Claims:

1. A process for treating waste fluid generated during a petrochemical process (4), wherein the waste fluid comprises at least one first water-based wastewater stream (8) and at least one second organic fluid-based waste fluid stream (10), wherein the process comprises the following steps:
   a) subjecting the at least one first water-based wastewater stream (8) to at least one freeze concentration stage (24) so as to produce a third clean water stream (26) and a fourth concentrated water-based wastewater stream (28),
   b) subjecting the at least one second organic fluid-based waste fluid stream (10) to at least one separation stage (30) so as to produce a fifth purified product stream (32) and a sixth concentrated organic fluid-based waste fluid stream (34), wherein the second organic fluid-based waste fluid stream (10) includes 5 to 99.5 % by weight of one or more organic compounds to be separated by the at least one separation stage (30) during step b) and being selected from the group consisting of phenol, cumene, acetophenone, 1,3-butylene glycol, acrylic acetate, acrylonitrile and arbitrary combinations of two or more of the aforementioned compounds and remainder to 100 % by weight of one or more dissolved and/or dispersed impurities, wherein the at least one separation stage (30), to which the second organic fluid-based waste fluid stream (10) is subjected in step b), is selected from the group consisting of layer crystallization, distillation, extraction and arbitrary combinations of two or more of the aforementioned methods, and wherein the fifth purified product stream (32) obtained in step b) comprises less than 2,000 ppm of dissolved and/or dispersed impurities,
   c) forwarding the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream

(34) to an incinerator (16) and incinerating the streams (28, 34) in the incinerator (16),

wherein the process is controlled so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

2. The process in accordance with claim 1, wherein during the process at least one of the concentration degree during the at least one freeze concentration stage (24) of step a), of the separation degree during the at least one separation stage (30) of step b) and of the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) is adjusted so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

3. The process in accordance with claim 1 or 2, wherein the process is controlled so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 80%, preferably at least 90%, more preferably at least 95% and most preferably at least all of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

4. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) includes 70 to 99.5 % by weight and preferably 80 to 95 % by weight of water and 0.5 to 30 % by weight and preferably 5 to 20 % by weight of dissolved and/or dispersed impurities.

5. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) to at least one suspension crystallization stage,

wherein the at least one suspension crystallization stage comprises at least one crystallization block for producing water crystals and at least one separation block for separating the crystals produced in the at least one crystallization block from the mother liquor, wherein the crystallization block comprises at least one scraped surface crystallizer (38, 38'), and wherein the separation block comprises at least one wash column (40), wherein preferably the wash column (40) comprises:

a cylindrical vessel, wherein the cylindrical vessel comprises:

- a piston with a piston head and a piston rod, wherein the piston is arranged reciprocatingly movable in the cylindrical vessel, wherein the piston bounds above the piston head a wash chamber inside the cylindrical vessel and wherein the piston head comprises at least one filter means,
- an inlet for supplying the crystal suspension mixture produced in the crystallization block composed of crystals and mother liquor into the cylindrical vessel,
- an outlet for discharging mother liquor from the cylindrical vessel and
- an outlet for discharging crystals and/or crystal melt from the cylindrical vessel.

6. The process in accordance with claim 5, wherein the cylindrical vessel is connected to a circulation conduit for circulating melt arranged outside the cylindrical vessel, which is in communication with the wash chamber and a means for partial melting and disintegrating of the crystal bed arranged in the wash chamber for restricting the movement of the crystal bed that has been compacted in the wash chamber by the piston and for directing the wash liquid entering into the cylindrical vessel from the circulation conduit so as to homogeneously distribute it over the entire cross-section of the wash column.

7. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) to at least one static crystallization stage.

8. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) i) to at least two suspension crystallization stages or ii) to at least one suspension crystallization stage and at least one static crystallization stage with the at least one static crystallization stage being downstream of the at least one suspension crystallization stage.

9. The process in accordance with any of the preceding claims, wherein the second organic fluid-based waste fluid stream (10) includes 10 to 30% by weight of one or more organic compounds to be separated by the at least one separation stage (30) during step b) and remainder to 100 % by weight of one or more dissolved and/or dispersed impurities.

10. The process in accordance with any of the preceding claims, wherein the fifth purified product stream (32) obtained in step b) comprises less than 1,000 ppm, preferably less than 100 ppm, more preferably less than 50 ppm and most preferably less than 10 ppm of dissolved and/or dispersed impurities.

11. The process in accordance with any of the preceding claims, wherein the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) is adjusted so that the incineration the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) occurs at at least 900°C, preferably between 900 and 1,100°C, more preferably between 900 and 1,000°C and most preferably between 900 and 950°C.

12. A plant for treating waste fluid generated during a petrochemical process (4), in particular for performing a process in accordance with any of the preceding claims, wherein the waste fluid comprises a first water-based wastewater stream (8) and a second organic fluid-based waste fluid stream (10), wherein the plant comprises:

a) a source (4) for a first water-based wastewater stream (8),

b) a source (4) for a second organic fluid-based waste fluid stream (10),

c) at least one freeze concentration stage (24) with an inlet line (42) for supplying the first water-based wastewater stream (8) into the at least one freeze concentration stage (24), with an outlet line (44) for withdrawing a third clean water stream (26) produced in the freeze concentration stage (24) and an outlet line (46, 46') for withdrawing a fourth concentrated water-based wastewater stream (28) produced in the at least one freeze concentration stage (24),

d) at least one separation stage (30) with an inlet line for supplying the second organic fluid-based waste fluid stream (10) into the at least one separation stage (30), with an outlet line for withdrawing a fifth purified product stream (32) produced in the at least one separation stage (30) and with an outlet line for withdrawing a sixth concentrated organic fluid-based waste fluid stream (34) produced in the at least one separation stage (30),

e) an incinerator (16) with an inlet line for supplying the fourth concentrated water-based wastewater stream (28) and with an inlet line for supplying the sixth concentrated organic fluid-based waste fluid stream (34) into the incinerator (16), and

f) a control unit embodied so that it can control that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

13. The plant in accordance with claim 12, wherein the control unit comprises at least one of a measurement device for the determination of the concentration of the fluid stream processed in the at least one freeze concentration stage (24), a measurement device for the determination of the separation degree during the at least one separation stage (30) and a device for controlling the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) being fed into the incinerator (16).

14. The plant in accordance with claim 12 or 13, wherein the at least one freeze concentration stage (24) comprises at least one suspension crystallization stage and/or at least one static crystallization stage, and wherein preferably the at least one separation stage (30) is selected from the group consisting of layer crystallization stages, distillation stages, extraction stages and arbitrary combinations of two or more of the aforementioned stages.

15. The plant in accordance with any of claims 12 to 14, wherein the at least one freeze concentration stage (24) comprises at least one suspension crystallization stage comprising at least one crystallization block for producing water crystals and at least one separation block for separating the crystals produced in the at least one crystallization block from the mother liquor, wherein the crystallization block comprises at least one crystallizer (38, 38'), and wherein the separation block comprises at least one wash column (40), wherein preferably the wash column (40) comprises:

a cylindrical vessel, wherein the cylindrical vessel comprises:

- a piston with a piston head and a piston rod, wherein the piston is arranged reciprocatingly movable in the cylindrical vessel, wherein the piston bounds above the piston head a wash chamber inside the cylindrical vessel and wherein the piston head comprises at least one filter means,
- an inlet line for supplying the crystal suspension mixture produced in the crystallization block composed of crystals and mother liquor into the cylindrical vessel,
- an outlet line for discharging mother liquor from the cylindrical vessel and
- an outlet line for discharging crystals and/or crystal melt from the cylindrical vessel.

16. The process in accordance with any of claims 12 to 15, wherein the at least one freeze concentration stage (24) comprises i) at least two suspension crystallization stages or ii) at least one suspension crystallization stage and at least one static crystallization stage.

Claims:

1. A process for treating waste fluid generated during a petrochemical process (4), wherein the waste fluid comprises at least one first water-based wastewater stream (8) and at least one second organic fluid-based waste fluid stream (10), wherein the process comprises the following steps:

   a) subjecting the at least one first water-based wastewater stream (8) to at least one freeze concentration stage (24) so as to produce a third clean water stream (26) and a fourth concentrated water-based wastewater stream (28),

   b) subjecting the at least one second organic fluid-based waste fluid stream (10) to at least one separation stage (30) so as to produce a fifth purified product stream (32) and a sixth concentrated organic fluid-based waste fluid stream (34),

   c) forwarding the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) to an incinerator (16) and incinerating the streams (28, 34) in the incinerator (16),

   wherein the process is controlled so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

2. The process in accordance with claim 1, wherein during the process at least one of the concentration degree during the at least one freeze concentration stage (24) of step a), of the separation degree during the at least one sepa-

ration stage (30) of step b) and of the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) is adjusted so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

3. The process in accordance with claim 1 or 2, wherein the process is controlled so that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 80%, preferably at least 90%, more preferably at least 95% and most preferably at least all of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

4. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) includes 70 to 99.5 % by weight and preferably 80 to 95 % by weight of water and 0.5 to 30 % by weight and preferably 5 to 20 % by weight of dissolved and/or dispersed impurities.

5. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) to at least one suspension crystallization stage, wherein the at least one suspension crystallization stage comprises at least one crystallization block for producing water crystals and at least one separation block for separating the crystals produced in the at least one crystallization block from the mother liquor, wherein the crystallization block comprises at least one scraped surface crystallizer (38, 38’), and wherein the separation block comprises at least one wash column (40), wherein preferably the wash column (40) comprises:

a cylindrical vessel, wherein the cylindrical vessel comprises:

- a piston with a piston head and a piston rod, wherein the piston is arranged reciprocatingly movable in the cylindrical vessel, wherein the piston bounds above the piston head a wash chamber inside the cylindrical vessel and wherein the piston head comprises at least one filter means,
- an inlet for supplying the crystal suspension mixture produced in the crystallization block composed of crystals and mother liquor into the cylindrical vessel,
- an outlet for discharging mother liquor from the cylindrical vessel and
- an outlet for discharging crystals and/or crystal melt from the cylindrical vessel.

6. The process in accordance with claim 5, wherein the cylindrical vessel is connected to a circulation conduit for circulating melt arranged outside the cylindrical vessel, which is in communication with the wash chamber and a means for partial melting and disintegrating of the crystal bed arranged in the wash chamber for restricting the movement of the crystal bed that has been compacted in the wash chamber by the piston and for directing the wash liquid entering into the cylindrical vessel from the circulation conduit so as to homogeneously distribute it over the entire cross-section of the wash column.

7. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) to at least one static crystallization stage.

8. The process in accordance with any of the preceding claims, wherein the at least one first water-based wastewater stream (8) is subjected in step a) for freeze concentration (24) i) to at least two suspension crystallization stages

or ii) to at least one suspension crystallization stage and at least one static crystallization stage with the at least one static crystallization stage being downstream of the at least one suspension crystallization stage.

9. The process in accordance with any of the preceding claims, wherein the second organic fluid-based waste fluid stream (10) includes 5 to 99.5 % by weight and preferably 10 to 30% by weight of one or more organic compounds to be separated by the at least one separation stage (30) during step b) and remainder to 100 % by weight of one or more dissolved and/or dispersed impurities.

10. The process in accordance with claim 9, wherein the organic compounds to be separated by the at least one separation stage (30) during step b) is selected from the group consisting of phenol, cumene, acetophenone, 1,3-butylene glycol, acrylic acetate, acrylonitrile and arbitrary combinations of two or more of the aforementioned compounds.

11. The process in accordance with any of the preceding claims, wherein the at least one separation stage (30), to which the second organic fluid-based waste fluid stream (10) is subjected in step b), is selected from the group consisting of layer crystallization, distillation, extraction and arbitrary combinations of two or more of the aforementioned methods.

12. The process in accordance with any of the preceding claims, wherein the fifth purified product stream (32) obtained in step b) comprises less than 2,000 ppm, preferably less than 1,000 ppm, more preferably less than 100 ppm, more preferably less than 50 ppm and most preferably less than 10 ppm of dissolved and/or dispersed impurities.

13. The process in accordance with any of the preceding claims, wherein the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) is adjusted so that the incineration the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) occurs at at least 900°C, preferably between 900 and 1,100°C, more preferably between 900 and 1,000°C and most preferably between 900 and 950°C.

14. A plant for treating waste fluid generated during a petrochemical process (4), in particular for performing a process in accordance with any of the preceding claims, wherein the waste fluid comprises a first water-based wastewater stream (8) and a second organic fluid-based waste fluid stream (10), wherein the plant comprises:

a) a source (4) for a first water-based wastewater stream (8),

b) a source (4) for a second organic fluid-based waste fluid stream (10),

c) at least one freeze concentration stage (24) with an inlet line (42) for supplying the first water-based wastewater stream (8) into the at least one freeze concentration stage (24), with an outlet line (44) for withdrawing a third clean water stream (26) produced in the freeze concentration stage (24) and an outlet line (46, 46') for withdrawing a fourth concentrated water-based wastewater stream (28) produced in the at least one freeze concentration stage (24),

d) at least one separation stage (30) with an inlet line for supplying the second organic fluid-based waste fluid stream (10) into the at least one separation stage (30), with an outlet line for withdrawing a fifth purified product stream (32) produced in the at least one separation stage (30) and with an outlet line for withdrawing a sixth concentrated organic fluid-based waste fluid stream (34) produced in the at least one separation stage (30),

e) an incinerator (16) with an inlet line for supplying the fourth concentrated water-based wastewater stream (28) and with an inlet line for supplying the sixth concentrated organic fluid-based waste fluid stream (34) into the incinerator (16), and

f) a control unit embodied so that it can control that the incineration of the sixth concentrated organic fluid-based waste fluid stream (34) generates at least 70% of the energy necessary to incinerate the fourth concentrated water-based wastewater stream (28).

15. The plant in accordance with claim 14, wherein the control unit comprises at least one of a measurement device for the determination of the concentration of the fluid stream processed in the at least one freeze concentration stage (24), a measurement device for the determination of the separation degree during the at least one separation stage (30) and a device for controlling the ratio between the fourth concentrated water-based wastewater stream (28) and the sixth concentrated organic fluid-based waste fluid stream (34) being fed into the incinerator (16).

16. The plant in accordance with claim 14 or 15, wherein the at least one freeze concentration stage (24) comprises at least one suspension crystallization stage and/or at least one static crystallization stage, and wherein preferably the at least one separation stage (30) is selected from the group consisting of layer crystallization stages, distillation stages, extraction stages and arbitrary combinations of two or more of the aforementioned stages.

17. The plant in accordance with any of claims 14 to 16, wherein the at least one freeze concentration stage (24) comprises at least one suspension crystallization stage comprising at least one crystallization block for producing water crystals and at least one separation block for separating the crystals produced in the at least one crystallization block from the mother liquor,

wherein the crystallization block comprises at least one crystallizer (38, 38'), and wherein the separation block comprises at least one wash column (40), wherein preferably the wash column (40) comprises:

a cylindrical vessel, wherein the cylindrical vessel comprises:

- a piston with a piston head and a piston rod, wherein the piston is arranged reciprocatingly movable in the cylindrical vessel, wherein the piston bounds above the piston head a wash chamber inside the cylindrical vessel and wherein the piston head comprises at least one filter means,
- an inlet line for supplying the crystal suspension mixture produced in the crystallization block composed of crystals and mother liquor into the cylindrical vessel,
- an outlet line for discharging mother liquor from the cylindrical vessel and
- an outlet line for discharging crystals and/or crystal melt from the cylindrical vessel.

18. The process in accordance with any of claims 14 to 17, wherein the at least one freeze concentration stage (24) comprises i) at least two suspension crystallization stages or ii) at least one suspension crystallization stage and at least one static crystallization stage.