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(54) **VERY LOW COD UNBLEACHED PULP**

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(76) Inventors: **Michael D. Vrbanac**, Seattle, WA (US);  
**Brian Wester**, Sumner, WA (US);  
**Brian E. Dennis**, Kamloops (CA);  
**Peter K. Lau**, Kamloops (CA); **Julie**  
**A. Reimer**, Seattle, WA (US); **David**  
**W. Bickell**, Kamloops (CA)

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(57) **ABSTRACT**

Correspondence Address:

**WEYERHAEUSER COMPANY**  
**INTELLECTUAL PROPERTY DEPT., CH 1J27**  
**P.O. BOX 9777**  
**FEDERAL WAY, WA 98063 (US)**

A pulp product that has a low COD is comprised of an unbleached pulp that is soaked and washed in alkaline water for a sufficient time so that the COD after soaking and washing is less than or equal to 3.0 kg/1000 kg of dry pulp. The pulp is produced by repetitively soaking and washing an unbleached pulp in alkaline water that is never allowed to drop below pH 7.0. The pulp is soaked and washed for a total of at least 400 minutes at an elevated temperature to produce the pulp product that has a low COD.

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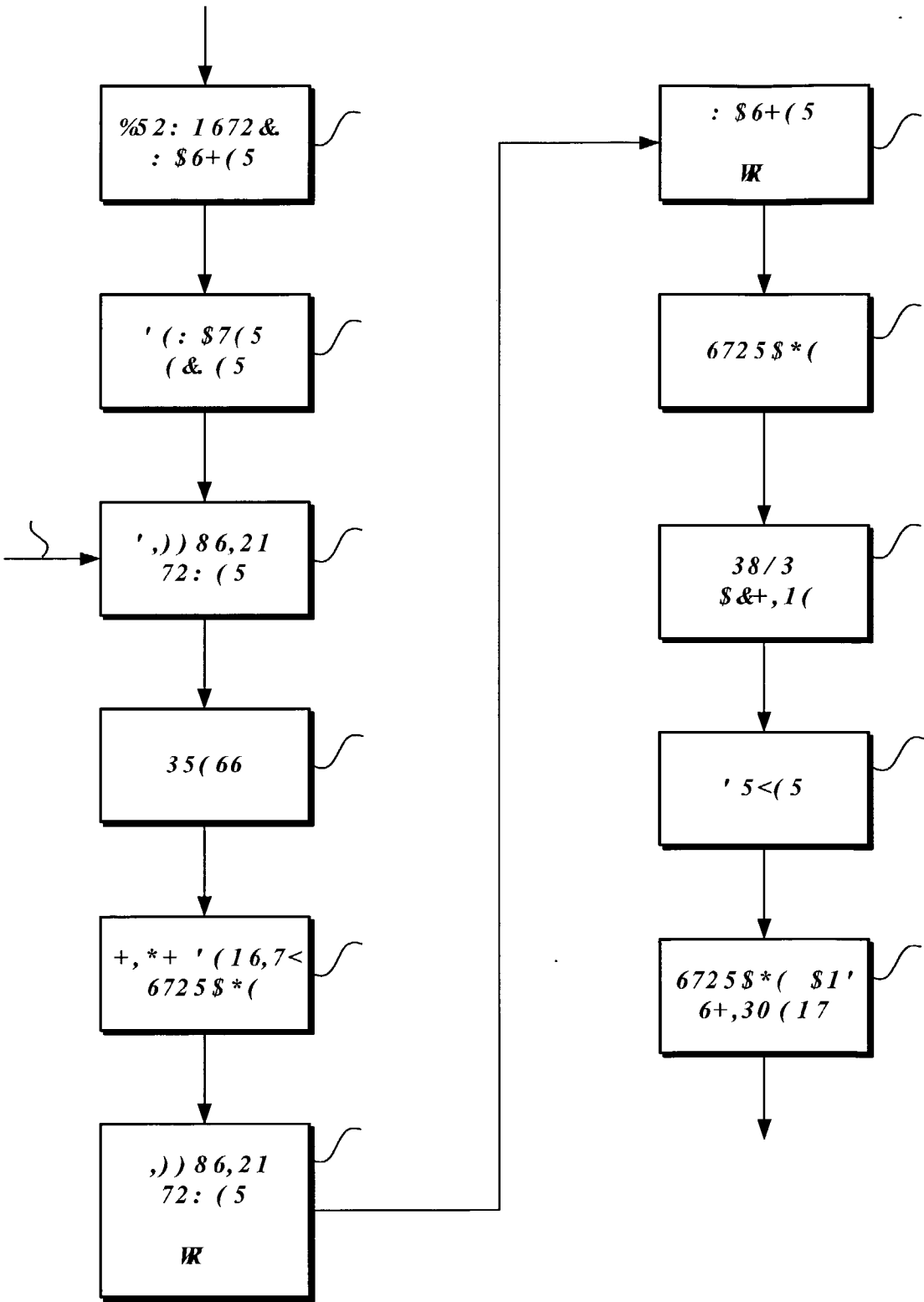


Fig. 1

## VERY LOW COD UNBLEACHED PULP

### FIELD OF THE INVENTION

[0001] The present invention relates to cellulosic pulps, and more particularly, to unbleached cellulosic pulps having a low COD that are useful in cementitious products.

### BACKGROUND OF THE INVENTION

[0002] The internal structures of houses and other buildings are commonly protected from environmental elements by exterior siding materials. These siding materials are typically planks or panels composed of wood, concrete, brick, aluminum, stucco, wood composites, or fiber-cement composites. A common fiber-cement composite is fiber-cement siding, which is generally composed of cement, silica sand, unbleached wood pulp, and various additives. Fiber-cement siding offers several advantages over other types of siding materials, such as wood siding: it is weatherproof, relatively inexpensive to manufacture, fire-resistant, and invulnerable to rotting or insect damage.

[0003] Commercial fiber-reinforced cement siding planks or panels are made using the Hatcheck process. The Hatcheck process was initially developed for the production of asbestos composites, but it is now used for the manufacture of non-asbestos, cellulose fiber reinforced cement composites. In this process, unbleached cellulose fibers are repulped in warm water at an alkaline pH of 11 to 12.5; the re-pulped fibers are refined and then mixed with cement, silica sand, and other additives to form a mixture. The fiber-cement mixture, is deposited on a felt band substrate, vacuum dewatered, and cured to form a fiber reinforced cement matrix in sheet form.

[0004] The curing of the cement matrix is hindered by the presence of sugars or other organic materials. These materials retard the hydration reaction of cement and thereby retard the setting or hardening of a mortar or concrete. Cement is purposely retarded in ready-mix concrete during long hours of transportation, for mitigation of stress due to temperature (heat) when used in a large-sized concrete structures, and for decorated washing finishes. When these organic materials are measured, the manufacturers of fiber-cement siding have observed an inverse relationship between the amount of these materials in an unbleached pulp and the strength properties of the final product. The amount of these materials is commonly measured using the chemical oxygen demand (COD) test. When considering the detrimental effect of these materials on strength properties, it is apparent that there are a needs in the art for very low COD unbleached pulp. The present invention fulfills these needs and provides further related advantages.

### SUMMARY OF THE INVENTION

[0005] The present invention provides a pulp product comprising an unbleached pulp that is soaked and washed only in alkaline water, and after soaking and washing, it has a COD less than or equal to 3.0 kg/1000 kg of dry pulp, and preferably 1.7 to 2.8 kg/1000 kg. This pulp is produced by repetitively soaking unbleached pulp in alkaline water that is at an elevated temperature so that organics will diffuse out of the fiber and into the water. Subsequently, the repetitively soaked and washed pulp is then preferably dewatered and dried.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description and the accompanying drawings, wherein:

[0007] **FIG. 1** illustrates the steps of the caustic washing process for the present invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] The present invention provides a low chemical oxygen demand (COD) pulp that is particularly useful for reinforcing fiber cement products. The low COD cellulosic pulp that is useful in the present invention is most preferably an unbleached pulp from a kraft pulping process. However, a wide variety of pulped cellulosic fibers can be used, which are derived from wood and non-wood sources. Of all the pulp sources, wood pulp is the most commonly employed because of its availability and price.

[0009] To obtain suitable wood pulp fibers, the sulfate pulping process is the most preferred method. Using this process and considering the desired composite properties, the preferred wood fiber source is long-fibered coniferous wood species. Examples of these species include the following: Southern pine, Douglas fir, spruce, hemlock, and Radiata pine. In addition to these wood fiber sources, other chemical pulps can be used that include pulps made from short or long fibered wood species or recycled, wood pulp fibers. Short wood fibers, which are typically produced from hardwood species such as eucalyptus, can also be used. The processes to produce these wood pulp fibers are well-known to those skilled in the art of pulp manufacturing. These fibers are commercially available from a number of companies, including the Weyerhaeuser Company. In contrast to wood pulp fiber sources, there are other natural cellulosic fiber sources which include straw, flax, kenaf, hemp, or similar materials. Like wood-based fibers, these non-wood fibers may also be pulped and subsequently used in fiber cement-based composites.

[0010] Referring to **FIG. 1**, unbleached pulp, preferably unbleached kraft pulp, is first passed through conventional brown stock washers **10** and a brown stock decker **20** at a consistency of approximately 10% when it exits from the decker. Prior to washing, the unbleached pulp that is used in the present invention must have a relatively low Kappa number. Preferably the Kappa number is less than or equal to 30, but it is more preferably less than or equal to 25±3. The unbleached pulp from the decker is at an alkaline condition and must be maintained at an alkaline condition (pH equal to or greater than 7.0) while it is processed in accordance with the present invention. The unbleached pulp from the decker, which is at a consistency of approximately 10%, is initially soaked in the first diffusion tower **30** at an alkaline condition for a predetermined length of time and a predetermined elevated temperature. This first soaking step is preferably conducted at a temperature of at least 60° C., and more preferably at approximately 65° C. or higher. The pulp is soaked in tower **30** preferably for at least 120 minutes. After tower **30**, the pulp is washed and dewatered in press **40**. However, this dewatering step is optional, but if

it is employed, then the pulp may preferably be dewatered to a consistency of approximately 30%.

[0011] After the initial step in which the pulp in tower **30** has been soaked and dewatered, the pulp is again diluted to a 10% consistency it is then sent to a set of successive diffusion and washing steps. Optionally, the pulp can be placed in a high density storage tank **50** in which it can reside anywhere from 0 to 430 minutes. However, if the high density storage tank is employed during normal operation, the pulp will reside in the tank for approximately 100 minutes. The purpose of the high density storage tank is to prevent diffusion tower flow variations from passing to the downstream processes that are after the storage tank.

[0012] After the high density storage tank, the pulp is then introduced into the first of a series **60n** of diffusion tanks at a consistency of approximately 10%. Hot water and steam or only steam are added to the pulp in a second of the series **60n** of diffusion tanks to raise the temperature to a value that is preferably equal to or greater than 80° C. The pulp is then repetitively soaked in the remaining series **60n** of diffusion towers. After soaking in each tower **60n**, the pulp is subjected to washing in successive washers **70n**. Preferably the pulp is soaked and washed five times in towers **60n** and washers **70n** before it is forwarded to a storage tank **80**. Each of the successive soaking and diffusion steps may take a minimum of 30 minutes but may take up to 100 or more minutes. These time periods include the washing steps that follow each soaking step. It is preferred that the repetitive soaking steps in diffusion towers **60n** occur for a total of at least 280 minutes but preferably 335 minutes and in either case at the elevated temperature of at least 80° C. It is preferred that the total soaking time in diffusion tower **30**, storage vessel **50**, and diffusion towers **60n** ranges from a minimum of 400 minutes (120 minutes in diffusion tower **30**, 0 minutes in vessel **50**, 280 minutes in diffusion towers **60n**) to a maximum of approximately 1,050 minutes (120 minutes in diffusion tower **30**, 430 minutes in vessel **50**, 500 minutes in diffusion towers **60n**). Conventionally, however, the soak will occur for approximately 555 minutes (120 minutes in diffusion tower **30**, 100 minutes in vessel **50**, 335 minutes in diffusion towers **60n**).

[0013] After the pulp has been repetitively soaked and washed, it is forwarded to the storage tank **80**. In this storage tank, the pulp remains at a consistency of about 10%. Thereafter, the pulp is fed in a conventional manner to a conventional pulp machine **100** and dryer **110**. After the pulp is dried into sheets, it is cut to size, sent to storage **120**, and ultimately shipped to a customer.

[0014] The unbleached and washed pulp produced by the process of the present invention has a COD of less than or equal to 3.0 kg per metric ton (1,000 kg), and preferably less than 1.7 to 2.8 kg/1000 kg. This level of COD is well below that achieved in ordinary pulp mills and particularly in kraft pulp mills.

[0015] A critical feature of the present invention is that the pulp must be maintained at alkaline conditions from the time it begins the initial soaking in tower **30** until the pulp is dried. It is preferred that the pH be maintained at or above 7.0 throughout the entire process, from the soaking in the initial diffusion tower **30** through the repetitive soaks in towers **60n**. Preferably in these steps, the pH is maintained in the range of from 10.0 to 11.0. The pulp is then run

through the pulp machine **100** and the dryer **110**. In these steps, the pH may be reduced, e.g., to 8.0 to 8.5, but can be run lower. Under certain circumstances, it may be necessary to add caustic solution (20% by weight aqueous sodium hydroxide) to the first diffusion tower **30**. It has been found that the addition of caustic at the rate of at least 2 kg per metric ton, and more preferably 3 kg per metric ton, will be sufficient to maintain the alkalinity of the pulp above pH 7.0 throughout the process. It is only necessary to add caustic during the initial portion of the run of the process. For example, at a throughput of about 40 to 50 tons per hour, the caustic needs to be added at the rate of 3 kg per metric ton for the initial 24 to 48 hour period that the pulp is run through the initial tower **30**. This will assure that the alkalinity will be maintained above pH 7.0 throughout the entire process, which includes the drying stage.

[0016] In the most preferred embodiment, the present invention is carried out in a converted oxygen delignification and bleaching plant that is normally associated with a Kraft pulp mill, which is used to convert unbleached pulp to bleached pulp. A typical bleach plant comprises an oxygen delignification reactor that is followed by a series, typically five, of bleach reactors, in which various bleaching agents such as chlorine dioxide are added. In accordance with the present invention, the bleach plant is converted to use with the present invention by first cutting off the supply of oxygen to the oxygen reactor, and thereafter, the supply of bleaching agents to the bleach reactors is sequentially shut off as the pulp (with no oxygen added) sequentially enters the bleach reactors.

[0017] In this preferred embodiment, the oxygen reactor becomes the first diffusion tower **30**. At the same time that oxygen is cut off from the diffusion tower, caustic is introduced into the pulp via line **32** at the rates set forth above. In the preferred mode of operation, the pulp is resident in the oxygen reactor (tower **30**) for approximately 120 minutes. The pulp is then run through the press that is typically associated with the oxygen reactor (tower **30**) to increase the consistency from approximately 10% to approximately 30%. The pulp is then diluted to 10% consistency and introduced into a high density storage vessel (vessel **50**). The vessel is normally operated at a partial capacity so that the pulp residence time in the storage vessel is approximately 100 minutes.

[0018] The pulp is then introduced into the first bleach reactor vessel (towers **60n**) that is one of five total. Steam and hot water are added to the pulp when the pulp enters the second of the series **60n** of reactor vessels to raise the temperature of the pulp to 80° C. or higher. Depending on the size of the vessel, the residence time for the pulp will vary. In one particular plant, the residence time in the five bleach reaction vessels was on the order of 60 minutes, 30 minutes, 45 minutes, 100 minutes, and 100 minutes, respectively. This residence time is dependent on the size of the successive reactors. It is very important in this cycle that the temperature be maintained at or above 80° C. This is accomplished by adding steam to the vessels, as necessary, to maintain temperatures. After soaking in each bleach reactor vessel, the pulp is run through conventional washing unit (washers **70n**) that normally following each of the bleach reactors. Preferably, fresh water is used to wash the pulp; however, white water from the associated pulp plant may be used, if necessary.

[0019] After the pulp from the fifth bleach reaction vessel is washed, it is placed into the vessel that is normally used for bleached pulp storage (vessel 80). It is thereafter diluted in successive steps to a consistency of about 1.5% and fed into a pulp head box on the pulp machine 100. The dewatered sheet produced on the pulp machine is then run through the pulp dryer 110, for example, a Flakt dryer. After drying, the sheet is subsequently cut, stacked, stored, and, thereafter sent to shipping operations.

[0020] If desired, the pulp machine and pulp dryer can be eliminated and the pulp can be introduced directly into a jet dryer. The jet dryer produces a dried singulated fiber, particularly useful in some cementitious products. One suitable jet dryer for use in the present invention is a fluid energy Aljet Model Thermajet, X0870L, manufactured by Fluid Energy Processing and Equipment Company. It is also possible to completely skip the drying stage and use the pulp in a never-dried state.

EXAMPLE

[0021] The following example is intended for illustrative purposes only and is not intended to in any way delimit the invention. Chemical oxygen demand (COD) is determined by the following method. Pulp sheets produced in accordance with the preferred embodiment of the present invention just described are torn or cut into small pieces (approximately 4 cm square). The small pieces are mixed and the moisture is measured in accordance with Tappi procedure T412 om-94. Forty grams of pulp, oven dried weight, are then carefully weighed. A 2,000 ml solution of 0.01 N sodium hydroxide solution is prepared using distilled or deionized water and analytical grade sodium hydroxide. Thereafter, the pulp is placed in 2,000 ml of the 0.01 N sodium hydroxide solution and placed in a disintegrater and disintegrated for 15 minutes at 3,000 rpm in a British Pulp Evaluation Apparatus (or British disintegrater) described in Tappi 505 sp-95. The pulp slurry is then vacuum filtered immediately after disintegration using a Whatman No. 3 filter paper. The filtration time is long enough so that a majority of the filtrate is passed through the filter. Two hundred and fifty ml of filtrate is separated for COD analysis. A sample is preserved with 2.5 ml of 50% sulfuric acid. Thereafter, the COD of the filtrate is measured using the titration method described in *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, Method #5220C, "Closed Reflux, Titrimetric Method". The COD content is then calculated as kilograms per metric ton of pulp based on the oven dried weight of the pulp.

[0022] The pulp samples were randomly selected from several production runs through the converted oxygen delignification and bleach plant described above. Unbleached pulp was run at the rate of 45 tons per hour through the converted oxygen delignification and bleach plant. Residence time in the oxygen reactor vessel was on the order of 120 minutes. Residence times in the successive bleach

vessels was 60, 35, 45, 100, and 100 minutes respectively. Pulp samples were taken during production runs downstream from the Flakt pulp dryer and tested for COD as set forth above. Samples A, B, C, D, and E were taken over a three-day treatment period. Samples C5, C7, C9, C11, and C13 were taken over a nine-day treatment period. The results are set forth below.

SAMPLE ID	COD (kg/metric ton)
E	2.34
C13	2.36
C	2.53
B	2.54
C11	2.55
A	2.63
D	2.73
C7	2.75
C5	2.78
C9	2.85

[0023] The pulp produced in accordance with the foregoing example was incorporated into cementitious products at about 8% by weight pulp using the Hatscheck process. (The pulp content may be varied from 6% to 10% by weight if desired.) Cement panels and planks were produced for use in residential and commercial construction. Tilebacker 10 boards used for ceramic tile underlayment were also produced. All of these products exhibited excellent strength characteristics.

[0024] While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A pulp product, comprising unbleached pulp that is soaked and washed in water that is always at alkaline conditions, wherein the pulp product has a COD that is less than or equal to 3.0 kg per 1000 kg dry pulp.
2. The product of claim 1, wherein said pulp is repetitively soaked and washed for at least 400 minutes at an elevated temperature.
3. The product of claim 2, wherein said pulp is maintained at a temperature of at least 80° C. for at least a portion of said 400 minutes.
4. The product of claim 1, wherein said unbleached pulp before washing has a Kappa number of  $\leq 30$ .
5. The product of claim 4, wherein said Kappa number is  $25\pm 3$ .
6. A cementitious product containing the pulp of any one of claims 1 through 5.

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