MINIFIBERS, INC.

The Function of Synthetic Pulp in Disposable Diapers

I. Changes in the Constituent Materials of Disposable Diapers

Until shortly after World War II, when disposable paper diapers were developed in Sweden, the only material used in diapers was cotton cloth. Today, however, the market has changed dramatically, to the point that almost all diapers used are the disposable type.

The basic constituents of diapers are the following three components:

A. A nonwoven fabric which comes into direct contact with the skin and allows fluid to pass through it (known as cover stock).
B. A material which absorbs and retains the fluid that has passed through the cover stock.
C. A waterproof sheet forming the outermost part which prohibits the fluid from further spreading (known as diaper backing).

The cover stock was initially a wet nonwoven fabric composed mainly of rayon. Due to the inherent drawbacks of rayon, the cover stock is now changing to polypropylene or polyester suspended nonwoven fabric. In the diaper backing, in almost all cases, polyethylene film is used.

For the absorbent material, crepe paper was used first but was later replaced with layers of fluffed cellulose pulp for improved absorbency and economics, among other reasons. Although the idea has existed to use SAP (super absorbent polymer) to improve the rate of fluid absorption in diapers, it was not readily utilized at first. Today, SAP is being used in disposable diapers.

We will be discussing the use of SAP in conjunction with fibrillated polyolefin pulp. For the purpose of this paper, all technical data was gathered using FYBREL™ Fibrillated polyolefin pulp grade UL415, which will be referred to as fibrillated polyolefin pulp.

II. SAP and Fibrillated polyolefin pulp

The use of SAP results in a considerably higher absorption capacity of the fluffed pulp, which is the main reason for the addition of SAP. With the increased absorption capacity, it is possible to reduce the quantity of fluffed pulp being used. As a result, it enables the absorbent part to be made thinner and lighter. When the absorbent part becomes thinner, it becomes difficult to make a uniform absorbent mat, and this mat is easily punctured before or during use, resulting in an unfavorable retention of SAP. By adding fibrillated polyolefin pulp to the mixture of fluffed pulp and SAP and then heat setting, it is possible to form the absorbent part into a sheet and eliminate these defects.

III. Method of Using Fibrillated polyolefin pulp

Fibrillated polyolefin pulp can be used on a conventional diaper or napkin manufacturing line with the addition of crushing and heat treating units (Table II).

A. Crushing
The pulp sheet and fibrillated polyolefin pulp sheet can be simultaneously crushed and blended by an impact type crusher (Table III).

B. Sheeting
Conventional equipment can be used without any problem.

C. Heat Treatment
Heat treatment of fibrillated polyolefin pulp causes it to become a binder. For this purpose, it is necessary to heat the fibrillated polyolefin pulp to its melting point of 123^{o}C or higher. Also, the heat treatment equipment should be a suction drier or thru-air drier in order to efficiently give a soft finish to the sheets.

D. Forming into Product
Conventional equipment is usable without making any modifications.

IV. Performance of Product

A. Absorption Speed
The absorbent sheet containing 20% by weight or lower of fibrillated polyolefin pulp has about the same absorption rate as that of a 100% crushed pulp sheet.

B. Rate of Absorption (Table IV)
Although the rate of absorption of fibrillated polyolefin pulp is low, the blend of fibrillated polyolefin pulp with crushed pulp shows a higher rate of absorption than that of 100% crushed pulp. This is because the fibrillated polyolefin pulp is heat-set and becomes a bridged structure, improving the absorbing performance of crushed pulp.

C. Strength of Absorbent Sheet (Table V)
Shown in Table V are the results of the test data on the absorbent sheets made of crushed pulp blended with 10% and 20% fibrillated polyolefin pulp. As can be readily seen, it is desirable to have the heat-treatment temperature exceed 135^{o}C.

Since crushed pulp is given strength, the uneven absorption resulting from the lopsided compaction or puncture that occurs before or during use is corrected to a great extent by the addition of fibrillated polyolefin pulp and the use of heat. It is possible to form not only a mere planar sheet but also a three-dimensional structure.

Diaper manufacturers generally use fibrillated polyolefin pulp for two different reasons; in one application, it is used for cost reduction, and in the other application, it is used for performance improvement of the diapers.

V. Fibrillated polyolefin pulp Used for Cost Reduction

Although it was known to be possible to improve the performance of crushed pulp by mixing it with SAP, there was no method available for holding SAP together in the crushed pulp. With the introduction of fibrillated polyolefin pulp, it has now become possible to keep SAP in the absorbent material. This is achieved by blending fibrillated polyolefin pulp with crushed pulp and SAP and heat setting the substrate.

This method permits improvement in absorption performance that is above conventional diapers, but leads to an increase in raw material cost because of the higher price of SAP and fibrillated polyolefin pulp as compared with crushed pulp. By reducing the basis weight of the absorbent material to a level at which the absorption performance equals that of conventional products, the manufacturing cost can be reduced to a level comparable or lower than that of conventional absorbent materials. It also brings about reductions in the weight and volume of the product, which in turn makes it possible to reduce packaging, transportation, and warehousing costs.

Fibrillated polyolefin pulp serves to hold the crushed pulp and SAP together in the sheet form, thereby keeping it from shifting in the diaper while in use. The optimum content of fibrillated polyolefin pulp to be used with the absorbent material is 5-10%.

VI. Fibrillated polyolefin pulp Used for Improved Absorption Performance

In terms of performance, particularly leakproof features, elastic type diapers are superior to the conventional wing fold type. This is attributable to the uniqueness of the crotch section, which is designed to fit nicely to a baby's body.

Recent trends point to the development and introduction of shape retentive elastic diapers that assure a neat fit. For use with these diapers, it is necessary to give even more flexibility and shape retentive ability to the crushed pulp used as absorbent material. Fibrillated polyolefin pulp meets these requirements most suitably when mixed with crushed pulp and then heat set.

Since shape retention is of primary importance in this case, the content of fibrillated polyolefin pulp is increased to 8-15%, slightly higher than in the case where cost reduction is of prime consideration. The basis weight of the material used is also increased to a level equal to or greater than that of the conventional material. Although the manufacturing cost becomes consequently higher than for conventional products, the increased portion of the cost may be added to the price of the product in consideration of its improved quality. The improved performance of the product obtained by this method well justifies its relatively higher price. Where necessary, SAP can also be used with crushed pulp and fibrillated polyolefin pulp in this application.

Fybrel™ Fibrillated polyolefin pulps available from

MINIFIBERS, INC.
2923 Boones Creek Road
Johnson City, TN 37615
Phone: (423) 282-4242
Fax: (423) 282-1450
www.minifibers.com