Claims

1. An integrated process for simultaneously preparing n mixtures P(i) comprising alkali metal methoxide and methanol, comprising
providing n reactive distillation columns K(i);
providing n aqueous liquid streams H(i), a given stream H(i) comprising a dissolved alkali metal hydroxide A(i)OH, wherein n is an integer with n ≥ 2 and i=1…n; and
providing a rectification column D;
the process further comprising
(a) providing a stream G comprising methanol;
(b) dividing the stream G into n streams G(i), each stream G(i) having the same composition as G;
(c) preparing the one or more alkali metal methoxides comprising
feeding each stream G(i) into the lower part of a respective reactive distillation column K(i), and feeding the aqueous liquid stream H(i) comprising the dissolved alkali metal hydroxide A(i)OH into the upper part of said reactive distillation column K(i); and
subjecting G(i) and H(i) in each K(i) to reactive distillation conditions, obtaining n top streams W(i) comprising methanol and water; and obtaining n bottoms streams P(i) comprising alkali metal methoxide A(i)OMe and methanol;
(d) feeding each stream W(i) into the lower part of the rectification column D, and feeding a stream M comprising methanol into the rectification column D; and subjecting the n streams W(i) and M in D to distillation conditions, obtaining the stream G according to (a) as a top stream;
wherein the rectification column D is operated at a reflux ratio of at least 0.5:1, wherein the rectification column D is operated with top vapor recompression, wherein for realizing the reflux ratio, the process comprises
(i) removing, in addition to G, a top stream T(2) from the rectification column D, passing said stream T(2) through a condenser V(4), obtaining a liquid stream and a waste gas stream T(2w);
(ii) removing, in addition to G and T(2), a further top stream T(1) from the rectification column D, passing said stream T(2) through a compressor C(3), passing the thus compressed stream through a reboiler V(6), obtaining a liquid stream, wherein the reboiler V(6) is an intermediate reboiler of the rectification column D;
(iii) feeding the liquid streams obtained according to (i) and (ii) into the top of the rectification column D;
or
(i) removing, in addition to G, a top stream T(2) from the rectification column D, passing said stream T(2) through a condenser V(4), obtaining a liquid stream T(2l) and a gas stream T(2g); passing the gas stream T(2g) through a condenser V(5), obtaining a liquid stream T(2gl) and a waste gas stream T(2w); and combining the liquid streams T(2l) and (T2gl), obtaining a combined liquid stream T(2cl);
(ii) removing, in addition to G and T(2), a further top stream T(1) from the rectification column D, passing said stream T(2) through a compressor C(3), passing the thus compressed stream through a reboiler V(6), obtaining a liquid stream, wherein the reboiler V(6) is an intermediate reboiler of the rectification column D;
(iii) feeding the combined liquid stream obtained according to (i) and the liquid stream obtained according to (ii) into the top of the rectification column D.

2. The process of claim 1, wherein n is in the range of from 2 to 10, preferably in the range of from 2 to 5, more preferably 2 or 3, more preferably 2.

3. The process of claim 1 or 2, wherein each alkali metal hydroxide A(i)OH is preferably selected from the group consisting of lithium hydroxide, sodium hydroxide and potassium hydroxide, more preferably from the group consisting of sodium hydroxide and potassium hydroxide and wherein a given aqueous liquid stream H(i) comprises an alkali metal hydroxide A(i)OH dissolved in water, in methanol, or in a mixture comprising water and methanol, preferably in water.

4. The process of any one of claims 1 to 3, being an integrated process for simultaneously preparing at least 2 mixtures P(i), preferably 2 mixtures P(i), wherein the mixture P(1) comprises A(1)OMe, preferably sodium methoxide, and methanol and the mixture P(2) comprises A(2)OMe, preferably potassium methoxide, and methanol, the process comprising
   (a) providing a stream G comprising methanol;
   (b) dividing the stream G into at least two streams G(1) and G(2), G(1) and G(2) having the same composition as G;
   (c.1) preparing A(1)OMe, preferably sodium methoxide, comprising
      (c.1.1) feeding the stream G(1) into the lower part of a reactive distillation column K(1), and feeding an aqueous liquid stream H(1) comprising dissolved A(1)OH, preferably sodium hydroxide, into the upper part of the reactive distillation column K(1);
      (c.1.2) subjecting G(1) and H(1) in K(1) to reactive distillation conditions, obtaining a top stream W(1) comprising methanol and water; and obtaining a bottoms stream P(1) comprising A(1)OMe, preferably sodium methoxide, and methanol;
   (c.2) preparing A(2)OMe, preferably potassium methoxide, comprising
      (c.2.1) feeding the stream G(2) into the lower part of a reactive distillation column K(2), K(2) being arranged in parallel with K(1), and feeding an aqueous liquid stream H(2) comprising dissolved A(2)OH, preferably potassium hydroxide, into the upper part of the reactive distillation column K(2);
      (c.2.2) subjecting G(2) and H(2) in K(2) to reactive distillation conditions, obtaining a top stream W(2) comprising methanol and water; and obtaining a bottoms stream P(2) comprising A(2)OMe, preferably potassium methoxide, and methanol;
   (d.1) feeding W(1) and W(2) into the lower part of a rectification column D, and feeding a stream M comprising methanol into the rectification column D;
   (d.2) subjecting W(1), W(2) and M in D to distillation conditions, obtaining the stream G according to (a) as a top stream.

5. The process of claim 4, wherein W(1) and W(2) are fed as gas streams into the rectification column D, preferably at a position between the bottoms and the 15th theoretical stage, preferably between the bottoms and the 10th theoretical stage, more preferably between the bottoms and the 8th theoretical of the rectification column D.

6. The process of any one of claims 1 to 5, wherein from 99 to 100 weight-%, preferably from 99.5 to 100 weight-%, more preferably from 99.9 to 100 weight-% of the stream M consist of methanol and optionally water, wherein the amount of water comprised in the stream M is at most 2000 weight-ppm, more preferably at most 1500 weight-ppm, more preferably

at most 1000 weight-ppm, wherein the stream M is preferably fed to the upper part of D, more preferably at least 4 theoretical stages from the top of D, more preferably between the 4th and the 20th theoretical stage from the top of D, more preferably between the 6th and the 15th theoretical stage from the top of D, preferably at a temperature of M in the range of from ambient temperature to the boiling point of methanol at the column pressure of D, more preferably at ambient temperature.

7. The process of any one of claims 1 to 6, wherein the rectification column D is operated at a reflux ratio in the range of from 0.55:1 to 1.4:1, preferably in the range of from 0.6:1 to 1.4:1.

8. The process of any one of claims 1 to 7, wherein the stream G provided according to (a) by obtaining from distillation according to (d.2) comprises methanol and water, wherein preferably from 99.95 to 100 weight-% of G consist of methanol and water, and wherein the water content of G is at most 200 weight-ppm, preferably at most 150 weight-ppm, more preferably at most 100 weight-ppm, wherein more preferably said water content is in the range of from 5 to 100 weight-ppm, more preferably in the range of from 10 to 100 weight-ppm, more preferably in the range of from 15 to 100 weight-ppm.

9. The process of any one of claims 1 to 8, wherein according to (b), the stream G is divided into the two streams G(1) and G(2).

10. The process of any one of claims 1 to 9, wherein prior to be fed into the reactive distillation column K(1), the stream G(1) is passed through a compressor C(1), thereby realizing a pressure increase of G(1) in the range of from 0.1 to 0.8 bar(abs), preferably in the range of from 0.15 to 0.6 bar(abs), more preferably in the range of from 0.2 to 0.4 bar(abs);
and/or, preferably and
prior to be fed into the reactive distillation column K(2), the stream G(2) is passed through a compressor C(2), thereby realizing a pressure increase of G(2) in the range of from 0.1 to 0.8 bar(abs), preferably in the range of from 0.15 to 0.6 bar(abs), more preferably in the range of from 0.2 to 0.4 bar(abs);

11. The process of any one of claims 1 to 9, wherein prior to being fed into the rectification column D, the stream W(1) is passed through a compressor C(1), thereby realizing a pressure increase of W(1) in the range of from 0.1 to 0.8 bar(abs), preferably in the range of from 0.15 to 0.6 bar(abs), more preferably in the range of from 0.2 to 0.4 bar(abs);
and/or, preferably and
prior to being fed into the rectification column D, the stream W(2) is passed through a compressor C(2), thereby realizing a pressure increase of W(2) in the range of from 0.1 to 0.8 bar(abs), preferably in the range of from 0.15 to 0.6 bar(abs), more preferably in the range of from 0.2 to 0.4 bar(abs).

12. A chemical production unit for carrying out the process according to any one of claims 1 to 11, comprising
- a rectification column D comprising
  -- inlet means for feeding the stream M into D;
  -- in its lower part, inlet means for feeding the streams W(i) or one or more combined stream thereof into D;

-- outlet means for removing the streams T(2) and G or a combined stream thereof from the top of D;
-- at least one condenser, preferably a condenser V(4) and optionally a further condenser V(5) arranged downstream of V(4), having inlet means for receiving the stream T(2) and having outlet means for removing the condensed stream T(3) and for removing a waste gas stream;
-- inlet means for feeding the stream T(3) to the top of D;
-- a bottom reboiler;

- a stream dividing device S for dividing the stream G into n streams G(i);
- means for passing the stream G to said stream dividing device S;
- n reactive distillation columns K(i), n≥2 and i=1…n; said reactive distillation columns K(i) being arranged in parallel, each reactive distillation column K(i) comprising
  -- in its upper part, preferably in its top, inlet means for feeding a stream H(i) into K(i);
  -- in its lower part, inlet means for feeding a stream G(i) into K(i);
  -- outlet means for removing a stream W(i) from the top of K(i);
  -- a bottom reboiler ;
  -- outlet means for removing a bottoms stream from K(i);
  -- a stream dividing means for separating a stream P(i) from the bottoms stream removed from K(i);
- means for passing the streams G(i) to the reactive distillation columns K(i);
- means for passing the streams W(i) to the rectification column D;
- one or more compressors C(i) for compressing either the stream G and/or the streams G(i) and/or the streams W(i);

the unit further comprising means for realizing recompression of the top vapor obtained from D, said means comprising a compressor C(3) for compressing a stream T(1) removed from the top of D, means for passing T(1) from the top of D to C(3), a reboiler V(6) for condensing said compressed stream, means for passing said compressed stream from (C3) to V(6), and means for feeding the obtained liquid stream to the top of D, wherein the reboiler V(6) is an intermediate reboiler of D.

13. The unit of claim 12, comprising n compressors C(i) arranged upstream of K(i) for compressing the streams G(i) or comprising n compressors C(i) arranged downstream of K(i) and upstream of D for compressing the streams W(i).

14. The unit of claim 12 or 13, wherein the inlet means for feeding the streams W(i) or one or more combined stream thereof into D is/are located at a position between the bottoms and the 15th theoretical stage, preferably between the bottoms and the 10th theoretical stage, more preferably between the bottoms and the 8th theoretical of D; and/or
wherein the inlet means for feeding the stream M into D are located in the upper part of D, preferably at least 4 theoretical stages from the top of D, preferably between the 4th and the 20th theoretical stage from the top of D, more preferably between the 6th and the 15th theoretical stage from the top of D.

15. Use of a chemical production unit according to any one of claims 12 to 14 or of a process according to any one of claims 1 to 11 for simultaneously producing n mixtures P(i) comprising alkali metal methoxide A(i)OMe and methanol, n being an integer with n≥2 and i=1…n, wherein
either at least 2 of the mixtures P(i) comprise different alkali metal methoxides A(i)OMe,

and/or at least 2 of the mixtures P(i) comprise the same alkali metal alkoxide A(i)OMe at different concentrations.