METHOD FOR CONVERTING SHEET CELLULOSE PULP TO DEFIBRATED PULP

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ABSTRACT
Method and apparatus are provided for converting sheet cellulose pulp to defibrated pulp, uniformity of the defibrated pulp stock being ensured by pooling the shredded pulp obtained from a plurality of cellulose pulp sheets, and uniformly feeding the pooled shredded pulp fibers to the disintegrators.

4 Claims, 2 Drawing Figures
METHOD FOR CONVERTING SHEET CELLULOSE PULP TO DEFEBRATED PULP

Cellulose fibers in individual or loose fiber form are employed in the manufacture of diapers, sanitary towels, absorbent pads, cellulose flock, and other uses. Such cellulose fibers are prepared by exposing the individual fibers of the cellulose by mechanical or chemical disintegration. Mechanical disintegration is generally referred to as "defibration," and its purpose is to separate the fibers while at the same time avoiding clipping or cutting of the fibers, or the formation of fiber bunches in which the fibers are not exposed as individual fibers.

Cellulose pulp is usually supplied by pulp mills either as rolls or as short sheets. In these forms, the cellulose pulp is compressed to a greater or a lesser extent, referred to as lightly pressed, low-density, medium-hard pressed or medium-density, and hard pressed or high-density pulp. However, the available defibrators for mechanically disintegrating cellulose pulp have been able to work only with cellulose pulps supplied in the form of a lightly pressed condition. This limitation arises from several conditions.

Roll pulp is really a very long strip of sheet pulp, rolled up to form a large roll of about 1 ton in weight. This form of sheet pulp can be fed to the defibrators with the expectation of obtaining a uniform and constant feed of disintegrated pulp fibers of uniform composition from the defibrator, since a roll is made up of like fibers prepared at the same time. If, however, the pulp is in short sheet form, actually short lengths of sheet pulp, ranging from about 1 foot 4 inches to about 3 feet 4 inches in length which are cut and stacked at the mill, the sheets cannot be fed to the defibrators without interruption of feed during transitions between different sheets. The interruption disturbs the uniformity of the defibrated fibers delivered by the disintegrators. Moreover, the sheets are not uniform among themselves, since they may come from different pulp stocks prepared at different times, and such variations in the feed from the defibrators cause the properties of the resulting pulp products to vary greatly. This problem is especially difficult when the defibrated pulp is delivered directly to the fiber processing equipment. For instance, in the manufacture of diapers, defibrated pulp is delivered to the diaper machine straight from the defibrator, and variations in feed from the defibrator cause the absorbent properties of the diaper to vary greatly. Since the variations in the absorbent properties of the finished diapers are proportional to the variations in the feed from the defibrators, and this variation in the case of sheet pulp cannot exceed ±75 percent, diaper manufacturers have been forced to rely on pulp rolls which are a more expensive source of pulp fibers.

On the other hand, short sheet pulp, if it could be used, would offer the advantage of a considerably lower manufacturing cost. Pulp sheet is more easily handled than pulp rolls, and less bulky. This affects storage and transport costs, which can accordingly be held at a lower level in the case of short sheet pulp than in the case of pulp rolls.

The reason only lightly pressed or low-density rolled pulp can be used is partly because of the difficulties in working mechanically hard and medium-hard pressed pulp, and partly because of the quantity of heat generated during the defibration. The resistance of the pulp to mechanical work in the defibration process increases rapidly with increasing hardness of the pulp. The quantity of heat generated can be so great, in fact, that the pulp can ignite, unless special precautions are taken to keep the pulp cool during defibration. Cooling is, of course, difficult to effect and increases the costs. On the other hand, the manufacturing costs increase appreciably when the pulp has a lesser hardness, partly because the pulp has a greater bulk, for the same weight of pulp fibers. Also, the pressure in the pressing portion of the heater is held low, when utilizing lightly pressed pulp, to avoid the formation of fiber bundles in the finished product. As a result, the pulp arriving from the pressing portion of the machine contains large quantities of water. This in turn means that a larger quantity of steam is required to dry the pulp and remove the water than is required when the pressure in the pickup machine is higher, and the drying time is correspondingly higher as well. Thus, from an economical point of view, the restriction to the use of lightly pressed pulp is a great disadvantage.

In accordance with the invention, a method is provided for converting sheet pulp into defibrated pulp while ensuring relative uniformity of the defibrated pulp and a relatively uniform feed from the defibrators to any other processing equipment. In the process of the invention, the sheet pulp is first shredded, and is then passed to a pulp uniformity regulating stage in which the pulp from a plurality of sheets is pooled, and a reserve supply retained in a pulp storage, sufficient to maintain a continuous feed of shredded pulp to the pulp disintegrators. In the preferred embodiment, a portion of the pulp fed to the disintegrators is recycled to storage, to ensure homogeneous and uniform blending of the shredded pulp from different pulp sheets. The result is a uniform continuous feed of a relatively uniform shredded pulp, despite any nonuniformity in the pulp sheets or in the shredding of the pulp sheets in the initial stage, and feeding of the shredded pulp to the pulp storage. Since the shredded pulp is fed uniformly to the disintegrators, a uniform feed of defibrated pulp from the defibrators is obtained.

The unit operations of the process of the invention are summarized below:

1. Light-pressed sheet pulp
2. Medium-pressed sheet pulp
3. Hard-pressed sheet pulp

(I) Pulp shredding stage
(IIa) Pulp uniformity regulating stage
(IIb) Shredded pulp storage
(IIc) Shredded pulp recycle
(III) Pulp disintegrating stage

It will, of course, be apparent that while the process of the invention finds its most economic application in the conversion of short sheet pulp to defibrated pulp, it is equally applicable to roll pulp, i.e., sheet pulp in great lengths, although at somewhat higher cost. Reference to "sheet pulp" herein will therefore be understood as encompassing short sheet pulp and roll pulp, with the term "short sheet pulp" referring to pulp sheets less than about 3/4 feet in length.

The invention also provides improved apparatus representing one embodiment of apparatus for carrying out the method, comprising, in combination, a storage vessel for shredded
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pulp, capable of retaining a reserve supply of pulp for the pulp disintegrators, a first conveyor for feeding more shredded pulp from the storage vessel to the pulp disintegrators than the latter can accept, and a second conveyor for recycling to the shredded pulp storage such surplus portion of the shredded pulp from the first conveyor. This not only ensures an adequate feed to the disintegrators, since more is fed in the first conveyor than they will accept, but it also promotes pooling and blending of shredded pulp from a greater number of short pulp sheets.

The apparatus can also include, in combination, means for shredding pulp, means for conveying it to the pulp storage, and pulp defibrators to which the shredded pulp is fed. The use of shredded pulp as feed for the defibrators offers two advantages. In the first place, it is possible in accordance with the invention to employ as a pulp source not only lightly pressed sheet pulp, but also medium pressed and hard pressed sheet pulp. Pulp shredders are capable of operating with any of the available pressed forms of sheet pulp. Moreover, the invention makes it possible to employ short sheet pulp as opposed to roll pulp, because any interruption in the shredded pulp feed does not affect the feed to the pulp defibrators, since such variations are taken up by the reserve supply of shredded pulp in the storage. The invention also affords the additional advantage that the shredded pulp from a plurality of pulp sheets can be homogenized and blended at all times by recycling a portion of the shredded pulp fed to the defibrators. This affords the opportunity for a blending of pulp from a greater number of sheets than the capacity of the storage, since in effect the conveyor system capacity is added to the storage capacity. This ensures that the shredded pulp delivered to the defibrators is in fact a blend of pulp obtained from a large plurality of pulp sheets. Thus, in effect the shredded pulp storage vessel creates a pool of shredded pulp that is relatively homogenous and uniform, as compared to the pulp obtained only from the shredding of individual sheets.

The invention also provides control means for regulating the quantity of shredded pulp in storage fed to the conveyor to the defibrators, by constructing this so that its length is greater than its cross section, and so that the shredded pulp feed flow opening is small, in relation to the shredded pulp feed capacity to the storage. It is also possible to supply a level control device to register any range of the expected variations in the quantity of shredded pulp fed to the storage, and/or the variations in the level of the pulp present in the storage between high and low limits. These registrations can then be used in a suitable manner to control the feed of sheet pulp to the shredding apparatus, so that any variations in the quantity of shredded pulp in storage are automatically obtained within desirable and appropriate limits by regulation of the quantity of sheet pulp fed to the shredding apparatus.

The apparatus of the invention is illustrated in the drawings. FIG. 1 is a perspective view of the pulp shredding and shredded pulp blending apparatus of the invention, with its respective lower and upper shredded pulp feed conveyors; FIG. 2 shows in perspective, from below, the upper conveyor trough of the apparatus illustrated in FIG. 1.

The apparatus shown in FIG. 1 includes a hammer mill 1 for shredding short sheet cellulose pulp. The sheet cellulose pulp is supplied to the hammer mill by the pair of feed rollers 2. At the discharge opening beneath the hammer mill there is a feed hopper 3, which is arranged to guide the pulp shredded in the hammer mill freely downwards to the feed-in opening of a lower screw conveyor 4, arranged horizontally beneath the hopper. The screw conveyor 4 comprises a U-shaped trough having a conveyor screw journaled therein. The worm of the screw is threaded in two different directions; the two portions of the screw conveyor 4 are identified by the references 4a and 4b. Shredded pulp moves from both ends of the screw 4 towards the center of the conveyor, to a vertically mounted worm 5. The portion 4a is arranged to feed shredded pulp from the hopper 3 to the screw conveyor 5, while the portion 4b is arranged to feed shredded pulp from the other end of the trough 4 towards the screw conveyor 5.

The screw conveyor 5 is enclosed within a cylindrical chimney, which opens at its upper end into a hopper 6. The conveyor 5 lifts shredded pulp from the first conveyor 4 to the hopper 6. The hopper 6 serves as a shredded pulp storage vessel for maintaining an ample normal supply plus a reserve supply of pulp for the pulp defibrators or defibrators 11a, 11b and 11c.

The hopper 6 has a special construction to limit feed of shredded pulp to the conveyor 8 to less than the feed capacity of conveyors 4, 5 and the hammer mill 1. It is longer than it is wide, and its through-flow opening is small in relation to this feed capacity, although it is of course capable of supplying the conveyors 10a, 10b, 10c to their capacity plus a surplus for recycling. In normal operation, the hopper 6 is maintained approximately half full with pulp. This is an ample supply to ensure uniformity of feed of shredded pulp fed to the defibrators, and it also ensures an adequate supply for recycle of a portion of the shredded pulp fed to the conveyor 8. Besides that, the supply is sufficient to also make it possible to regulate the supply of sheet pulp to the hammer mill automatically.

Regulation of the feed of sheet pulp via the feed rolls 2 of the hammer mill 1 is effected by an ultrasonic control device 7, which is mounted on the side of the hopper 6 in a manner such that it can register the supply of pulp between any designated upper and lower levels. The ultrasonic control device is connected to the prime mover (not shown) for the feed rolls 2, so that at the higher level in the hopper 6, the feed rate is decreased, and at the lower level in the hopper 6, the feed rate is increased, thus maintaining the level of shredded pulp in the hopper between these two limits.

The hopper 6 is arranged to feed shredded pulp into the upper horizontal screw conveyor 8. The conveyor 8 is provided with a U-shaped trough, at the underside of which are arranged, in series, three rectangular transversely extending openings 9a, 9b, 9c. These are arranged in sequence in the longitudinal direction of feed of shredded pulp in the trough, and in uniform spaced relationship with each other, as best seen in FIG. 2. Each opening is arranged to feed shredded pulp into the upper conveyors 10a, 10b, 10c, respectively, which extend at right angles to the conveyor 8, and which are fixedly mounted to and sealed against the openings.

The conveyors 10a, 10b and 10c, which are identical, are arranged to feed shredded pulp to each of the defibrators 11a, 11b, 11c. The defibrators are of known construction, and are accordingly shown only diagrammatically. Each defibrator can in turn be connected to a machine for further processing of the defibrated pulp, such as, for instance, a machine which manufactures diapers.

The upper conveyor 8 is provided with a connection to the lower conveyor 4 for recycling of a portion of the shredded pulp fed through the conveyor 8, if desired. All that is necessary to obtain recycling is to feed to the conveyor 8 more shredded pulp than will be accepted for feed to the defibrators through the openings 9a, 9b, 9c, as a result of which any surplus shredded pulp proceeds to the end of the conveyor 8. At this end, remote from the hopper 6, there is a further opening 12 on the underside of the trough, and this opening opens into a feed hopper 13, which permits the shredded pulp to drop directly to the conveyor 4 beneath. From there, this shredded pulp is fed by the screw portion 4b directly to the vertical screw conveyor 5, and thus returned to the storage 6.

In operation, the apparatus functions as follows. In starting up, in order to build up a sufficient supply of shredded pulp in the storage 6, sheet pulp is fed to the hammer mill 1 by the feed rolls 2 in a quantity which exceeds the total quantity required to be fed to the defibrators via the conveyors 8 and 10. The sheet pulp is shredded in the hammer mill into small pieces, for instance, pieces approximately 2 cm. in their largest diameter, after which the shredded pulp is passed to the
hopper 6 via the conveyor 4, screw portion 4a, and conveyor 5. The greater portion of this pulp is fed directly to the conveyor 8 while a smaller quantity remains behind in the hopper 6, building up the reserve supply until feed is reduced. The shredded pulp leaving the hopper 6 is conveyed by the conveyor 8 to the openings 9a, 9b, 9c, whence it falls through into the underlying conveyors 10a, 10b, 10c, in a quantity which is determined by the size of the openings, the capacity of the conveyors 8, 10a, 10b, 10c, and the extent to which they are filled. In the exemplary embodiment, the quantity of shredded pulp that passes to the conveyors 10a, 10b, 10c is the maximum that they can accept, but only a portion of the pulp that is fed to the conveyor 8. The remainder of the shredded pulp passes to the hopper 13, and is thence recycled by the screw 4b of the conveyor 4 to the vertical screw conveyor 5 and returned to storage 6. This ensures a homogeneous and uniform mixing of the pulp from a large plurality of pulp sheets.

The pulp passed to the conveyors 10a, 10b, 10c, is transported thereby to the defibrators, in which the pulp is defibrated, and can then be passed to further processing stages.

Because a portion of the shredded pulp fed from the hammer mill 1 per unit of time remains behind in the hopper 6, the level of pulp in the hopper continues to rise, provided that the rate of feed to the hammer mill and the rate of discharge from the hammer mill are unchanged. When the level of pulp in the storage 6 has reached the upper level at which the ultrasonic control device 7 is activated, to slow the rate of feed of sheet pulp via the rollers 2, an impulse is sent to the prime mover of the feed rollers 2, so that the feed of sheet pulp is decreased. The amount of pulp passed to the hammer mill now is reduced, and so is the amount of shredded pulp passed to the storage 6, while at the same time the rate of feed of pulp to the defibrators is not decreased. The result of this is that relatively more pulp is now fed out of reserve to the defibrators than is fed to the reserve, and this causes the amount of reserve supply of pulp in the hopper 6 to decrease.

The level of pulp in the storage 6 continues to decrease until it has reached the lower level at which the ultrasonic device 7 is activated. An impulse is then sent by the device 7 to the prime mover of the feed rollers 2, so that the feed of the sheet pulp to the hammer mill increases to the original rate. This causes the supply of shredded pulp in the storage to increase again, and this sequence is repeated cyclically throughout the time of operation, thus alternatingly decreasing and increasing the feed of shredded sheet pulp to the storage 6 without the feed to the defibrators being affected in any way thereby, and without any interruptions in the feed of shredded pulp to the defibrators during the transition period from one sheet pulp of the next.

It will, of course, be understood that the ultrasonic control device 7 can also be arranged so that it actuates the feed means so as to keep approximately equal the rate of feed of shredded pulp to the storage and to the defibrators, by means of continuous impulses corresponding to a narrower range of levels in the hopper. In this way, the variations in the feed rate are less, and the feed is even more uniform. However, they can never be the same when short sheet pulp is used, because the intermittent halts between successive sheets of pulp, however brief these may be.

Should one of the defibrators and consequently conveyors 10a, 10b, or 10c be taken out of operation, the level in the hopper 6 will rise again, because now shredded pulp is not being fed through one of the openings 9a, 9b and 9c, and the amount of shredded pulp recycled increases, thus reducing the rate of removal of pulp from the hopper. The ultrasonic control device 7 then activates the prime mover for the feed rollers 2, and the rate of feed of shredded sheet pulp is reduced. If, in spite of this, the level in the hopper still rises, as may occur if the rate of feed to the defibrators is rather high, the ultrasonic control device can be arranged to send further signals until the feed has been reduced to an extent at which the level in the hopper 6 still falls within the upper and lower levels for which it is designed. If all conveyors 10 are stopped, or fail for some reason, the feed to the hammer mill is stopped automatically and completely by the ultrasonic control device 7.

It will be evident from the foregoing that the pulp storage 6 fulfills very important functions. It takes up the variations in the feed from the hammer mill caused by an intermittent feed of short sheet pulp to the mill, or by the time taken, for instance, to affix a new roll of pulp to the feeding means. It makes possible, by means of ultrasonic control device 7 a fully automatic feeding of the shredded sheet pulp, and ensures that the quantity of pulp present at any given moment in the conveyor system to the defibrators beyond the storage 6 is essentially constant.

The pulp shredding means can, of course, be any type of pulp shredding means that is known to the art. A hammer mill is illustrated, and is preferred, but other types of pulp shredding means that can be used comprise rotary devices provided with knives, toothed rolls and the like. A hammer mill is preferred, because it does not solely shred the sheet into small pieces, but also loosens the fibers in the separate pieces.

The level maintaining mechanism in the storage 6 need not be an ultrasonic control device, but can any type of level detector, arranged to operate optically, mechanically, or electrically. Such means are, of course, well known.

The conveyor 4 can be arranged as a conventional screw conveyor, and this conveyor can be arranged to slope upwardly in the direction of transport, so as to intersect the conveyor 5. The vertical conveyor 5 can then be omitted, and both the shredding means and the conveyor intended for surplus pulp can be connected directly to the conveyor 8 via the hopper 6.

In another embodiment of the invention, the conveyors 10a, 10b, 10c can each be provided with a double worm thread. These worm threads may then be mounted in the trough, either on respective shafts parallel with each other, or on the same shaft. In both instances, the worm thread should be mutually displaced through an angle of 180°. This embodiment affords the advantage of a uniform feed from the respective conveyors that is not influenced by any pulsation, such as is normally associated with single screw conveyors. Pulsations can also be eliminated by providing the conveyors 10a, 10b, 10c in a conventional manner with one shaft in a worm attached thereon, although in this instance the worm and the trough should have a slightly tapering diameter at the discharge end. This embodiment also prevents pulp located in the upper portion of the trough at the discharge end from falling downwards, as the result of the subpressure in the subsequent defibrators 11a, 11b, 11c, and being fed from the conveyors in lumps. It is also possible to reduce the diameter of the worm screw at the feeding end of the conveyors while retaining the diameter of the trough, so that the distance between the worm and the trough at the feed-in end increases the direction towards the feed opening. Such an embodiment affords the advantage of eliminating the risk of overloading the conveyor motor when the amount of pulp from the preceding conveyor is too great.

Having regard to the foregoing disclosure, the following is claimed as the inventive and patentable embodiments thereof:

1. A method for conveying pulp in solid pressed sheet form into defibrated pulp while ensuring relative uniformity of the defibrated pulp and a relatively uniform feed of the defibrated pulp to any other processing equipment, which comprises feeding the solid pressed sheet pulp to the shredder, shredding the sheet pulp, passing the shredded pulp particles to a pulp uniformity regulating stage, pooling the shredded pulp particles from a plurality of sheets, in the pulp uniformity regulating stage and storing the shredded pooled pulp particles in a sufficient reserve supply to maintain a continuous and relatively uniform feed of shredded pulp particles therefrom, and feeding the shredded pulp particles from the reserve supply
relatively uniformly and continuously to a pulp disintegrating stage.

2. A method according to claim 1, in which a portion of the pulp fed to the disintegrating stage is recycled to storage, to ensure homogeneous and relatively uniform blending of the shredded pulp from different pulp sheets, and a relatively uniform continuous feed of a relatively uniform shredded pulp, despite any nonuniformity in the pulp sheets or in the shredding of the pulp sheets in the initial stage.

3. A method according to claim 1, in which short sheet pulp is converted to defibrated pulp.

4. A method according to claim 1, in which roll pulp is converted to defibrated pulp.