Claims

1. Process of removing volatile compounds from a fluid (F) containing at least one non-volatile polymer and at least one volatile compound which comprises at least the steps of:

a) treating the fluid (F) in at least one concentrator unit comprising at least a heater (2), a degassing vessel (4) and a vapor line (4.1), whereby the fluid (F) is heated, the heated fluid (G) is fed into a degassing vessel (4) where part of the volatile compounds are removed via the vapor line (4.1) to obtain a concentrated fluid (H),

b) reheating the concentrated fluid (H) from step a) in at least one reheating unit (6) to obtain a reheated concentrated fluid (L);

c) feeding the reheated concentrated fluid (L) from step b) into at least one extruder unit comprising at least an extruder degassing section comprising at least a conveying section (16), a vent port (15) with one or more vapor lines (15.1), a accumulating section (20) and an outlet section (22), whereby volatile compounds are removed through the vent ports (15) and vapor lines (15.1);

whereby the reheated concentrated fluid (L) is free-flowing upon entering the extruder degassing section and the product (P) obtained at the outlet section (22) is substantially free of volatile compounds.

2. The process pursuant to claim 1, characterized in that the viscosity of the reheated concentrated fluid (L) is in the range of 500 to 50.000.000 mPa*s.

3. The process pursuant to claim 1 or 2, characterized in that the content of volatile compounds in product (P) is less than 1 wt% based on the mass of the polymer.

4. The process pursuant to one of the claims 1 to 3, characterized in that the non-volatile polymers are synthetic rubber products.

5. The process pursuant to claim 4, characterized in that the synthetic rubber product are styrene butadiene rubbers and butadiene rubbers, preferably Lithium catalyzed butadiene rubber, Nickel catalyzed butadiene rubber, Titanium catalyzed butadiene rubber, Cobalt catalyzed butadiene rubber and Neodymium catalyzed butadiene rubber .

6. The process pursuant to claims 1 to 5, characterized in that the Fluid (F) contains from 3 to 50 wt % of a non-volatile polymer and from 60 to 97 wt% volatile compounds, whereby the aforementioned components add up to 90 to 100 of the total mass of fluid (F).

7. The process pursuant to claims 1 to 6, characterized in that the fluid (F) entering the heater (2) has a temperature of 10°C to 100°C.

8. The process pursuant to claims 1 to 8, characterized in that the fluid (F) entering the heater (2) has a viscosity of 100 mPa*s to 60,000 mPa*s.

9. The process pursuant to claims 1 to 8, characterized in that the heated fluid G has a temperature of 100 to 200 °C.

10. The process pursuant to claims 1 to 9, characterized in that the pressure in the degassing vessel (4) is in the range of 100 hPa to 4,000 hPa.

11. The process pursuant to claims 1 to 10, characterized in that the degassing vessel (4) is designed in the shape of a cyclone and has at least a torisperical shaped bottom to facilitate removal of concentrated fluid (H).

12. The process pursuant to claims 1 to 11, characterized in that the pump 4.2 is selected from the group consisting of positive displacement type pumps, gear pumps, piston pumps, membrane pumps, screw type pumps, extruder type pumps like counter-rotating or co-rotating single or twin screw extruders or kneader type pumps or combinations thereof.

13. The process pursuant to claims 1 to 12, characterized in that the temperature of the concentrated fluid (H) is lower than that of heated fluid (G) and is in the range of 15 to 100°C.

14. The process pursuant to claims 1 to 13, characterized in that the temperature of the reheated concentrated fluid (L) is higher than that of the concentrated fluid (H) and is in the range of 50°C to 200°C.

15. The process pursuant to claims 1 to 14, characterized in that the extruder unit comprises an extruder selected from the group consisting of single and multiscrew extruders.

16. The process pursuant to claims 1 to 15, characterized in that the extruder unit comprises means to operate separate zones of the extruder independently of each other at different temperatures so that the zones can either be heated, unheated or cooled.

17. The process pursuant to claims 1 to 16, characterized in that the extruder is made of a material selected from nitrided steel, duplex steel, stainless steel, nickel-based alloys, composite materials like sintered metals, hot isostatic pressed materials, hard wear resistant materials like Stellite, coated metals with coatings made from ceramics, titanium nitride, chromium nitride and diamond like carbon.

18. The process pursuant to claims 1 to 17, characterized in that the vent ports (15) comprise means to prevent the reheated concentrated fluid (L) or the Product (P), from coming out of the vent ports.

19. The process pursuant to claims 1 to 18, characterized in that the accumulation in the accumulating sections (18, 20) is accomplished by kneading or throttling elements, blister discs or die plates.

20. The process pursuant to claims 1 to 19, characterized in that the extruder unit comprises 1 to 30 conveying and accumulating sections.

21. The process pursuant to claims 1 to 20, characterized in that the outlet section (22) comprises means to allow the product to exit the extruder and product processing equipment, whereby the processing equipment is selected from the group consisting of combinations of die plates and cutters; die plates und underwater-pelletizing means; means for crumb formation, turbulators and fixed knifes placed at the end plate of the extrude.

22. The process pursuant to claims 1 to 21, characterized in that the outlet section (22) further comprises cooling means, whereby the cooling means are selected from the group consisting of pneumatic crumb conveyers with convective air cooling, vibrating crumb conveyers with convective air cooling, vibrating crumb conveyer with cooled contact surfaces, belt conveyers with convective air cooling, belt conveyer with cooled belts, water spraying on hot crumbs upon outlet of the extruder and underwater-pelletizing means..

23. The process pursuant to claims 1 to 22, characterized in that the extruder unit is operated at a feed rate of 5 to 25,000 kilograms per hour.

24. The process pursuant to claims 1 to 23, characterized in that a stripping agent is added in the extruder unit.

25. The process pursuant to claims 1 to 24, characterized in that additives are added to fluid (F) or in the extruder unit by means of a side feeder or, as far as they are liquid together with a stripping agent.

26. The process pursuant to claims 1 to 25, characterized in that step a) is repeated a least once.

27. The process pursuant to claims 1 to 26, characterized in that the repetition is accomplished by connecting the respective number of concentrating units in series.

28. The process pursuant to claims 1 to 27, characterized in that the pressure in the concentration unit, the reheating unit or the extruder unit is equipped with one or more pressure regulation devices.

29. The process pursuant to claims 1 to 28, characterized in that the extruder unit comprises at least one extruder degassing section in upstream direction.

30. The process pursuant to claims 1 to 29, characterized in that fluid (F) is obtained by a process of removing hydrophilic compounds and optionally water from a crude fluid (A) containing at least one non-volatile polymer, at least one volatile organic compound, one or more hydrophilic compounds and optionally water which comprises at least the step of

pre a) treating the crude fluid (A) in at least one pre-washing unit comprising at least a separating apparatus (26), whereby the fluid (A) is mixed with water to obtain an organic phase (28) comprising primarily non-volatile polymer and volatile organic compounds and an aqueous phase (27) comprising primarily water and hydrophilic compounds, and whereby the organic phase (28) is separated from the aqueous phase (27) in a separating apparatus (26) and further used as fluid F and whereby at least a part of the aqueous phase (27) is removed from the separating apparatus (fluid C).

31. The process pursuant to claim 30, characterized in that the separation is supported by means of a coalescer (39).

32. The process pursuant to claim 30 or 31, characterized in that step pre-a) is repeated at least once.

33. The process pursuant to claim 32, characterized in that the repetition is accomplished by connecting the respective number of separating apparatuses (26) in series.

34. The process pursuant to claims 30 to33, characterized in that the separation is performed at temperatures of more than 40°C.

35. Polymer, obtained by a process pursuant to claims 1 to34

36. Polymer pursuant to claim 35, characterized in that it is a Synthetic Rubber Product

37. Polymer pursuant to claim 36, characterized in that it is styrene butadiene rubber, butadiene rubber.

38. Polymer pursuant to claim 37, characterized in that it is Neodymium catalized butadiene rubber.

39. Device comprising a least

- one concentrating unit comprising a heater (2) in communication with a degassing vessel (4), whereby the bottom part of the degassing vessel (4) is in communication

with a pump (4.2) the upper part of the degassing vessel (4) is in communication with at least one vapour line (4.1)

- one heating unit (6) in communication with the pump (4.2) of the concentrating unit and a feeding point (12) on an extruder unit
- one extruder unit comprising at least one feeding point (12), one extruder degassing section (16), one accumulating section (20) and one outlet section (22), whereby the extruder degassing section (16) further comprises at least one vent port (15) connected to a vapour line (15.1).

40. Device pursuant to claim 39,, characterized in that the pump (4.2) is selected from the group consisting of positive displacement type pumps, gear pumps, piston pumps, membrane pumps, screw type pumps, extruder type pumps like counter-rotating or co-rotating single or twin screw extruders or kneader type pumps or combinations thereof.

41. Device pursuant to claim 39 or 40, characterized in that the extruder unit comprises an extruder selected from the group consisting of single screw and multiscrew extruders.

42. Device pursuant to claims 39 to 41, characterized in that the extruder unit comprises a twin-screw extruder a ring extruder or a planetary roller extruder.

43. Device pursuant to claims 39 to 42, characterized in that the accumulating section (20) comprises kneading or throttling elements, blister discs or die plates.

44. Device pursuant to claims 39 to 43, characterized in that the outlet section (22) comprises product processing equipment selected from the group consisting of combinations of die plates and cutters; die plates und underwater-pelletizing means; means for crumb formation, turbulators and fixed knifes placed at the end plate of the extruder.

45. Device pursuant to claims 39 to 44, characterized in that the outlet section (22) comprises cooling means.

46. Device pursuant to claims 39 to 45, characterized in that it is designed to allow operation with a feed rate of 5 to 25,000 kilograms per hour.

47. Device pursuant to claims 39 to 46, characterized in that the extruder unit is designed to allow the addition of a stripping agent.

48. Device pursuant to claims 39 to 47, characterized in that the extruder unit comprises one or more side feeders.

49. Device pursuant to claims 39 to 48, characterized in that it comprises more than one concentration units, whereby the concentration units are connected in series.

50. Device pursuant to claims 39 to 49, characterized in that the concentration unit, the reheating unit or the extruder unit is equipped with one or more pressure regulation devices.

51. Device pursuant to claims 39 to 50, characterized in that the extruder unit comprises more than one extruder degassing sections, whereby the feeding point (12) is located at the first extruder degassing section, whereby the first extruder degassing section comprises at least one conveying section (16A), a rear vent port (13) connected to a vapor line (13.1) in upstream direction.

52. Device pursuant to claims 39 to 51, characterized in that it further comprises one or more pre-washing units, each comprising at least a separating apparatus (26) in communication with one or more of the concentration units.

53. Device pursuant to claim 52, characterized in that the separating apparatus (26) comprises at least one mixer (30).

54. Device pursuant to claim 52 or 53, characterized in that the separating apparatus (26) comprises at least one coalescer (39).

55. Device pursuant to claims 52 to 54, characterized in that the separating apparatus (26) comprises at least one separating wall (34).

56. Device pursuant to claims 52 to 55, characterized in that the separating apparatus (26) is designed to be operated under pressure.

57. Device pursuant to claims 52 to 56, characterized in that the degassing vessel (4) has at least torisperical shaped bottom.

58. Use of a device pursuant to claims 39 to 57 or any of its components in a process according to claims 1 to 38.

59. Plant comprising at least one device according to claims 39 to 57.

Claims

1. Process of removing volatile compounds from a fluid (F) containing at least one non-volatile polymer and at least one volatile compound which comprises at least the steps of:

   a) treating the fluid (F) in at least one concentrator unit comprising at least a heater (2), a degassing vessel (4) and a vapor line (4.1), whereby the fluid (F) is heated, the heated fluid (G) is fed into a degassing vessel (4) where part of the volatile compounds are removed via the vapor line (4.1) to obtain a concentrated fluid (H),

   b) reheating the concentrated fluid (H) from step a) in at least one reheating unit (6) to obtain a reheated concentrated fluid (L);

   c) feeding the reheated concentrated fluid (L) from step b) into at least one extruder unit comprising at least an extruder degassing section comprising at least a conveying section (16), a vent port (15) with one or more vapor lines (15.1), a accumulating section (20) and an outlet section (22), whereby volatile compounds are removed through the vent ports (15) and vapor lines (15.1);

   d) feeding the reheated concentrated fluid (H or L) from step a) or b) into at least one kneader unit comprising at least a degassing section, a vent port with one or more vapor lines, and an outlet section, whereby volatile compounds are removed through the vent ports and vapor lines to obtain a high viscous fluid (N or P);

   e) feeding the high viscous fluid (N) from step d) into at least one extruder unit comprising at least an extruder degassing section comprising at least a conveying section, a vent port with one or more vapor lines, a accumulating section and an outlet section, whereby volatile compounds are removed through the vent ports and vapor lines;

   f) feeding the high viscous fluid (M) from step c) into at least one kneader unit comprising at least a degassing section, a vent port with one or more vapor lines, and an outlet section, whereby volatile compounds are removed through the vent ports and vapor lines;

   whereby

   - the non-volatile polymers are synthetic rubber products, such as styrene butadiene rubbers and Lithium catalyzed butadiene rubber, Nickel catalyzed butadiene rubber, Titanium catalyzed butadiene rubber, Cobalt catalyzed butadiene rubber and Neodymium catalyzed butadiene rubber and

- whereby the reheated concentrated fluid (L) is free-flowing upon entering the extruder degassing section and the product (P) obtained at the outlet section is substantially free of volatile compounds to obtain a high viscous fluid.

2. The process pursuant to claim 1, characterized in that the viscosity of the reheated concentrated fluid (L) is in the range of 500 to 50.000.000 mPa*s.

3. The process pursuant to claim 1 or 2, characterized in that the content of volatile compounds in product (P) is less than 1 wt% based on the mass of the polymer.

4. The process pursuant to claims 1 to 3, characterized in that the Fluid (F) contains from 3 to 50 wt % of a non-volatile polymer and from 60 to 97 wt% volatile compounds, whereby the aforementioned components add up to 90 to 100 of the total mass of fluid (F).

5. The process pursuant to claims 1 to 4, characterized in that the fluid (F) entering the heater (2) has a temperature of 10°C to 100°C.

6. The process pursuant to claims 1 to 5, characterized in that the fluid (F) entering the heater (2) has a viscosity of 100 mPa*s to 60,000 mPa*s.

7. The process pursuant to claims 1 to 6, characterized in that the heated fluid G has a temperature of 100 to 200 °C.

8. The process pursuant to claims 1 to 7, characterized in that the pressure in the degassing vessel (4) is in the range of 100 hPa to 4,000 hPa.

9. The process pursuant to claims 1 to 8, characterized in that the degassing vessel (4) is designed in the shape of a cyclone and has at least a torisperical shaped bottom to facilitate removal of concentrated fluid (H).

10. The process pursuant to claims 1 to 9, characterized in that the pump 4.2 is selected from the group consisting of positive displacement type pumps, gear pumps, piston pumps, membrane pumps, screw type pumps, extruder type pumps like counter-rotating or co-rotating single or twin screw extruders or kneader type pumps or combinations thereof.

11. The process pursuant to claims 1 to 10, characterized in that the temperature of the concentrated fluid (H) is lower than that of heated fluid (G) and is in the range of 15 to 100°C.

12. The process pursuant to claims 1 to 11, characterized in that the temperature of the reheated concentrated fluid (L) is higher than that of the concentrated fluid (H) and is in the range of 50°C to 200°C.

13. The process pursuant to claims 1 to 12, characterized in that the extruder unit comprises an extruder selected from the group consisting of single and multiscrew extruders.

14. The process pursuant to claims 1 to 13, characterized in that the extruder unit comprises means to operate separate zones of the extruder independently of each other at different temperatures so that the zones can either be heated, unheated or cooled.

15. The process pursuant to claims 1 to 14, characterized in that the extruder is made of a material selected from nitrided steel, duplex steel, stainless steel, nickel-based alloys, composite materials like sintered metals, hot isostatic pressed materials, hard wear resistant materials like Stellite, coated metals with coatings made from ceramics, titanium nitride, chromium nitride and diamond like carbon.

16. The process pursuant to claims 1 to 15, characterized in that the vent ports (15) comprise means to prevent the reheated concentrated fluid (L) or the Product (P), from coming out of the vent ports.

17. The process pursuant to claims 1 to 16, characterized in that the accumulation in the accumulating sections (18, 20) is accomplished by kneading or throttling elements, blister discs or die plates.

18. The process pursuant to claims 1 to 17, characterized in that the extruder unit comprises 1 to 30 conveying and accumulating sections.

19. The process pursuant to claims 1 to 18, characterized in that the outlet section (22) comprises means to allow the product to exit the extruder and product processing equipment, whereby the processing equipment is selected from the group consisting of combinations of die plates and cutters; die plates und underwater-pelletizing means; means for crumb formation, turbulators and fixed knifes placed at the end plate of the extrude.

20. The process pursuant to claims 1 to 19, characterized in that the outlet section (22) further comprises cooling means, whereby the cooling means are selected from the group consisting of pneumatic crumb conveyers with convective air cooling, vibrating crumb conveyers with convective air cooling, vibrating crumb conveyer with cooled contact surfaces, belt conveyers with convective air cooling, belt conveyer with cooled belts, water spraying on hot crumbs upon outlet of the extruder and underwater-pelletizing means.

21. The process pursuant to claims 1 to 20, characterized in that the extruder unit is operated at a feed rate of 5 to 25,000 kilograms per hour.

22. The process pursuant to claims 1 to 21, characterized in that a stripping agent is added in the extruder unit.

23. The process pursuant to claims 1 to 22, characterized in that additives are added to fluid (F) or in the extruder unit by means of a side feeder or, as far as they are liquid together with a stripping agent.

24. The process pursuant to claims 1 to 23, characterized in that step a) is repeated a least once.

25. The process pursuant to claims 1 to 24, characterized in that the repetition is accomplished by connecting the respective number of concentrating units in series.

26. The process pursuant to claims 1 to 25, characterized in that the pressure in the concentration unit, the reheating unit or the extruder unit is equipped with one or more pressure regulation devices.

27. The process pursuant to claims 1 to 26, characterized in that the extruder unit comprises at least one extruder degassing section in upstream direction.

28. The process pursuant to claims 1 to 27, characterized in that fluid (F) is obtained by a process of removing hydrophilic compounds and optionally water from a crude fluid (A) containing at least one non-volatile polymer, at least one volatile organic compound, one or more hydrophilic compounds and optionally water which comprises at least the step of

pre a) treating the crude fluid (A) in at least one pre-washing unit comprising at least a separating apparatus (26), whereby the fluid (A) is mixed with water to obtain an organic phase (28) comprising primarily non-volatile polymer and volatile organic compounds and an aqueous phase (27) comprising primarily water and hydrophilic compounds, and whereby the organic phase (28) is separated from the aqueous phase (27) in a separating apparatus (26) and further used as fluid F and whereby at least a part of the aqueous phase (27) is removed from the separating apparatus (fluid C).

29. The process pursuant to claim 28, characterized in that the separation is supported by means of a coalescer (39).

30. The process pursuant to claim 28 or 29, characterized in that step pre-a) is repeated at least once.

31. The process pursuant to claim 30, characterized in that the repetition is accomplished by connecting the respective number of separating apparatuses (26) in series.

32. The process pursuant to claims 28 to 31, characterized in that the separation is performed at temperatures of more than 40°C.

33. Device comprising a least

- one concentrating unit comprising a heater (2) in communication with a degassing vessel (4), whereby the bottom part of the degassing vessel (4) is in communication with a pump (4.2) the upper part of the degassing vessel (4) is in communication with at least one vapour line (4.1)
- one heating unit (6) in communication with the pump (4.2) of the concentrating unit and a feeding point (12) on an extruder unit
- one extruder unit comprising at least one feeding point (12), one extruder degassing section (16), one accumulating section (20) and one outlet section (22), whereby the

extruder degassing section (16) further comprises at least one vent port (15) connected to a vapour line (15.1).

34. Device pursuant to claim 33, characterized in that the pump (4.2) is selected from the group consisting of positive displacement type pumps, gear pumps, piston pumps, membrane pumps, screw type pumps, extruder type pumps like counter-rotating or co-rotating single or twin screw extruders or kneader type pumps or combinations thereof.

35. Device pursuant to claim 33 or 34, characterized in that the extruder unit comprises an extruder selected from the group consisting of single screw and multiscrew extruders.

36. Device pursuant to claims 33 to 35, characterized in that the extruder unit comprises a twin-screw extruder a ring extruder or a planetary roller extruder.

37. Device pursuant to claims 33 to 36, characterized in that the accumulating section (20) comprises kneading or throttling elements, blister discs or die plates.

38. Device pursuant to claims 33 to 37, characterized in that the outlet section (22) comprises product processing equipment selected from the group consisting of combinations of die plates and cutters; die plates und underwater-pelletizing means; means for crumb formation, turbulators and fixed knifes placed at the end plate of the extruder.

39. Device pursuant to claims 33 to 38, characterized in that the outlet section (22) comprises cooling means.

40. Device pursuant to claims 33 to 39, characterized in that it is designed to allow operation with a feed rate of 5 to 25,000 kilograms per hour.

41. Device pursuant to claims 33 to 40, characterized in that the extruder unit is designed to allow the addition of a stripping agent.

42. Device pursuant to claims 33 to 41, characterized in that the extruder unit comprises one or more side feeders.

43. Device pursuant to claims 33 to 42, characterized in that it comprises more than one concentration units, whereby the concentration units are connected in series.

44. Device pursuant to claims 33 to 43, characterized in that the concentration unit, the reheating unit or the extruder unit is equipped with one or more pressure regulation devices.

45. Device pursuant to claims 33 to 44, characterized in that the extruder unit comprises more than one extruder degassing sections, whereby the feeding point (12) is located at the first extruder degassing section, whereby the first extruder degassing section comprises at least one conveying section (16A), a rear vent port (13) connected to a vapor line (13.1) in upstream direction.

46. Device pursuant to claims 33 to 45, characterized in that it further comprises one or more pre-washing units, each comprising at least a separating apparatus (26) in communication with one or more of the concentration units.

47. Device pursuant to claim 46, characterized in that the separating apparatus (26) comprises at least one mixer (30).

48. Device pursuant to claim 46 or 47, characterized in that the separating apparatus (26) comprises at least one coalescer (39).

49. Device pursuant to claims 46 to 48, characterized in that the separating apparatus (26) comprises at least one separating wall (34).

50. Device pursuant to claims 46 to 49, characterized in that the separating apparatus (26) is designed to be operated under pressure.

51. Device pursuant to claims 46 to 50, characterized in that the degassing vessel (4) has at least torisperical shaped bottom.

52. Use of a device pursuant to claims 33 to 51 or any of its components in a process according to claims 1 to 38.

53. Plant comprising at least one device according to claims 33 to 51.