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(72) Inventeurs/Inventors:
BOKSTROM, MONICA, SE;
HAGGQVIST, JAN-ERIC, SE

(73) Propriétaire/Owner:
VALMET FIBERTECH AKTIEBOLAG, SE

(74) Agent: FETHERSTONHAUGH & CO.

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A method of controlling oxygen delignification of pulp, i.e. reduction of the kappa number of the pulp, where the delignification is carried out in two stages, and the main portion of the chemicals required for the delignification is added to the first stage. The ingoing kappa number of the pulp prior to the delignification and the reduction of the kappa number of the pulp during the total delignification in the two stages are used for adjusting the chemical addition to the first stage. The control is carried out so that higher ingoing kappa number yields lower charge and higher kappa number reduction yields higher charge, calculated per reduced kappa number unit. Said chemical addition to the first stage in its tum is used for control the temperature in the second stage.

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(71) Applicant *(for all designated States except US)*: SUNDS DEFIBRATOR INDUSTRIES AB [SE/SE]; S–851 94 Sundsvall (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: BOKSTRÖM, Monica [SE/SE]; Bjärme 3251, S–860 25 Kovland (SE). HÄGGQVIST, Jan–Erik [SE/SE]; Lindvägen 12, S–862 33 Kvissleby (SE).

(74) Common Representative: SUNDQVIST, Hans; Sunds Defibrator Industries AB, Strandbergsgatan 61, S–112 51 Stockholm (SE).

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(54) Title: METHOD FOR CONTROLLING OXYGEN DELIGNIFICATION OF PULP

(57) Abstract

A method of controlling oxygen delignification of pulp, i.e. reduction of the kappa number of the pulp, where the delignification is carried out in two stages, and the main portion of the chemicals required for the delignification is added to the first stage. The ingoing kappa number of the pulp prior to the delignification and the reduction of the kappa number of the pulp during the total delignification in the two stages are used for adjusting the chemical addition to the first stage. The control is carried out so that higher ingoing kappa number yields lower charge and higher kappa number reduction yields higher charge, calculated per reduced kappa number unit. Said chemical addition to the first stage in its turn is used for control the temperature in the second stage.

METHOD FOR CONTROLLING OXYGEN DELIGNIFICATION OF PULP

This invention relates to the control of a method for oxygen delignification of lignocellulosic material in two steps at medium consistency, i.e. 8-16%.

Since the introduction of oxygen delignification at medium consistency, not much development work has been invested in this process. When chlorine free bleaching and closure of bleach plants came into being, the interest in extended delignification, i.e. further reduction of the kappa number with oxygen, has increased. Extended delignification with oxygen in one or several stages, however, can result in deteriorated pulp quality. Application of proper conditions, however, can bring about several advantages.

With extended oxygen delignification the pulp yield could also be maintained better than at extended cooking, i.e. cooking to lower kappa number.

At a multi-stage method, the chemicals can be distributed between the stages so as to create optimum conditions in each stage. Other conditions could also be optimized for each stage.

The present invention provides a method of controlling oxygen delignification in such a manner, that a lower kappa number is obtained without deterioration of the pulp properties. By using the extended delignification according to the invention, the total delignification can amount to 50-85% of the lignin content (kappa number) of unbleached pulp. The method is carried out at medium consistency in two subsequent steps.

In one aspect, the invention provides a method of controlling oxygen delignification of pulp, by reduction of the kappa number of the pulp from an ingoing kappa number to a desired kappa number, wherein: (i) the delignification is carried out in a first stage in a first reactor and in a second stage in a second reactor; (ii) the pulp is fed to the first reactor at a temperature below 90°C; (iii) the main portion of the chemicals required for the delignification is added to the first stage; (iv) the desired reduction of the kappa number of the pulp during the total delignification in the two stages is used for adjusting the chemical addition to the first stage, wherein a greater kappa number reduction requires a higher charge of chemicals, calculated per reduced kappa number unit; and (v) chemical addition to the first stage results in a requirement for increased temperature in the second stage so that a final pH of 10.5-11.5 is obtained, wherein the increased temperature in the second stage is less than 20°C and is obtained by the addition of steam to the second stage.

The invention is described in greater detail in the following, with reference to the accompanying Figure 1, which schematically shows a plant for carrying out the method according to the invention.

In the plant shown cooked pulp is pumped at medium consistency, i.e. 8-16%, by a first pump 1 from the brown pulp washing to oxygen delignification. Alkali is charged to the pulp ahead of the first pump 1. After this pump 1 a first mixer 2 is used for admixing oxygen to the pulp. The pulp is thereafter supplied into a first reactor 3, in which the first delignification stage is carried out. The pulp is moved from there, possibly by means of a second pump 4, via a second mixer 5 for admixing steam and possibly more oxygen

and alkali to a second reactor 6 for the second delignification stage. After the second reactor 6 the pulp is moved to a blow tank 7 and further to subsequent processing stages.

The method thus implies that the delignification is carried out in two subsequent stages. To the first reactor 3 a high alkali addition as well as a high oxygen addition are made. This means a charge of 10-50 kg alkali (NaOH) per ton pulp, preferably 10-35 kg/ton. The oxygen charge should be 10-50 kg/ton pulp, preferably 10-30 kg/ton.

The temperature of the pulp at its feed to the reactor 3 shall be below 90°C, preferably 75-90°C. The retention time in the reactor 3 should be relatively short, 5-30 min, preferably 15-25 min.

The pressure in the first reactor 3 should be 4-15 bar. The high pressure, together with the high alkaliness of the pulp and the high oxygen charge, result in a high delignification rate. At the same time, the rate of the cellulose degradation is held on a low level due to the relatively low temperature and the short retention time.

After the first delignification stage in the first reactor 3 the pulp is moved to the second delignification stage in the second reactor 6. The temperature in the second reactor 6 should be higher than in the first reactor 3. The temperature difference, however, shall be less than 20°C, preferably 10-15°C. In order to bring about the necessary increase in temperature, steam is supplied to the second mixer 5.

The pressure in the second reactor should be 2-5 bar and lower than in the first reactor 3. The retention

time should be relatively long, 45-180 min, preferably 60-120 min.

The second delignification stage is primarily a long extraction stage, where, in relation to the first step, the increased temperature and extended retention time give extended delignification. At temperatures above 90°C, thus, good extraction/leaching rate is obtained.

The entire or main part of the chemical addition is made to the first stage. To the second stage preferably a very small or no addition of alkali or oxygen should be made, not even for compensating for the consumption in the first stage. The alkaliness of the pulp can thereby be held relatively low in the second stage. Hereby cellulose degradation is substantially avoided, in spite of high temperature and long retention time.

The charge of alkali and oxygen to the second stage, respectively, can be up to 5 kg/ton pulp.

The control of the oxygen delignification according to the invention is based on forward control, which means it implies the least possible back feed coupling. The control is carried out as follows.

The kappa number of the ingoing pulp is measured and compared to the desired value (set value) of the kappa number of the pulp after the oxygen delignification. The reduction of the kappa number thus determined is used for adjusting the chemical addition (oxygen, alkali) to the first stage. A greater kappa number reduction implies higher charge, calculated per reduced kappa number unit. The level of the kappa number of the ingoing pulp is also used for adjusting the chemical charge, so that a higher ingoing kappa number implies a lower charge, calculated per

reduced kappa number unit. For instance, a kappa number reduction of about 60%, such as from kappa 25 to kappa 10, implies an alkali charge measured in kg NaOH/ton pulp of about 2.2 times (ingoing kappa minus outgoing kappa). A delignification of 50% from kappa 25 to kappa 12.5 implies an alkali charge of 2.0 times (ingoing kappa minus outgoing kappa). A delignification of 50% from kappa 20 to kappa 10 implies an alkali charge of 2.2 times (ingoing kappa minus outgoing kappa). The exact factor is corrected in each individual case by means of obtained kappa number in relation

to final pH value. If the final pH is somewhat high and the kappa number somewhat low the alkali charge is adjusted somewhat downwards. If the final pH is somewhat low and the kappa number somewhat high the alkali charge is adjusted somewhat upwards.

Oxygen is charged in the relation 1:1 to the alkali charge, but with a maximum oxygen charge of 25-30 kg/ton pulp. When the degree of delignification is higher, i.e. when the alkali charge exceeds 25-30 kg NaHO/ton pulp, the ratio between oxygen and alkali charge is reduced. Thereby it is possible to avoid gas channeling as a result of large gas amounts.

The temperature level in the second stage is controlled partly in the usual way by the production level, so-called kappa factor control, and partly by the chemical addition to the first stage, so that a higher chemical charge to the first stage should result in a higher temperature in the second stage. The temperature is controlled so that a final pH of 10.5-11.5, preferably 10.7-11.0, is obtained. The factor between a change in chemical charge and the temperature level is adjusted manually by means of a final pH as mentioned above. However, the increase in temperature between the first and second stage should always be less than 20°C, preferably 10-15°C, in order to avoid too large cellulose degradation due to high temperature.

Normally, however, no compensation takes place of the temperature in the first stage to the chemical addition and production level. The pulp ingoing to the first stage is not heated, but it might need some cooling, so that a temperature suitably low for the process is obtained, below 90°C.

The control of the oxygen delignification according to the invention implies that a high delignification degree with good selectivity can be obtained. A low and even kappa number and an even pH-value can be obtained after the second delignification stage.

CLAIMS:

1. A method of controlling oxygen delignification of pulp, by reduction of the kappa number of the pulp from an ingoing kappa number to a desired kappa number, wherein:

(i) the delignification is carried out in a first stage in a first reactor and in a second stage in a second reactor;

(ii) the pulp is fed to the first reactor at a temperature below 90°C;

(iii) the main portion of the chemicals required for the delignification is added to the first stage;

(iv) the desired reduction of the kappa number of the pulp during the total delignification in the two stages is used for adjusting the chemical addition to the first stage, wherein a greater kappa number reduction requires a higher charge of chemicals, calculated per reduced kappa number unit; and

(v) chemical addition to the first stage results in a requirement for increased temperature in the second stage so that a final pH of 10.5-11.5 is obtained, wherein the increased temperature in the second stage is less than 20°C and is obtained by the addition of steam to the second stage.

2. A method as defined in claim 1, wherein the entire chemical addition required for the delignification is made in the first stage.

3. A method as defined in claim 1 or 2, wherein the pulp is fed to the first reactor at a temperature of at least 75°C.

4. A method as defined in any one of claims 1 to 3, wherein the increased temperature in the second stage is 10 to 15°C.

5. A method according to any one of claims 1 to 4, wherein the final pH is 10.7 to 11.0.

6. A method as defined in any one of claims 1 to 5, wherein the chemicals added to the first stage are 10 to 50 kg NaOH and 10 to 50 kg O_2 per ton of pulp.

7. A method as defined in claim 6, wherein 10 to 35 kg NaOH and 10 to 35 kg O_2 are added per ton of pulp.

8. A method as defined in any one of claims 1 to 7, wherein the first stage is for 5 to 30 minutes.

9. A method as defined in claim 8, wherein the first stage is for 15 to 20 minutes.

10. A method as defined in any one of claims 1 to 9, wherein the pressure in the first reactor is 4 to 15 bar.

11. A method as defined in any one of claims 1 to 10, wherein the second stage is for 45 to 180 minutes.

12. A method as defined in claim 11, wherein the second stage is for 60 to 120 minutes.

13. A method as defined in any one of claims 1 to 12, wherein the pressure in the second reactor is 2 to 5 bar and is lower than in the first reactor.

14. A method as defined in any one of claims 1 and 3 to 13, when not dependent on claim 2, wherein up to 5 kg NaOH and 5 kg O_2 per ton of pulp are added to the second stage.

15. A method as defined in any one of claims 1 to 14, wherein the total delignification is 50 to 85% of the lignin content of unbleached pulp.

FETHERSTONHAUGH & CO.
PATENT AGENTS
OTTAWA, CANADA

Figure 1

