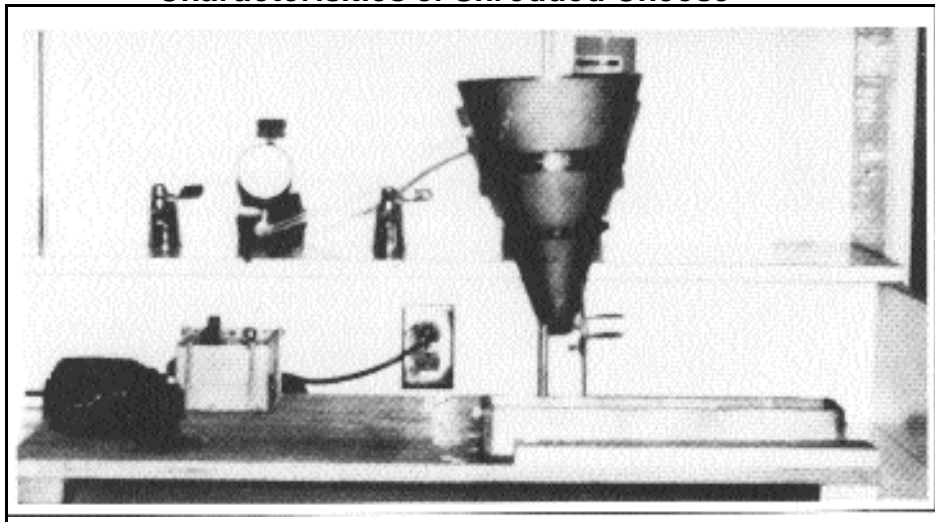
The functionality of MCC (Novagel® - FMC trademark) as a flow aid for certain types of grated cheese blends has been proved in commercial situations and can be demonstrated visually simply by comparing a cellulose-based product to a control product. However, to instrumentally assess flowability by conventional methods is difficult due to the unusual configuration of shredded cheese particles and variability in fat and moisture contents between different types of cheese. Consequently, we had to develop a device and establish a method and set of conditions before we could measure relative differences in flow.

Conventional methods of flow measurements, such as angle of repose and angle of spatula, were not suitable for measuring the flow of shredded cheese. Several different constant delivery devices were constructed and evaluated in an effort to accurately characterize the cheese flow in near absolute terms. The criteria in determining if a device was suitable were (1) its ability to reasonable duplicate the flow of a given cheese sample; and 2) its sensitivity was such that differences in flow between samples could be measured.

A stainless steel funnel with a vibrator attachment was selected as our delivery system. By trial and error with cheese samples representing the extremes of flow, we were able to determine the proper orifice size for our tests. Bridging at the lip of the funnel was minimized by cutting the orifice on a bias to form an elliptical-shaped opening 24 mm x 28 mm (Figure 2).

In addition to measuring total flow as a function of time, it was also desirable to obtain a profile that would indicate the uniformity of flow. The grated cheese was metered through the vibrating funnel into an elongated container that was divided into six in-line compartments of equal volume and spacing. Exact alignment of the container to funnel was ensured by two channels that served as guides. The orifice was positioned directly on the leading edge of the first compartment of the container which in turn was attached to a constant speed motor with a nylon cord. Motor activation and stopper removal were initiated simultaneously. Each compartment required 1.66 seconds to completely transverse the orifice. When the cycle was completed, the sample deposited in each of the compartments was weighted. Neither the first nor last compartment containing sample was utilized in our calculations. The average of five consecutive cycles was calculated on a cumulative basis and represented graphically either as a flow profile or total flow versus time.

### **Apparatus Used to Evaluate Free Flow Characteristics of Shredded Cheese**



**Figure 2**

An indication of the precision of our method for measuring flow is shown in Figure 3. Duplication of a given sample was reasonably good, and relative differences between samples of different flow were easily distinguishable. Thus, a reliable laboratory method for flow measurement of shredded cheese was achieved that is essentially the principle of the tablet weight method used in the pharmaceutical industry.

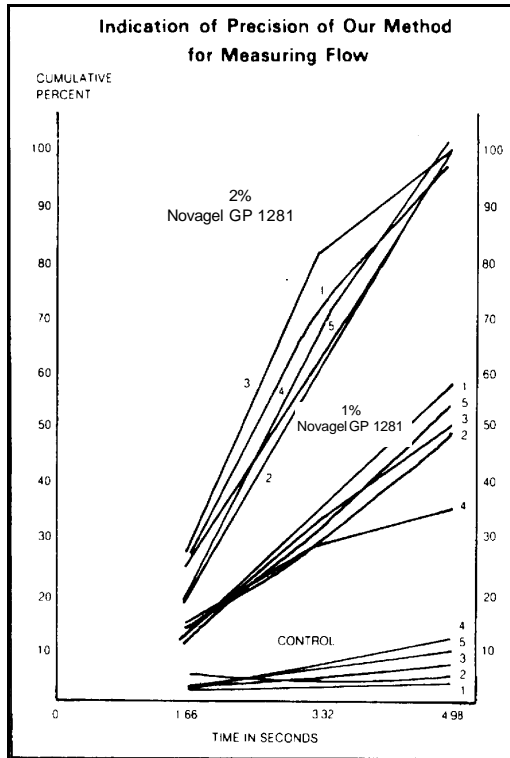


Figure 3

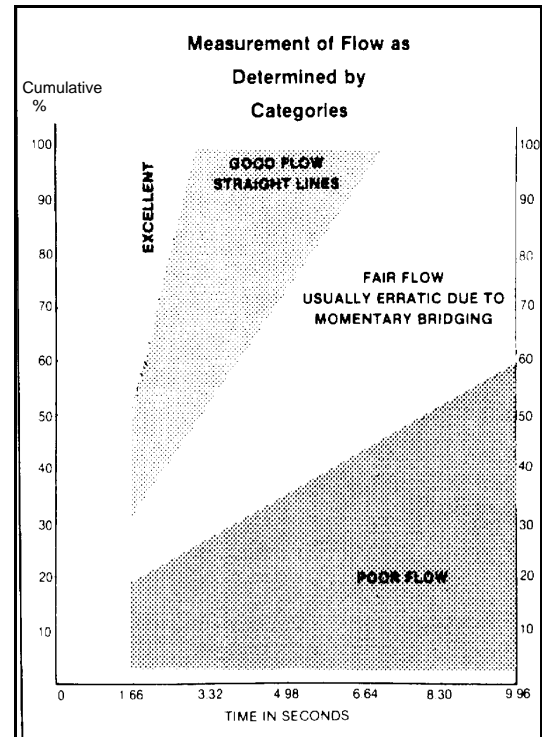


Figure 4

Analysis of the results of 100 different tests has enabled us to categorize cheese flow according to our method. In Figure 4 straight upright lines in the graph are representative of samples with good flow properties; broken lines are indicative of momentary bridging or interrupted flow and, of course, in the case of poor flow, only a small amount of sample is collected in the prescribed time.

The flow profiles of various types of grated cheeses without the flow aids are shown in Figure 5. Commercial blends A,B, and C consist of Parmesan and Romano dehydrated to a 14-28% moisture content and grated to a fine particle size. Conventional Parmesan and Romano grated to medium size particles exhibited a fair-to-good flow. The high moisture varieties such as Mozzarella, Cheddar and a processed Gruyere exhibited very poor flow properties.

Except where cheese particle size was a variable, all samples were hand grated to an intermediate size consisting of irregular shaped particles 1 mm x 15 mm. Total sample amount was confined to 100 grams. Blending of the MCC powder with the grated cheese was accomplished by hand tumbling for a few minutes in a bowl. Different methods of blending were investigated with no significant differences noted between gentle tumbling methods. However, it would be advisable to avoid blending operations that exert pressure on the sample resulting in compaction of the particles.

MCC has an affinity for both moisture and free fat contained on the surface of cheese particles. The particle of size of the MCC in comparison to the micro fine size of other anti-caking agents allows for a uniform distribution of the cellulose on the cheese.

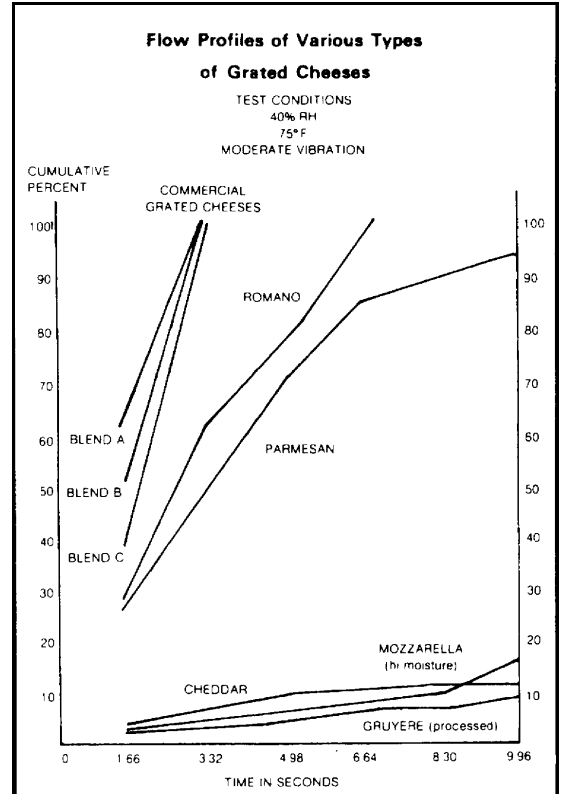


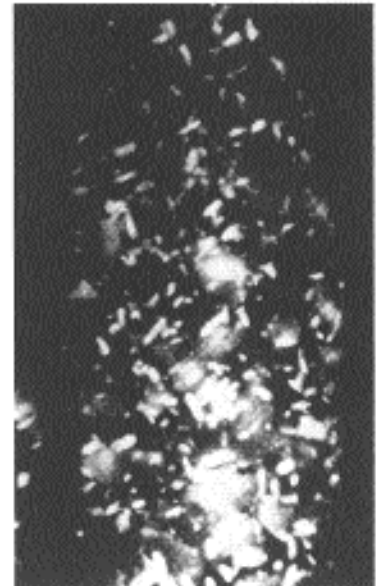
Figure 5

**Shredded Low Moisture, Part-skim Mozzarella**

Figure 6 indicates that sufficient cellulose to cellulose contact rather than cheese to cheese contact will greatly minimize caking. Even when pressure is exerted during blending or storage and compaction results in a cheese to cheese bond between the cellulose particles, the surface area involved is small enough and bonds weak enough that gentle agitation will quickly break them apart.



**Control  
2.5X**



**With 2% Novagel® GP 1281  
2.5X**

Figure 6

Grated Cheddar or Mozzarella cheese particles are very moist, cake readily, and exhibit a poor flow profile (Figures 7 and 8). When MCC is added to the cheese at gradually increasing use levels, the slope of the curve sharply increases resulting in more product being delivered per given time unit at a more uniform rate.

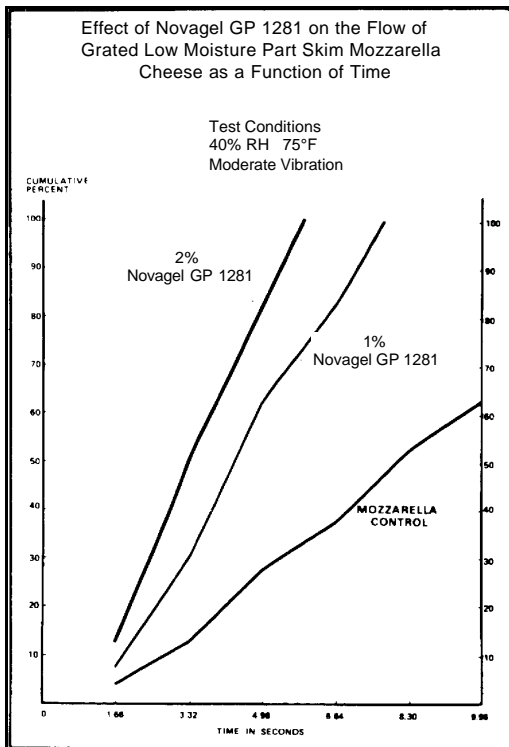


Figure 7

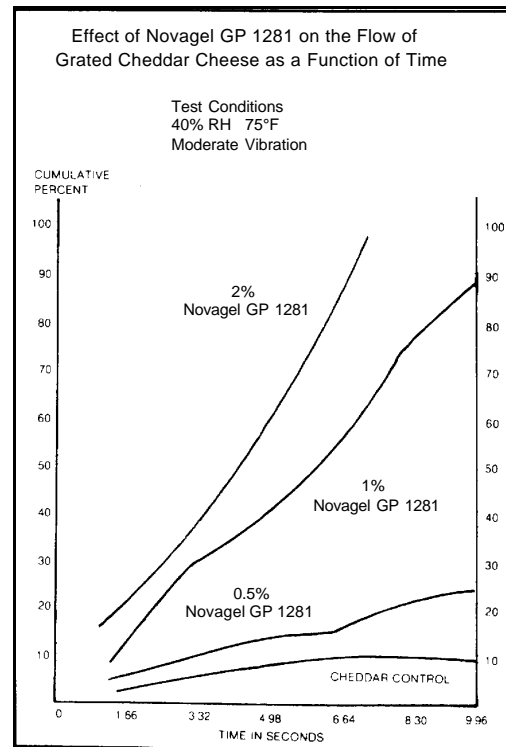


Figure 8

The size and configuration of the particles are an important consideration when evaluating the flow of any food product. Generally, the smaller (up to a point) and more uniform the particle size, the better the flow. Cheddar cheese was grated to three different particle sizes; namely, (a) small uniformly shaped particles 9 mm x 2 mm, (b) intermediate particles 4 mm x 15 mm, and (c) large, irregularly shaped particles 5 mm x 30 mm (Figure 9). Due to the poor inherent flow properties of the Cheddar, we were unable to determine the effect of particle size on the flow of the control sample; however, the application of 2% MCC to the same cheese made the effect of particle size on flow quite apparent. In addition to functioning as an anti-caking agent, MCC also facilitates the flow of large, irregularly shaped cheese particles.

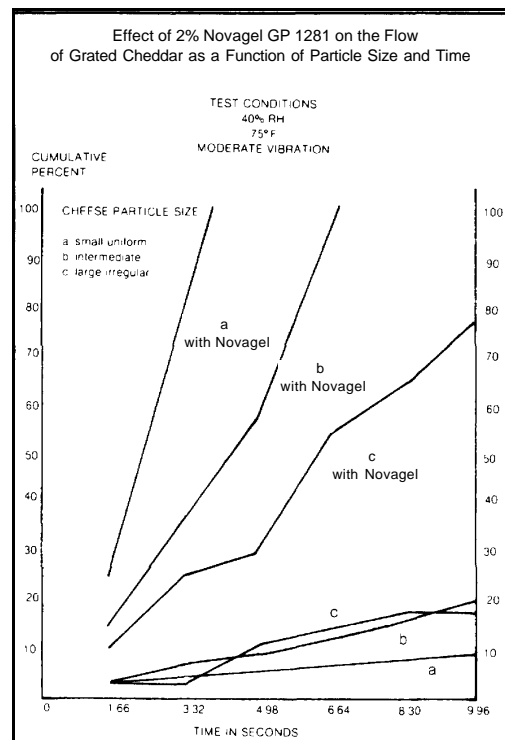


Figure 9

Four one hundred gram samples of grated Cheddar cheese blended with two percent MCC were conditioned at 5, 21, 30 and 46°C (40, 70, 85 and 105°F) for twenty-four hours then immediately subjected to the flow test to determine the ability of MCC to counteract high temperature flow problems (Figure 10). Caking at 15°C (40°F) is primarily due to surface moisture, and the effect of the cellulose anti-caking agent is readily apparent. At 30°C (85°F) the grated Cheddar cheese containing the anti-caking agent is far superior in terms of flow than Cheddar containing no MCC at 15°C (40°F). Above 30°C (85°F) a gross separation of the melted butter-fat occurs which even MCC is unable to contain.

Two percent MCC was applied to a blend consisting of equal parts high moisture Mozzarella, Cheddar and Romano cheeses. Initial moisture content of the blend was 37%. Samples of the blend were conditioned at 15, 33, and 97% relative humidity for 24 hours prior to evaluation. Changes in sample moisture content were as follows:

- Control blend @ 15% RH - 25% moisture loss
- Control blend @ 33% RH - 4.5 moisture loss
- Control blend @ 97% RH - 1.1% moisture gain

- MCC/cheese blend @ 15% RH - 23% moisture loss
- MCC/cheese blend @ 33% RH - 3.2% moisture loss
- MCC/cheese blend @ 97% RH - 0.45% moisture gain

As can be observed in Figure 11, MCC will counteract the effects of high relative humidity on the flow of this cheese blend.

In conclusion, MCC is an ideal anti-caking agent and flow aid for certain types of grated high moisture cheeses; namely, Cheddar and Mozzarella. MCC blends easily with the shredded cheese particles without creating the dusting problem associated with the micro fine anti-caking agents. MCC can be easily distributed on the surface of the cheese so as not to distract from product appearance. Adverse temperature, humidity and particle size conditions can be overcome when MCC is applied to grated or shredded high moisture cheeses.

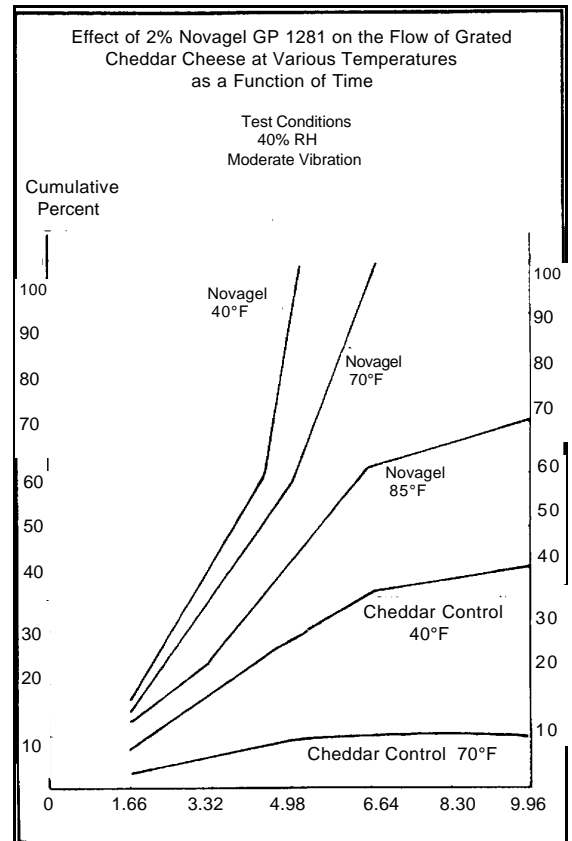


Figure 10

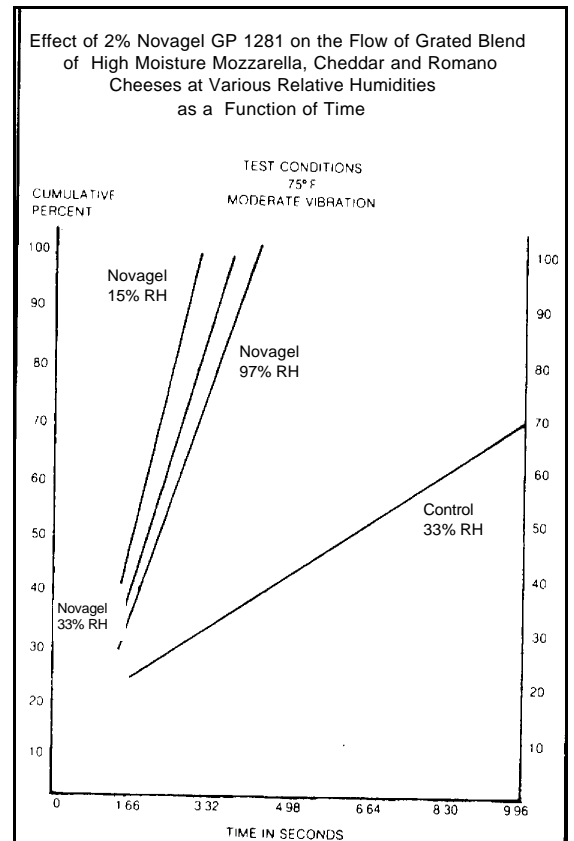


Figure 11

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