Patent claims

1. A counter-current liquid-liquid extraction column (1) adapted for the flow of two or more liquids (2) therein and comprising within one common vessel (3):

   a first inlet (41) for a first liquid feed stream (51),
   a second inlet (42) for a second liquid feed stream (52),

   a first outlet (61) for a product stream (71),
   a second outlet (62) for a byproduct stream (72),

   a mixing section (8) comprising an agitation means (9),

   a static section (10) comprising a packing (11),

   optionally a collector (12) and/or distributor (13), **characterized in that** within the common vessel (3) are only one mixing section (8) and only either one or two static sections (10).

2. The column (1) of claim 1, wherein the column (1) is substantially vertical, wherein within the common vessel (3) is only one static section (10), and wherein the mixing section (8) is preferably located substantially above the static section (10).

3. The column (1) of either claim 1 or claim 2, wherein the column (1) additionally comprises a collector (12) and/or distributor (13).

4. The column (1) of any one of claims 1 to 3, wherein no collector (12) or distributor (13) is located between the mixing section (8) and the one or two static sections (10).

5. The column (1) of any one of claims 1 to 4, wherein the agitation means (9) comprises either a magnetic drive unit (14) or a motor (15), wherein the motor (15) is located substantially above or substantially to the side of the mixing section (8).

6. The column (1) of any one of claims 1 to 5, wherein the packing (11) comprises trays, a random packing, a structured packing, or combinations thereof.

7. The column (1) of any one of claims 1 to 6, wherein the column (1) additionally comprises a third inlet (43) located between the first inlet (41) and the second inlet (42) and for the addition of a third liquid feed stream (53).

8. The column (1) of any one of claims 1 to 7, wherein the column (1) additionally comprises a pulsing means (200) in fluid connection with the column (1) for increasing shear stress and dispersion within the column (1).

9. A counter-current liquid-liquid extraction process, wherein to a column (1) of any one of claims 1 to 8,

a first liquid feed stream (51) is fed by means of the first inlet (41) and a second liquid feed stream (52) is fed by means of the second inlet (42),

liquid-liquid contact occurs between the stream (51) and the stream (52) to form a product stream (71) and a byproduct stream (72),

and the formed product stream (71) is removed by means of the first outlet (61), and the formed byproduct stream (72) is removed by means of the second outlet (62).

10. The process of claim 9, wherein the column (1) is substantially vertical, preferably wherein within the common vessel (3) of the column (1) is only one static section (10), and wherein the mixing section (8) is preferably located substantially above the static section (10), and wherein the density of the stream (52) is less than the density of the stream (51), and wherein the inlet (41) is located within a top portion (161) of the column (1) and the inlet (42) is located within a bottom portion (162) of the column (1).

11. The process of either one of claims 9 or 10, wherein the stream (52) comprises two or more organic compounds and the stream (51) comprises water, preferably wherein the stream (52) consists essentially of organic compounds and the stream (51) consists essentially of water.

12. The process of either one of claims 9 or 10, wherein the stream (51) comprises a solvent and the stream (52) comprises an oil and an aromatic compound and, wherein the aromatic compound is extracted from the stream (52) by counter-current contact with stream (51) within the column (1) to yield a purified oil, wherein the extracted aromatic compound is removed with the solvent as part of a byproduct stream

(72) by means of outlet (62) located within the bottom portion (162) of the column (1), and wherein the purified oil is removed as part of a product stream (71) by means of outlet (61) located within the top portion (161) of the column (1).

13. The process of any one of claims 9 to 12, wherein a third liquid feed stream (53) having a density greater then the density of stream (52) but less than the density of stream (51) is added to the column by means of a third inlet (43) located between the inlet (42) and the inlet (41).

14. The process of any one of claims 9 to 13, wherein a liquid (2) within the the column (1) is pulsed by a pulsing means (200) in order to increase the shear stress on and the dispersion of the liquid (2).

15. Use of the column (1) of any one of claims 1 to 8 or the process of any one of claims 9 to 14, in removing aromatic compounds from organic streams, in treating an oil stream of a refinery, or in a liquid-liquid extraction process having at least two feed streams of different density, interfacial tension or viscosity.

Claims

1. A counter-current liquid-liquid extraction column (1) adapted for the flow of two or more liquids (2) therein and comprising within one common vessel (3):

a first inlet (41) for a first liquid feed stream (51),

a second inlet (42) for a second liquid feed stream (52),

a first outlet (61) for a product stream (71),

a second outlet (62) for a by-product stream (72),

a mixing section (8) comprising an agitation means (9),

a static section (10) comprising a packing (11),

characterized in that within the common vessel (3) are only one mixing section (8) and only either one or two static sections (10).

2. The column according to claim 1, further comprising a collector (12) and/or distributor (13).

3. The column (1) according to claim 1 or claim 2, wherein the column (1) is vertical, wherein within the common vessel (3) is only one static section (10), and wherein the mixing section (8) is located above the static section (10).

4. The column (1) according to any one of the preceding claims, wherein the column (1) additionally comprises a collector (12) and/or distributor (13).

5. The column (1) according to any one of the preceding claims, wherein no collector (12) or distributor (13) is located between the mixing section (8) and the one or two static sections (10).

6. The column (1) according to any one of the preceding claims, wherein the agitation means (9) comprises either a magnetic drive unit (14) or a motor (15), wherein the motor (15) is located above or to the side of the mixing section (8).

7. The column (1) according to any one of the preceding claims, wherein the packing (11) comprises trays, a random packing, a structured packing, or combinations thereof.

8. The column (1) according to any one of the preceding claims, wherein the column (1) additionally comprises a third inlet (43) located between the first inlet (41) and the second inlet (42) and for the addition of a third liquid feed stream (53).

9. The column (1) according to any one of the preceding claims, wherein the column (1) additionally comprises a pulsing means (200) in fluid connection with the column (1) for increasing shear stress and dispersion within the column (1).

10. A counter-current liquid-liquid extraction process, wherein to a column (1) of any one of claims 1 to 8, a first liquid feed stream (51) is fed by means of the first inlet (41) and a second liquid feed stream (52) is fed by means of the second inlet (42), liquid-liquid contact occurs between the stream (51) and the stream (52) to form a product stream (71) and a by-product stream (72), and the formed product stream (71) is removed by means of the first outlet (61), and the formed by-product stream (72) is removed by means of the second outlet (62).

11. The process according to claim 10, wherein the column (1) is vertical, and wherein the density of the stream (52) is less than the density of the stream (51), and wherein the inlet (41) is located within a top portion (161) of the column (1) and the inlet (42) is located within a bottom portion (162) of the column (1).

12. The process according to claim 11, wherein when the column (1) is vertical, the common vessel (3) of the column (1) is only one static section.

13. The process according to claim 11 or claim 12, wherein the mixing section (8) is located above the static section (10).

14. The process according to any one of claims 10 to 13, wherein the stream (52) comprises two or more organic compounds and the stream (51) comprises water.

15. The process according to claim 14, wherein the stream (52) consists of organic compounds and the stream (51) consists of water.

16. The process according to any one of claims 10 to 13, wherein the stream (51) comprises a solvent and the stream (52) comprises an oil and an aromatic compound and, wherein the aromatic compound is extracted from the stream (52) by counter-current contact with stream (51) within the column (1) to yield a purified oil, wherein the extracted aromatic compound is removed with the solvent as part of a by-product stream (72) by means of outlet (62) located within the bottom portion (162) of the column (1), and wherein the purified oil is removed as part of a product stream (71) by means of outlet (61) located within the top portion (161) of the column (1).

17. The process according to any one of claims 10 to 16, wherein a third liquid feed stream (53) having a density greater than the density of stream (52) but less than the density of stream (51) is added to the column by means of a third inlet (43) located between the inlet (42) and the inlet (41).

18. The process according to any one of claims 10 to 17, wherein a liquid (2) within the column (1) is pulsed by a pulsing means (200) in order to increase the shear stress on and the dispersion of the liquid (2).

19. Use of the column (1) of any one of claims 1 to 9 in removing aromatic compounds from organic streams, in treating an oil stream of a refinery, or in a liquid-liquid extraction process having at least two feed streams of different density, interfacial tension or viscosity.