METHOD AND PLANT FOR PRODUCING A FIBROUS WEB

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ABSTRACT

The present invention relates to a method and a corresponding plant for producing a fibrous web, in particular a paper web, paperboard web or tissue web. The formation of the fibrous web is defined online as a controlled variable and is held at a preselectable set-point level by way of an automatic formation control system.
METHOD AND PLANT FOR PRODUCING A FIBROUS WEB

FIELD OF THE INVENTION

[0001] This invention relates to a method and an industrial plant for the production of a fibrous web, which can be in particular a paper web, paperboard web or tissue web.

DESCRIPTION OF THE RELATED ART

[0002] The formation of a paper web or paperboard web, for example, is a decisive quality feature that influences the further processing of the fibrous web in many different ways. An example is the influence exerted by the formation on the strength and printability of the finished product.

[0003] The formation of a paper web or paperboard web, for example, is influenced on the one hand by the raw material used and on the other hand, to a not inconsiderable extent, by the sheet forming. In this case the sheet forming is defined by the headbox and the forming unit. The forming unit can be a long mesh, a hybrid former or a modern twin wire former.

[0004] The variables which influence the formation in this process step can be the material density, vacua in the forming unit, the retention and the water quantity for example, as was determined during the operation of production and test paper machines for example.

[0005] Experience indicates that even slight changes in the composition and properties of the fibrous material used can exert considerable influence on the formation. Also, every change to the gsm mass of a paper web requires readjustment of the variables which exert an influence on the formation.

[0006] For the reasons mentioned, the formation is subject to constant fluctuations. These formation fluctuations are particularly pronounced in particular on products containing old paper, which is owed to the corresponding fluctuations of the raw material composition.

[0007] A comparison of the formation producible on average over a long period of time on production machines with that on test machines reveals that it is nearly always possible to produce a far better formation on the test machines. The reason for this lies in the experience of the operating personnel and their constant readiness to make optimizing interventions. Hence time and again production machines have been shown to possess considerable potential for improvement with regard to the formation.

[0008] What is needed in the art is an improved method and an improved plant of the type initially referred to, with which the formation, in particular on production machines, can be stabilized at a higher level. In this case the results are to be optimized in terms of an improved and more uniform printability, so-called mottling for example, higher strength, etc.

SUMMARY OF THE INVENTION

[0009] The present invention provides a method for producing a fibrous web, in particular a paper web, paperboard web or tissue web, with which the formation of the fibrous web is defined online as a controlled variable and is held at a preselectable set-point level by way of an automatic formation control system.

[0010] On a practical embodiment of the method according to the invention, the formation is defined directly. This is done by way of at least one formation sensor.

[0011] Alternatively or in addition, it is advantageously possible for the formation to be defined also indirectly by way of at least one auxiliary variable. The water quantity in the bar section of the forming unit can be measured as the auxiliary variable for indirectly defining the formation.

[0012] It is expedient for the formation to be held at the preselectable set-point level by a corresponding change of one or more set-point variables.

[0013] In this case the material density is changed accordingly in order to hold the formation at the preselectable set-point level.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a schematic of a first embodiment of the automatic formation control system according to the present invention; and

[0015] FIG. 2 is a schematic of a second embodiment of the automatic formation control system according to the present invention.

[0016] Corresponding reference characters indicate corresponding parts throughout the views. The exemplifications set out herein illustrate two embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0017] According to an advantageous embodiment of the inventive method it is possible, alternatively or in addition, for at least the material density also to be changed accordingly in order to hold the formation at the preselectable set-point level.

[0018] It can also be an advantage, alternatively or in addition, for at least the retention to be changed accordingly in order to maintain a preselectable set-point level of the formation.

[0019] According to another expedient embodiment it is possible, alternatively or in addition, for the opening cross-section of the outlet gap of the headbox nozzle also to be changed accordingly in order to hold the formation at the preselectable set-point level.

[0020] Alternatively or in addition it is advantageously possible for one or more vacua in the region of the forming unit also to be changed accordingly in order to maintain the preselectable set-point level of the formation.

[0021] It is also an advantage, alternatively or in addition, for one or more bar pressures in the region of the forming unit also to be changed accordingly in order to hold the formation at the preselectable set-point level.

[0022] According to another advantageous embodiment of the inventive method, provision is made, alternatively or in addition, for at least the wrap angle, through which the fibrous web is conveyed over a curved surface such as in
particular a forming roller, to be changed accordingly in order to hold the formation at the preselectable set-point level.

Alternatively or in addition it is advantageous for at least the mesh tension, with which an in particular outer lying dewatering mesh is conveyed over a curved path, such as a forming roller or the like, to be changed accordingly in order to hold the formation at the preselectable set-point level.

In particular in order to at least reduce any negative influence on other important properties of the fibrous web, which are closely related to the formation, it is advantageous for the actuating range of at least one set-point variable to be limited to a preselectable extent.

For this purpose, the value of at least one auxiliary variable can be measured and the actuating range limited as a factor of the measured value of this auxiliary variable.

For this purpose the dry content of the fibrous web downstream from the forming unit is measured as the auxiliary variable. Alternatively or in addition it is expediently possible also for a value representative of the web take-off from in particular a central roller to be measured as the auxiliary variable.

An alarm is triggered upon reaching at least one preselectable limit of the actuating range of at least one set-point variable.

It is a particular advantage for formation of the fibrous web to be defined at the exit of the forming unit. By the formation being defined already at the exit of the forming unit and not until at the end of the production machine, e.g. a paper machine, the dynamic response of the control circuit is notably increased by the correspondingly reduced dead time.

According to a practical embodiment of the inventive method, at least one formation value defined online is entered into a controller for controlling the formation, and the formation is held at the preselectable set-point level by way of the controller through accordingly changing one or more set-point variables.

Expediently the value of at least one auxiliary variable is entered in addition into the controller in order to limit the actuating range of at least one set-point variable as a factor thereof.

Advantageously at least one PID controller is used.

Alternatively or in addition to the simple control concept, for example on the basis of at least one PID controller, the use of at least one state controller and/or the use of at least one controller with at least one self-learning control algorithm is advantageously possible, which particularly with regard to the complexity of the relationships in the formation control in question is a great advantage.

To improve the quality of the control, at least one so-called soft sensor is used to define the formation and/or to measure at least one auxiliary variable. Such a soft sensor is used as a rule to calculate non-measurable variables by way of measurable variables.

Furthermore, an industrial plant for producing a fibrous web, in particular a paper web, paperboard web or tissue web, is provided having an automatic formation control system with which the formation of the fibrous web is defined online as a controlled variable and is held at a preselectable set-point level.

The plant has a way for directly defining the formation. In this case it is expediently possible for these ways to include in particular at least one formation sensor.

Alternatively or in addition it is advantageously possible also to provide a way for indirectly defining the formation by way of at least one auxiliary variable. In this case these ways for indirectly defining the formation include ways for measuring the water quantity in the bar section of the forming unit.

Expediently one or more set-point variables can be changed by way of the automatic formation control in order to hold the formation at the preselectable set-point level.

In this case it is advantageous for at least the material density to be accordingly changeable by way of the automatic formation control in order to hold the formation at the preselectable set-point level.

Alternatively or in addition it is expedient for at least the retention also to be accordingly changeable by way of the automatic formation control in order to hold the formation at the preselectable set-point level.

It is also an advantage, alternatively or in addition, in particular for at least the opening cross-section of the outlet gap of the headbox nozzle also to be accordingly changeable by way of the automatic formation control in order to maintain the preselectable set-point level.

Alternatively or in addition it is expedient for one or more vacua in the region of the forming unit also to be accordingly changeable by way of the automatic formation control in order to hold the formation at the preselectable set-point level.

Alternatively or in addition it can also be an advantage for one or more bar pressures in the region of the forming unit to be accordingly changeable by way of the automatic formation control in order to maintain the preselectable set-point level.

Alternatively or in addition it is possible according to another advantageous embodiment of the inventive method for at least the wrap angle, through which the fibrous web is conveyed over a curved surface such as in particular a forming roller or the like, to be accordingly changeable in order to hold the formation at the preselectable set-point level.

Alternatively or in addition it can also be an advantage for at least the mesh tension, with which an in particular outer lying dewatering mesh is conveyed over a curved path, such as a forming roller or the like, to be accordingly changeable in order to hold the formation at the preselectable set-point level.

To reduce or prevent any negative influence on other important properties of the fibrous web, which are closely related to the formation, the actuating range of at least one set-point variable can be limited to a preselectable extent.
For this purpose, provision is made for ways for measuring the value of at least one auxiliary variable, wherein the actuating range is accordingly limitable as a factor of the measured value of this auxiliary variable.

The ways for measuring the value of at least one auxiliary variable include advantageously ways for measuring the dry content of the fibrous web downstream from the forming unit.

Alternatively or in addition it is expediently possible for these ways for measuring the value of at least one auxiliary variable also to include in particular ways for measuring a value representative of the web take-off from in particular a central roller.

The plant can include ways for triggering an alarm upon reaching at least one preselectable limit of the actuating range of at least one set-point variable.

To increase the dynamic response of the control circuit, the formation of the fibrous web can be defined by ways of the ways in question at the exit of the forming unit.

According to a practical embodiment of the inventive plant, the latter includes a controller for controlling the formation, into which at least one formation value defined online can be entered, wherein one or more set-point variables are accordingly changeable by way of the controller in order to hold the formation at the preselectable level.

The value of at least one auxiliary variable can be entered in addition into the controller in order to limit the actuating range of at least one set-point variable as a factor thereof.

 Expediently the plant includes at least one PID controller.

With regard to the complexity of the relationships in a formation control system it is also advantageous in particular for the plant to include at least one state controller and/or at least one controller with at least one self-learning control algorithm.

To improve the quality of the control the plant includes advantageously at least one soft sensor for defining the formation and/or for measuring at least one auxiliary variable. As previously mentioned, such a soft sensor is used to determine non-measurable variables from measurable variables by calculation.

Formation is generally understood to mean in particular the structure and the degree of fiber distribution in the fibrous web, e.g. paper, measured or assessed by way of transmitted light. The formation is generally also referred to as the “look-through” of the fibrous web or paper.

While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A method for producing a fibrous web comprising the steps of:
   - defining a formation of the fibrous web online as a controlled variable; and
   - holding said formation of the fibrous web at a preselectable set-point level using an automatic formation control system.

2. The method according to claim 1, wherein said formation is defined directly.

3. The method according to claim 2, wherein said formation is defined by at least one formation sensor.

4. The method according to claim 1, wherein said formation is defined indirectly by at least one auxiliary variable.

5. The method according to claim 4, wherein said at least one auxiliary variable for indirectly defining said formation comprises a water quantity in a bar section of a forming unit, said water quantity being measured.

6. The method according to claim 1, wherein said formation is held at said preselectable set-point level by a corresponding change of at least one set-point variable.

7. The method according to claim 6, further comprising changing accordingly at least a material density in order to hold said formation at said preselectable set-point level.

8. The method according to claim 6, further comprising changing accordingly at least a retention in order to hold said formation at said preselectable set-point level.

9. The method according to claim 6, further comprising changing accordingly at least one vacua in a region of a forming unit in order to hold said formation at said preselectable set-point level.

10. The method according to claim 6, further comprising changing accordingly at least one bar pressure in a region of a forming unit in order to hold said formation at said preselectable set-point level.

11. The method according to claim 6, further comprising changing accordingly at least one bar pressure in a region of a forming unit in order to hold said formation at said preselectable set-point level.

12. The method according to claim 6, further comprising changing accordingly at least a wrap angle, through which...
the fibrous web is conveyed over a curved surface, in order to hold said formation at said preselectable set-point level.

13. The method according to claim 12, wherein said curved surface comprises a forming roller.

14. The method according to claim 6, further comprising changing accordingly at least a mesh tension, with which an outer lying dewatering mesh is conveyed over a curved path, in order to hold said formation at said preselectable set-point level.

15. The method according to claim 14, wherein said curved path comprises a forming roller.

16. The method according to claim 6, wherein said at least one set-point variable includes an actuating range, said actuating range of said at least one set-point variable is limited to a preselectable extent.

17. The method according to claim 16, further comprising measuring a value of at least one auxiliary variable, wherein said actuating range is limited as a factor of a measured value of said at least one auxiliary variable.

18. The method according to claim 17, wherein said at least one auxiliary variable which is measured comprises a dry content of the fibrous web downstream from a forming unit.

19. The method according to claim 17, wherein said at least one auxiliary variable which is measured comprises a value representative of a web take-off.

20. The method according to claim 17, wherein said at least one auxiliary variable which is measured comprises a value representative of a web take-off from a central roller.

21. The method according to claim 16, further comprising triggering an alarm upon reaching at least one preselectable limit of said actuating range of said at least one set-point variable.

22. The method according to claim 1, wherein said formation of the fibrous web is defined at an exit of a forming unit.

23. The method according to claim 1, further comprising entering at least one formation value defined online into a controller for controlling said formation, wherein said formation is held at said preselectable set-point level by said controller through accordingly changing at least one set-point variable.

24. The method according to claim 23, further comprising entering a value of at least one auxiliary variable into said controller in order to limit an actuating range of at least one set-point variable as a factor thereof.

25. The method according to claim 1, further comprising providing at least one Proportional-Integral-Derivative controller.

26. The method according to claim 1, further comprising providing at least one state controller.

27. The method according to claim 1, further comprising providing at least one controller with at least one self-learning control algorithm.

28. The method according to claim 1, further comprising at least one soft sensor at least one of to define said formation and to measure at least one auxiliary variable.

29. An industrial plant for producing a fibrous web, said plant comprising an automatic formation control system for defining a formation of the fibrous web online as a controlled variable and holding said formation of the fibrous web at a preselectable set-point level.

30. The industrial plant according to claim 29, further comprising a device for directly defining said formation.

31. The industrial plant according to claim 30, wherein said device for directly defining said formation comprises at least one formation sensor.

32. The industrial plant according to claim 29, further comprising a device for indirectly defining said formation by an auxiliary variable.

33. The industrial plant according to claim 32, wherein said device for indirectly defining said formation is configured for measuring a water quantity in a bar section of a forming unit.

34. The industrial plant according to claim 29, wherein said automatic formation control system is configured for accordingly changing at least one set-point variable in order to hold said formation at said preselectable set-point level.

35. The industrial plant according to claim 34, wherein said automatic formation control system is configured for accordingly changing at least a material density in order to hold said formation at said preselectable set-point level.

36. The industrial plant according to claim 34, wherein said automatic formation control system is configured for accordingly changing at least a retention in order to hold said formation at said preselectable set-point level.

37. The industrial plant according to claim 34, further comprising a headbox nozzle including an outlet gap having an opening cross-section, wherein said automatic formation control system is configured for accordingly changing at least said opening cross-section of said outlet gap of said headbox nozzle in order to hold said formation at said preselectable set-point level.

38. The industrial plant according to claim 34, further comprising a forming unit, wherein said automatic formation control system is configured for accordingly changing at least one bar pressure in a region of said forming unit in order to hold said formation at said preselectable set-point level.

39. The industrial plant according to claim 34, further comprising a forming unit, wherein said automatic formation control system is configured for accordingly changing at least a wrap angle, through which the fibrous web is conveyed over said curved surface, in order to hold said formation at said preselectable set-point level.

40. The industrial plant according to claim 34, further comprising a curved surface, wherein said automatic formation control system is configured for accordingly changing at least one auxiliary variable, with which the fibrous web is conveyed over a curved path, wherein said automatic formation control system is configured for accordingly changing at least one mesh tension, with which said outer lying dewatering mesh is conveyed over said curved path, in order to hold said formation at said preselectable set-point level.

41. The industrial plant according to claim 40, wherein said curved surface comprises a forming roller.

42. The industrial plant according to claim 34, further comprising an outer lying dewatering mesh which is conveyed over a curved path, wherein said automatic formation control system is configured for accordingly changing at least one mesh tension, with which said outer lying dewatering mesh is conveyed over said curved path, in order to hold said formation at said preselectable set-point level.

43. The industrial plant according to claim 42, wherein said curved path comprises a forming roller.

44. The industrial plant according to claim 29, wherein the plant includes at least one set-point variable having an actuating range, said actuating range of said at least one set-point variable being limitable to a preselectable extent.

45. The industrial plant according to claim 44, further comprising a device configured for measuring a value of at
least one auxiliary variable, wherein said actuating range is accordingly limitable as a factor of a measured value of said auxiliary variable.

46. The industrial plant according to claim 45, further comprising a forming unit, wherein said device for measuring said value of said at least one auxiliary variable is configured for measuring a dry content of the fibrous web downstream from said forming unit.

47. The industrial plant according to claim 45, wherein said device for measuring said value of said at least one auxiliary variable is configured for measuring a value representative of a web take-off.

48. The industrial plant according to claim 45, further comprising a central roller, wherein said device for measuring said value of said at least one auxiliary variable is configured for measuring a value representative of a web take-off from said central roller.

49. The industrial plant according to claim 29, further comprising a device for triggering an alarm upon reaching at least one preselectable limit of an actuating range of at least one set-point variable.

50. The industrial plant according to claim 29, further comprising a forming unit including an exit, wherein said formation of the fibrous web can be defined at said exit of said forming unit.

51. The industrial plant according to claim 29, further comprising a controller configured for controlling said formation, for entering into said controller at least one formation value defined online, and for accordingly changing at least one set-point variable in order to hold said formation at said preselectable level.

52. The industrial plant according to claim 51, wherein said controller is configured for entering into said controller a value of at least one auxiliary variable in order to limit an actuating range of at least one set-point variable as a factor thereof.

53. The industrial plant according to claim 29, further comprising at least one Proportional-Integral-Derivative controller.

54. The industrial plant according to claim 29, further comprising at least one state controller.

55. The industrial plant according to claim 29, further comprising at least one controller with at least one self-learning control algorithm.

56. The industrial plant according to claim 29, further comprising at least one soft sensor at least one of for defining said formation and for measuring at least one auxiliary variable.

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