Machine and method for providing paper pulp and durable paper sheets

Field

The present invention relates to the field of machine, more specifically stamper machine, for producing paper pulp and for further providing papar sheets, as well as method using such machine for providing paper pulp, as well as paper sheets.

Background

Paper is composed of cellulose fibres derived from plants. Paper quality depends largely on fibre source and production method, which determine length of the cellulose fibres. Long-fibred paper is stronger, more flexible and more durable than short-fibred paper.

Beating cotton and linen cloth rags to separate the cellulose fibres into a paste called pulp, and then using screens to form sheets of paper from this pulp, began in the 13th century. The resulting product is called “rag paper” which is known for its chemical and mechanical stability due to its pure cellulose fibres, which are long and strong.

There has been a need of durable paper for paper records intended for long-term retention, such as important legal documents, and for preservation photocopies in archives and museums.

The traditional method of making paper pulp by stamper beating is described in T. Barrett’s Encyclopedia of Papermaking "Paper through Time", i.e. Document D1, which largely preserves the long fibres of cellulose.

In D1, the traditional method of making paper pulp comprises the steps of soaking, fermenting and bleaching cotton and linen cloth rags, followed by beating in vats fitted with hammers to separate the cellulose fibres into a pulp. This pulp in D1 is then poured onto screens, where after water being filtered out a thin layer of cellulose fibres is left on the screen. This layer is then further processed and submitted to sizing (see below).

D1 also shows a general set-up of a traditional set up in the papermaking mills, comprising a number of vats each fitted with a hammer consisting of a hammer head solidly attached at a fixed 90 degree angle to hammer shaft, wherein the face of the hammer may be fitted with iron or bronze nails designed to perform a specific task.

But using cotton and linen cloth rags as dislcosed in D1 requires bleaching, which is environmentally damaging.

In view of D1, the problem that remains to be solved is thus how to provide paper pulp, as well as duarable paper sheets obtained from this paper pulp, in a manner that is environment friendly, cheaper and more sustainable.

D2 uses, among other things, wood, instead of cotton and linen cloth rags as dislcosed in D1.

More specifically, D2 discloses manufacturing paper from straw, hay, thistles, nettles, waste and refuse from hemp and flax, and different kinds of wood and bark. The process using such materials is also disclosed in D2.

But the material in D2 contains substances other than cellulose, namely lignin. When exposed to UV light and heat, the wood pulp paper produced in D2 deteriorates rapidly, becoming yellow and brittle due to the short cellulose fibres of ground wood and the inherent acidity of lignin.

Further, when paper sheets are formed from this pulp, the quality and strength of the resulting paper is poor compared to paper made from cotton and linen cloth rags. Furthermore, the paper is very rough and so has a pronounced surface texture.

These drawbacks may be diminished by sizing. Sizing refers to the application of a coating by soaking the sheets of paper in a glue solution, such as starch or gelatin, and then drying them. Sizing strengthens the paper surface and prevents ink from bleeding into the fibres, ultimately yielding sharper print quality.

Unfortunately, the traditional method of sizing by soaking and drying the paper sheets is cumbersome and takes too long.

Further, a traditional stamper machine as the one disclosed in D1 is found to be unsuitable if one would try beating the pulp together with the glue since that resulted in a sharp increase in the viscosity of the mixture, hindering the circulation and homogeneous treatment of the pulp. The paper pulp obtained in this way was found to be unsuitble for providing enduability for paper records intended for long-term retention, or for preservation photocopies.

In view of D1 and D2, the problem that further remains to be solved is thus how to provide paper pulp, as well as duarable paper sheets obtained from this paper pulp, that are of high quality with a smooth and impermeable writing or printing surface, in a manner that is efficient and with reduced labor requirement. In particular, a modified stamper machine suited for this purpose is needed.

Summary

It is thus an object of the present invention to provide a stamper machine that is suitable for providing

paper pulp that is suitable for further producing enduarble paper sheets with smooth and impermiable paper surface, in a manner that is environment friendly, economical, efficient and more sustaniable.

Similarly, an object of the present invention is also to provide a method using such stamper machine, where the quality of the procuded paper sheets obtained from the paper pulp is high.

Object is also to provide such paper pulp and paper sheets obtained from the paper pulp with high writing and printing quality.

In order to solve the problems above, stamper machine is provided in accordance with claim 1.

Apart from the traditional set up of a stamper machine as disclosed in D1, the invention specifies that a head-to-shaft angle is set at a fixed angle deviating from 90 degrees. That is, the hammer head is positioned at a slant to the hammer shaft. In the tradition machine, this angle is set to 90 degrees.

This modification provided by the present invention achieves an effective circulation of the pulp in the vat and a homogeneous distribution of the glue during beating. In particular, this machine according to the present invention is suited to as well as necessary for the method for providing paper pulp (see below) where a glue solution is directly added to the mix of raw plant material and quicklime in the vat of the machine.

Without this specific angle as set out in claim 1, beating the pulp together with the glue in a traditional vat as the one shown in D1 resulted in a sharp increase in the viscosity of the mixture, hindering the circulation and homogeneous treatment of the pulp. The paper pulp obtained in this way was found to be unsuitable for providing enduarble paper sheet.

With this specific angle as set out in claim 1, effective circulation of the pulp is achieved due to the head swept volume increasing considerably the more the head-to-shaft angle deviates from 90 degrees. Head swept volume refers to the volume of pulp in the vat that is displaced as the hammer head falls and rises.

This ensures that the pulp is circulated so that over 90% of the pulp volume in the vat is swept/displaced with each stroke of the hammer. This enhanced pulp circulation leads to homogeneously intermix the glue in the viscous pulp, and thus the desired paper strength and surface quality.

Preferably, the head-to-shaft angle is set at between 82 and 60 degrees. As a result, the head swept volume increases by 10% to 40%.

Preferably, the head-to-shaft angle is set at smaller than 70 degrees, wherein the hammer shaft has a 5-degree downslope in resting position. That is, the shaft-to-horizontal angle is set to be 5 degree.

In order to solve the problems above, method for providing paper pulp suitable for producing duarable paper sheets is provided in accordance with claim 4.

Compared with the trasitional method provided in D2, the raw plant material used in the invention does not contain lignin. Instead, in the invention only raw plant material such as flax, hemp, straw, hay, thistles or nettles, or mixtures thereof, is used, which does not contain lignin, thereby avoiding the disadvantage brought about by the inherent acidity of lignin of D2.

There is also no need to use cotton and linen cloth rags as in D1. The raw plant material can be collected locally in the region, making the method environment freindly, cheaper and more sustainable.

The paper pulp thus produced, and hence paper sheets obtained out of this paper pulp, is different from those obtained from D1 and D2 as according to the invention, there is no cotton rags or lignin comprised in the paper pulp.

Further, it is important that the mixing with quicklime lasts at least 5 days,
preferably 6 to 8 days, otherwise the cellulose extraction will not be complete.

Further, the method comprises transforming the treated raw plant material into paper pulp by stamper beating using the stamper machine as described above , wherein it is important that a glue solution is added to the paper pulp directly in the vat of the stamper machine during the stamper beating.

Use of this machine as set out above achieves an effective circulation of the pulp in the vat and a homogeneous distribution of the glue during beating (see above).

D2 uses a trasitional sizing step where the glue is added after sheets are formed, whcih is cubursome and time consuming. This is solved with the invention.

Preferably, the step of treating with quicklime is implemented by the traditional steps as provided in D2, including a) grinding the raw plant material; b) soaking the ground plant material in water, preferably 20 litres per 1 kg of the raw plant material; c) adding the quicklime, preferably 1.5 kg per 1 kg of plant material, d) mixing the quicklime and the ground plant material into a slurry, and e) drawing off the water.

Preferably, the glue solution comprises starchn or gelatin, and more preferably, the gelatin solution has a concentration of about 3%. Gelatin provides smoother surfaces.

In view of the above problems identified, there is also provided paper pulp, as set out in claim 9, that is obtainable by the above-described method .

Preferably, viscosity of samples from the top layer and viscosity of samples from the bottom of the vat has differences not greater than 1%. Methods for measuring viscosity are well known in the art.

In view of the above problems identified, there is also provided method for producing durable paper sheet. The method is as set out in claim 11.

The method comprises the trasitional steps for producing paper sheets out of paper pulp as descibed in detail in D1.

According to the method, as the glue is already homogeneously mixed with the pulp in the beating process, after filtering water in the paper pulp through the screen, what is left on the screen is of pure cellulose fibres homogeneously intermixed with the glue. As a result, the thus produced paper sheets exhibits high quality in endurability and impermeability in that the glue is added and hence mixed with the pulp at the earlier step of beating. Thus, there is no need to additionall using the sizing step by applying a coating which traditionally is cubursome and time consuming. Using the spefically designed machine as described above achieves the above effect.

The paper obtained in this manner is chemically inert and has excellent endurance and age-resistant properties. It has a smooth surface for printing that is impermeable enough for ink not to bleed into the fibres. The homogeneously intermixed glue gives the cellulose fibres greater coherence and bonding properties.

Preferably, the screen is a linen fabric, a metal mesh, or a wire cloth stretched on a wooden frame.

In view of the above problems identified, there is also provided durable paper sheet, as set out in claim 13, obtained by the above-desribed method.

Preferably, the durable paper sheet has a grammage of 70 g/m2.

Preferably, the tensile strength of the durable paper sheet of the durable paper sheet is above 1 900 N/m, preferably above 2 600 N/m. The thus produced paper outperforms historical rag paper, which always has a tensile strength of well below 1 900 N/m. The tensile strength is obtained according to the standard method (ISO 1924-2), and refers to the maximum stress required to tear a strip off a sheet.

Detailed description

It is suggested to use the relevant parts of paras. [8]-[26] of the letter as a furthe detailed description, with Fig. 1 of the letter being used in the figure part of the application.

Claims

1. Stamper machine for providing paper pulp suitable for producing durable paper sheets, comprising a

vat (1) fitted with a hammer comprising a hammer head (2), a hammer shaft (3), and a hammer face (4), wherein a head-to-shaft angle (α) is set at a fixed angle deviating from 90 degrees.

2. The stamper machine according to claim 1, wherein the head-to-shaft angle (α) is set at between 82 and 60 degrees.

3. The stamper machine according to claim 2, wherein the head-to-shaft angle (α) is set at smaller than 70 degrees, wherein the hammer shaft (3) has a 5-degree downslope in resting position.

4. Method for providing paper pulp suitable for producing duarable paper sheets, comprising:

treating raw plant material with quicklime, wherein the raw plant material does not contain lignin, and the raw plant material is mixed with the quicklime for at least 5 days;

transforming the treated raw plant material into paper pulp by stamper beating using the stamper machine according to any of claims 1 to 3, wherein a glue solution is added to the paper pulp directly in the vat (1) of the stamper machine during the stamper beating.

5. The method according to claim 4, wherein the raw plant material is mixed with the quicklime for 6 to 8 days.

6. The method according to claim 4 or claim 5, wherein the raw plant material comprises flax, hemp, straw, hay, thistles or nettles, or mixtures thereof.

7. The method according to any one of claims 4 to 6, wherein the step of treating the raw plant material with the quicklime comprises:

a) grinding the raw plant material;

b) soaking the ground plant material in water, preferably 20 litres per 1 kg of the raw plant material;

c) adding the quicklime, preferably 1.5 kg per 1 kg of plant material,

d) mixing the quicklime and the ground plant material into a slurry, and

e) drawing off the water.

8. The method according to any one of claims 4 to 7, wherein the glue solution comprises starch or gelatin, and more preferably, the gelatin solution has a concentration of about 3%.

9. Paper pulp obtainable by the method according to any of claims 4 to 8.

10. Paper pulp according to claim 9, wherein viscosity of samples of the paper pulp from the top layer and viscosity of samples of the paper pulp from the bottom of the vat has differences not greater than 1%.

11. Method for producing durable paper sheet, comprising:

pouring the paper pulp obtained according to the method of any of claims 4 to 8 onto a screen;

filtering water in the paper pulp through the screen, lefting a layer of cellulose fibres intermixed with the glue;

pressing and drying the layer, and stripping the layer from the screen; and

cutting and flattening the layer.

12. The method according to claim 11, wherein the screen is a linen fabric, a metal mesh, or a wire cloth stretched on a wooden frame.

13. Durable paper sheet obtainable by the method according to claim 11 or claim 12.

14. Durable paper sheet according to claim 13, wherein the paper sheet has a grammage of 70 g/m^2.

15. Durable paper sheet according to claim 13 or claim 14, wherein the tensile strength of the durable paper sheet is above 1 900 N/m, preferably above 2 600 N/m.