FORM 2

THE PATENTS ACT, 1970
(39 of 1970)
AND
THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

(See Section 10; rule 13)

TITLE OF THE INVENTION

"PROCESS FOR PRODUCING HYDROGEN PEROXIDE"

APPLICANT

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The following specification particularly describes
the invention and the manner in which
it is to be performed

CLAIMS

1. A process for the manufacture of hydrogen peroxide by the AO-process comprising the two alternate essential steps of

(a) hydrogenation of a working solution in a hydrogenation unit in the presence of a catalyst, wherein said working solution contains at least one alkylanthraquinone dissolved in at least one organic solvent, to obtain at least one corresponding alkylanthrahydroquinone compound; and

(b) oxidation of said at least one alkylanthrahydroquinone compound to obtain hydrogen peroxide in an oxidation unit;

and further comprising the step of

(c) extracting the hydrogen peroxide formed in the oxidation step in an extraction unit, wherein the units of step (a) to (c), optionally together with further ancillary units as appropriate, constitute a hydrogen peroxide production site,

characterized in that one or more of said units are equipped with one or more sensors for monitoring one or more AO-process parameters, optionally involving at least one chemical AO-process parameter, at the hydrogen peroxide production site, said sensors being interconnected with one or more first computers at the hydrogen peroxide production site, said first computers being linked via a communication network to one or more second computers in a control room being remote from the hydrogen peroxide production site, and wherein said control room is remotely controlling, particularly remotely operating and controlling, said hydrogen peroxide production site.

2. A process for the manufacture of hydrogen peroxide by the AO-process according to claim 1, characterized in that the control room remotely controlling the hydrogen peroxide production site is located at another hydrogen peroxide plant being different from said remotely controlled hydrogen peroxide production site, preferably at another hydrogen peroxide plant with a larger scale of hydrogen peroxide production capacity than in said remotely controlled hydrogen peroxide site, and more preferably with a scale of hydrogen peroxide

production capacity of at least 30 kilo tons per year, more preferably of at least 40 kilo tons per year.

3. A process for the manufacture of hydrogen peroxide by the AO-process according to claim 1, characterized in that the process is a small to medium scale AO-process with a production capacity of hydrogen peroxide of up to 20 kilo tons per year, preferably with a production capacity of hydrogen peroxide of up to 15 kilo tons per year, more preferably with a production capacity of hydrogen peroxide of up to 10 kilo tons per year, and most preferably with a production capacity of hydrogen peroxide of up to 5 kilo tons per year.

4. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 3, characterized in that one or more of said units being equipped with one or more sensors for monitoring one or more AO-process parameters such as pressure, temperature, quantity, flow rate, density, viscosity, catalyst activity, acidity, purity, concentration, hydrogen peroxide productivity or other process parameters relevant for the production of hydrogen peroxide according to the AO-process.

5. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 4, characterized in that one or more of the units (a) to (c) are equipped with one or more sensors for monitoring one or more parameters of the process chemistry of the AO-process, preferably involving at least one chemical AO-process parameter controlling the process chemistry related to the working solution of the AO-process.

6. A process for the manufacture of hydrogen peroxide by the AO-process according to the claim 5, characterized in that the AO-process is run without permanently controlling, particularly without continuously or permanently directly controlling, of the working solution and the controlling of the working solution is conducted only occasionally as deemed appropriate according to one or more pre-set AO-process parameter as defined in claim 4 and in relation to the result of monitoring said one or more AO-process parameter.

7. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 6, characterized in that the controlling of the working solution is directly conducted, preferably directly conducted by remotely controlling one or more physical and/or chemical

parameters indicative for the productivity and/or quality of the working solution, more preferably by remotely controlling one or more parameters indicative for the productivity and/or cyclic conversion of one or more working compounds from the quinone form into the hydroquinone form and vice versa, and/or one or more parameters indicative for the formation of undesired quinone by-products or their reconversion into a quinone form and/or into a hydroquinone form useful for the AO-process.

8. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 7, characterized in that the working solution is remotely operationally controlled by one or more analytical parameter which is electronically measurable by internet or other on-line communication means, preferably by electronically measuring one or more parameter selected from the group of density, viscosity, refractive index, color, including wavelength and/or extinction coefficient, interfacial tension of water, acidity of the working solution and/or of the extracted aqueous hydrogen peroxide solution, preferably by automatic titration or more preferably by electronic pH-measurement, any spectroscopic method, especially IR methods, parameters measured by refractive indew meters, or other electronically measurable analytical parameter of the working solution.

9. A process for the manufacture of hydrogen peroxide by the AO-process according to claim 8, characterized in that the working solution is remotely operationally controlled by means of a near infra-red (NIR) spectroscopy on-line analyzer for remotely operating and controlling the hydroquinone (QH) concentration of the working solution and/or in that the working solution is remotely operationally controlled by means of a refractive indew meter used for remotely operating and controlling the working solution, preferably for remotely operating and controlling the extraction of the hydrogen peroxide from the working solution in extraction step (c) as defined in claim 1.

10. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 9, characterized in that the remote control is a remote operational control of a satellite AO-process depending on a mother AO-process, preferably wherein the remote operational control of the satellite AO-process is based on a dependence of the working solution and/or the catalyst from a distant mother AO-process, more preferably

wherein the remote operational control of the working solution of the said satellite AO-process depends on the distant mother AO-process.

11. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 10, characterized in that a safety equipment or safety means to allow for automatic safe shutdown, preferably a safety PLC (independent protection layer) or hardwired relay based system for the monitoring and automatic safe shutdown (interlock system), is foreseen.

12. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to claim 11, characterized in that the hydrogen peroxide production site is located proximal to or on-site of an end user site or customer site utilizing the hydrogen peroxide an industrial application, preferably an end user or customer site with an industrial application of hydrogen peroxide selected from pulp and paper industry or the textile industry, or the mining industry or sites with environmental applications.

13. A process for the manufacture of hydrogen peroxide by the AO-process according to claim 12, characterized in that from the extraction unit at least a portion of an aqueous solution of hydrogen peroxide is delivered to a site of use that is proximal to the hydrogen peroxide production site, preferably proximal to the extraction unit.

14. A process for the manufacture of hydrogen peroxide by the AO-process according any of the claim 12 to claim 13, characterized in that the aqueous hydrogen peroxide solution is delivered as an aqueous hydrogen peroxide solution containing a predetermined concentration of hydrogen peroxide which is suitable for being directly utilized in the specified industrial application of the site of use.

15. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to 14, characterized in that the hydrogenation, oxidation and extraction steps of the AO-process are performed in a reactor system which is designed as a compact modular system of a hydrogenation unit for the hydrogenation of a working solution in the presence of a catalyst, of an oxidation unit and of an extraction unit, and wherein said reactor system is configured to operate without a reversion or regeneration unit, in particular without a reversion unit for continuous reversion of the working

solution, and wherein the working solution and/or the catalyst are replaced and/or treated for regeneration or reactivation only intermittently or periodically.

16. A process for the manufacture of hydrogen peroxide by the AO-process according to any of the claim 1 to 15, characterized in that the hydrogenation, oxidation and extraction steps of the AO-process are performed in a reactor system which is designed as a compact modular system of a hydrogenation unit for the hydrogenation of a working solution in the presence of a catalyst, of an oxidation and of an extraction unit, and wherein said reactor system is configured to operate without a reversion or regeneration unit, in particular without a reversion unit for continuous reversion of the working solution, and wherein the working solution and/or the catalyst are replaced and/or treated for regeneration or reactivation only intermittently or periodically with a low frequency of only about monthly periods, preferably only after periods of at least 3 months in the loop of the AO-process steps (a), (b) and (c).

17. A computer-controlled device for carrying out a process for the manufacture of hydrogen peroxide by the AO-process according to any one of claims 1 to 16, comprising a reactor system of

(a) a hydrogenation unit (hydrogenator) for hydrogenation of a working solution in the presence of a catalyst, wherein said working solution contains at least one alkylanthraquinone dissolved in at least one organic solvent, to obtain at least one corresponding alkylanthrahydroquinone compound; and

(b) an oxidation unit for oxidation of said at least one alkylanthrahydroquinone compound to obtain hydrogen peroxide; and further comprising

(c) an extraction unit for extracting the hydrogen peroxide formed in the oxidation unit, wherein the units (a) to (c), optionally together with further ancillary units as appropriate, being a hydrogen peroxide production site,

characterized in that one or more of said units being equipped with one or more sensors for monitoring one or more AO-process parameters at the hydrogen peroxide production site, said sensors being interconnected with one or more first computers at the hydrogen peroxide production site, said first computers being linked via a communication network to one or more second computers in a control room being remote from the hydrogen peroxide production site, and

wherein said control room is remotely controlling said hydrogen peroxide production site.

18. A computer-controlled device according to claim 17, characterized in that one or more of said units being equipped with one or more sensors for monitoring one or more AO-process parameters such as pressure, temperature, quantity, flow rate, density, viscosity, catalyst activity, acidity, purity, concentration, hydrogen peroxide productivity or other process parameters relevant for the production of hydrogen peroxide according to the AO-process.

19. A computer-controlled device according to any of the claim 17 to claim 18, characterized in that one or more of the units (a) to (c) are equipped with one or more sensors for monitoring one or more parameters of the process chemistry of the AO-process, preferably involving at least one chemical AO-process parameter controlling the process chemistry related to the working solution of the AO-process, and more preferably in that the device is equipped with one or more sensors for monitoring one or more parameters of the process chemistry of the AO-process as defined in any of the claims 6 to 10.

20. A computer-controlled device according to any of the claim 17 to claim 19, characterized in that it comprises a safety equipment or safety means to allow for automatic safe shutdown, preferably a safety PLC (independent protection layer) or hardwired relay based system for the monitoring and automatic safe shutdown (interlock system).

21. A computer-controlled device according to any one of claims 17 to 20, characterized in that the reactor system contains a working solution of at least one alkylanthraquinone dissolved in at least one organic solvent, said at least one alkylanthraquinone being capable to be hydrogenated to at least one corresponding alkylanthrahydroquinone compound, and said at least one alkylanthrahydroquinone compound being capable to be oxidized to obtain hydrogen peroxide and to revert back into the at least alkylanthraquinone, characterized in that the reactor system is designed as a compact modular reactor system of a hydrogenation unit containing a hydrogenation catalyst, an oxidation unit and an extraction unit, and further characterized in that said reactor system (mini-AO-plant) is devoid of a regeneration unit for continuous and/or periodical cyclic reversion of the working solution, and wherein the reactor system is configured to operate without a such a continuous or permanent regeneration or

reversion unit as a small to medium scale AO-process reactor system with a production capacity of hydrogen peroxide of up to 20 kilo tons per year, preferably with a production capacity of hydrogen peroxide of up to 15 kilo tons per year, and more preferably with a production capacity of hydrogen peroxide of up to 10 kilo tons per year, and most preferably with a production capacity of hydrogen peroxide of up to 5 kilo tons per year.

22. A computer-controlled device according to claim 21, characterized in that the reactor system is configured to operate without a such a continuous or permanent regeneration or reversion unit and wherein the working solution and/or the catalyst are replaced and/or treated for regeneration or reactivation only intermittently or periodically, preferably intermittently or periodically with a low frequency of some weeks or months, more preferably wherein the working solution and/or the catalyst are replaced and/or treated for regeneration or reactivation only periodically after periods of at least 3 months in the loop of the AO-process steps (a), (b) and (c).

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