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DETERGENT FOR KRAFT PULP AND PROCESS FOR PRODUCING KRAFT PULP WITH THE (54) SAME

(57)A detergent for Kraft pulp, containing a nonionic surfactant containing at least one compound expressed by any of the following general formulae 1 to 3:

> R¹O-(PO)_n-[(EO)_m·(PO)_k]H General Formula 1

R²-CO-(AO)_v-OR³

General Formula 2

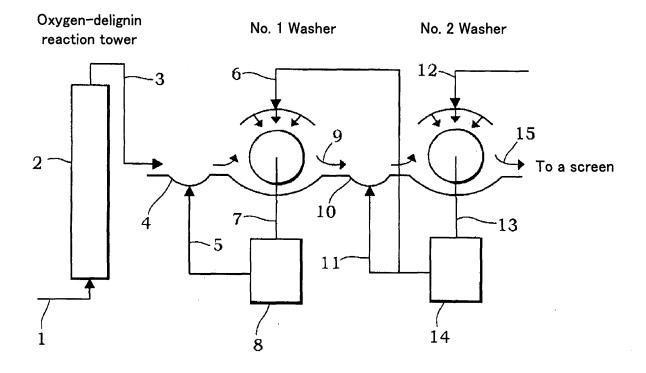
 $R^4 - N \begin{pmatrix} (EO)_x H \\ (EO)_z H \end{pmatrix}$

General Formula 3

2 236 665 A1 ш

wherein the detergent is used for washing a raw material of pulp after decomposing a lignin substance contained in the cooked raw material of pulp using oxygen, and wherein the nonionic surfactant has a clouding point lower than a washing temperature during washing of the raw material of pulp.

FIG. 1



Description

BACKGROUND OF THE INVENTION

5 Technical Field

[0001] The present invention relates to a detergent for Kraft pulp, and a method for producing Kraft pulp using such detergent.

10 Background Art

[0002] Kraft pulp is generally produced through a cooking process, and a separation process, where the cooking process is to subject wood chips cooking using a mixed solution of caustic soda and sodium sulfide, and the separation process is to separate a black liquor containing lignin from the pulp slurry obtained in the cooking process.

- ¹⁵ **[0003]** In the latest Kraft pulp manufacturing facilities, an oxygen (O₂) delignification process is performed after the separation process so as to reduce the environmental loads due to drainage. In the reaction process, the oxygen is allowed to react in the alkaline, high temperature and high pressure environment. After this reaction process for removing lignin using the oxygen, the resulting pulp is washed to thereby produce an unbleached pulp (unexposed Kraft pulp), and the produced unbleached pulp is then used to form a cardboard (or a paperboard or board), or the like. Moreover,
- 20 this unbleached pulp is bleached to produce a bleached pulp whose whiteness is improved, and the resulting bleached pulp is used form woodfree paper.
 [0004] Bleaching is performed in a several stages (multiple bleaching). In the multiple bleaching, chloring dioxide

[0004] Bleaching is performed in a several stages (multiple bleaching). In the multiple bleaching, chlorine dioxide, hydrogen peroxide, and the like are commonly used as a bleaching agent. Moreover, a method for improving bleaching efficiency has been proposed. In such method, use of a bleaching assistant, such as polyhydric alcohol, polyhydric

- 25 phenol, and an ether compound formed from alkylene oxide adduct of the aforementioned polyhydric alcohol or polyhydric phenol, and aliphatic monoalcohol has been proposed (see PTL 1), and use of a bleaching assistant including the combination of a certain water-soluble polymer and/or peroxide with a nonionic surfactant has also been proposed (see PTL 2).
- [0005] When chlorine dioxide is used as a bleaching agent, however, organic chlorine compound contained in the ³⁰ waste water from bleaching will be a potential pollution source to the environment. Therefore, the bleaching waste water needs to be subjected to an activated sludge treatment. In addition, there is a problem such that the production cost has increased along with the increased prices of bleaching agents, such as chlorine dioxide. Accordingly, there is a demand for reducing an amount of the bleaching agent to be used in productions of pulp.
- [0006] Furthermore, as a washing method of pulp, a pulp washing method where a polyoxyethylene alkylphenyl ether surfactant is added during various washing processes in the pulp production method (see PTL 3), and a pulp washing method where a surfactant is added during a washing process that is carried out after a cooking process (see PTL 4) have been proposed.

Citation List

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Patent Literature

[0007]

- 45 [PTL1] Japanese Patent Application Laid-Open (JP-A) No. 05-186987
 [PTL2] JP-A No. 2002-180391
 [PTL3] JP-A No. 05-302284
 [PTL4] JP-A No. 2005-336620
- 50 Disclosure of Invention

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[0008] The present invention aims at solving the various problems in the art, and achieving the following object. Namely, an object of the present invention is to provide a detergent for Kraft pulp, and a method producing Kraft pulp using such detergent, which can improve washing efficiency of pulp, and energy efficiency in the production of pulp, and in the case where the pulp is bleached by a bleaching agent after the O_2 dilignification process, which can improve whiteness of the pulp after the O_2 dilignification process, to thereby reduce an amount of the bleaching agent for use, and which can suppress formations of air bubbles, to thereby reduce an amount of a defoaming agent for use. **[0009]** Means for solving the aforementioned problems are as follows:

<1> A detergent for Kraft pulp, containing:

a nonionic surfactant containing at least one compound expressed by any of the following general formulae 1 to 3:

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 $R^1O-(PO)_n-[(EO)_m \cdot (PO)_k]H$

General Formula 1

where R¹ is a C10-20 straight or branched alkyl group, or a C10-20 straight or branched alkenyl group; n is 0 to 10, and the sum of m and k is 1 to 100, where n, m, and k each express an average adduct molar number; EO and PO express an ethylene oxide unit and a propylene oxide unit, respectively, and a form of addition of EO and PO in $[(EO)_m (PO)_k]$ is random or block,

R²-CO-(AO)_v-OR³ General Formula 2

where R² is a C10-20 straight alkyl group or a C10-20 straight alkenyl group; AO is at least one oxyalkylene
 group selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene
 group; y is 1 to 10; and R³ is a methyl group,

20	$R^4 - N \begin{pmatrix} (EO)_x H \\ (EO)_z H \end{pmatrix}$
25	(EO) _z H General Formula 3
30	where R ⁴ is a C10-20 alkyl group; EO is an ethylene oxide group; x and z each express an adduct molar number of ethylene oxide, and the sum of x and z is 2 to 10, wherein the detergent is used for washing a raw material of pulp after decomposing a lignin substance, which is contained in the cooked raw material of pulp, using oxygen, and wherein the nonionic surfactant has a clouding point lower than a temperature for washing the raw material of pulp.
35	The detergent for Kraft pulp according to <1> contains a nonionic surfactant which is at least one of the compounds expressed by the general formulae 1 to 3, and has a clouding point lower than the temperature for washing the raw material of pulp, and thus the washing efficiency of the raw material of pulp improves. <2> The detergent for Kraft pulp according to <1>, wherein the nonionic surfactant has a clouding point of 55°C or
40	lower. <3> A method for producing Kraft pulp, containing:
45	cooking a raw material of pulp; decomposing a lignin substance contained in the cooked raw material of pulp using oxygen; and washing the raw material of pulp after the decomposing (i.e., the oxygen delignification process), wherein a detergent for Kraft pulp is added in the washing, and wherein the detergent containing:
50	a nonionic surfactant containing at least one compound expressed by any of the following general formulae 1 to 3:
	R ¹ O-(PO) _n -[(EO) _m ·(PO) _k]H General Formula 1
55	where R ¹ is a C10-20 straight or branched alkyl group, or a C10-20 straight or branched alkenyl group; n is 0 to 10, and the sum of m and k is 1 to 100, where n, m, and k each express an average adduct molar number; EO and PO express an ethylene oxide unit and a propylene oxide unit, respectively, and a state of addition of EO and PO in $[(EO)_m \cdot (PO)_k]$ is random or block,

R²-CO-(AO)_v-OR³

General Formula 2

where R² is a C10-20 straight alkyl group or a C10-20 straight alkenyl group; AO is at least one oxyalkylene group selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene group; y is 1 to 10; and R³ is a methyl group,

$$R^4 - N \begin{pmatrix} (EO)_x H \\ (EO)_z H \end{pmatrix}$$

General Formula 3

where R⁴ is a C10-20 alkyl group; EO is an ethylene oxide group; x and z each express an adduct molar number of ethylene oxide, and the sum of x and z are 2 to 10,

wherein the nonionic surfactant has a clouding point lower than a temperature for washing the raw material of pulp.

In the method for producing Kraft pulp according to <3>, the raw material of pulp is cooked in the cooking, the lignin substance contained in the cooked raw material of pulp is decomposed using oxygen in the decomposing, the detergent for Kraft pulp, which contains the nonionic surfactant containing at least one compound expressed by any of the general formulae 1 to 3, and has a clouding point lower than the washing temperature in the washing, is added, and the raw material of pulp is washed in the washing after the decomposing. As a result, the washing efficiency of pulp is improved.

30 <4> The method for producing Kraft pulp according to <3>, further containing bleaching the raw material of pulp after the washing.

<5> The method for producing Kraft pulp according to any of <3> or <4>, wherein the nonionic surfactant has a clouding point of 55°C or lower.

- ³⁵ **[0010]** According to the present invention, the various problems in the art can be solved, and the following object can be achieved. Moreover, there can be provided a detergent for Kraft pulp, and a method producing Kraft pulp using such detergent, which can improve washing efficiency of pulp, and energy efficiency in the production of pulp, and in the case where the pulp is bleached by a bleaching agent after the reaction process to remove lignin using oxygen, which can improve whiteness of the pulp after the reaction process for removing lignin using oxygen, to thereby reduce an amount
- ⁴⁰ of the bleaching agent for use, and which can suppress formations of air bubbles, to thereby reduce an amount of a defoaming agent for use.

Brief Description of Drawings

45 **[0011]**

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FIG. 1 is a schematic diagram for explaining one example of the method for producing Kraft pulp of the present invention.

FIG. 2 is a schematic diagram for explaining another example of the method for producing Kraft pulp of the present invention.

FIG. 3 is a schematic diagram for explaining washers A and B of FIG. 2.

Best Mode for Carrying Out the Invention

55 (Detergent for Kraft Pulp)

[0012] The detergent for Kraft pulp of the present invention is used for washing a raw material of pulp after decomposing a lignin substance contained in the cooked raw material of pulp using oxygen, and contains at least a certain nonionic

surfactant, and may further contain other substances, if necessary.

<Nonionic Surfactant>

⁵ **[0013]** The nonionic surfactant for use in the present invention is suitably selected depending on the purpose without any restriction, provided that it is at least one compound expressed by any of the general formulae 1 to 3, and has a clouding point lower than a washing temperature during washing of the raw material of pulp.

[0014] To attain a sufficient effect of the nonionic surfactant, the clouding point of the nonionic surfactant is lower than the washing temperature preferably by 10°C or more. Since the washing temperature is generally 65°C to 90°C, the clouding point of the nonionic surfactant is preferably 55°C or lower.

[0015] When the washing temperature is equal to or higher than the clouding point of the nonionic surfactant, the nonionic surfactant generally does not form micells. In this case, the surface activeness of the nonionic surfactant is not exhibited, and the nonionic surfactant component is dispersed in the washing water in the state of oil droplets to tint the washing water cloudy white. In the present invention, the nonionic surfactant is used at the temperature equal or higher

than the clouding point thereof. Namely, the nonionic surfactant is used in the temperature condition where the nonionic surfactant does not function as a surfactant.

[0016] A clouding point is a unique characteristic of nonionic surfactants, and is a temperature at which a nonionic surfactant solution clouds in white when the temperature of the solution increases. A nonionic surfactant causes hydration due to hydrogen bonding between hydrophilic groups of the nonionic surfactant and water molecules. The aforementioned

20 clouding occurs at the clouding point or higher, as the hydrogen bonds between the nonionic surfactant and water is cut in such the temperature range and hence the hydration degree of the nonionic surfactant reduces. In the present invention, the clouding point is the value measured in the following manner.

(Method for Measuring Clouding Point of Nonionic Surfactant)

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[0017] After preparing a 2% by weight nonionic surfactant solution at 25°C, the nonionic surfactant solution was weighted to 80 g and poured into a 100 mL transparent glass vessel equipped with a thermometer and a stirrer. The nonionic surfactant was stirred with its temperature gradually increased by placing the glass vessel in a hot bath. Once the nonionic solution starts clouding, the glass vessel was removed from the hot bath at the temperature 3°C to 5°C

- ³⁰ higher than the temperature at which the nonionic solution has started clouding. The nonionic solution is then cooled, and the temperature at which the cloudiness of the nonionic surfactant solution disappears is visually measured. This temperature is determined as a clouding point. In the case where a nonionic surfactant solution is already clouded when it is prepared in the concentration of 2% by weight at 25°C, the nonionic surfactant is still poured into a 100 mL transparent glass vessel in the same manner as the above, and the glass vessel is stood left in a water bath having a constant
- ³⁵ temperature of 25°C for 1 hour. Then, the cloudiness of the nonionic surfactant solution is visually observed. If the nonionic surfactant solution is still clouded, the clouding point of the nonionic surfactant is determined as 25°C or lower. [0018] Other than having the clouding point lower than the temperature for washing the raw material of pulp, the nonionic surfactant needs to have a certain number of hydrophilic groups per molecule. An alkylene oxide adduct (EO/PO) of higher alcohol, alkylene oxide adduct (EO/PO) of fatty acid alkyl ester, alkylene oxide adduct (EO) of aliphatic amine,
- ⁴⁰ all of which have C10-20 straight or branched aliphatic hydrocarbon groups as the aforementioned hydrophilic groups, can be used as the nonionic surfactant.

-Alkylene oxide adduct of higher alcohol-

45 **[0019]** As the alkylene oxide adduct of higher alcohol, the compound expressed by the following general formula 1 can be used.

$R^{1}O-(PO)_{n}-[(EO)_{m}\cdot(PO)_{k}]H$ General Formula 1

- ⁵⁰ **[0020]** In the general formula 1, R¹ is a C10-20 straight or branched alkyl group, or a C10-20 straight or branched alkenyl group; n is 0 to 10, and m and k are each 1 to 100, where n, m, and k each express an average adduct molar number; EO and PO expresses an ethylene oxide unit and a propylene oxide unit, respectively, and a form of addition of EO and PO in [(EO)_m·(PO)_k] may be random or block.
- **[0021]** The higher alcohol forming the alcohol residue expressed as R¹O in the general formula 1 is suitably selected depending on the purpose without any restriction, provided that the number of carbon atoms of R¹ is 10 to 20. The number of carbon atoms thereof is preferably 12 to 18 for achieving both increased whiteness and desirable handling ability at low temperature. When the number of carbon atoms thereof is less than 10, the affinity thereof to the colored substance reduces, and thus the effect for enhancing whiteness may reduce. When the number of carbon atoms thereof

is more than 20, the melting point thereof is excessively high, and thus handling ability may be impaired at low temperature. In addition, the affinity thereof to the colored substance reduces, and thus the obtainable effect for enhancing whiteness may reduce. Furthermore, higher fatty acid, which will be a raw material thereof, does not exist in nature, and therefore use of such material will be disadvantageous in terms of the cost.

- ⁵ **[0022]** The higher alcohol used for forming an alcohol residue expressed as R¹O is suitably selected depending on the intended purpose without any restriction, and may be a synthesized alcohol having a branched molecular structure, or a natural alcohol having a linear molecular structure and a molecular weight distribution. Examples of the higher alcohol include decyl alcohol, lauryl alcohol, tridecyl alcohol, myristyl alcohol, pentadecyl alcohol, cetyl alcohol, heptadecyl alcohol, stearyl alcohol, oleyl alcohol, nonadecyl alcohol, and eicosyl alcohol. Among them, lauryl alcohol, tridecyl alcohol,
- cetyl alcohol, and stearyl alcohol are preferable because they can achieve both enhanced whiteness and improved handling at low temperature. Moreover, a mixture of those listed above may be used as the alcohol.
 [0023] The adduct molar number n of propylene oxide that is directly adducted to the higher alcohol residue R¹O is suitably selected depending on the purpose without any restriction, provided that it is 0 to 10, but is preferably 2 to 6.
 [0024] The total number of carbon atoms contained in R¹ and carbon atoms contained in propylene oxide directly
- ¹⁵ adducted to the higher alcohol, i.e. the lower limit number of carbon atoms in the portion of $(R^{1}O-(PO)_{n})$ in the general formula 1, is suitably selected depending on the purpose without any restriction, provided that it is 10 or more, but is preferably 22 or more, and more preferably 24 or more. When the number of carbon atoms in the portion of $(R^{1}O-(PO)_{n})$ in the general formula 1 is less than the lower limit value (i.e., less than 10), the hydrophilicity necessary for attaining the affinity to the colored substance is insufficient, and thus the effect for increasing the whiteness may reduce.
- **[0025]** The upper limit of the number of carbon atoms in the portion of $(R^1O-(PO)_n)$ in the general formula 1 is suitably selected depending on the purpose without any restriction, provided that it is 50 or less, but is preferably 45 or less, and more preferably 40 or less. When the number of carbon atoms in the portion of $(R^1O-(PO)_n)$ in the general formula 1 is more than the upper limit value (i.e., 50), the melting point thereof is excessively high, and thus handling ability may be impaired at low temperature.
- ²⁵ **[0026]** The sum of m and k in the general formula 1 is suitably selected depending on the purpose without any restriction, provided that it is 1 to 100. However, the sum thereof is preferably 2 to 80, and more preferably 5 to 60 for further enhancing the effect for improving whiteness. When the sum of m and k is less than 1, the affinity to the colored substance is weak, and thus the effect for improving whiteness may reduce. When the sum of m and k is more than 100, the speed of the surfactant to penetrate into inner portions of fibers lowers and thus the production cost increases, which will be
- ³⁰ disadvantageous in terms of the cost. At the same time, the effect for improving whiteness also reduces. **[0027]** The adduct molar number is determined depending on the number of carbon atoms of higher alcohol forming the alcohol residue or the number of carbon atoms of the portion of $(R^1O-(PO)_n)$ so that the nonionic surfactant of the general formula 1 has a clouding point lower than the washing temperature. For example, in the case where the number of carbon atoms in the portion of $(R^1O-(PO)_n)$ is constant, the clouding point becomes lower as the adduct molar number number of carbon atoms in the portion of $(R^1O-(PO)_n)$ is constant.
- ³⁵ of EO is smaller. In the case where the adduct molar number of EO is constant, the clouding point becomes lower as the number of carbon atoms in the portion of $(R^1O-(PO)_n-)$ is larger. Moreover, in the case where the number of carbon atoms in the portion of $(R^1O-(PO)_n-)$ or the adduct molar number of EO in the portion of $(-[(EO)_m-(PO)_k]H)$ is constant, the clouding point becomes lower as the adduct molar number of PO in the portion of $(-[(EO)_m-(PO)_k]H)$ is larger. As mentioned above, the adduct molar numbers m, k of EO and PO, respectively, are determined depending on the number
- ⁴⁰ of carbon atoms of the higher alcohol forming the alcohol residue or the number of carbon atoms in the portion of $(R^{1}O-(PO)_{n})$ so that the nonionic surfactant of the general formula 1 has the clouding point lower than the predetermined washing temperature.

[0028] In the case where n and k are 0, examples of the compound expressed with the general formula 1 include polyoxyethylene(4EO)decyl ether, polyoxyethylene(5EO)decyl ether, polyoxyethyl-

- ⁴⁵ ene(7EO)decyl ether, polyoxyethylene(8EO)decyl ether, polyoxyethylene(5EO) secondary alkyl (C12-14) ether, polyoxyethylene(7E.O.) secondary alkyl (C12-14) ether, polyoxyethylene(8EO) secondary alkyl (C12-14) ether, polyoxyethylene(9EO) secondary alkyl (C12-14) ether, polyoxyethylene(3EO) isotridecyl ether, polyoxyethylene(5EO) isotridecyl ether, polyoxyethylene(5EO) isotridecyl ether, polyoxyethylene(3EO) isotridecyl ether, polyoxyeth
- ⁵⁰ yethylene(7EO)lauryl ether, polyoxyethylene(2EO)cetyl ether, polyoxyethylene(3EO)cetyl ether, polyoxyethylene(5EO) cetyl ether, polyoxyethylene(7EO)cetyl ether, polyoxyethylene(2EO)stearyl ether, polyoxyethylene(3EO)stearyl ether, polyoxyethylene(5EO)stearyl ether, polyoxyethylene(6EO)stearyl ether, and polyoxyethylene(8EO)stearyl ether. Commercial products thereof are available, and examples of the commercial products thereof include: NOIGEN XL-40 (Dai-Ichi Kogyo Seiyaku Co., Ltd.), NOIGEN XL-50 (Dai-Ichi Kogyo Seiyaku Co., Ltd.), NOIGEN XL-50 (Dai-Ichi Kogyo Seiyaku Co., Ltd.)
- Seiyaku Co., Ltd.), NOIGEN XL-70 (Dai-Ichi Kogyo Seiyaku Co., Ltd.) and NOIGEN XL-80 (Dai-Ichi Kogyo Seiyaku Co., Ltd.); LEOCOL SC-50 (Lion Corporation), LEOCOL SC-70 (Lion Corporation), LEOCOL SC-80 (Lion Corporation), LEOCOL SC-90 (Lion Corporation), LEOCOL TD-30 (Lion Corporation), LEOCOL TD-50 (Lion Corporation), LEOCOL TD-70 (Lion Corporation), LEOCOL TD-90 (Lion Corporation), LEOX CC-30 (Lion Corporation), LEOX CC-40 (Lion

Corporation), LEOX CC-50 (Lion Corporation), LEOX CC-60 (Lion Corporation), and LEOX CC-70 (Lion Corporation); EMALEX102 (Nihon-Emulsion Co., Ltd.), EMALEX 103 (Nihon-Emulsion Co., Ltd.), EMALEX 105 (Nihon-Emulsion Co., Ltd.), EMALEX 107 (Nihon-Emulsion Co., Ltd.), EMALEX 602 (Nihon-Emulsion Co., Ltd.), EMALEX 603 (Nihon-Emulsion Co., Ltd.), EMALEX 605 (Nihon-Emulsion Co., Ltd.), EMALEX 606 (Nihon-Emulsion Co., Ltd.), and EMALEX 608 (Nihon-

- ⁵ Emulsion Co., Ltd.).
 [0029] In the case where n is 0 and k is 1 to 10, examples of the compound expressed with the general formula 1 include polyoxyethylene(7EO)polyoxypropylene(3PO)isotridecyl ether, polyoxyethylene(20EO)polyoxypropylene(7PO)isotridecyl ether, polyoxyethylene(2EO)polyoxypropylene(1PO)isotridecyl ether,
- ¹⁰ polyoxyethylene(3EO)polyoxypropylene(1PO)isotridecyl ether, polyoxyethylene(5EO)polyoxypropylene(1PO)isotridecyl ether, polyoxyethylene(9EO)polyoxypropylene(2PO)isotridecyl ether, polyoxyethylene(5EO)polyoxypropylene(3.5PO)secondary alkyl (C12-14) ether, polyoxyethylene(7EO)polyoxypropylene(4.5PO)secondary alkyl (C12-14) ether,
- ¹⁵ polyoxyethylene(7EO)polyoxypropylene(8.5PO)secondary alkyl (C12-14) ether, and polyoxyethylene(9EO)polyoxypropylene(5PO)secondary alkyl (C12-14) ether. Commercial products thereof are available, and examples of the commercial products thereof include LIONOL TD-730 (Lion Corporation), LIONOL TD-2007 (Lion Corporation), LIONOL TDL-20 (Lion Corporation), LIONOL TDL-30 (Lion Corporation), LIONOL TDL-50 (Lion Corporation), LIONOL TDM-90 (Lion Corporation), LIONOL L-535 (Lion Corpora-
- tion), LIONOL L-745 (Lion Corporation), LIONOL L-785 (Lion Corporation), and LIONOL L-950 (Lion Corporation).
 [0030] The compound expressed by the general formula 1 is required to have a clouding point which is lower than a washing temperature. To attain sufficient effects, the clouding point thereof needs to be lower than the washing temperature by 10°C or more. When the clouding point thereof is higher than the washing temperature, it is difficult to separate colored compounds (decomposition products of lignin) and pulp, which are subjects for washing, using warm washing
- 25 water.

-Alkylene oxide adduct of fatty acid alkyl ester-

[0031] As the alkylene oxide adduct of fatty acid alkyl ether, the compound expressed by the following general formula 2 can be used.

R²-CO-(AO)_v-OR³ General Formula 2

[0032] In the general formula 2, R² is a C10-20 straight alkyl group or a C10-20 straight alkyl group; AO is at least one oxyalkylene group selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene group; y is 1 to 10; and R³ is a methyl group.

[0033] In the general formula 2, (R^2 -CO-) is a fatty acid ester residue. A number of carbon atoms contained in the fatty acid ester residue is suitably selected depending on the purpose without any restriction, provided that it is 10 to 20, but the number thereof is preferably 12 to 18. When the number of carbon atoms is less than 10, the affinity thereof to

- the colored substance reduces, and thus the effect for enhancing whiteness reduces. When the number of carbon atoms is more than 20, the melting point thereof is excessively high, and thus handling ability is impaired at low temperature.
 [0034] The fatty acid ester is suitably selected depending on the purpose without any restriction. Examples thereof include methyl caprate, methyl laurate, methyl myristate, methyl palmitate, methyl stearate, and methyl oleate.
 [0035] The adduct molar number y of the polyoxyalkylene group in the general formula 2 is suitably selected depending
- 45 on the purpose without any restriction, provided that it is 1 to 10. The adduct molar number y is determined depending on the length of the alkyl chain of the fatty acid ester so that the compound expressed by the general formula 2 has a clouding point lower than washing temperature. In the case where the polyoxyalkylene group is a polyoxyethylene group, for example, y is 1 to 9 where R² is lauric acid ester, and y is 1 to 10 where R² is oleic acid ester so that the clouding point is made 55°C or lower.

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-Alkylene oxide adduct of aliphatic amine-

[0036] As the alkylene oxide adduct of aliphatic amine, the compound expressed by the following general formula 3 can be sued.

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General Formula 3

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[0037] In the general formula 3, R^4 is a C10-20 alkyl group; EO is an ethylene oxide group; and x and y each express an adduct molar number of ethylene oxide, and the sum of x and y are 2 to 10.

- [0038] R⁴ of the general formula 3 is suitably selected depending on the purpose without any restriction, provided that it is a C10-20 alkyl group. The number of carbon atoms thereof is preferably 12 to 18. When the number of carbon atoms thereof less than 10, the affinity to the colored substance reduces, and thus the effect for improving whiteness may reduce. When the number of carbon atoms thereof is more than 20, the melting point is excessively high, and thus the handling of the resulting detergent may be impaired at low temperature.
- [0039] The adduct molar number x+z of the polyoxyethylene group in the general formula 3 is suitably selected depending on the purpose without any restriction, provided that it is 1 to 10. The adduct molar number x+y is determined depending on the length of the alkyl chain so that the nonionic surfactant has a clouding point lower than the washing temperature.

[0040] The compound expressed by the general formula 3 is suitably selected depending on the purpose without any restriction. Examples thereof include polyoxyethylene(EO adduct molar number: 2 to 10)oleyl amine (ETHOMEEN O/ 12, O/17, O/20, manufactured by Lion Corporation), and polyoxyethylene (EO adduct molar number: 2 to 10) C12-14 amine (ETHOMEEN C/12, O/15, manufactured by Lion Corporation).

-Other Substances-

[0041] As the aforementioned other substances, other processing additives, such as a defoaming agent, a pitchcontrolling agent, and a scale-controlling agent, may be added, provided that these do not adversely affect the obtainable effects of the present invention.

-Form of Detergent for Kraft Pulp-

³⁵ **[0042]** The form of the detergent for Kraft pulp of the present invention is suitably selected depending on the purpose without any restriction, provided that it is fluid. The nonionic surfactant may be directly added, may be formulated with water, or may be diluted with water and then added thereto.

-Amount of Active Substance in Detergent for Kraft Pulp-

 $R^4 - N \begin{pmatrix} (EO)_x H \\ (EO)_z H \end{pmatrix}$

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[0043] The detergent for Kraft pulp of the present invention is suitably selected depending on the purpose without any restriction, provided that it contains the aforementioned nonionic surfactant. It is preferred that the detergent contain water for improving handling thereof. In the case where the detergent contains water, it is preferred that the moisture content thereof be adjusted so that the detergent does not turn into gel, as the detergent may become gel with the

45 moisture content of approximately 30% by mass to 70% by mass, though it depends on the adduct molar number of ethylene oxide or the like. The amount of water is preferably 1% by mass to 20% by mass, more preferably 5% by mass to 15% by mass.

-Used Amount of Detergent for Kraft Pulp-

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[0044] An amount of the detergent for Kraft pulp for use is suitably selected depending on the purpose without any restriction, but it is preferably 0.003% by mass to 10% by mass of the compound expressed by any of the general formulae 1 to 3 per bone dry pulp, more preferably 0.005% by mass to 1% by mass, and even more preferably 0.01% by mass to 0.1% by mass. When the used amount thereof is less than 0.003% by mass, the intended effect for improving whiteness may not be attained. When the used amount thereof is more than 10% by mass.

⁵⁵ whiteness may not be attained. When the used amount thereof is more than 10% by mass, the detergent may have high foamability, or the effect for improving whiteness comparable to the added amount may not be attained. Therefore, it is disadvantageous in terms of the cost.

[0045] According to the detergent for Kraft pulp of the present invention, the whiteness of pulp can be improved.

Especially when the Kraft pulp production method includes a bleaching method, the pulp before subjected to the bleaching process improves its whiteness to thereby reduce the amount of chlorine dioxide for use, foaming of the detergent is prevented to thereby reduce the amount of a defoaming agent for use. It is not certain why these effects can be attained. However, it is assumed that, as a result of use of the nonionic surfactant having the clouding point lower than the washing

- 5 temperature of the washing step, colored substances present on the surface of the pulp dissolves to an active agent layer formed by a phase separation of the nonionic surfactant due to the phenomenon caused at the clouding point, the colored substances are removed from the surface of the pulp by repeating washing and dewatering of the pulp in a multiple stage washing step, so that the whiteness of the pulp is improved, which contributes to the reduction in an amount of a chemical for use in the bleaching step. Accordingly, the nonionic surfactant needs to have, not only a certain
- 10 clouding point, but also a chain having certain hydrophobicity in the molecular structure thereof.

(Method for Producing Kraft Pulp)

[0046] The method for producing Kraft pulp of the present invention contains at least a cooking step, a reacting step for removing lignin using oxygen, and a washing step, and may further contain other steps, if necessary.

- **[0047]** In the washing step, a detergent for Kraft pulp is added, where the detergent is contains a nonionic surfactant which is at least one of the compounds expressed by the general formulae 1 to 3, and which has a clouding point lower than the washing temperature of the washing step by 10°C or more.
- [0048] The nonionic surfactant has the clouding point lower than the washing temperature preferably by 10°C or more to attain sufficient effect thereof. Since the washing temperature is generally 65°C to 90°C, the clouding point of the nonionic surfactant is preferably 55°C or lower.

<Cooking Step>

- ²⁵ **[0049]** The cooking step is cooking a raw material of pulp. In the cooking step, for example, a raw material of pulp (e.g. wood chips) is cooked in a mixture of sodium hydroxide and sodium sulfide under the compressed environment so that the non-fibrous portions of the raw material of pulp, such as a lignin substance, fatty acid sodium salts, and rosinic acid sodium salts, are dissolved. After the alkali-cooking, the cooked raw material is separated into pulp-slurry and black liquor, and then is subjected to washing.
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<Oxygen Delignification Step>

[0050] The oxygen delignification step is decomposing the lignin substance contained in the cooked raw material of pulp using oxygen. Specifically, it is a step to decompose the lignin substance left even after the cooking step. A method for removing lignin with oxygen, in which the oxygen is made function in the alkaline, high temperature, and compressed environment, at the early stage just after the cooking process, has been proposed, and currently commonly used. Since 40% to 50% of the lignin remained in the pulp after the cooking step is decomposed by the oxygen-lignin removing reaction. Therefore, it enables the reduction in the used amount of a chlorine-based bleaching chemical in the later stage. In addition to that, it enables to recycle the waste water generated from the oxygen-lignin removing reaction in

40 the cooking step. Therefore, the chemicals and energy can be recovered, and the environmental loads due to the waste water can be reduced.

<Washing Step>

⁴⁵ **[0051]** The washing step is washing the raw material of pulp after the oxygen delignification step. Namely, the washing step is removing the lignin decomposed products or colored substances generated by the oxygen-lignin removing reaction by washing.

[0052] In the case a bleaching step, which will be mentioned later, is performed, the washing step is performed between the oxygen delignification step and the bleaching step.

- ⁵⁰ **[0053]** Washing of the raw material of pulp is carried out, for example, by adding pulp-slurry (the pulp concentration of approximately 10% by mass) sent from the cooking step to washing water so as to form slurry having the pulp concentration of approximately 1% by mass.
 - [0054] The washing step is generally performed by counter flow rinsing.
- **[0055]** The counter flow rinsing is a washing method where two to five washers are connected in series. Fresh water (e.g. warm water collected from a boiler, namely warm washing water) is used only for the washing liquid in the washer of the latest stage. The washing water collected from the washer of the latest stage is used as washing water for the washer of the former stage, and the washing water collected from the former stage is used as washing water for the washer of the further former stage. Use of such counter flow rinsing method enables to recover, not only the chemicals

used in the cooking step and oxygen delignification step, as well as decomposed products of lignin at high concentration. [0056] The temperature of the pulp-slurry introduced to the washer, i.e. the washing temperature, is generally 65°C to 90°C, which is the temperature of the pulp-slurry in the vat of the washer.

- [0057] The washer is suitably selected depending on the purpose without any restriction. Examples thereof include a drum filter, a diffuser, a pressure diffuser, a compressed drum filter, and a press washer. The washing step is preferably a multi-stage washing step in which a combination of these washer is used.
 - **[0058]** It is preferred that multiple washing where at least one, preferably two or more stages of rinsing are performed followed by the washing stage adding the detergent for Kraft pulp be performed for removing the added detergent for Kraft pulp. In the case where a single washer is used, the added detergent for Kraft pulp is not sufficiently removed, and thus the effect for improving whiteness may not be sufficiently attained because of the re-attachment of the coloring.
- 10 thus the effect for improving whiteness may not be sufficiently attained because of the re-attachment of the coloring substances.

[0059] For enhancing the effect of the detergent, it is preferred that multiple washers of two or more be used, and the detergent for Kraft pulp be added to the washer of the first stage just after the oxygen delignification step.

- [0060] The position for adding the detergent for Kraft pulp relative to the washer is suitably selected depending on the ¹⁵ purpose without any restriction, provided that it enables to uniformly mix the detergent with the pulp-slurry that is prior to the treatment by the washer but posterior to the oxygen delignification step. The position is preferably a suction opening of a pump for sending the pulp-slurry to the washer, an inlet of diluting water for controlling the concentration of the pulp-slurry, or a suction opening of a pump for sending diluting water. For example, in the case where the detergent of Kraft pulp is directly added to a vat of a drum filter, compared to the case where the detergent is added from the
- 20 aforementioned position, the detergent for Kraft pulp is not sufficiently diffused into the pulp-slurry, and thus the sufficient effect of the detergent may not be exhibited. In the case where the detergent for Kraft pulp is added to the shower used in the washer, the troubles may be caused due to foaming.

[0061] The detergent for Kraft pulp is preferably added just after the oxygen delignification step. For example, in the case of the washing step using a counter two-step vacuum drum washer after the oxygen delignification step, it is

25 preferred that the detergent be added to the pulp-slurry which is sent to the washer of the first step. By adding the detergent in the washer of the first step, the detergent sufficiently includes the colored substance of the pulp therein, the removal of the detergent for Kraft pulp is sufficiently carried out in the washer of the second stage. In the case where the detergent is added in the washer of the second stage, the effect of removing the detergent for Kraft pulp may not be sufficiently obtained.

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<Other steps>

[0062] Other steps are suitably selected depending on the purpose without any restriction. Examples thereof include a bleaching step, and the like.

-Bleaching Step-

[0063] The bleaching step is bleaching the pulp after the washing step, and uses an oxidizing agent such as chlorine, hydrochlorite, chlorine dioxide, ozone, and hydrogen peroxide.

- ⁴⁰ **[0064]** In recent years, the environmental problems have been concerned. As the method for preventing the generation of organic chlorine compounds or chloroform, an elemental chlorine free (ECF) bleaching method has been used. In such method, ozone or chlorine dioxide is used instead of chlorine, and hydrogen peroxide or chlorine dioxide is used instead of hydrochlorite.
- [0065] In the method for producing Kraft pulp of the present invention, for example as shown in FIG. 1, pulp-slurry 1 is loaded in an oxygen-lignin removing reaction tower 2 to obtain the pulp-slurry 3 after the oxygen-lignin removing reaction. This pulp-slurry 3 after the oxygen-lignin removing reaction is transferred to a No. 1 washer through a No. 1 repulper 4, and then the pulp-slurry 3 is washed with shower water 6 of the No. 1 washer. The pulp (outlet pulp sheet) 9 washed by the No. 1 washer is then transferred to a No. 2 washer through a No. 2 repulper 10, and the pulp 9 is washed with shower water 12 of the No. 2 washer. The pulp (outlet pulp sheet) 15 washed by the No. 2 washer is
- transferred to a screen. Moreover, a filtrate 7 of the No. 1 washer is transferred to a filtrate tank 8 of the No. 1 washer so as to use as the diluting water 5 of the No. 1 repulper, and the filtrate 13 of the No. 2 washer is transferred to the filtrate tank 14 of the No. 2 washer to use as the shower water 6 of the No. 1 washer or the diluting water 11 of the No. 2 repulper.
- [0066] In the case of the washer of FIG. 1, the position for adding the detergent of Kraft pulp is, for example, preferably a position which enables to supply and uniformly mix the detergent at the inlet of the washer of the first stage in the multiple washing step (pulp-slurry 3 after the oxygen delignification, No. 1 repulper 4, or No. 1 repulper diluting water 5).
 [0067] Moreover, the method for producing Kraft pulp of the present invention contains, for example, a cooking step, an oxygen delignification step performed by an oxygen delignification tower (O₂TW) shown in FIG. 2, a washing step

performed by a counter vacuum drum two stage washer (washers A and B shown in FIG. 2), and a multi-stage bleaching step.

[0068] FIG. 3 is a schematic diagram for explaining the washers A and B of FIG. 2. It is preferred that the detergent for Kraft pulp of the present invention add in a supplying pulp of diluting filtrate (a) or pulp in the schematic diagram of

- 5 the washer of FIG. 3 so as to uniformly mix the detergent with the pulp. In the case where the detergent is added to the vat (c) or shower washing section (d) of the washer, the mixing of the detergent is insufficient, and thus the sufficient effect of the detergent may not be attained, or the detergent may be foamed in the washer. In accordance with the method for producing Kraft pulp shown in FIGs. 2 and 3, especially in the case where bleaching of the pulp is performed, whiteness of the pulp after the oxygen delignification step can be increased so that an amount of a bleaching agent to
- ¹⁰ be added can be reduced, and the formation of air bubbles can be prevented so that an amount of a defoaming agent to be added can be reduced.

[0069] Moreover, in the production of a paperboard, the method for producing Kraft pulp does not contain the bleaching step, the method does not have an effect of reducing the amount of chlorine for use. However, as the washing efficiency is enhanced, an amount of warm water used to attain the same washing effect can be reduced. Furthermore, as the

- ¹⁵ amount of the warm water for use is reduced, the amount of the black liquor to be generated can be reduced, which reduced the load of the recycling boiler. Furthermore, if it is in the situation where increase in the manufacturing scale is possible, the amount of the pulp to be treated with the same amount of the warm water can be increased, to thereby improve the production ability.
- 20 Examples

[0070] Examples of the present invention will be explained hereinafter, but these examples shall not be construed as limiting the scope of the present invention.

²⁵ (Examples 1 to 10, and Comparative Examples 1 to 7)

[0071] A production device of cellulose pulp was used, and the device operated a cooking step, an oxygen delignification step, a multiple-stage filter washing step, and a multiple-stage bleaching step by chloride dioxide and hydrogen peroxide. A broad leaved tree cellulose pulp, which was before subjected to the multiple-stage bleaching step, was taken out from

- ³⁰ the first washer of the multiple-stage filter washing step. The obtained cellulose pulp was weighted to 5.6 g as a dry mass and placed in a 500 mL beaker. Warm water having the temperature of 65°C was added thereto so that the concentration of the pulp was to be 1% by mass. Thereafter, 1% by mass (based on the solid content) of the detergent for Kraft pulp formed of EO or PO adduct of each higher alcohol shown in Table 1 was added to the pulp, and 4% by mass (based on the solid content) of 10% by mass sodium hydroxide solution was added to the pulp, and the mixture
- ³⁵ was stirred in the warm bath for 10 minutes while maintaining the temperature thereof at 65°C, to thereby prepare pulpslurry. The prepared pulp-slurry was subjected to suction filtration straight away using KIRIYAMA ROHTO (diameter: 95 mm) to thereby make paper. At the time of papermaking, the pulp-slurry was divided to have basis weight of 250 g/m², and three pieces of evaluation sheets were prepared in total. After pressing the prepared evaluation sheets, each evaluation sheet was subjected to forced-air drying for about 24 hours, to thereby prepare a sample for measuring whiteness.
 - **[0072]** For comparison, Comparative Example 1 used no detergent, Comparative Example 6 used EO(12 moles) adduct of nonyl phenol (LIPONOX NC 120, manufactured by Lion Corporation) was used as the detergent, and Comparative Example 7 used an anionic surfactant, which was sodium dodecylbenzenesulfonate (LIPON LS-250, manufactured by Lion Corporation), as the detergent.
- 45 **[0073]** In Table 1, Compounds 1 to 6 are prepared in Production Examples 1 and 2 below.

(Production Example 1)

[0074] To autoclave equipped with a stainless steel, electromagnetic-induced rotational stirrer connected to a meas-⁵⁰ uring tank for EO, PO, or a mixture of EO and PO, thermometer, nitrogen-inlet tube, and decompression tube, 394 g of isotridecyl alcohol [product name: Exxal 13, manufacturer: Exxon Mobil Corporation] and as a catalyst 5 g of 40% potassium hydroxide solution were added. After replacing the inner atmosphere thereof with nitrogen gas, the temperature thereof increased to 90°C, and the mixture was subjected to dewatering under the pressure of 0.003 MPa. Thereafter, the temperature was increased to 120°C, and 176 g (2 moles relative to 1 mole of alcohol) of ethylene oxide (EO,

⁵⁵ manufactured by Mitsubishi Chemical Corporation) and 116 g (1 mole relative to 1 mole of alcohol) of propylene oxide (PO, manufactured by Asahi Glass Co., Ltd.) were uniformly mixed together under the pressure of 0.5 MPa or lower and mixed to the aforementioned mixture. The obtained mixture was then matured for 2 hours, to thereby obtain a random adduct. Then, unreacted EO and PO were removed under the reduced pressure, and then cooled. The reacted

product was neutralized by adding an equivalent amount of 80% by weight acetic acid solution relative to the catalyst, to thereby obtain a predetermined random adduct (Compound 1).

[0075] Compounds 2 and 3 shown in Table 1 were synthesized in the same manner as in Production Example 1 so as to each attain the predetermined adduction molar number.

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(Production Example 2)

[0076] An autoclave was charged with 108.2 g (0.4 moles) of stearyl alcohol (CONOL 30S, manufactured by New Japan Chemical Co., Ltd.) and 0.278 g (0.18% by weight relative to propylene oxide (2 moles) adduct of stearyl alcohol) of KOH (caustic potash flakes, manufactured by Toa Gosei Co., Ltd.) as a catalyst, and after sufficiently replacing the inner atmosphere of the reaction system with nitrogen gas, dewatering was sufficiently performed at $140\pm5^{\circ}$ C for 1 hour under the reduced pressure. Thereafter, 46.4 g (0.8 moles) of propylene oxide (PO, manufactured by Asahi Glass Co., Ltd.) was gradually added so that the temperature and gauge pressure were respectively maintained at $115\pm5^{\circ}$ C and 0.1 MPa to 0.3 MPa. After the completion of the addition of propylene oxide, the mixture was matured for 2 hours.

- ¹⁵ Then, unreacted PO was removed under the reduced pressure. The reaction product was then cooled, and 0.06 g of KOH was added thereto. After sufficiently replacing the inner atmosphere of the reaction system with nitrogen gas, a mixture of 387.2 g (8.8 moles) of ethylene oxide (EO, manufactured by Mitsubishi Chemical Corporation) and 324.8 g (5.6 moles) of propylene oxide was gradually added so that the temperature and gauge pressure were respectively maintained at 120 ± 5°C and 0.1 MPa to 0.3 MPa. After completion of adding, the obtained mixture was matured, and
- 20 unreacted ethylene oxide and propylene oxide were removed therefrom under the reduced pressure. The mixture was then cooled, and acetic acid (99% industrial acetic acid, manufactured by Nippon Synthetic Chemical Industry Co., Ltd.) was added thereto so that a pH value thereof was adjusted to 7 (Compound 4).
 [0077] Compounds 5 and 6 shown in Table 1 were synthesized in the same manner as in Production Example 2 so

25 supplying and adding ethylene oxide, and propylene oxide to propylene oxide adduct of stearyl alcohol, in this order step by step.

(Examples 11 and 12)

³⁰ **[0078]** In Example 11, the detergent synthesized by Production Example 3 below was used.

(Production Example 3)

- [0079] Aluminum magnesium hydroxide (Kyoward 300, manufactured by Kyowa Chemical Industry Co., Ltd.) having the chemical formula of 2.5MgO·Al₂O₃·nH₂O was baked at 750°C for 3 hours with the airflow of nitrogen gas, to thereby obtain baked aluminum magnesium hydroxide. A 4 L autoclave was charged with 1.2 g of the obtained baked aluminum magnesium hydroxide catalyst, 1.3 g of 5% potassium hydroxide methanol solution, and 350 g of methyl laurate, and the catalyst was modified in the autoclave. After replacing the inner atmosphere of the autoclave with nitrogen gas, the temperature was increased. While the temperature and pressure were respectively maintained at 180°C and 3 atm.,
- ⁴⁰ 504 g of ethylene oxide was introduced thereto. The mixture was allowed to react with stirring, to thereby obtain an adduct of lauric acid polyoxyethylene methyl ether having an average ethylene oxide adduct molar number of 7.0. This adduct was used as the detergent of Example 11.

[0080] Example 12 used ETHOMEEN C/12 (manufactured by Lion Corporation), which is corresponded to the general formula 3, and is an ethylene oxide adduct (average adduct molar number: 2 moles) of aliphatic primary amine derived from coconut oil fatty acid.

[0081] For Examples 1 to 12, Comparative Examples 1 to 7, whiteness, and the clouding point of the detergent were respectively measured in the following manner. The results are shown in Table 2.

<Measurement of whiteness>

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[0082] Whiteness of the prepared evaluation sheet was measured at three positions per sheet using a spectrophotometer for Paper PF-10(manufactured by Nippon Denshoku Industries Co., Ltd.), and the average value of three sheets was obtained. Among the evaluation results shown in the table, the larger value of whiteness is more preferable. The effect for improving whiteness (Δ whiteness) was measured based on the deference to the whiteness obtained when

⁵⁵ no nonionic surfactant as a detergent for Kraft pulp was added (Comparative Example 1). As the condition for this experiment, the effect of improving whiteness of 1.5% or more is determined as contributing to the effect of reducing chlorine dioxide.

<Measurement of clouding point of detergent for Kraft pulp>

[0083] After preparing a 2% by weight nonionic surfactant solution at 25°C, the nonionic surfactant solution was weighted to 80 g and placed in a 100 mL transparent glass screw top bottle equipped with a thermometer and stirring 5 bar. The bottle was placed in a warm bath to increase the temperature of the solution with stirring. Once the solution started clouding, the bottle was taken out from the warm bath to cool the solution when the temperature of the solution was 3°C to 5°C higher than the temperature at which the solution started clouding. Then the temperature at which the cloudiness of the solution disappeared was visually measured, and was determined as a clouding point. In the case where cloudiness was already observed when a 2% by weight nonionic surfactant solution was prepared at 25°C, the 10 solution was placed in a 100 mL glass container in the same manner as above, and was left to stand for 1 hour with the container placed in a water tank having the constant temperature of 25°C. Then, the cloudiness of the solution was visually confirmed, and a clouding point thereof was determined as 25°C or lower.

15 [Table 1]

			Chemical name	Manufacturer	Length of alkyl chain	n	m	k
20		1	EMALEX 102	Nihon-Emulsion Co., Ltd.	16	0	2	NA
		2	Compound 1	Synthesized	13	0	2	1
		3	Compound 2	Synthesized	13	0	3	1
25	0	4	Compound 3	Synthesized	13	0	5	1
	mple	5	LEOCOL SC-50	Lion Corporation	13	0	5	NA
ĺ	Example	6	NOIGEN XL-40	Dai-Ichi Kogyo Seiyaku Co. Ltd.	10	0	4	NA
30		7	LEOX CC-50	Lion Corporation	12	0	5	NA
		8	Compound 4	Synthesized	18	2	22	14
		9	Compound 5	Synthesized	18	2	18	20
5		10	Compound 6	Synthesized	18	6	28	20
	le	1	NA	NA	NA	NA	NA	NA
	Examp	2	EMALEX BHA-5	Nihon-Emulsion Co., Ltd.	22	0	5	NA
0	Comparative Example	3	2-ethylhexyl diglycol	Nippon Nyukazai Co., Ltd.	8 (2-ethylhexyl)	0	2	NA
	omp	4	LEOCOL SC-120	Lion Corporation	13	0	12	NA
45	Ŭ	5	FD-9000N	Lion Corporation	18	6	35	10

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5			Structure		Clouding	Result	
5					point	Whiteness	Difference
						(%)	∆(%)
		1	C16·EO2	Formula 1	25°C or lower	51.8	3.8
10		2	C13·(EO2/PO1)	Formula 1	25°C or lower	52.1	4.2
		3	C13 (EO3/PO1)	Formula 1	25°C or lower	51.9	4.0
		4	C13·(EO5/PO1)	Formula 1	25°C or lower	51.7	3.7
		5	C13·EO5	Formula 1	25°C or lower	52.6	4.6
15	e	6	C10·EO4	Formula 1	25°C or lower	51.3	3.4
	Example	7	C12·EO5	Formula 1	25°C or lower	51.1	3.2
	Exa	8	C18·PO2·(EO22/PO14)	Formula 1	53°C	50.4	2.5
20		9	C18·PO2·(EO18/PO20)	Formula 1	31°C	51.1	3.1
20		10	C18·PO6·EO28·PO20	Formula 1	40°C	50.1	2.2
		11	R ² =C12, AO=EO, y=7,	Formula 2	41°C	50.3	2.4
			R ³ =CH ₃				
25		12	R4=C12, 14 mixed	Formula 3	25°C or lower	51.4	3.5
		<u> </u>	(coconut derived), $x+y = 2$				
		1	NA	NA	NA	47.9	NA
	aple	2	C22·EO5	Formula 1	25°C or lower	48.7	0.8
30	xan	3	C8·EO2	Formula 1	25°C or lower	48.8	0.9
	veE	4	C13·EO12	Formula 1	83°C	48.9	1.0
	Comparative Example	5	C18·PO6·(EO35/PO10)	Formula 1	73°C	49.0	1.1
35	npa	6	C9H19C6H5·EO12	NA	70°C or higher	48.8	0.9
55	Col	7	Sodium dodecylbenzene	NA	NA	48.6	0.7
			sulfate				

[Table 2]

⁴⁰ **[0084]** In Table 2, "Formula 1," "Formula 2," and "Formula 3" respectively denote the general formula 1, the general formula 2, and the general formula 3.

(Example 13)

- 45 [0085] A method for producing Kraft pulp containing a cooking step, an enzyme-delignification step, a washing step for washing pulp using three vacuum drum washers (first stage: No. 1 washer, second stage: No. 2 washer, third stage: No. 3 washer) after the enzyme-delignification step, and a bleaching step was performed in a Kraft pulp manufacturing factory (production of needle-leaved tree pulp: 350 ton/day).
- [0086] To a filtrate for controlling the concentration of pulp introduced to the No. 1 washer (vat temperature (washing temperature): 80°C) of the vacuum drum washer, the nonionic surfactant used in Example 8 was added so as to be 300 ppm relative to the pulp.

[0087] Then, the pulp washed and released from the No. 3 washer was taken out, and subjected to the measurement of whiteness in the following manner. As a result, the whiteness thereof increased by 1.0% compared to the case where no nonionic surfactant (detergent) was added.

⁵⁵ **[0088]** Moreover, the amount of chlorine dioxide for use in the bleaching step was measured in the following manner. As a result, it was found that the amount thereof could be reduced by 11.0%.

<Whiteness>

[0089] An evaluation sheet having basis weight of 250 g/m² was prepared using TAPPI paper machine, and the whiteness of the evaluated sheet was measured in accordance with JIS P8148. The difference (Δ) to the whiteness when no nonionic surfactant (detergent) was added was determined as an evaluation index. An amount of chlorine dioxide used in the bleaching step of chemical pulp is generally adjusted by continuously sensing whiteness of pulp contained in the slurry. Accordingly, the effect of improving the whiteness of 0.5% or more is determined as contributing the effect of reducing chlorine dioxide.

10 <Amount of Used Chlorine Dioxide>

[0090] The reduction rate of the amount of chlorine dioxide for use was calculated by the formula:

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[(the amount of chlorine dioxide added when no detergent was added – the

amount of chlorine dioxide added when the detergent was added)/the amount of

chlorine dioxide added when no detergent was added]×100

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[0091] In order to remove the error depending on the variations in the degree of delignin resulted from the oxygen delignification, a graph was prepared by taking Kappa number (KN) showing the delignin degree of the pulp after the enzyme-delignification on the horizontal axis, and taking the amount of chlorine dioxide necessary for obtaining the desired whiteness of the pulp finally attained after the bleaching on the longitudinal axis. Based on this graph, the amount was read from the amount of chlorine dioxide when KN was identical to the delignin degree after the oxygen-delignification. This was performed in both cases where no detergent was added and where the detergent was added, and the reduction

rate of chlorine dioxide was calculated. Note that, Kappa number was measured in accordance with JIS P8211.

(Example 14)

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[0092] A method for producing Kraft pulp containing a cooking step, an enzyme-delignification step, a washing step for washing pulp using a vacuum drum washer, a drum compression washer, and a press washer after the enzyme-delignification step, and a bleaching step was performed in a Kraft pulp manufacturing factory (production of broad-leaved tree pulp: 1050 ton/day).

³⁵ **[0093]** To a suction side of a filtrate for controlling the concentration of pulp introduced to the vacuum drum washer (vat temperature (washing temperature): 83°C), the nonionic surfactant used in Example 8 was added so as to be 300 ppm relative to the pulp.

[0094] The washed pulp was taken out from the press washer, and whiteness thereof was measured in the same manner as in Example 13. The whiteness thereof was increased by 1.1% and the amount of chlorine dioxide for use in the bleaching step was reduced by 5.2%, compared to the case where no nonionic surfactant (detergent) was added.

(Example 15)

[0095] A method for producing Kraft pulp containing a cooking step, an enzyme-delignification step, a washing step for washing pulp using two vacuum drum washers (first stage: No. 1 washer, second stage: No. 2 washer) after the enzyme-delignification step, and a bleaching step was performed in a Kraft pulp manufacturing factory (production of needle-leaved tree pulp: 300 ton/day).

[0096] To a suction side of a pump of a filtrate for controlling the concentration of pulp introduced to the No. 1 washer (vat temperature (washing temperature): 80°C) of the vacuum drum washer, the nonionic surfactant used in Example 8 was added so as to be 300 ppm relative to the pulp.

[0097] The washed pulp was taken out from the No. 2 washer of the vacuum drum washer, and whiteness thereof was measured in the same manner as in Example 13. The whiteness thereof was increased by 1.0% and the amount of chlorine dioxide for use in the bleaching step was reduced by 12.0%, compared to the case where no nonionic surfactant (detergent) was added.

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(Example 16)

[0098] A method for producing Kraft pulp containing a cooking step, an enzyme-delignification step, a washing step

for washing pulp in two stages using a drum displacer (compression multiple stage washer: DD washer) after the enzymedelignification step, and a bleaching step was performed in a Kraft pulp manufacturing factory (production of needleleaved tree pulp: 300 ton/day).

[0099] To the pulp for introducing to the DD washer (pulp temperature (washing temperature): 80°C), the nonionic surfactant used in Example 8 was added so as to be 300 ppm relative to the pulp.

[0100] The washed pulp was taken out from the outlet of the DD washer, and whiteness thereof was measured in the same manner as in Example 13. The whiteness thereof was increased by 0.5% and the amount of chlorine dioxide for use in the bleaching step was reduced by 5.0%, compared to the case where no nonionic surfactant (detergent) was added.

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Industrial Applicability

[0101] The detergent for Kraft pulp of the present invention can be suitably applicable as a detergent for washing Kraft pulp used for productions, for example, of woodfree paper, cardboard, and the like.

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Claims

1. A detergent for Kraft pulp, comprising:

a nonionic surfactant containing at least one compound expressed by any of the following general formulae 1 to 3:

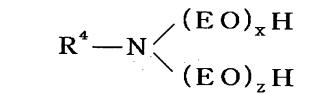
R¹O-(PO)_n-[(EO)_m·(PO)_k]H

General Formula 1

where R¹ is a C10-20 straight or branched alkyl group, or a C10-20 straight or branched alkenyl group; n is 0 to 10, and the sum of m and k is 1 to 100, where n, m, and k each express an average adduct molar number; EO and PO express an ethylene oxide unit and a propylene oxide unit, respectively, and a form of addition of EO and PO in [(EO)_m·(PO)_k] is random or block,

30	R ² -CO-(AO) _v -OR ³	General Formula 2
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where R² is a C10-20 straight alkyl group or a C10-20 straight alkenyl group; AO is at least one oxyalkylene group selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene group; y is 1 to 10; and R³ is a methyl group,



General Formula 3

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where R^4 is a C10-20 alkyl group; EO is an ethylene oxide group; x and z each express an adduct molar number of ethylene oxide, and the sum of x and z is 2 to 10,

wherein the detergent is used for washing a raw material of pulp after decomposing a lignin substance, which is contained in the cooked raw material of pulp, using oxygen, and

- wherein the nonionic surfactant has a clouding point lower than a temperature for washing the raw material of pulp.
- 2. The detergent for Kraft pulp according to claim 1, wherein the nonionic surfactant has a clouding point of 55°C or lower.

3. A method for producing Kraft pulp, comprising:

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cooking a raw material of pulp;

decomposing a lignin substance, which is contained in the cooked raw material of pulp, using oxygen; and washing the raw material of pulp after the decomposing,

wherein a detergent for Kraft pulp is added in the washing, and wherein the detergent comprising:

a nonionic surfactant containing at least one compound expressed by any of the following general formulae 1 to 3:

 $R^{1}O-(PO)_{n}-[(EO)_{m}\cdot(PO)_{k}]H$ General Formula 1

¹⁰ where R¹ is a C10-20 straight or branched alkyl group, or a C10-20 straight or branched alkenyl group; n is 0 to 10, and the sum of m and k is 1 to 100, where n, m, and k each express an average adduct molar number; EO and PO express an ethylene oxide unit and a propylene oxide unit, respectively, and a state of addition of EO and PO in [(EO)_m·(PO)_k] is random or block,

R²-CO-(AO)_v-OR³ General Formula 2

 $R^4 - N \begin{pmatrix} (EO)_x H \\ (EO)_7 H \end{pmatrix}$

where R^2 is a C 10-20 straight alkyl group or a C 10-20 straight alkenyl group AO is at least one oxyalkylene group selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene group; y is 1 to 10; and R^3 is a methyl group,

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where R^4 is a C10-20 alkyl group; EO is an ethylene oxide group; x and z each express an adduct molar number of ethylene oxide, and the sum of x and z are 2 to 10, wherein the nonionic surfactant has a clouding point lower than a temperature for washing the raw material of

General Formula 3

pulp in the washing.

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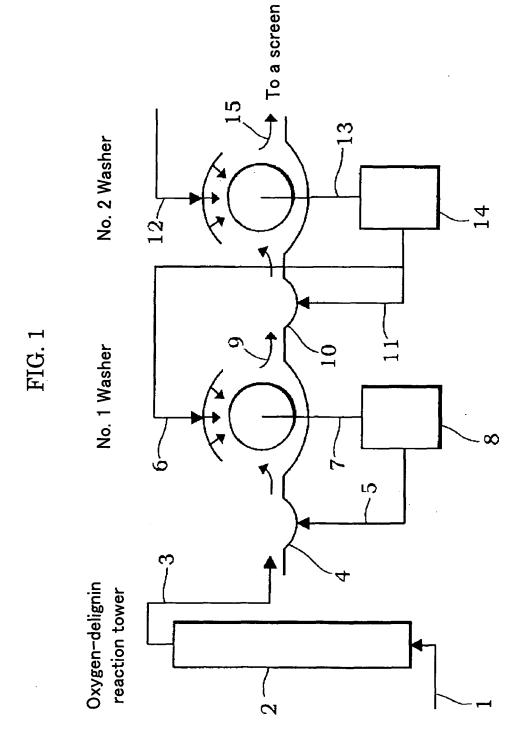
4. The method for producing Kraft pulp according to claim 3, further comprising bleaching the raw material of pulp after the washing.

5. The method for producing Kraft pulp according to any of claim 3 or 4, wherein the nonionic surfactant has a clouding point of 55°C or lower.

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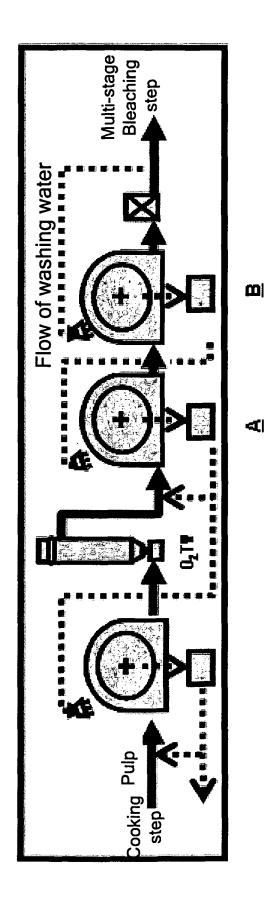
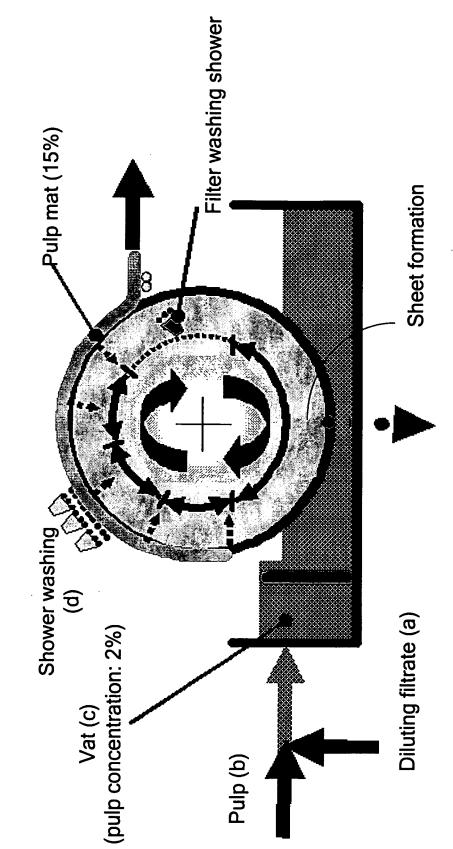


FIG. 2





	INTERNATIONAL SEARCH REPORT		International appli	cation No.	
			PCT/JP2	009/050890	
	A. CLASSIFICATION OF SUBJECT MATTER D21C9/02(2006.01)i				
According to Inte	ernational Patent Classification (IPC) or to both nationa	al classification and II	PC		
B. FIELDS SE					
	nentation searched (classification system followed by cl 11/14, C11D1/00-19/00	lassification symbols)			
Jitsuyo		ent that such documer tsuyo Shinan T vroku Jitsuyo S	Toroku Koho	ne fields searched 1996-2009 1994-2009	
Electronic data t	base consulted during the international search (name of	data base and, where	practicable, search	terms used)	
C. DOCUMEN	NTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where ap	propriate, of the relev	ant passages	Relevant to claim No.	
X Y				1,2 1-5	
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Y	JP 2006-176910 A (Oji Paper 06 July, 2006 (06.07.06), Claims; Par. Nos. [0018], [00 (Family: none)			1-5	
× Further do	ocuments are listed in the continuation of Box C.	See patent far	nily annex.		
"A" document de	gories of cited documents: fining the general state of the art which is not considered to lar relevance	date and not in co		national filing date or priority ion but cited to understand rention	
date	cation or patent but published on or after the international filing which may throw doubts on priority claim(s) or which is	considered nove		aimed invention cannot be red to involve an inventive	
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03 Apr.	Date of the actual completion of the international search 03 April, 2009 (03.04.09)Date of mailing of the international search report 14 April, 2009 (14.04.09)				
	ng address of the ISA/ se Patent Office	Authorized officer			
Facsimile No.		Telephone No.			

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	INTERNATIONAL SEARCH REPORT	International appli	cation No.	
		PCT/JP2009/050890		
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT			
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REFERENCES CITED IN THE DESCRIPTION

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