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(54) **METHOD AND SYSTEM FOR DEWATERING AND CONTROLLING FOAM IN PULP AND PAPER PROCESSES**

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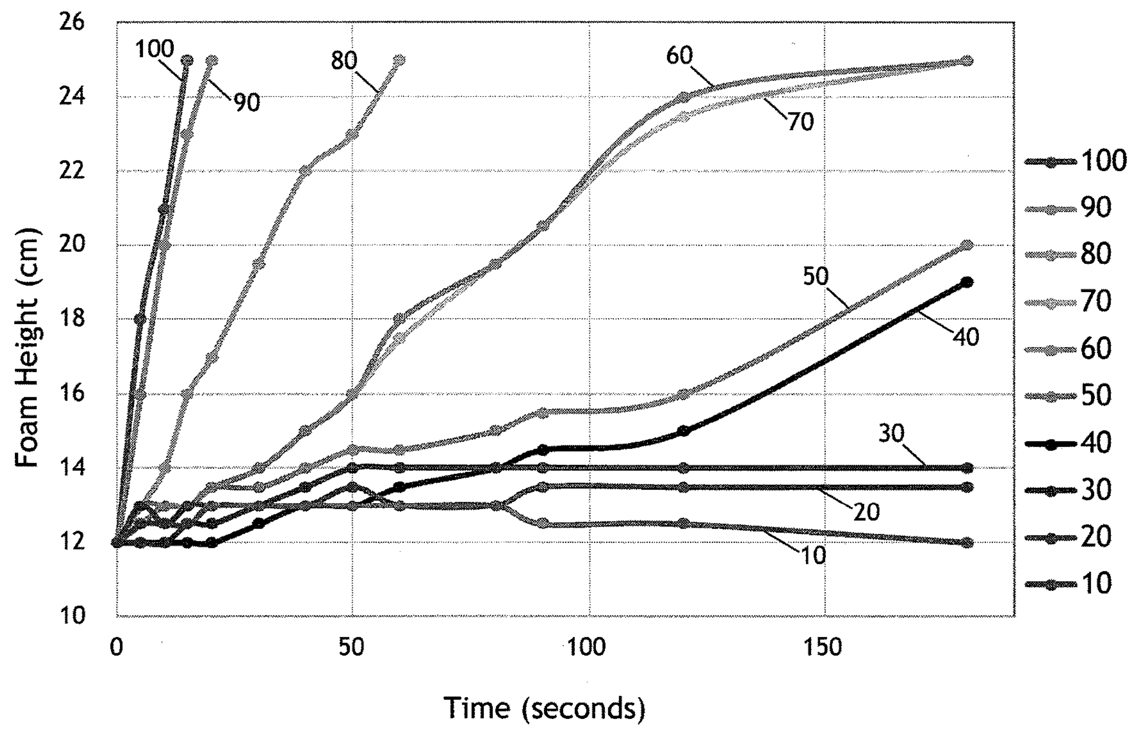
(57) **ABSTRACT**

Methods and systems are provided for dewatering an aqueous cellulosic pulp slurry or mat of cellulosic fibers or sludge. The method includes adding at least one anionic surfactant and at least one amide of a carboxylic acid to cellulose containing material to form a treated material and then dewatering the material. Besides effective dewatering, the present invention also provides foam control such as, but not limited to, the suppression of foam. Pulp products containing the treatment compounds are also described.

Fig. 1



Foam Height (cm)
Time (seconds)
26
24
22
20
18
16
14
12
10
0
50
100
150
100
90
80
60
70
50
40
30
20
10
100
90
80
70
60
50
40
30
20
10

METHOD AND SYSTEM FOR DEWATERING AND CONTROLLING FOAM IN PULP AND PAPER PROCESSES

BACKGROUND OF THE INVENTION

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of prior U.S. Provisional Patent Application No. 62/797,416, filed Jan. 28, 2019, which is incorporated in its entirety by reference herein.

[0002] The present invention is useful in the pulp and paper industry and processes utilized in pulp and/or paper processes, including, but not limited to, processes used in the production of pulp, market pulp, and paper and byproducts of these processes (e.g., sludge from the pulp and paper process). More particularly, methods and systems are provided for dewatering, such as improving drainage of products such as pulp or pulp slurries, paper, or any surface that desires removal of water, whether a particulate surface or mat. The dewatering effect can be achieved without causing formation of an excessive amount of foam.

[0003] In the pulp making industry, cellulose-containing feed material has been defibrated chemically, mechanically, or both, and then typically is washed and at least partly dewatered after such operations. In pulping processes in which the pulp is chemically treated, such as by chemical digestion, bleaching, or other chemical treatments, dewatering can be used to drain water and separate free chemical from the fibers. Some pulp mills may be integrated with a paper making plant, wherein the dewatering of the product pulp may be limited such that slurry pulp or wet laid pulp can be directly advanced to a papermaking machine at the same production site. Other pulp mills produce market pulp in non-integrated production operations. Market pulp can be a pulp product which has been significantly dewatered in the final stages of pulp processing. Market pulp further may be formed into bales or rolls of dewatered pulp. The market pulp can be transported to other locations for later use.

[0004] A particular process for producing market pulp which uses diverse ionic compounds before pulp drying is described in U.S. Pat. No. 8,916,024. According to the process of U.S. Pat. No. 8,916,024, pulp is treated with a combination of cationic and anionic surfactants before drying, and more particularly, the treatment involves treating pulp with a combination of at least one cationic polymer and at least one anionic polymer effective to form a polyelectrolyte complex in the treated pulp. U.S. Pat. No. 6,706,144 shows a method of dewatering an aqueous cellulosic pulp slurry, which may be a market pulp slurry, wherein a mixture of one or more nontoxic surfactants and one or more anionic surfactants is added to the slurry.

[0005] While the chemicals used to enhance dewatering can be effective, certain chemicals and their use in the process of dewatering can generate excessive amounts of foaming. This is particularly a problem with the use of certain surfactants. While conventional defoamer agents have been tried, often times, a trade-off occurs. The addition of a defoamer provides added cost. In other cases, while the foam can be controlled, the enhanced dewatering effects are reduced, thus a deleterious effect on the dewatering of the pulp and other products. With the present invention, there was an effort to design a method and system that can maintain the enhanced dewatering effects of the pulp and/or other products and yet control or suppress the undesired foam formation. Further, a method and system that can have the defoamer agent actually further enhance dewatering, besides controlling foaming would be most desired. The present invention can achieve this as described herein. Such an invention permits an increased rate at which pulp dewatering can be accomplished in a pulp mill and can significantly affect the overall line speed and production capacity of the pulp mill or similar production facility.

SUMMARY OF THE PRESENT INVENTION

[0006] A feature of the present invention is to provide a method for dewatering a cellulose-containing material.

[0007] A further feature of the present invention to provide a method that improves one or more properties of a dewatering process, such as improving dewatering performance and efficiency.

[0008] Another feature of the present invention is to provide a method that enhances dewatering of a cellulose containing material, such as pulp, and further achieves foam suppression or foam control during the dewatering process.

[0009] An additional feature of the present invention is to provide a method where the foam can be controlled without negatively affecting the enhanced dewatering effects. A further feature is to provide a method and system that can maintain the enhanced dewatering effects of the pulp and/or other products and yet control or suppress the undesired foam formation.

[0010] Another feature is to provide a method and system that can have the defoamer agent actually further enhance dewatering, besides controlling foaming.

[0011] Additional features and advantages of the present invention will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practice of the present invention. The objectives and other advantages of the present invention will be realized and attained by means of the elements and combinations particularly pointed out in the description and appended claims.

[0012] To achieve these and other advantages, and in accordance with the purposes of the present invention, as embodied and broadly described herein, the present invention relates, in one embodiment, to a method for dewatering a cellulose-containing material. The method includes adding at least one anionic surfactant and at least one amide of a carboxylic acid to a cellulose-containing material to form a treated cellulose-containing material and the method further includes dewatering the treated cellulose-containing material to provide a dewatered cellulose-containing material. The cellulose-containing material can be in the form of an aqueous cellulosic pulp slurry or can be in the form of a mat of cellulosic fibers, or can be in the form of a sludge from a paper and pulp manufacturing process.

[0013] The present invention further relates to a method to dewater a cellulose-containing material and at the same time control or suppress foam or foam formation. The method includes adding at least one anionic surfactant and at least one amide of a carboxylic acid to a cellulose-containing material to form a treated cellulose-containing material and the method further includes dewatering the treated cellulose-containing material to provide a dewatered cellulose-containing material, wherein the at least one anionic surfactant and at least one amide of a carboxylic acid are each present in effective amounts to improve dewatering properties and improve in foam control and/or suppression.

[0014] The present invention further relates to a system for producing pulp or market pulp comprising a supply of cellulosic fibers; at least one pulp forming unit for forming pulp from the cellulosic fibers; at least one feeding device for feeding at least one anionic surfactant, to the pulp; at least one feeding device for feeding at least one amide of a carboxylic acid to the pulp; a dewatering device for mechanically removing water from the pulp; and optionally a dryer for thermally removing water from the pulp to provide pulp or market pulp.

[0015] The present invention further relates to a dewatered cellulosic containing material containing a dewatered cellulosic containing material, at least one anionic surfactant, and at least one amide of a carboxylic acid. The dewatered cellulosic containing material can be a dewatered pulp or dewatered sludge. In the dewatered cellulosic containing material, the anionic surfactant can be present in an amount of from 1 ppm to 1,000 ppm and the amide of a carboxylic acid can be present in an amount of from 1 ppm to 1,000 ppm.

[0016] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are intended to provide a further explanation of the present invention, as claimed.

[0017] The accompanying drawings, which are incorporated in and constitute a part of this application, illustrate some of the embodiments of the present invention and together with the description, serve to explain the principles of the present invention.

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. **1** is a graph showing foam height vs. time (seconds) for a variety of treatments utilizing the present invention and one comparative example.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0019] The present invention relates to a method for dewatering a cellulose-containing material.

[0020] The present invention further relates to method for foam control and/or foam suppression during a dewatering process of cellulose-containing material and/or other part of a process in a paper making or pulp making process (e.g., a step or part of a process in a paper making or pulp making process wherein foam control or foam suppression and/or drainage is desired).

[0021] The method of the present invention has the unique ability to provide dual property improvements, namely, an improvement in dewatering performance and an improvement in foam control and/or foam suppression.

[0022] For instance, the method of the present invention has the unique ability to provide dual property improvements, namely, an improvement in dewatering performance and an improvement in foam control and/or foam suppression, wherein each component used can actually increase both properties collectively. It was unexpected to discover that a particular class of foam-controlling additive, when combined with an anionic surfactant(s), can achieve the same degree or about the same degree (e.g., within 10%) of dewatering improvement without the high amount of foam that usually forms or occurs with the use of anionic surfactants. Thus, with the present invention, the addition of anionic surfactant and an amide of a carboxylic acid controls the foam problem while at the same time not interfering with the desired dewatering effect.

[0023] The present invention includes a method that comprises, consists essentially of, consists of, or includes adding at least one anionic surfactant and at least one amide of a carboxylic acid to a cellulose-containing material to form a treated cellulose-containing material.

[0024] The method can further include dewatering the treated cellulose-containing material to provide a dewatered cellulose-containing material (or dewatered treated cellulose-containing material).

[0025] For purposes of the present invention, the cellulose-containing material can comprise, consist essentially of, consists of, or be an aqueous cellulosic pulp slurry. For purposes of the present invention, the cellulose-containing material can be or include a mat of cellulosic fibers. For purposes of the present invention, the cellulose-containing material can be or include a sludge from a paper and pulp manufacturing process.

[0026] Regarding the adding of the anionic surfactant and the amide of a carboxylic acid, the anionic surfactant and the amide of a carboxylic acid can be added together as a pre-combined mixture or can be added as separate components or compositions or streams to the cellulose-containing material or tank or container holding the cellulose containing material or added to an aqueous stream or other industrial stream that contacts the cellulose containing material. Agitation of the cellulose-containing material can optionally occur before, during, and/or after the addition of the anionic surfactant and the amide of a carboxylic acid.

[0027] As an option, the anionic surfactant and the amide of a carboxylic acid can be added separately to the cellulose-containing material. The separate additions can be at the same time of each other, or at about the same time (e.g., within 15 seconds of each other), or the anionic surfactant can be added before and/or after the amide of a carboxylic acid, and/or the amide of the carboxylic acid can be added before and/or after the anionic surfactant during the method of the present invention. The time of such additions can be within seconds or minutes of each other (e.g., within 15 minutes, within 10 minutes, within 5 minutes, within 1 minute or other times more than or less than any of these time amounts).

[0028] Regarding the anionic surfactant, one or more than one type of anionic surfactant can be used. The anionic surfactant can be an organic anionic surfactant(s).

[0029] The anionic surfactant(s) can be one or more anionic compounds and/or can be one or more anionic polymers. Examples include, but are not limited to, an alcohol sulfate, an alcohol alkoxy sulfate, a sulfonate, a sulfosuccinate, a sulfosuccinic acid ester with an ethoxylated alcohol, and any soluble or dispersible salts thereof, or any combinations thereof. A sulfonate refers to a salt or ester of a sulfonic acid. A sulfosuccinate refers to a sulfonate derivative of succinate (e.g., a salt or ester of sulfosuccinic acid). For salts thereof, the counterion can be a metal ion, such as an alkali metal (e.g., sodium, potassium). More specific examples include, but are not limited to, a fatty alcohol sulfate (e.g., C12-18 fatty alcohol sulfate), an alkyl alcohol sulfate (e.g., C10-C16 alkyl alcohol sulfate), an ethoxylated alcohol sulfate (e.g., ethoxylated C4-C12 alcohol sulfate), a sulfonated fatty acid alkyl ester, an olefin sulfonate, a paraffin sulfonate, an alkylbenzylsulfonate, and a dialkyl sulfosuccinate. Additional examples include dodecyl alcohol sulfate, hexadecyl alcohol sulfate, dodecyl ethoxy sulfate, tetradecyl ethoxy sulfate, decylbenzene sulfonate, tetradecyl benzene sulfonate, tetradecyl sulfonate, octadecyl sulfonate, 3-hydroxy-1-hexadecane sulfonate, 2-hexadecene-1-sulfonate, dioctylsulfosuccinate sodium salt, or others. The anionic surfactant can be an anionic surfactant, which is a sulfate surfactant, a sulfonate surfactant, a sulfosuccinate surfactant, or any combinations thereof. To avoid any doubt, the anionic surfactant is a separate component from the amide of a carboxylic acid.

[0030] As an option, at least one anionic surfactant can be added to the pulp in the processes of the present invention in an amount from about 0.1 lb. to about 10 pounds (lb.) anionic surfactant/ton dry fiber, or from about 0.2 to about 8 lb. charged compound/ton dry fiber, or from about 0.3 to about 4 lb. anionic surfactant/ton dry fiber, or from about 0.5 to about 3 lb. anionic surfactant/ton dry fiber (on a solids/solids basis).

[0031] Regarding the amide of a carboxylic acid, one or more types of an amide of a carboxylic acid can be used. For purposes of the present invention, the amide of a carboxylic acid can be a carboxylic acid amide(s). Any carboxylic acid containing from 12-18 carbon atoms is suitable. The amide of a carboxylic acid can be an amide of a straight chain carboxylic acid. For instance, N,N-dimethylamides of carboxylic acids can be prepared from straight chain carboxylic acids containing from 12-18 carbon atoms. The carboxylic acid part can be further characterized by having at least one carbon to carbon double bond. Acids can include: oleic, linoleic, linolenic, ricinoleic, and mixtures thereof. Also suitable are mixed acids such as tall, castor, corn, cottonseed, linseed, olive, peanut, rapeseed, safflower, sesame, and/or soybean oils. A mixture of carboxylic acids commercially available as a tall oil fatty acid is UNITOL ACD SPECIAL.

[0032] The amide of a carboxylic acid can be at least one compound of formula I:

$$R_3C(O)\text{—}N(R_1)(R_2) \qquad \text{(I)}$$

wherein R_1 is a hydrogen or a substituted or unsubstituted C_1-C_{12} alkyl (such as a C_1-C_6 alkyl) group; R_2 is a hydrogen or a substituted or unsubstituted C_1-C_{12} alkyl (such as a C_1-C_6 alkyl) group; and $R_3C(O)$— is a substituted or unsubstituted fatty acid residue of 6 to 22 carbon atoms such as 8 to 12 carbon atoms.

[0033] The fatty acid residue, $R_3C(O)$—, of compound I, defined above, may be a substituted or unsubstituted residue of a fatty acid which occurs in a vegetable oil. The vegetable oil may be selected from tall oil, palm oil, soybean oil, cottonseed oil, coconut oil, corn oil, peanut oil, canola oil, safflower oil, sunflower oil, babassu oil, castor oil, linseed oil, olive oil, and tung oil.

[0034] In general, the dialkylamides of any carboxylic acid having 8 to 22 carbon atoms can be used in the methods of the present invention. Examples include those based on fatty acids having 18 carbon atoms such as stearic, oleic, linoleic, linolenic and ricinolenic acid. An example of a dialkyl amide is N,N-dimethyl oleamide.

[0035] A further example of an amide of a carboxylic acid is carboxylic acid dialkyl amides, and more particularly dimethyl amides, dibutyl amides, dioctyl amides, or di-2-ethylhexyl amides. Specific examples include dialkyl amides, such as, capric acid dimethyl amide, capric acid dibutyl amide, capric acid dioctyl amide, capric acid di-2-ethylhexyl amide, caprylic acid dimethyl amide, caprylic acid dibutyl amide, caprylic acid dioctyl amide, caprylic acid di-2-ethylhexyl amide, capronic acid dimethyl amide, capronic acid dibutyl amide, capronic acid di-2-ethylhexyl amide, lauric acid dimethyl amide, lauric acid dibutyl amide, lauric acid di-2-ethylhexyl amide, lactic acid dimethyl amide, lactic acid dibutyl amide, and/or lactic acid di-2-ethylhexyl amide and/or their blends.

[0036] The amide of a carboxylic acid can comprise, consists essentially of, consist of, or be a dimethylamide of a fatty acid. The dimethylamide of a fatty acid can have from 4 to 22 carbon atoms, such as 14 to 18 carbon atoms.

[0037] The amide of the carboxylic acid can be added to the cellulose containing material in an amount from about 0.001 to about 2 pounds (lb.) per ton dry fiber, or from about 0.01 to about 1.5 lb./ton dry fiber, or from about 0.1 to about 1 lb./ton dry fiber, or other amounts.

[0038] The amount of the amide of the carboxylic acid added generally is an amount that causes at least some foam control or suppression during the dewatering process. For instance, this can be measured, as shown in the example, by a foam height measurement test. With the present invention, the maximum foam height achieved is reduced, for instance by at least 10 percent in height, as compared to when no amide of carboxylic acid is present or compared to when no defoaming agent is present at all, or compared to when no amide of carboxylic acid is present but at least one anionic surfactant is present.

[0039] As an option, no other class of defoaming agent is used in the method of the present invention.

[0040] As an option, at least one anionic surfactant and at least one amide of carboxylic acid can be added to the cellulose containing material in a total amount of from about 0.2 lb./ton dry fiber to about 12 lb./ton dry fiber, or from about 0.4 to about 10 lb./ton dry fiber, or from about 0.6 to about 8 lb./ton dry fiber, or from about 1 to about 6 lb./ton dry fiber (on a solids/solids basis), or other values.

[0041] As an option, at least one anionic surfactant and at least one amide of a carboxylic acid can be added to the cellulose containing material in a weight amount of from about 95 wt %:5 wt % (anionic surfactant: amide of carboxylic acid) to about 5 wt %:95 wt %, such as 90:10 to 10:90, or 80:20 to 20:80, or 70:30 to 30:70 (each number in wt %). The amide of carboxylic acid can be present in an amount of from about 50 wt % to about 90 wt %. The anionic surfactant can be present in an amount of from about 50 wt % to 10 wt %. For each of these wt % provided here, the wt % are based on the total weight of both components present.

[0042] The anionic surfactant and amide of carboxylic acid, for example, can be added to the cellulose containing material, such as pulp, sequentially by separate additions thereof at different process locations or at different times at the same process location, or they can be added concurrently at least in part at the same process location (e.g., as separate feeds or as a pre-mixture). As an option, pulp or market pulp can be produced by sequentially adding at least about 80% up to 100% by weight of the total added amount of the anionic surfactant after addition of the at least one amide of carboxylic acid to the pulp before dewatering the pulp. In such an option, the amide of carboxylic acid is given the opportunity to interact first with the pulp fibers before interactions are made with the anionic surfactant. The addition of the at least one anionic surfactant and at least one amide of carboxylic acid in this sequence can magnify the enhancements in the foam control and dewatering performance that can be achieved. As another option, at least a portion or all of the anionic surfactant can be added to the pulp before the amide of carboxylic acid is added to the pulp. With the present invention, compared to pulp drainage seen without the addition of any anionic surfactant or amide of carboxylic acid, or using just the anionic surfactant alone or using the amide of carboxylic acid alone, to the pulp, pulp drainage performance in combination with foam control in the production of pulp or market pulp can be significantly increased, such as by a factor of one, two, or three or more with processes of the present invention. Further, as compared to use of only an anionic surfactant alone or the use of an amide of carboxylic acid alone, to treat the pulp, drainage efficiencies along with foam control can be significantly increased, such as by about 10% to about 200%, or other increases, by the combined addition of at least one anionic surfactant and at least one amide of carboxylic acid to the pulp. In addition, drainage rates with foam control can be achieved that exceed the sum of the individual rates obtained from use of the anionic surfactant alone or the amide of carboxylic acid individually to treat a pulp. For instance, better drainage and reduced foaming in the wire section of the pulp dryer can lead to reduced moisture of pulp in the press section, and as a result, steam consumption in the drying section can be significantly reduced, which can provide energy savings. Further, improvements of pulp dewatering and foam control provided by treatment of digested pulp with the present invention prior to pulp drying can allow for faster pulp throughout rates or speeds in the pulp mill, whereby the productivity of the pulp mill can be increased. Free drainage properties of the pulps treated with the present invention before pulp drying can demonstrate good correlations with water retention properties, such as in terms of water retention values or WRV, of the treated pulps, which indicates that the treatment can yield reliable non-randomized results.

[0043] With the present invention, a lower amount of anionic surfactant than conventionally used for a dewatering process, can be utilized in view of the use of at least one amide of carboxylic acid. For instance, the amount of anionic surfactant used can be reduced by at least 10 wt %, at least 25 wt %, at least 50 wt % or more and yet achieve the same or substantially the same (e.g. within 15%, or within 10%, or within 5%, or within 1%) of dewatering properties of the cellulose containing material.

[0044] In the method of the present invention, when the cellulose containing material is an aqueous cellulosic pulp slurry, the method can include a step of bleaching the aqueous cellulosic pulp slurry after pulp forming and before the adding of the anionic surfactant and the amide of a carboxylic acid.

[0045] In addition, or separately, in the method of the present invention, when the cellulose containing material is an aqueous cellulosic pulp slurry, the method can include a step of thermally drying the dewatered cellulose-containing material. This step can form a market pulp.

[0046] As a further example, the present invention can be utilized in the production of market pulp. The pulp during the production is treated with one or more anionic surfactants and with one or more amide of a carboxylic acid to improve pulp dewatering performance and efficiency thereof and/or foam control and/or foam suppression and/or other properties. As used herein, "market pulp" refers to mechanically dewatered pulps which are thermally dried. The market pulp provides a dry form of product material which has useful storage stability and can be more easily shipped and handled than bulkier aqueous forms of pulp product. The market pulp can be stored, transported, or both for subsequent use as a process material used in other production processes. The market pulp optionally can be securely wrapped as a unitized product for shipping or transport for further processing, such as papermaking.

[0047] The present invention further relates to a dewatered cellulosic containing material dewatered by the method of present invention. Due to the process that the cellulosic containing material is subjected to, a unique cellulosic containing material can be obtained.

[0048] In more detail, the present invention provides a dewatered cellulosic containing material comprising, consisting essentially of, consisting of, or is a dewatered cellulosic containing material with the anionic surfactant and the amide of a carboxylic acid present. The amount of the anionic surfactant and amide of the carboxylic acid can be residue amounts or other amounts. The dewatered cellulosic containing material can be a dewatered pulp or dewatered cellulosic containing mat or dewatered market pulp or dewatered sludge. The dewatered cellulosic containing material can comprise from about 1 ppm to 1,000 ppm anionic surfactant(s) (e.g., from 10 ppm to 1,000 ppm, from 25 ppm to 1,000 ppm, from 50 ppm to 1,000 ppm, from 100 ppm to 1,000 ppm, from 100 ppm to 500 ppm, from 250 ppm to 500 ppm) and from about 1 ppm to 1,000 ppm of an amide(s) of a carboxylic acid (e.g., from 10 ppm to 1,000 ppm, from 25 ppm to 1,000 ppm, from 50 ppm to 1,000 ppm, from 100 ppm to 1,000 ppm, from 100 ppm to 500 ppm, from 250 ppm to 500 ppm) and the balance can be cellulosic materials (such as cellulosic fibers or pulp), and these amounts can be based on dry weight of the fibers or wet weight after dewatering and/or after dewatering and drying. The dewatered cellulosic containing material can comprise, for example, from about 0.001 to about 5 pounds (lb.) anionic surfactant/ton dry fiber, or from about 0.01 to about 3 lb. anionic surfactant/ton dry fiber, or from about 0.1 to about 2 lb. anionic surfactant/ton dry fiber, or from about 0.2 to about 1 lb. anionic surfactant/ton dry fiber (on a solids/solids basis), and the amide of carboxylic acid can be contained in the cellulosic containing material in an amount of from about 0.000001 lb. to about 1 lb./ton dry fiber or from about 0.00001 lb. to about 0.1 lb./ton dry fiber.

[0049] With the present invention, in general, these treatment additives (i.e., anionic surfactant and the amide of carboxylic acid) impact the dewatering performance (including foam control and/or suppression) in significant and beneficial ways that would not be expected from the use of either the anionic surfactant alone or the amide of carboxylic acid alone, and in some options may exceed additive expected effects from each individual component. The combined treatment of the cellulose containing material with the anionic surfactant and amide of carboxylic acid can provide a synergistic effect on water removal (including foam control and/or suppression) which is much better than either treatment alone and much better than the additive effect expected.

[0050] It has been observed that the high basis weight of some pulp sheets on a pulp dryer, for example, can be an impediment to good drainage. It has been found that significant improvements in dewatering performance at a pulp dryer can be provided in the production of pulp or market pulp by treatment of pulps after digestion or other mode of defibration, and any bleaching, and before pulp drying, with the anionic surfactant and amide of carboxylic acid used in combined treatment of pulps. Treatment of the pulp prior to the pulp dryer with the combination of the anionic surfactant and with the amide of carboxylic acid, for example, can increase the free drainage rate of the pulp while controlling foam and/or suppressing foam. Increasing the free drainage rate of the pulp and controlling foam makes it feasible to increase the production speed and capacity of the process for producing market pulp. As an option, the pulp treatment methods and systems of the present invention are not part of, nor integrated with, a paper making machine.

[0051] As an option, at least one anionic surfactant and at least one amide of carboxylic acid are added to treat the pulp before the pulp is dewatered and dried in a pulp dryer. As an option, the amide of carboxylic acid can be added to the pulp at a feed line and the anionic surfactant can be added at a separate or same feed line at the inlet side of the pulp dryer. The addition of at least one anionic surfactant and at least one amide of carboxylic acid to the pulp before the dryer can improve dewatering performance at the dryer. As an option, for bleached pulp, at least one anionic surfactant and at least one amide of carboxylic acid can be added to the pulp anywhere after the bleach plant and before the dryer. As another option, for unbleached pulp, at least one anionic surfactant and at least one amide of carboxylic acid can be added to the pulp anywhere after the digester and before the dryer. As an option, the anionic surfactant is added to the pulp no earlier than the addition of the amide of carboxylic acid to the pulp. As an option, the anionic surfactant is added to the pulp at times which can partially overlap with the addition times of the amide of carboxylic acid. As an option, all amounts of the amide of carboxylic acid are added to the pulp before the addition of all amounts of the anionic surfactant to the pulp. As an option, about 80% to 100%, or from about 85% to 100%, or from about 90% to 100%, or from about 95% to 100% by weight, of the total weight amount of amide of carboxylic acid, is added to the pulp prior to the earliest adding of the anionic surfactant to the pulp.

[0052] As an option, one or more enzymes can be additionally added in the methods of the present invention to the cellulose containing material. The enzyme can include, for example, an enzyme having cellulolytic activity, hemicellulolytic activity, pectinolytic activity, or glycosidasic activity. The enzyme can be a hydrolytic enzyme which has activity that affects the hydrolysis of fiber (e.g., hydrolytic activity), such as to accelerate the hydrolysis of a chemical bond. The enzyme can be, for example, cellulase, hemicellulase, lipase, pectinase, cellobiase, xylanase, protease, mannanase, β-glucanase, carboxymethylcellulase (CMCase), amylase, glucosidase, galactosidase, laccase, or any combinations thereof. A single type of enzyme or a combination of two or more different types of enzymes can be used jointly with the anionic surfactant(s). A cellulolytic enzyme composition can contain, for example, from about 5% by weight to about 20% by weight enzyme. These enzyme compositions can further contain, for example, polyethylene glycol, hexylene glycol, polyvinylpyrrolidone, tetrahydrofuryl alcohol, glycerine, and/or water, and/or other conventional enzyme composition additives, as for example, described in U.S. Pat. No. 5,356,800, which is incorporated herein in its entirety by reference. If enzyme substrates are present with dry powder forms of the enzymes, the substrates should not adversely interact with or interfere with the pulp treatment or other papermaking processes.

[0053] The enzyme can be added in an amount, for example, of from about 0.0001% by weight to about 5% by weight enzyme based on the dry weight of the pulp, or from about 0.0005% by weight to about 4.5% by weight, or from about 0.001% to about 4% by weight, or from about 0.005% to about 3.5% by weight, or from about 0.01% to about 3% by weight, or from about 0.05% by weight to about 2.75% by weight, or from about 0.1% by weight to about 2.5% by weight, or from about 0.2% by weight to about 1.5% by weight, or from about 0.001% to about 0.1% by weight, or from about 0.005% to about 0.5% by weight enzyme based on dry weight of the pulp, though other amounts can be used.

[0054] As indicated, the combination of treating the pulp with at least one anionic surfactant and at least one enzyme before dewatering beneficially influences the drainage and dewatering behavior of the treated pulps and further provides the control of foam formation and/or provides foam suppression.

[0055] With the present invention, the combination of treating the pulp with the at least one anionic surfactant and at least one amide of a carboxylic acid before said dewatering can be effective to provide at least one (or two or three or all) of the following:

[0056] (i) increased pulp free drainage (g/90 sec) to a value which is at least 7.5% greater than free drainage value obtained without any treatment in the pulp;

[0057] (ii) reduced foam height during said dewatering compared to foam height occurring with using the same anionic surfactant in the absence of said amide of a carboxylic acid.

[0058] (iii) increased removal of water from the cellulose fibers in the pressing process that occurs after drainage.

[0059] (iv) accelerated removal of water from the cellulose fibers in a heated drying process that is used to produce a dry pulp sheet.

[0060] With the present invention, the method can be effective for increasing obtained free drainage to a value which is at least two times, at least three times, at least four times, or at least five times greater than free drainage value obtained without any treatment of the pulp. Water removal measurements can be obtained using a Mütek DFR-05 drainage/retention tester. The Mütek DFR-05 drainage freeness retention simulates the retention and drainage conditions prevailing in a pulp or paper machine.

[0061] These and/or other effects of the present invention can be provided by treatment of the pulp optionally without the need for co-addition or the co-presence in the pulp under treatment of any nonionic or cationically charged compounds, such as a nonionic surfactant, a cationic surfactant, a cationic polymer, or a cationic flocculant. As an option, the method of the present invention can be conducted free or essentially free of nonionic surfactant and/or cationically charged compounds and/or any additional defoaming agent, since the beneficial effects obtained by the present invention do not rely on the co-presence of such nonionic surfactant or cationically charged compounds or additional defoamers. With regard to added nonionic surfactants, as an option, the pulp can be treated with less than 0.1 kg/metric ton dry fiber, or less than 0.05 kg/metric ton dry fiber, or less than 0.01 kg/metric ton dry fiber, or less than 0.001 kg/metric ton dry fiber, or less than 0.0001 kg/metric ton dry fiber or in the absence of nonionic surfactant, based on total nonionic surfactants. With regard to added cationically charged compounds, as an option, the pulp can be treated with less than 0.1 kg/metric ton dry fiber, or less than 0.05 kg/metric ton dry fiber, or less than 0.01 kg/metric ton dry fiber, or less than 0.001 kg/metric ton dry fiber, or less than 0.0001 kg/metric ton dry fiber or in the absence of cationically charged compounds (e.g., cationic surfactant(s), cationic polymer(s)), cationic flocculant(s), and the like), based on total cationically charged compounds.

[0062] As an option, the indicated at least one anionic surfactant and at least one amide of a carboxylic acid used to treat the pulp to improve dewatering performance can be water soluble or water dispersible compounds.

[0063] As an option, inorganic anionic coagulants can be used, such as polyphosphates, anionic silica sol, or any combinations thereof.

[0064] The methods of the present invention can be used to improve dewatering of pulpable materials, including cellulosic pulpable materials, noncellulosic pulpable materials, recycled paper waste pulpable materials, or any combinations thereof. As an option, the cellulosic pulpable materials can be lignocellulosic. The drainage and dewatering improvements due to the pulp treatment according to methods and systems of the present invention is not limited to treating any particular type of pulp and can find application in all grades of pulp. The treatable pulps can be chemical pulps, mechanical pulps, or combinations of these types of pulps. As an option, the treatable pulp is a chemical pulp at least in part. The treatable pulp can be bleached or unbleached when treated. The treatable pulp can include, for example, Kraft pulp, dissolving pulp, fluff pulp, semichemical pulps (e.g., bleached chemothermomechanical pulp or BCTMP), sulfite pulp, soda pulp, organosolv pulp, polysulfide pulp, or other pulps, and any combinations thereof. Nonchemical mechanical pulps, such as pulps mechanically defibrated only, such as by use of disk or conical refiners only for defibration of feedstock, also can be processed with the indicated pulp treatment.

[0065] As used herein, "dried pulp" refers to laid, stacked, piled or otherwise physically accumulated pulp which is sufficiently dewatered to be exposed to air and unsuspended and non-immersed in aqueous medium.

[0066] "Anionically charged compound" refers to a compound having a net negative charge on the molecule in aqueous solution. The anionically charged compound can be organic or inorganic. "Organic" means the compound contains at least one C—H bond.

[0067] "Enzyme" refers to a protein that is capable of catalyzing a chemical reaction.

[0068] "Surfactant" refers to an organic compound which can lower the surface tension of a liquid, the interfacial tension between two liquids, or that between a liquid and a solid.

[0069] "Anionic surfactant" refers to a surfactant having a net negative charge on the molecule in aqueous solution. Accordingly, the anionic surfactant can have only anionic moieties as the charged groups thereon or may be amphoteric with a net anionic charge for the overall molecule.

[0070] "Nonionic compound" refers to a compound that is amphiphilic and has no charge group at either terminal end group thereof.

[0071] "Nonionic surfactant" refers to a surfactant that is amphiphilic and has no charge group at either terminal end group thereof.

[0072] "Cationically charged compound" refers to a compound having a net positive charge on the molecule in aqueous solution. The cationically charged compound can be organic or inorganic.

[0073] "Cationic surfactant" refers to a surfactant having a net positive charge on the molecule in aqueous solution. Accordingly, the cationic surfactant can have only cationic moieties as the charged groups thereon or may be amphoteric with a net cationic charge for the overall molecule.

[0074] "Cationic polymer" refers to a polymer having a net positive charge on the molecule in aqueous solution. Accordingly, the cationic polymer can have only cationic moieties as the charged groups thereon or may be amphoteric with a net cationic charge for the overall molecule.

[0075] "Kraft pulp" refers to chemical wood pulp produced by digesting wood by the sulfate process.

[0076] "Fluff pulp" refers to a chemical, mechanical or combination of chemical/mechanical pulp, usually bleached, used as an absorbent medium in disposable diapers, bed pads, and other hygienic personal products. Fluff pulp is also known as "fluffing" or "comminution" pulp.

[0077] "Dissolving pulp" refers to a higher purity, special grade pulp made for processing into cellulose derivatives including rayon and acetate.

[0078] "Bleached chemothermomechanical pulp" or "BCTMP" refers to bleached CTMP. "CTMP" refers to chemical-mechanical pulp produced by treating wood chips with chemicals (e.g., sodium sulfite) and steam before mechanical defibration.

[0079] "Unitize" refers to a process by which a plurality of market fibers can be bundled or packaged together as a single unitary product for handling.

[0080] "Defibration" refers to separation of wood fibers by mechanical means, chemical means, or combinations of both.

[0081] Wood chips as a source of the cellulose containing material or that is suitable for use in the production of pulp in the present invention can be derived from hardwood tree species, softwood tree species, or combinations thereof. Softwood tree species include, but not limited to: fir (such as Douglas fir and balsam fir), pine (such as Eastern white pine and Loblolly pine), spruce (such as white spruce), larch (such as Eastern larch), cedar, and hemlock (such as Eastern and Western hemlock). Examples of hardwood tree species include, but are not limited to: acacia, alder (such as red alder and European black alder), aspen (such as quaking aspen), beech, birch, oak (such as white oak), gum trees (such as eucalyptus and sweet gum), poplar (such as balsam poplar, Eastern cottonwood, black cottonwood, and yellow poplar), maple (such as sugar maple, red maple, silver maple, and big leaf maple). These types of woods can be used individually or in any combinations thereof. As an option, a combination of hemlock and cottonwood particulates can be used. As an option, the wood chips to be pulped include virgin wood material, such as at least 50% by weight up to 100% by weight virgin wood material. As an option, other pulpable material may be used or included in the feedstock, such as recycled fiber materials, such as recycled fiber from post-consumer waste, or non-wood materials, such as grasses, agricultural residues, bamboo, Bast materials (e.g., Ramie, flax, hemp), or any combinations thereof.

[0082] In addition to at least one anionic surfactant and at least one amide of a carboxylic acid, the pulps may be treated with one or more optional additives within the pulp making system as long as they do not interfere with the indicated function of at least one anionic surfactant and at least one amide of a carboxylic acid to improve dewatering performance of the treated pulps and/or foam control and/or foam suppression. A list of optional chemical additives that can be used in conjunction with the present invention include, for example, pH modifiers, dry strength agents, wet strength agents, softening agents, debonding agents, adsorbency agents, sizing agents, dyes, optical brighteners, chemical tracers, opacifiers, and/or dryer adhesive chemicals, and the like. Additional optional chemical additives may include, for example, pigments, emollients, humectants, viricides, bactericides, buffers, waxes, fluoropolymers, odor control materials, deodorants, zeolites, perfumes, vegetable oils, mineral oils, polysiloxane compounds, other surfactants, moisturizers, UV blockers, antibiotic agents, lotions, fungicides, preservatives, aloe-vera extract, and/or vitamin E, or the like. Suitable optional chemical additives can be retained by the pulp fibers and may or may not be water soluble or water dispersible. As indicated, cationically charged compounds are not required to be additionally added or present in a pulp treatment of the present invention.

[0083] Regarding paper making sludge and the present invention, the manufacture of paper involves blending, in water, a pulp material (generally wood fiber) with fillers, such as clay, and other additives to create a stock slurry mixture referred to herein as a pulp. The pulp is then processed through a papermaking machine to form a sheet. The water is then extracted from the sheet and the sheet is then pressed and dried, thereby forming a paper product. The drained water contains an amount of fiber and filler material. This material is collected for later processing; however, the recovery is usually not complete. Discarded material and material not captured for reuse are generally transported to a waste treatment facility where still-remaining solids, e.g., the fibers and filler materials, are removed. The cleaned water is discharged back into the environment or communicated back to the papermaking process for reuse. After dewatering using the method of the present invention, the solids are contained in a concentrated, typically 40 wt %-60 wt % solids, papermaking sludge. The main components of this sludge are fibers and clay filler material. As stated, the methods of the present invention can improve the dewatering of this sludge, and/or control foam.

[0084] The present invention will be further clarified by the following examples, which are intended to be only exemplary of the present invention. Unless indicated otherwise, all amounts, percentages, ratios and the like used herein are by weight.

EXAMPLES

Example 1

[0085] Experiments were conducted to compare water drainage of pulp treated using an anionic surfactant (alpha-sulfo-omega-hydroxypoly(oxy-1,2-ethanidiyl)C10-16 alkyl ether, sodium salt CAS 68585-34-2, AKA sodium laureth sulfate (~3 moles EO)) alone, an amide of a carboxylic acid (Dimethylamide of tall oil fatty acid—DMAFA) alone, and their combination (at different weight ratios) as added to the pulp, and compared to water drainage of untreated pulp. A control test also was conducted with no chemical additive used on the pulp.

[0086] The following testing procedure was applied. A slurry of bleached pulp to be tested was prepared with a consistency of about 1 percent by weight in tap water. Water removal from the slurry was evaluated using a Mütek DFR-05 drainage/retention tester. A selected volume of this slurry (500 mL) was added into a chamber which has a screen at the bottom. Any anionic surfactant and/or amide of a carboxylic acid included in a test sample was pre-mixed with the slurry before addition to the chamber. The screen was a metallic mesh screen (mesh size=600 mesh). When the test was initiated, the water was allowed to drain from the slurry through the screen. The amount of water that drained freely from the sample, and the rate of drainage was monitored. No vacuum nor pressure was applied for the first 30 seconds after initiating drainage from the chamber. At 30 seconds after the drainage is initiated, the testing apparatus (i.e., a DFR with forced dewatering (controlled mechanical level)) was used to apply pressure to the pad (i.e., the fiber mat collected on the screen). Again, the rate of water being removed from the pad was measured. At 50 seconds additional pressure was applied, and at 70 seconds again additional pressure was applied. This procedure, including the amount of pressure applied at each stage, mimics the dewatering and pressing that occurs on a paper machine or on a pulp dryer. Free drainage rates in g/30 sec and g/90 sec were determined based on the measurements.

[0087] The results of these experiments are shown in the Tables. The result after 30 seconds is known as free drainage, and the data from 30 seconds after drainage was initiated is shown in Table 1. Table 2 below shows raw data from a set of tests. The numbers in Table 2 are based on the grams of water drained from a sample and are reflected as wt % water removed and final consistency (in wt %). Note that there may or may not be a large improvement in drainage: the more important effect is the reduction in moisture in the sheet after the complete process of drainage, pressing and drying and at the same time, the control of foam. That is shown in Table 2 and FIG. **1**.

TABLE 1

Ratio anionic to DMAFA	wt % water removed in free drainage
100 anionic/0 DMAFA	70.30
80 anionic/20 DMAFA	69.49
60 anionic/40 DMAFA	69.09
40 anionic/60 DMAFA	70.51
20 anionic/80 DMAFA	68.69
0 anionic/100 DMAFA	68.28
Blank	67.88

[0088] The results shown in Table 2 is after 90 seconds and for the total water removed after free drainage and the 3 additional pressings.

TABLE 2

Ratio anionic to DMAFA	wt % water removed	final consistency (%)
100 anionic/0 DMAFA	80.40	4.90
80 anionic/20 DMAFA	79.19	4.63

TABLE 2-continued

Ratio anionic to DMAFA	wt % water removed	final consistency (%)
60 anionic/40 DMAFA	78.18	4.42
40 anionic/60 DMAFA	80.40	4.90
20 anionic/80 DMAFA	78.18	4.42
0 anionic/100 DMAFA	77.98	4.39
Blank	76.36	4.10

[0089] As shown in the data provided, the foam-controlling additive when used alone without the anionic surfactant provides some improvement in dewatering but nowhere near the results provided by the anionic surfactant. However, when the foam-controlling additive is combined with the anionic surfactant, the results are improved, even reaching the same maximum positive effect in some cases. This is an unexpected result, and the primary benefit is that the dewatering is done without the high amount of foam that occurs when there is only anionic surfactant used. Thus, the addition of an anionic surfactant and a dimethylamide of a fatty acid controls the foam problem while at the same time not interfering with the dewatering effect. These experimental results show that treating a pulp slurry with the combination of anionic surfactant and amide of a carboxylic acid together can provide unexpected results.

Example 2

[0090] An additional experiment was conducted to compare the control of foam (or foam suppression) from a simulation of agitation that would occur during a dewatering process. Pulp was prepared in the same manner as in Example 1. The same anionic surfactant and amide of a carboxylic acid (foam suppressing component) was used here as in Example 1. Table 3 sets forth the amounts of each component for each sample (samples 1 through 10). For each test run, a sample was added, the pulp slurry was agitated in a recirculating apparatus to cause high agitation. The foam height that formed over a time of 10 or more seconds was recorded and plotted in FIG. **1**. Table 3 shows a legend to better understand the results shown in FIG. **1** which shows foam height over time for 10 samples with varying amounts of anionic surfactant and foam suppressing agent (amide of a carboxylic acid). When the foam exceeded 24 cm in height, the test was stopped for that sample. Otherwise, the test was conducted for almost 200 seconds. As can be seen in FIG. **1**, excellent results were achieved when the wt % for the foam suppressing component was 50 wt % or more (based on total weight of anionic surfactant and foam suppressing component). Foam control was also achieved for a period of time for samples where the foam suppressing component was present in an amount of 30 wt % to 50 wt % (based on total weight of anionic surfactant and foam suppressing component).

TABLE 3

Sample	wt % anionic	wt % foam suppressing component
1	100	0
2	90	10
3	80	20
4	70	30
5	60	40

TABLE 3-continued

Sample	wt % anionic	wt % foam suppressing component
6	50	50
7	40	60
8	30	70
9	20	80
10	10	90

[0091] The present invention includes the following aspects/embodiments/features in any order and/or in any combination:

[0092] 1. The present invention relates to a method for dewatering a cellulose-containing material, said method comprising:

[0093] adding at least one anionic surfactant and at least one amide of a carboxylic acid to said cellulose-containing material to form a treated cellulose-containing material; and

[0094] dewatering said treated cellulose-containing material to provide a dewatered cellulose-containing material.

[0095] 2. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry.

[0096] 3. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is a mat of cellulosic fibers.

[0097] 4. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is a sludge from a paper and pulp manufacturing process.

[0098] 5. The method of any preceding or following embodiment/feature/aspect, wherein said anionic surfactant and said amide of a carboxylic acid are added together to said cellulose-containing material.

[0099] 6. The method of any preceding or following embodiment/feature/aspect, wherein said anionic surfactant and said amide of a carboxylic acid are separately added to said cellulose-containing material.

[0100] 7. The method of any preceding or following embodiment/feature/aspect, wherein the anionic surfactant is an organic anionic surfactant.

[0101] 8. The method of any preceding or following embodiment/feature/aspect, wherein said amide of a carboxylic acid comprises a dimethylamide of a fatty acid.

[0102] 9. The method of any preceding or following embodiment/feature/aspect, wherein said amide of a carboxylic acid comprises a dimethylamide of a fatty acid having 14 to 18 carbon atoms.

[0103] 10. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry, and wherein said method further comprising bleaching the aqueous cellulosic pulp slurry after pulp forming and before the adding of the anionic surfactant and said amide of a carboxylic acid.

[0104] 11. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry, and wherein said method further comprising thermally drying said cellulose-containing material that is dewatered to form market pulp.

[0105] 12. The method of any preceding or following embodiment/feature/aspect, wherein the anionic surfactant is a sulfate surfactant, a sulfonate surfactant, a sulfosuccinate surfactant, or any combinations thereof.

[0106] 13. The method of any preceding or following embodiment/feature/aspect, wherein the anionic surfactant is an alcohol sulfate, an alcohol alkoxy sulfate, a sulfonate, a dialkyl sulfosuccinate, a sulfosuccinic acid ester with an ethoxylated alcohol, or a soluble or dispersible salt thereof, or any combinations thereof.

[0107] 14. The method of any preceding or following embodiment/feature/aspect, said method further comprising bleaching said cellulose-containing material before the adding of the at least one anionic surfactant and the at least one amide of a carboxylic acid.

[0108] 15. The method of any preceding or following embodiment/feature/aspect, said method further comprising adding at least one enzyme to said cellulose-containing material before said dewatering step.

[0109] 16. The method of any preceding or following embodiment/feature/aspect, wherein said amide of a carboxylic acid is added in an amount to control foam height during said dewatering.

[0110] 17. The method of any preceding or following embodiment/feature/aspect, wherein the at least one anionic surfactant and the at least one amide of a carboxylic acid are added to the pulp in a weight ratio of from about 90:10 to about 10:90.

[0111] 18. The method of any preceding or following embodiment/feature/aspect, wherein the anionic surfactant is added to the pulp in an amount of from about 0.1 lb./ton dry fiber to about 10 lb./ton dry fiber, and the amide of a carboxylic acid is added to the pulp in an amount of from about 0.001 lb./ton dry fiber to about 2 lb./ton dry fiber.

[0112] 19. The method of any preceding or following embodiment/feature/aspect, wherein said cellulose-containing material is formed from hardwood chips, softwood chips, recycled paper fiber, or any combinations thereof.

[0113] 20. The method of any preceding or following embodiment/feature/aspect, wherein the combination of treating the pulp with the at least one anionic surfactant and at least one amide of a carboxylic acid before said dewatering is effective to provide at least one of the following:

[0114] (i) increased dewatering of a pulp slurry to a value which is at least 7.5% times greater than the amount of water removed obtained without any treatment in the pulp;

[0115] (ii) reduced foam height during said dewatering compared to foam height occurring with using the same anionic surfactant in the absence of said amide of a carboxylic acid.

[0116] 21. The method of any preceding or following embodiment/feature/aspect, wherein said method is effective for increasing obtained water removal to a value which is at least five times greater than the water removal obtained without any treatment of the pulp.

[0117] 22. A dewatered cellulosic containing material dewatered by the method of any preceding or following embodiment/feature/aspect, said dewatered cellulosic containing material comprising dewatered cellulosic containing material, said anionic surfactant and said amide of a carboxylic acid.

[0118] 23. The dewatered cellulosic containing material of any preceding or following embodiment/feature/aspect, wherein said dewatered cellulosic containing material is dewatered pulp or dewatered sludge.

[0119] The present invention can include any combination of these various features or embodiments above and/or below as set forth in sentences and/or paragraphs. Any combination of disclosed features herein is considered part of the present invention and no limitation is intended with respect to combinable features.

[0120] Applicant specifically incorporates the entire contents of all cited references in this disclosure. Further, when an amount, concentration, or other value or parameter is given as either a range, preferred range, or a list of upper preferable values and lower preferable values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or preferred value and any lower range limit or preferred value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the invention be limited to the specific values recited when defining a range.

[0121] Other embodiments of the present invention will be apparent to those skilled in the art from consideration of the present specification and practice of the present invention disclosed herein. It is intended that the present specification and examples be considered as exemplary only with a true scope and spirit of the invention being indicated by the following claims and equivalents thereof.

What is claimed is:

1. A method for dewatering a cellulose-containing material, said method comprising:

adding at least one anionic surfactant and at least one amide of a carboxylic acid to said cellulose-containing material to form a treated cellulose-containing material; and

dewatering said treated cellulose-containing material to provide a dewatered cellulose-containing material.

2. The method of claim **1**, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry.

3. The method of claim **1**, wherein said cellulose-containing material is a mat of cellulosic fibers.

4. The method of claim **1**, wherein said cellulose-containing material is a sludge from a paper and pulp manufacturing process.

5. The method of claim **1**, wherein said anionic surfactant and said amide of a carboxylic acid are added together to said cellulose-containing material.

6. The method of claim **1**, wherein said anionic surfactant and said amide of a carboxylic acid are separately added to said cellulose-containing material.

7. The method of claim **1**, wherein the anionic surfactant is an organic anionic surfactant.

8. The method of claim **1**, wherein said amide of a carboxylic acid comprises a dimethylamide of a fatty acid.

9. The method of claim **1**, wherein said amide of a carboxylic acid comprises a dimethylamide of a fatty acid having 14 to 18 carbon atoms.

10. The method of claim **1**, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry, and wherein said method further comprising bleaching the aqueous cellulosic pulp slurry after pulp forming and before the adding of the anionic surfactant and said amide of a carboxylic acid.

11. The method of claim **1**, wherein said cellulose-containing material is an aqueous cellulosic pulp slurry, and wherein said method further comprising thermally drying said cellulose-containing material that is dewatered to form market pulp.

12. The method of claim **1**, wherein the anionic surfactant is a sulfate surfactant, a sulfonate surfactant, a sulfosuccinate surfactant, or any combinations thereof.

13. The method of claim **1**, wherein the anionic surfactant is an alcohol sulfate, an alcohol alkoxy sulfate, a sulfonate, a dialkyl sulfosuccinate, a sulfosuccinic acid ester with an ethoxylated alcohol, or a soluble or dispersible salt thereof, or any combinations thereof.

14. The method of claim **1**, said method further comprising bleaching said cellulose-containing material before the adding of the at least one anionic surfactant and the at least one amide of a carboxylic acid.

15. The method of claim **1**, said method further comprising adding at least one enzyme to said cellulose-containing material before said dewatering step.

16. The method of claim **1**, wherein said amide of a carboxylic acid is added in an amount to control foam height during said dewatering.

17. The method of claim **1**, wherein the at least one anionic surfactant and the at least one amide of a carboxylic acid are added to the pulp in a weight ratio of from about 90:10 to about 10:90.

18. The method of claim **1**, wherein the anionic surfactant is added to the pulp in an amount of from about 0.1 lb./ton dry fiber to about 10 lb./ton dry fiber, and the amide of a carboxylic acid is added to the pulp in an amount of from about 0.001 lb./ton dry fiber to about 2 lb./ton dry fiber.

19. The method of claim **1**, wherein said cellulose-containing material is formed from hardwood chips, softwood chips, recycled paper fiber, or any combinations thereof.

20. The method of claim **1**, wherein the combination of treating the pulp with the at least one anionic surfactant and at least one amide of a carboxylic acid before said dewatering is effective to provide at least one of the following:

(i) increased dewatering of a pulp slurry to a value which is at least 7.5% times greater than the amount of water removed obtained without any treatment in the pulp;

(ii) reduced foam height during said dewatering compared to foam height occurring with using the same anionic surfactant in the absence of said amide of a carboxylic acid.

21. The method of claim **1**, wherein said method is effective for increasing obtained water removal to a value which is at least five times greater than the water removal obtained without any treatment of the pulp.

22. A dewatered cellulosic containing material dewatered by the method of claim **1**, said dewatered cellulosic containing material comprising dewatered cellulosic containing material, said anionic surfactant and said amide of a carboxylic acid.

23. The dewatered cellulosic containing material of claim **22**, wherein said dewatered cellulosic containing material is dewatered pulp or dewatered sludge.

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