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(54) **APPLICATION OF RETENTION, DRAINAGE, AND FORMATION (RDF) CHEMICAL AIDS AFTER A HEADBOX OF A PAPERMAKING PROCESS**

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(57) **ABSTRACT**

A method for improving RDF aids efficacy, paper machine performance and sheet properties formed during a papermaking process is disclosed. The methodology includes the following steps: (a) applying one or more RDF aids to the papermaking process to a point between after the headbox and on or before the first drainage element of a papermaking process.

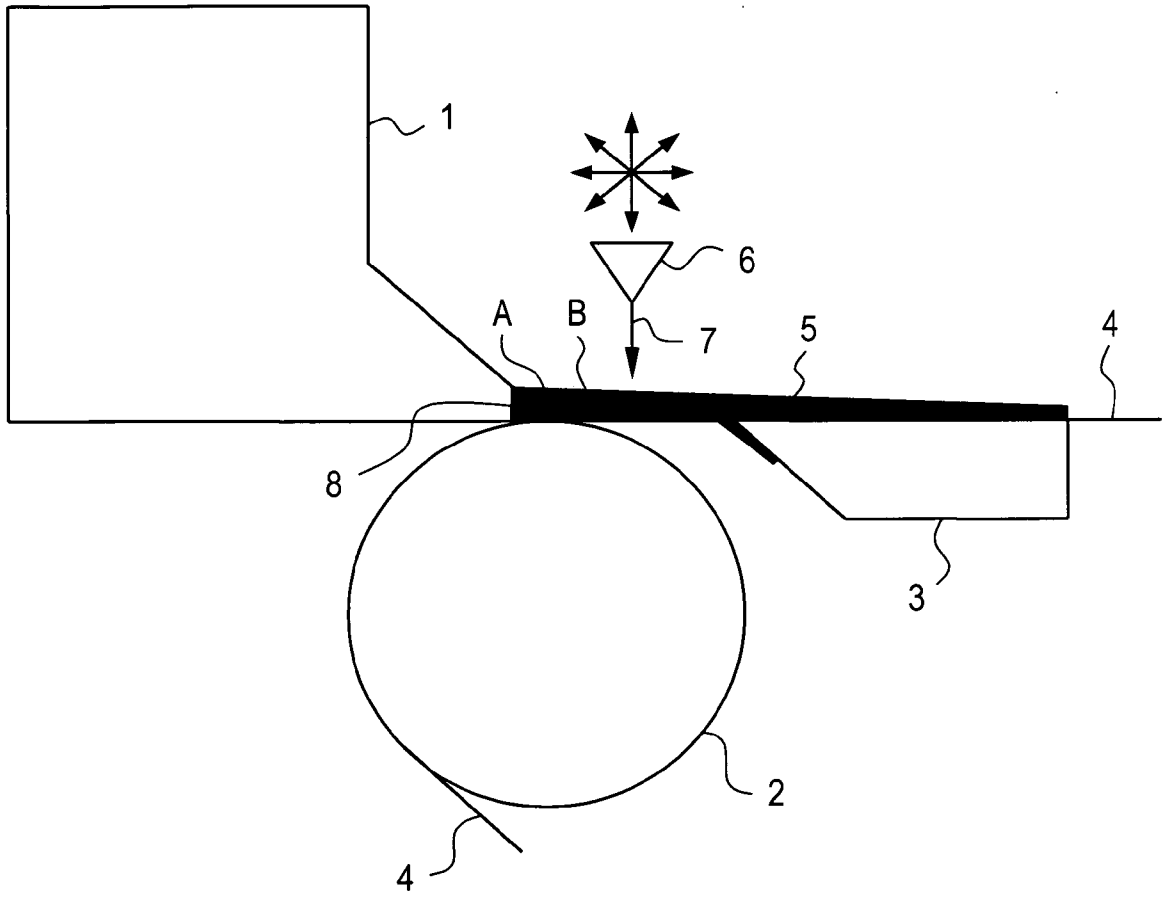


FIG. 1

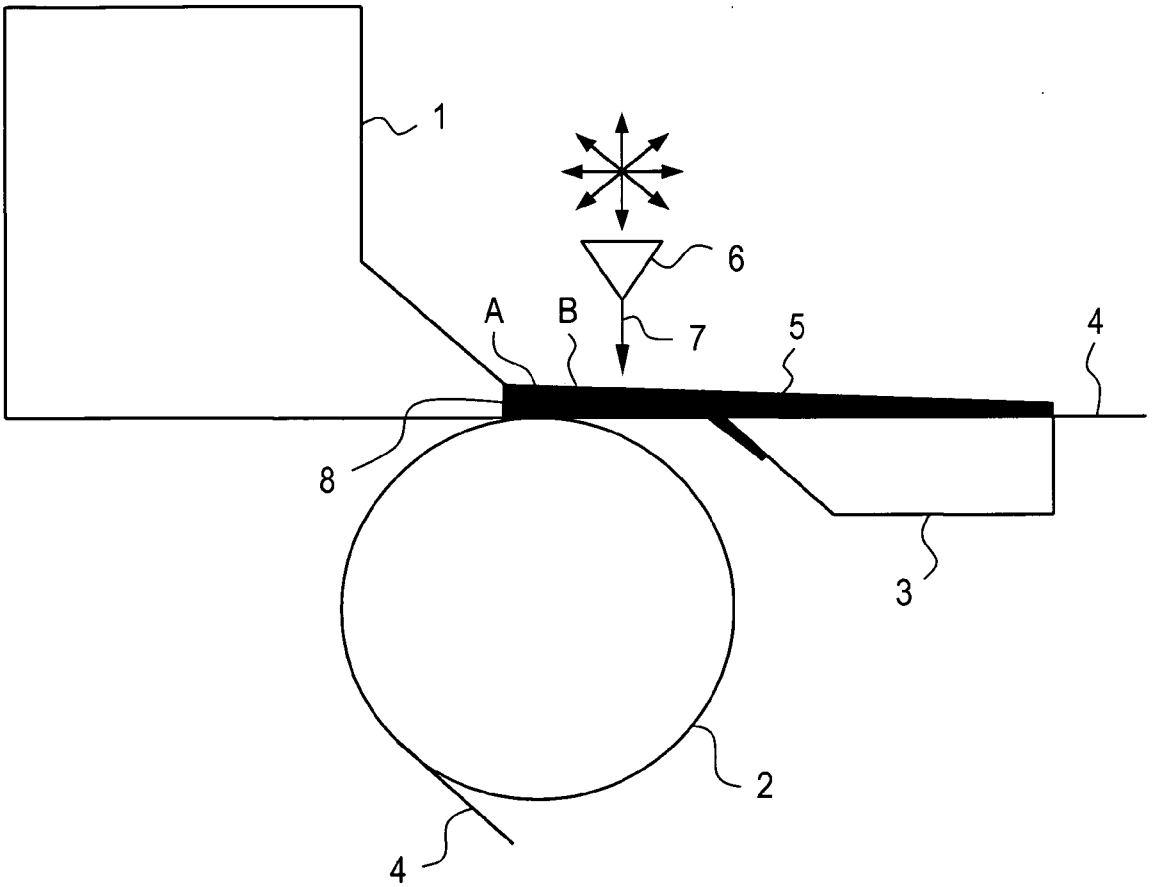


FIG. 2

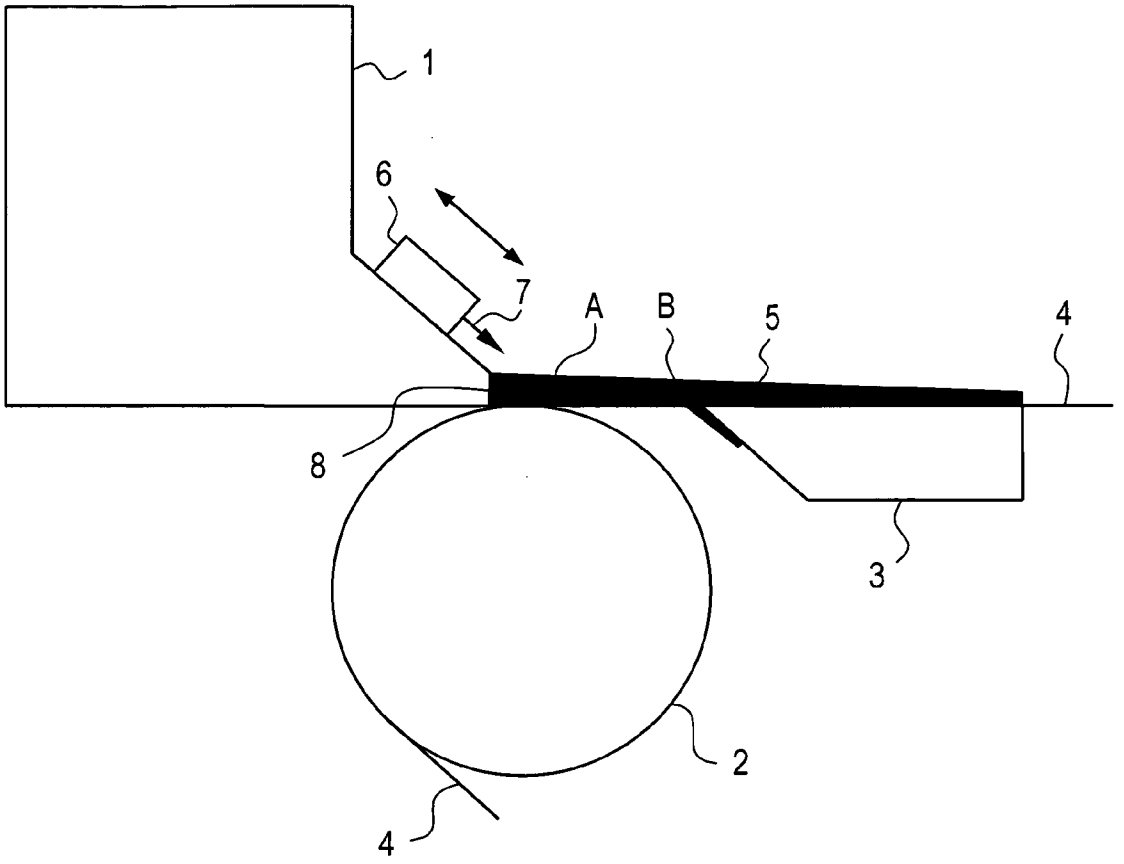


FIG. 3

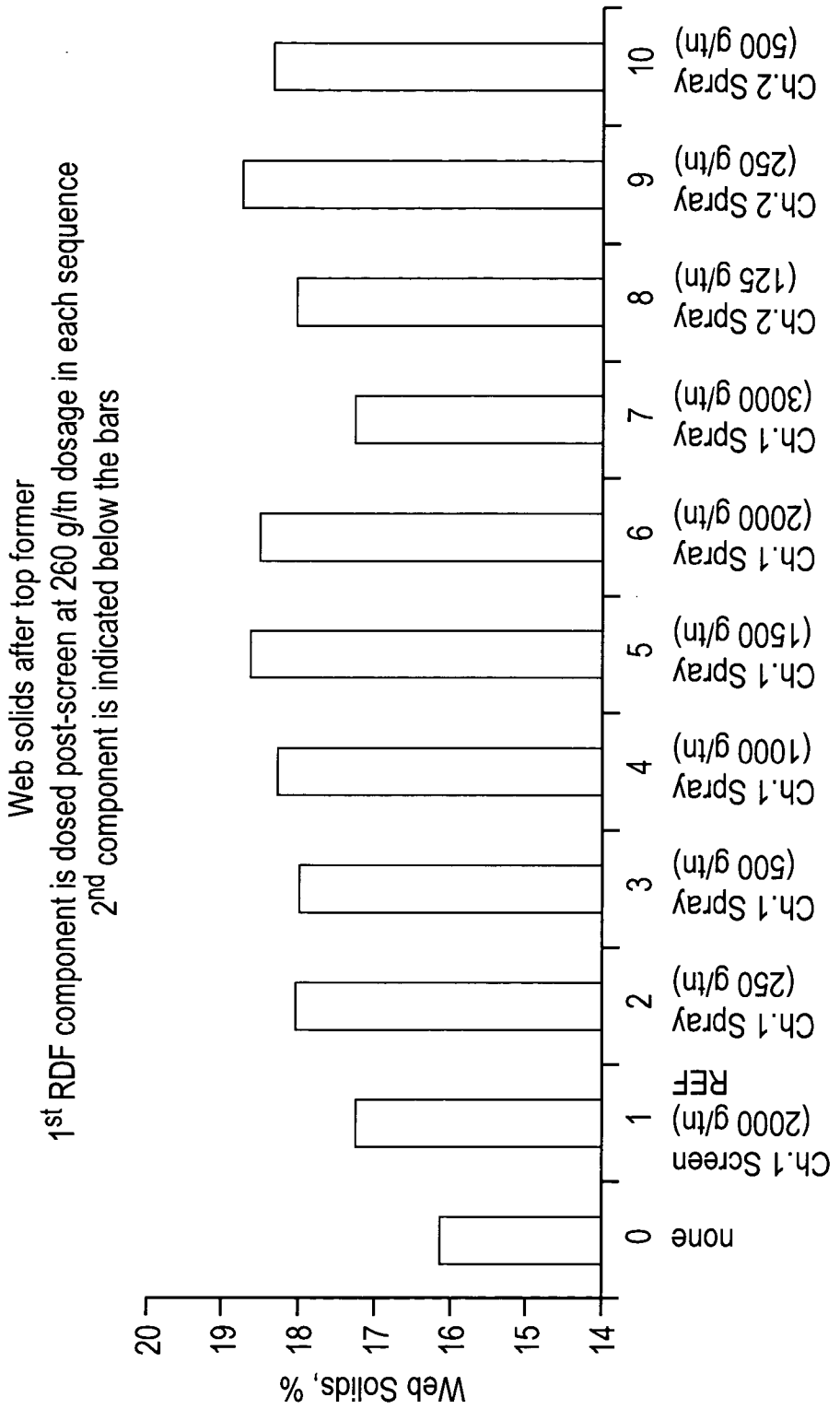
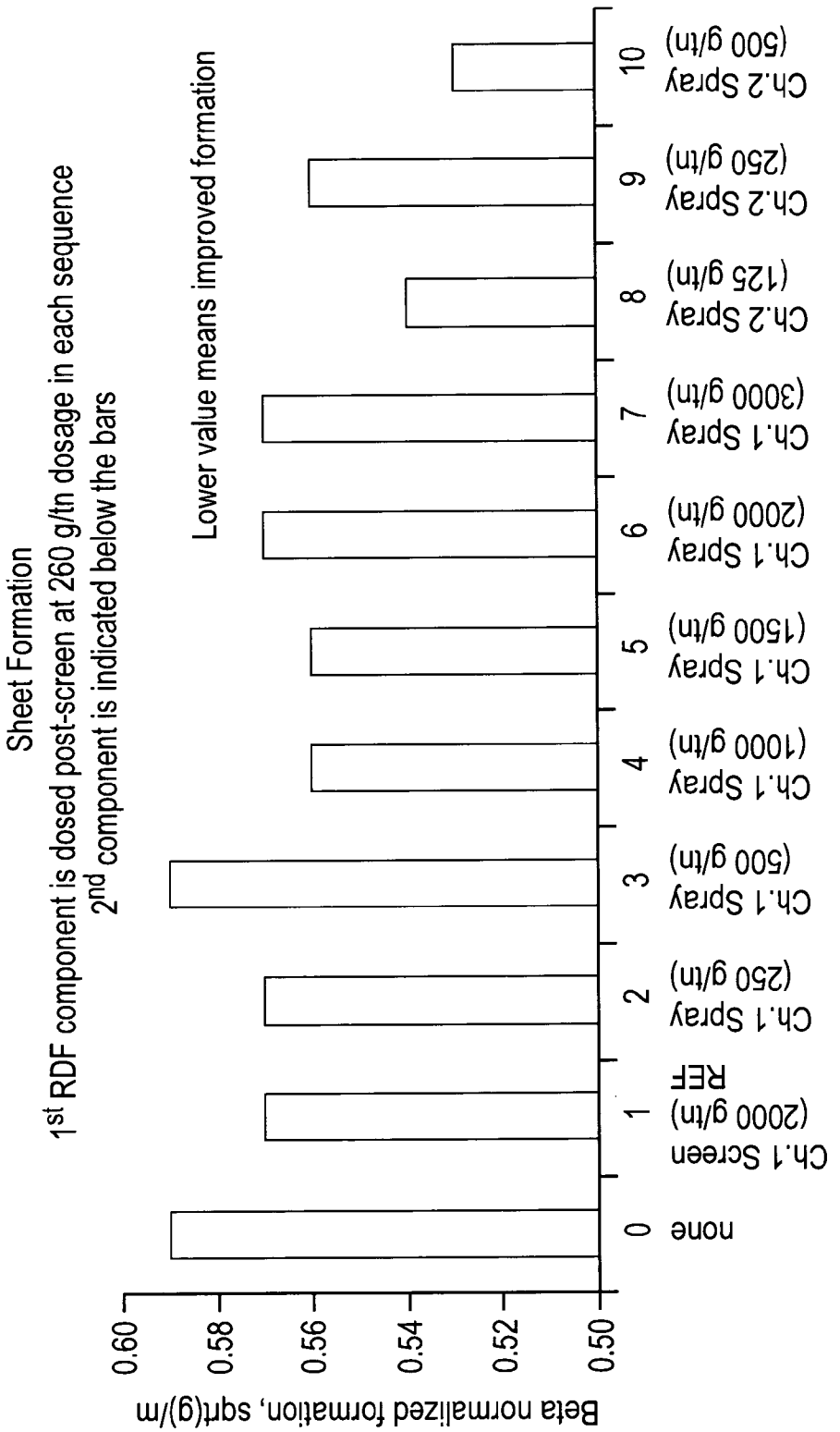

Web solids after top former
1st RDF component is dosed post-screen at 260 g/tn dosage in each sequence
2nd component is indicated below the bars
Web Solids, %
20
19
18
17
16
15
14
0 none
1 Ch.1 Screen (2000 g/tn) REF
2 Ch.1 Spray (250 g/tn)
3 Ch.1 Spray (500 g/tn)
4 Ch.1 Spray (1000 g/tn)
5 Ch.1 Spray (1500 g/tn)
6 Ch.1 Spray (2000 g/tn)
7 Ch.1 Spray (3000 g/tn)
8 Ch.2 Spray (125 g/tn)
9 Ch.2 Spray (250 g/tn)
10 Ch.2 Spray (500 g/tn)

FIG. 4


Sheet Formation
1st RDF component is dosed post-screen at 260 g/tn dosage in each sequence
2nd component is indicated below the bars
Lower value means improved formation
Beta normalized formation, sqrt(g)/m
0.60
0.58
0.56
0.54
0.52
0.50
0 none
1 Ch.1 Screen (2000 g/tn) REF
2 Ch.1 Spray (250 g/tn)
3 Ch.1 Spray (500 g/tn)
4 Ch.1 Spray (1000 g/tn)
5 Ch.1 Spray (1500 g/tn)
6 Ch.1 Spray (2000 g/tn)
7 Ch.1 Spray (3000 g/tn)
8 Ch.2 Spray (125 g/tn)
9 Ch.2 Spray (250 g/tn)
10 Ch.2 Spray (500 g/tn)

APPLICATION OF RETENTION, DRAINAGE, AND FORMATION (RDF) CHEMICAL AIDS AFTER A HEADBOX OF A PAPERMAKING PROCESS

BACKGROUND OF THE INVENTION

[0001] RDF (retention, drainage and formation aids) affect the phenomena that take place in the wet end operations of a paper machine of a papermaking process. The effect is based on electrochemical interactions between oppositely charged chemicals and furnish components. Typically electrochemical reactions are assumed to be infinitely fast, hence, chemical kinetics can usually be assumed to be of minor interest. Therefore, the residence time for RDF aids to take an effect is usually limited by physical mixing.

[0002] Introduction of RDF aids into the flowing suspension of a papermaking furnish in an approach system of a paper machine is challenging due to a relative small amount of RDF aids to be mixed in a large flow of furnish. The typical ratio to be mixed is an order of magnitude of 1:1000. On the other hand, mixing should be as rapid as possible to minimize the RDF deactivation due to: a) local overdose because of improper mixing, b) polymer adsorption along with time and, and c) shear effects caused by the approach system pipe and related components, e.g. pumps, pressure screens and headbox.

[0003] In a conventional RDF system all components are dosed before the headbox. The most common dosing point for the first component (e.g. cationic flocculant) has been traditionally before the headbox fan pump or a pressure screen, mainly to break-up the flocs and improve the mixing profiles, while the other RDF aid components (e.g. anionic and/or cationic microparticle) are usually dosed post-screen. Other alternatives of dosing the RDF system components and order of dosing is also very common, like for example, dosing all the components between the pressure screen and the headbox, or dosing one component into the pressure screen. In paper machines, a typical residence time from the RDF aid dosing point to the headbox is between 2 and 10 seconds. When exposed to shear in the pump/screen, the RDF aid's induced formed fiber flocs will break up. As the system is allowed to reflocculate again, the bridging mechanisms of other RDF components dosed post-screen is believed to maintain the same structure as in the initial flocculated state. The main effect is that the retention and drainage responses are the same as those before the shear. The drawback may be an increased RDF aids consumption in order to reach the target retention or to compensate the losses in chemical performance due to high shear conditions in the screen or fan pump. The term "chemical performance" in this context means when the effect of an RDF aid is maximized, i.e., when for the given dosage, the retention and drainage is improved, while the formation is deteriorated.

[0004] Long residence times of RDF aids from the dosing point to the forming section makes also the control of RDF chemistry more challenging. In addition, the possibility to affect a specific sheet property decreases if the distance between the feeding location and the former section where the sheet properties are mainly fixed is long. Hence, in many cases it has been observed that closer or even direct feed into the headbox increases the performance, meaning increased retention, drainage and floe size due to RDF aid effect.

[0005] There are several existing technologies to introduce RDF aids into the headbox, like using the dilution headbox stream or special channels inside the headbox installed hardware. The use of dilution stream concept is not preferred as the anionic dilution streams reduces the performance of cationic RDF aids and limits the application only to anionic RDF aids. In addition, a dilution stream is applied in the headbox to decrease the basis weight locally, i.e. to control the basis weight profile variation. The response from each individual dilution valve is partly hindered if RDF aids are applied with the dilution stream due to increased local retention, i.e. increased basis weight. The hardware modifications of a headbox are not preferred due to the relative high investment costs and long shut down periods for installations and risks involved to affect negatively the operation of the head box. A more facile manner of adding RDF aids is desired—e.g. a method of enhancing the performance of one or more retention, drainage, and/or formation aids that are applied to a papermaking process.

BRIEF DESCRIPTION OF THE FIGURES

[0006] FIG. **1** shows a schematic of a headbox and initial part of the forming section of a papermaking process; the schematic shows various points between the headbox and first drainage element, including points of application for RDF aids.

[0007] FIG. **2** shows a non-contact applicator for RDF chemical aid feed using a modified headbox top slice cover as an application bar for RDF aid.

[0008] FIG. **3** shows paper web's solids content after top former of a forming section for different dosing concepts, RDF aid types and dosage amounts. The web drainage, i.e. the solid content is measured with a portable drainage analyzer.

[0009] FIG. **4** shows sheet's small-scale basis weight variation, i.e. sheet uniformity or formation for different dosing concepts, RDF aid types and dosage amounts. The sheet formation was determined by a beta-formation tester.

SUMMARY OF THE INVENTION

[0010] This disclosure pertains to a method of applying one or more retention, drainage, and/or formation aids to a papermaking process comprising: applying said aids between a headbox slice opening and a first drainage element of said papermaking process.

[0011] This disclosure also pertains to a method of improving sheet and/or web properties formed from a cellulosic suspension of a papermaking process: providing one or more retention, drainage, and/or formation aids; applying said aids between a headbox slice opening and a first drainage element of said papermaking process; optionally performing one or more measurements of the retention and/or drainage of a forming section of a papermaking process and/or formation properties of a sheet and/or web of said papermaking process; optionally wherein a plurality of said measurements provide a cross-directional profile of said web and/or said sheet properties in said papermaking process; and optionally controlling said web and/or sheet properties by adjusting the application of said aids to the papermaking process in response to said one or more measurements.

[0012] This disclosure also pertains to a method to activate a papermaking process chemical program containing a plurality of chemical components that are applied to said papermaking process comprised of: applying a first chemical component before a headbox slice opening and wherein a second

chemical component is applied between headbox slice opening and a first drainage element of a papermaking process.

DETAILED DESCRIPTION OF THE INVENTION

Definitions:

[0013] "Papermaking process"/"papermaking processes" refer to a method(s) of making any kind of paper products (e.g. paper, tissue, board, etc.) from pulp comprising forming an aqueous cellulosic papermaking furnish, draining the furnish to form a sheet and drying the sheet. The steps of forming the papermaking furnish, draining and drying may be carried out in any manner known to those skilled in the art. The papermaking process/processes may also include a pulping stage, e.g. making pulp from wood and/or non-wood raw material and bleaching stage, e.g. chemical treatment of the pulp for brightness improvement.

[0014] "Wet end" refers to papermaking process operations in the approach system, sheet forming section and pressing section.

[0015] "Sheet"/"sheets" refer to sheet(s) formed as a result of or during a papermaking process/papermaking processes.

[0016] "RDF aids" include one of more retention, drainage, and/or formation aids. One of ordinary skill in the art would be knowledgeable of the metes and bounds of what is meant by retention, drainage, and formation aids. The scope of RDF aids include what is currently available and what is later developed after the filing date of this disclosure, because this disclosure is not directed to RDF aid chemistries per se, but is directed to a selected methodology of applying RDF aid chemistry to a papermaking process.

[0017] The selection and application scheme of retention, drainage, and/or formation aids or a combination thereof, which is appropriate for a papermaking process, would be appreciated by one of ordinary skill in the art. By choosing various RDF aid chemistries and schemes for applying these chemistries, the process parameters, e.g. retention and/or drainage and sheet structural and physical properties, e.g. formation, Z-directional filler distribution, manual basis weight and/or moisture can be controlled.

[0018] How much RDF aid is added to a papermaking process depends on various factors, which would be appreciated by one of ordinary skill in the art. For example, factors such as the type of papermaking process, e.g. board, paper sheet, or tissue may impact the amount of chemistry added to a papermaking process.

[0019] In one embodiment, one or more flocculants are added in the range 500-1500 grams/ton (g/tn) (as product) and preferably 250-1000 g/tn (as product).

[0020] In another embodiment, the microparticles are added in the range of 1000-5000 (g/tn) and preferably 500-3000 g/tn.

[0021] Examples of RDF aids include, but are not limited to, coagulants and flocculants with different molecular weight, charge (e.g. cationic or anionic) and strength, inorganic and organic microparticles/micropolymers with different molecular weight, charge (e.g. anionic and/or cationic) and strength.

A. Effective Application of RDF Aids

[0022] As stated above, the RDF aids are applied between a headbox slice opening and a first drainage element of a papermaking process.

[0023] In one embodiment, the aids are applied to a papermaking process location that is approximate to a headbox slice opening. In a further embodiment, proximate refers to a distance from 0 cm to about 20 cm. In a further embodiment, proximate refers to a distance is from 0 cm to about 10 cm.

[0024] In another embodiment, the RDF aids are applied to a headbox free jet of a papermaking process. One of ordinary skill in the art would appreciate the scope of what is meant by a free jet of a papermaking process, e.g. a free jet is the fluid that flows out from the headbox, typically the free jet is 5 cm in length from the headbox and can be 2 cm in height, depending upon the slice opening that is associated with the headbox.

[0025] In another embodiment, the RDF aids are applied to a reflocculation region prior to when a paper web is formed. One of ordinary skill in the art would appreciate the scope of what is meant by a reflocculation region of a papermaking process, e.g. a reflocculation region is typically the area between 0 cm (at exit point) and 20 cm from the headbox in the direction of the forming wire. In another embodiment, the aids are selected from the group consisting of: anionic particles, cationic particles, particles with anionic and cationic sites, flocculants, coagulants and a combination thereof.

[0026] In another embodiment, the papermaking process contains a foudrinier paper machine.

[0027] In another embodiment, the papermaking process contains a gap forming paper machine.

[0028] The application of the RDF aids to the papermaking process can take place in various ways, e.g. non-contact ways or through a non-contact applicator, which would be appreciated by one of ordinary skill in the art.

[0029] In one embodiment, the aids are applied to said papermaking process by a spray bar, optionally wherein the spray bar is installed onto a headbox top slice cover.

[0030] In another embodiment, the aids are applied to said papermaking process by a curtain applicator.

[0031] In another embodiment, the aids are applied to a papermaking process by using a slice blade, which is associated with the papermaking process.

[0032] In another embodiment, the methodology further comprises adding RDF aids to an additional area of the papermaking process aside from between a headbox slice opening and a first drainage element. These areas include typical application areas, including, but not limited to, the dilution headbox stream or channels inside the headbox installed hardware.

B. Improving Sheet and Web Quality

[0033] The application of RDF aids between a headbox slice opening and a first drainage element of said papermaking process can be utilized to improve sheet qualities, e.g. the improvement in sheet and/or web properties can result in a given amount of chemicals imparting a better sheet/web property compared to a situation when the chemicals are added only to an area before the free jet, e.g. into dilution lines leading to the headbox and/or the headbox itself.

[0034] This disclosure, therefore, can encompass a method of improving sheet and/or web properties formed from a cellulosic suspension of a papermaking process. The method comprises: providing one or more retention, drainage, and/or formation aids; applying said aids between a headbox slice opening and a first drainage element of said papermaking process; optionally performing one or more measurements of the retention and/or drainage of a forming section of a papermaking process and/or formation properties of a sheet and/or

web of said papermaking process; optionally wherein a plurality of said measurements provide a cross-directional profile of said web and/or said sheet properties in said papermaking process; and optionally controlling said web and/or sheet properties by adjusting the application of said aids to the papermaking process in response to said one or more measurements.

[0035] In one embodiment, the aids are applied to a papermaking process location that is proximate to a headbox slice opening. In a further embodiment, proximate refers to a distance from 0 cm to about 20 cm. In a further embodiment, proximate refers to a distance from 0 cm to 10 cm.

[0036] In another embodiment, the RDF aids are applied to a headbox free jet of a papermaking process. One of ordinary skill in the art would appreciate the scope of what is meant by a free jet of a papermaking process, e.g. a free jet is the fluid that flows out from the headbox, typically the free jet is 5 cm in length from the headbox and can be 2 cm in height, depending upon the slice opening that is associated with the headbox.

[0037] In another embodiment, the RDF aids are applied to a reflocculation region prior to when a paper web is formed. One of ordinary skill in the art would appreciate the scope of what is meant by a reflocculation region of a papermaking process, e.g. a reflocculation region is typically the area between 0 cm (at exit point) and 20 cm from the headbox in the direction of the forming wire.

[0038] In another embodiment, the aids are selected from the group consisting of: anionic particles, cationic particles, particles with anionic and cationic sites, flocculants, coagulants and a combination thereof.

[0039] In another embodiment, the papermaking process contains a foudrinier paper machine.

[0040] In another embodiment, the papermaking process contains a gap forming paper machine.

[0041] The application of the RDF aids to the papermaking process can take place in various ways, e.g. non-contact ways or through a non-contact applicator, which would be appreciated by one of ordinary skill in the art.

[0042] In one embodiment, the aids are applied to said papermaking process by a spray bar, optionally wherein the spray bar is installed onto a headbox top slice cover.

[0043] In another embodiment, the aids are applied to said papermaking process by a curtain applicator.

[0044] In another embodiment, the aids are applied to a papermaking process by using a slice blade, which is associated with the papermaking process.

[0045] In another embodiment, the methodology further comprises adding RDF aids to an additional area of the papermaking process aside from between a headbox slice opening and a first drainage element. These areas include typical application areas, including, but not limited to, the dilution headbox stream or channels inside the headbox installed hardware of said papermaking process.

[0046] In another embodiment, the methodology provides for performing the measurement of the retention and/or drainage of a forming section and/or formation properties of the sheet and/or web and optionally wherein a plurality of said measurement(s) provide a cross-directional profile of said web and/or said sheet properties in said papermaking process.

[0047] In a further embodiment, the plurality of measurements of the sheet properties (e.g. formation, ash, and air permeability) is practically done by taking a dry-sheet CD strip from the reel and the properties are measured in the lab.

[0048] In another embodiment, the web profile allows an operator to control the distribution of chemicals added to a web/sheet and pinpoint the application of chemical in one area over the other to produce a sheet that has an even application of chemicals, e.g. RDF aids, applied to it.

[0049] In a further embodiment, the basis weight CD profile is controlled.

[0050] In a further embodiment, the ash CD profile is controlled.

[0051] In a further embodiment, the sheet formation CD profile is controlled.

[0052] In a further embodiment, the sheet permeability CD profile is controlled.

C. Program Management

[0053] This disclosure, also encompasses, a method to activate a papermaking process chemical program containing a plurality of chemical components that are applied to said papermaking process comprised of: applying a first chemical component before a headbox slice opening and wherein a second chemical component is applied between headbox slice opening and a first drainage element of a papermaking process.

[0054] In one embodiment, the second chemical component is applied to forming wire that contains a papermaking furnish and wherein said application is optionally applied across the whole forming wire width.

[0055] In another embodiment, the aids are applied to a papermaking process location that is proximate to a headbox slice opening. In a further embodiment, proximate refers to a distance from 0 cm to about 20 cm. In a further embodiment, proximate refers to a distance from 0 cm to 10 cm.

[0056] In another embodiment, the RDF aids are applied to a headbox free jet of a papermaking process. One of ordinary skill in the art would appreciate the scope of what is meant by a free jet of a papermaking process, e.g. a free jet is the fluid that flows out from the headbox, typically the free jet is 5 cm in length e.g. a free jet is the fluid that flows out from the headbox, typically the free jet is 5 cm in length from the headbox and can be 2 cm in height, depending upon the slice opening that is associated with the headbox.

[0057] In another embodiment, the RDF aids are applied to a reflocculation region prior to when a paper web is formed. One of ordinary skill in the art would appreciate the scope of what is meant by a reflocculation region of a papermaking process, e.g. a reflocculation region is typically the area between 0 cm (at exit point) and 20 cm from the headbox in the direction of the forming wire.

[0058] In another embodiment, the aids are selected from the group consisting of: anionic particles, cationic particles, particles with anionic and cationic sites, flocculants, coagulants and a combination thereof.

[0059] In another embodiment, the papermaking process contains a foudrinier paper machine.

[0060] In another embodiment, the papermaking process contains a gap forming paper machine.

[0061] The application of the RDF aids to the papermaking process can take place in various ways, e.g. non-contact ways or through a non-contact applicator, which would be appreciated by one of ordinary skill in the art.

[0062] In one embodiment the aids are applied to said papermaking process by a spray bar, optionally wherein the spray bar is installed onto a headbox top slice cover.

[0063] In another embodiment, the aids are applied to said papermaking process by a curtain applicator.

[0064] In another embodiment, the methodology further comprises adding RDF aids to an additional area of the papermaking process aside from between a headbox slice opening and a first drainage element. These areas include typical application areas, including, but not limited to, the dilution headbox stream or channels inside the headbox installed hardware.

EXAMPLES

[0065] FIGS. **1** and **2** show a schematic of a section of a papermaking process between the headbox and the first drainage element. The following legend applies to both FIG. **1** and FIG. **2**: (1) headbox; (2) breast roll; (3) drainage element; (4) forming Wire; (5) papermaking furnish; (6) non-contact applicator; (7) RDF aid(s); (8) slice opening; (A) free jet; and (B) reflocculation region.

[0066] FIG. **1** shows the application of a non-contact applicator for RDF chemical aid(s) feed after the headbox. The application can be, for example, by spraying via a curtain application or other non-contact means. The applicator's position in regards to the forming web can be adjusted.

[0067] FIG. **2** shows a non-contact applicator for a RDF chemical aid feed using the modified headbox top slice cover as an application bar for the RDF aid.

[0068] FIGS. **3** and **4** show the results from a mill trial in which the second component of a chemical program was dosed in different amounts, in a typical way (before headbox) and through a non-contact applicator after the headbox (in this case with a spray bar). The first component of a program was dosed between the pressure screen and a headbox at constant dosage for each sequence.

[0069] Compared to the typical dosing (both chemical components are dosed before headbox into screen and post-screen), the following can be observed.

[0070] FIGS. **3** and **4** show the performance of RDF aids, which are applied at the screen (REF)/post-screen, before the headbox of a papermaking process, and after the headbox of a papermaking process. A 1^{st} RDF component/aid is sprayed before the headbox, post-screen, and a 2^{nd} RDF component/aid, categorized by Chemical 1 or Chemical 2, are applied after the headbox.

[0071] FIG. **3** shows results from a trial that looked at web solids after the top former of a papermaking process. It is clear from FIG. **3** that the spraying of Chemical 1 (no. 4) after the headbox improved the web solids from the reference REF. The REF (no. 1) doses Chemical 1 before the headbox and that is compared to added Chemical 1 after the headbox (nos. 2-7) and Chemical 2 (nos. 9-10), which is added after the headbox as well. Chemical 1 is added by at least 1% units of web dry solids and Chemical 2 by at least 1.5% units of web dry solids, which can be regarded as significant.

[0072] With reference to FIG. **3**, as a rule of thumb, a 1% web dryness increase of Chemical 1 roughly means an increase in dryness after the press of 2% and after drying 8% units, meaning that less drying energy is required to achieve the desired final sheet dryness, or alternatively, the machine speed can be increased and get more production. Another benefit is Chemical 1's dosage reduction by at least 50% from the REF (1000 grams/ton (g/t) vs 2000 g/t, respectively).

[0073] FIG. **4** shows results from a trial that looked at sheet formation of a papermaking process. The formation was indicated as a small-scale basis weight variation normalized to the basis weight. The lower the value in the Y-axis of the graph means an improved function of sheet formation. FIG. **4** shows a slight improvement of sheet formation (e.g. concepts no. 4-Chemical 1 and more significant in the case of no. 10-Chemical 2), which is achieved by spraying Chemical 2 of the RDF program compared to the REF.

We claim:

1. A method of applying one or more retention, drainage, and/or formation aids to a papermaking process comprising: applying said aids between a headbox slice opening and a first drainage element of said papermaking process.

2. The method of claim **1**, wherein said aids are applied to a papermaking process location that is proximate to a headbox slice opening.

3. The method of claim **2**, wherein said proximate refers to a distance from 0 cm to about 20 cm.

4. The method of claim **2**, wherein said proximate refers to a distance from 0 cm to about 10 cm.

5. The method of claim **1**, wherein the aids are selected from the group consisting of: anionic particles, cationic particles, particles with anionic and cationic sites, flocculants, coagulants and a combination thereof.

6. The method of claim **1**, wherein said papermaking process contains a foudrinier paper machine.

7. The method of claim **1**, wherein said papermaking process contains a gap forming paper machine.

8. The method of claim **1**, wherein said aids are applied to said papermaking process by a spray bar, optionally wherein the spray bar is installed onto a headbox top slice cover.

9. The method of claim **1**, wherein said aids are applied to a papermaking process by using a slice blade, which is associated with the papermaking process.

10. A method of improving sheet and/or web properties formed from a cellulosic suspension of a papermaking process: providing one or more retention, drainage, and/or formation aids; applying said aids between a headbox slice opening and a first drainage element of said papermaking process; optionally performing one or more measurements of the retention and/or drainage of a forming section of a papermaking process and/or formation properties of a sheet and/or web of said papermaking process; optionally wherein a plurality of said measurements provide a cross-directional profile of said web and/or said sheet properties in said papermaking process; and optionally controlling said web and/or sheet properties by adjusting the application of said aids to the papermaking process in response to said one or more measurements.

11. A method to activate a papermaking process chemical program containing a plurality of chemical components that are applied to said papermaking process comprised of: applying a first chemical component before a headbox slice opening and wherein a second chemical component is applied between a headbox slice opening and a first drainage element of a papermaking process.

12. The method of claim **11**, wherein said second chemical component is applied to a forming wire that contains a papermaking furnish and wherein said application is optionally applied across the whole forming wire width.

* * * * *