CLAIMS

1. Devolatilisation apparatus comprising at least one extruder which has:

- a barrel and n barrel holes B_n having the associated hole diameters D_n where n is an integer, and the barrel holes in the case of n being greater than 1 pass through opposite one another and are likewise arranged parallel to one another,
- one or more screws W_n which can be driven so as to rotate and are in each case arranged concentrically in one of the barrel holes B_n, have an axis of rotation A_n and are equipped with treatment elements whose cross-sectional profile in the circumferential direction has
  - m relative maxima $R^m_{max\ n}$ in respect of the radial dimension of the cross-sectional profile to the axis of rotation A_n of the screw W_n, where m is an integer from 1 to 8,
  - a maximum value $R_{max\ n}$ in respect of the radial dimension of the cross-sectional profile to the axis of rotation A_n of the screw W_n, where $R_{max\ n}$ fulfils:

    $R_{max\ n} <= (D_n/2)$
- at least one feed zone,
- one or more devolatilisation zones comprising in each case at least one devolatilisation opening which is suitable for discharge of volatile constituents from a polymer-containing medium from the extruder,
- at least one discharge zone,

where the extruder has screw elements SE having a pitch t as treatment elements, which are configured so that at least two of the following three conditions are met:

S1) the cross-sectional profile has at least one relative maximum $R^m_{max\ n}$ based on the radial dimension of the profile curve, for which:

$0.430\ D_n >= R^m_{max\ n} < 0.485\ D_n$,

S2) $1.60\ D_n < t < 3.00\ D_n$,

S3) the cross-sectional profile of the respective screw element has no tangential angle β greater than 25° on the active flanks located at the front in the direction of rotation in the range of the radial dimension from $0.90\ R_{max}$ to R_{max} whereby the tangential angle β is defined as

- the smaller of the two angles formed on drawing the tangents at any point on the cross-sectional profile of the treatment element at which the cross-sectional profile cannot be continually differentiated
- and is 0° at any point on the cross-sectional profile of the treatment element at which the cross-sectional profile can always be differentiated.

2. Devolatilisation apparatus according to Claim 1, characterized in that the screw elements SE have a modular construction and consist of a core shaft and screw elements which have an accommodation opening for the core shafts or are configured as screws having a solid construction or as screws consisting of individual subsegments and produced in solid construction.

3. Devolatilisation apparatus according to Claim 1 or 2, characterized in that the extruder has a barrel and n = 1 to 16 barrel holes B_n.

4. Devolatilisation apparatus according to any of Claims 1 to 3, characterized in that when n is greater than 1, the barrel holes B_n pass through and are arranged parallel to one another.

5. Devolatilisation apparatus according to any of Claims 1 to 4, characterized in that single-screw and multiscrew extruders are used as extruders.

6. Devolatilisation apparatus according to any of Claims 1 to 5, characterized in that the extruder of the devolatilisation apparatus has at least one dispersing zone.

7. Devolatilisation apparatus according to any of Claims 1 to 5, characterized in that the screw elements SE satisfy the features S1) and S2) or S2) and S3) or S1) and S3) or all three features S1), S2) and S3).

8. Devolatilisation apparatus according to any of Claims 1 to 7, characterized in that the last devolatilisation zone of the extruder in the transport direction of the extruder (14), is equipped with screw elements SE.

9. Devolatilisation apparatus according to any of Claims 1 to 8, characterized in that the number of devolatilisation zones is from 1 to 20.

10. Devolatilisation apparatus according to any of Claims 1 to 9, characterized in that at least one devolatilisation zone is located upstream of the feed zone (4) of the extruder (14).

11. Devolatilisation apparatus according to any of Claims 1 to 10, characterized in that the devolatilisation openings (16) and the devolatilisation domes (17) are configured so that they effectively prevent or reduce exit of polymer-containing medium and in particular have single-screw or multiscrew stopping screws which are mounted at the devolatilisation openings and are operated so as to convey into the extruder or have rollers or belts which are arranged on the inside of the devolatilisation openings in order to push polymer-containing medium or product back into the extruder.

12. Devolatilisation apparatus according to any of Claims 1 to 11, characterized in that coatings which reduce or prevent adhesion of the material to the surface are used at the devolatilisation openings (15).

13. Devolatilisation apparatus according to any of Claims 1 to 12, characterized in that the extruder has at least one dispersing zone.

14. Devolatilisation apparatus according to any of Claims 1 to 13, characterized in that at least some depressurisation elements are located upstream of the devolatilisation zones of the extruder.

15. Devolatilisation apparatus according to Claim 14, characterized in that the perforated plates are made up of a plurality of parts, preferably two parts, so that they can be taken from the barrel (21) without removal of the screws.

16. Devolatilisation apparatus according to any of Claims 1 to 15, characterized in that the extruder comprises one or more feed openings for the introduction of additives.

17. Devolatilisation apparatus according to any of Claims 1 to 16, characterized in that the screw elements SE have a cross-sectional profile which can be represented completely by a profile curve which can be continually differentiated.

18. Devolatilisation apparatus according to Claim 17, characterized in that the screw elements SE are two-flighted or three-flighted.

19. Devolatilisation apparatus according to Claims 17 or 18, characterized in that the screw elements SE are unsymmetrical or symmetrical.

20. Devolatilisation apparatus according to any of Claims 1 to 19, characterized in that the screw elements SE are made of steels or powder-metallurgically produced metallic composites based on iron, nickel or cobalt.

21. Devolatilisation apparatus according to any of Claims 1 to 20, characterized in that a preextruder (2) or a prekneader which are each configured as devolatilisation extruder or devolatilisation kneader are located upstream of the extruder (3).

22. Devolatilisation apparatus according to Claim 21, characterized in that the transfer zone (12) connecting the devolatilising preextruder or devolatilising prekneader and the extruder (3) has at least one depressurisation element.

23. Devolatilisation apparatus according to Claim 21 or 22, characterized in that at least one pressure regulating unit is present in the transfer zone (12).

24. Devolatilisation apparatus according to any of Claims 1 to 23, characterized in that one or more further concentrator units are located upstream.

25. Process for removing volatile compounds from a polymer-containing medium (PM) which contains at least one polymer and at least one volatile compound, which process comprises at least the following steps:

a) provision of a devolatilisation apparatus according to any of Claims 1 to 24,

b) introduction of the polymer-containing medium (PM) into the devolatilisation apparatus which is operated so that volatile compounds are given off from the polymer-containing medium (PM) through the devolatilisation openings of the devolatilisation unit and the polymer-containing medium (PM) is in this way depleted in volatile compounds and the polymer is isolated as product P from the polymer-containing medium on discharge from the devolatilisation apparatus and the product P then has a lower proportion of volatile compounds than the polymer-containing medium (PM) introduced into the devolatilisation apparatus and has a total concentration of volatile compounds of less than 1% by weight based on the mass of the polymer.

26. Process according to Claim 25, characterized in that the polymer-containing medium contains natural or synthetic polymers.

27. Process according to Claim 25 or 26, characterized in that the polymer-containing medium contains at least one elastomer.

28. Process according to any of Claims 25 to 27, characterized in that the polymer-containing medium contains butyl rubber and/or halogenated butyl rubbers.

29. Process according to any of Claims 25 to 28, characterized in that the polymer-containing medium is in the form of suspensions, pastes, melts, solutions, particulate solid compositions or mixed forms of the abovementioned forms.

30. Process according to any of Claims 25 to 29, characterized in that the polymer-containing medium contains from 3 to 98% by weight of a polymer and from 2 to 97% by weight of volatile compounds where the polymer and the volatile compounds make up up to 90-100% by weight of the total mass of the polymer-containing medium.

31. Process according to any of Claims 25 to 30, characterized in that the pressure in the devolatilisation openings (16) and devolatilisation domes (17) is in the range from 1 hPa to 2000 hPa.

32. Process according to any of Claims 25 to 31, characterized in that stripping agents are introduced into the extruder of the devolatilisation apparatus.

33. Use of screw elements having a pitch t which are configured so that at least two of the three following conditions are satisfied:

S1) the cross-sectional profile has at least one relative maximum $R^m_{max\ n}$ based on the radial dimension of the profile curve, for which:

$0.430\ D_n >= R^m_{max\ n} < 0.485\ D_n$

S2) $1.60\ D_n < t < 3.00\ D_n$

S3) the cross-sectional profile of the respective screw element has no tangential angle β greater than 25° on the active flanks located at the front in the direction of rotation in the range of the radial dimension from $0.90\ R_{max}$ to R_{max} whereby the tangential angle β is defined as

- the smaller of the two angles formed on drawing the tangents at any point on the cross-sectional profile of the treatment element at which the cross-sectional profile cannot be continually differentiated
- and is 0° at any point on the cross-sectional profile of the screw element at which the cross-sectional profile can always be differentiated,

in an extruder.

CLAIMS

1. Devolatilisation apparatus comprising at least one extruder which has:

- a barrel and n barrel holes B_n having the associated hole diameters D_n where n is an integer, and the barrel holes in the case of n being greater than 1 pass through opposite one another and are likewise arranged parallel to one another,

- one or more screws W_n which can be driven so as to rotate and are in each case arranged concentrically in one of the barrel holes B_n, have an axis of rotation A_n and are equipped with treatment elements whose cross-sectional profile in the circumferential direction has

  - m relative maxima $R^m_{max\ n}$ in respect of the radial dimension of the cross-sectional profile to the axis of rotation A_n of the screw W_n, where m is an integer from 1 to 8,

  - a maximum value $R_{max\ n}$ in respect of the radial dimension of the cross-sectional profile to the axis of rotation A_n of the screw W_n, where $R_{max\ n}$ fulfils:

    $R_{max\ n} <= (D_n/2)$

- at least one feed zone,

- one or more devolatilisation zones comprising in each case at least one devolatilisation opening which is suitable for discharge of volatile constituents from a polymer-containing medium from the extruder,

- at least one discharge zone,

where the extruder has screw elements SE having a pitch t as treatment elements, which are configured so that the following three conditions are met:

S1) the cross-sectional profile has at least one relative maximum $R^m_{max\ n}$ based on the radial dimension of the profile curve, for which:

$0.430\ D_n >= R^m_{max\ n} < 0.485\ D_n$,

S2) $1.60\ D_n < t < 3.00\ D_n$,

S3) the cross-sectional profile of the respective screw element has no tangential angle β greater than 25° on the active flanks located at the front in the direction of rotation in the range of the radial dimension from $0.90\ R_{max}$ to R_{max}whereby the tangential angle β is defined as

- the smaller of the two angles formed on drawing the tangents at any point on the cross-sectional profile of the treatment element at which the cross-sectional profile cannot be continually differentiated
- and is 0° at any point on the cross-sectional profile of the treatment element at which the cross-sectional profile can always be differentiated.

2. Devolatilisation apparatus according to Claim 1, characterized in that the screw elements SE have a modular construction and consist of a core shaft and screw elements which have an accommodation opening for the core shafts or are configured as screws having a solid construction or as screws consisting of individual subsegments and produced in solid construction.

3. Devolatilisation apparatus according to Claim 1 or 2, characterized in that the extruder has a barrel and n = 1 to 16 barrel holes B_n.

4. Devolatilisation apparatus according to any of Claims 1 to 3, characterized in that when n is greater than 1, the barrel holes B_n pass through and are arranged parallel to one another.

5. Devolatilisation apparatus according to any of Claims 1 to 4, characterized in that single-screw and multiscrew extruders are used as extruders.

6. Devolatilisation apparatus according to any of Claims 1 to 5, characterized in that the extruder of the devolatilisation apparatus has at least one dispersing zone.

7. Devolatilisation apparatus according to any of Claims 1 to 6, characterized in that the last devolatilisation zone of the extruder in the transport direction of the extruder (14), is equipped with screw elements SE.

8. Devolatilisation apparatus according to any of Claims 1 to 7, characterized in that the number of devolatilisation zones is from 1 to 20.

9. Devolatilisation apparatus according to any of Claims 1 to 8, characterized in that at least one devolatilisation zone is located upstream of the feed zone (4) of the extruder (14).

10. Devolatilisation apparatus according to any of Claims 1 to 9, characterized in that the devolatilisation openings (16) and the devolatilisation domes (17) are configured so that they effectively prevent or reduce exit of polymer-containing medium and in particular have single-screw or multiscrew stopping screws which are mounted at the devolatilisation openings and are operated so as to convey into the extruder or have rollers or belts which are arranged on the inside of the

devolatilisation openings in order to push polymer-containing medium or product back into the extruder.

11. Devolatilisation apparatus according to any of Claims 1 to 10, characterized in that coatings which reduce or prevent adhesion of the material to the surface are used at the devolatilisation openings (15).

12. Devolatilisation apparatus according to any of Claims 1 to 11, characterized in that the extruder has at least one dispersing zone.

13. Devolatilisation apparatus according to any of Claims 1 to 12, characterized in that at least some depressurisation elements are located upstream of the devolatilisation zones of the extruder.

14. Devolatilisation apparatus according to Claim 13, characterized in that the perforated plates are made up of a plurality of parts, preferably two parts, so that they can be taken from the barrel (21) without removal of the screws.

15. Devolatilisation apparatus according to any of Claims 1 to 14, characterized in that the extruder comprises one or more feed openings for the introduction of additives.

16. Devolatilisation apparatus according to any of Claims 1 to 15, characterized in that the screw elements SE have a cross-sectional profile which can be represented completely by a profile curve which can be continually differentiated.

17. Devolatilisation apparatus according to Claim 16, characterized in that the screw elements SE are two-flighted or three-flighted.

18. Devolatilisation apparatus according to Claims 16 or 17, characterized in that the screw elements SE are unsymmetrical or symmetrical.

19. Devolatilisation apparatus according to any of Claims 1 to 18, characterized in that the screw elements SE are made of steels or powder-metallurgically produced metallic composites based on iron, nickel or cobalt.

20. Devolatilisation apparatus according to any of Claims 1 to 19, characterized in that a preextruder (2) or a prekneader which are each configured as devolatilisation extruder or devolatilisation kneader are located upstream of the extruder (3).

21. Devolatilisation apparatus according to Claim 20, characterized in that the transfer zone (12) connecting the devolatilising preextruder or devolatilising prekneader and the extruder (3) has at least one depressurisation element.

22. Devolatilisation apparatus according to Claim 20 or 21, characterized in that at least one pressure regulating unit is present in the transfer zone (12).

23. Devolatilisation apparatus according to any of Claims 1 to 22, characterized in that one or more further concentrator units are located upstream.

24. Process for removing volatile compounds from a polymer-containing medium (PM) which contains at least one polymer and at least one volatile compound, which process comprises at least the following steps:

a) provision of a devolatilisation apparatus according to any of Claims 1 to 23,

b) introduction of the polymer-containing medium (PM) into the devolatilisation apparatus which is operated so that volatile compounds are given off from the polymer-containing medium (PM) through the devolatilisation openings of the devolatilisation unit and the polymer-containing medium (PM) is in this way depleted in volatile compounds and the polymer is isolated as product P from the polymer-containing medium on discharge from the devolatilisation apparatus and the product P then has a lower proportion of volatile compounds than the polymer-containing medium (PM) introduced into the devolatilisation apparatus and has a total concentration of volatile compounds of less than 1% by weight based on the mass of the polymer.

25. Process according to Claim 24, characterized in that the polymer-containing medium contains natural or synthetic polymers.

26. Process according to Claim 24 or 25, characterized in that the polymer-containing medium contains at least one elastomer.

27. Process according to any of Claims 24 to 26, characterized in that the polymer-containing medium contains butyl rubber and/or halogenated butyl rubbers.

28. Process according to any of Claims 24 to 27, characterized in that the polymer-containing medium is in the form of suspensions, pastes, melts, solutions, particulate solid compositions or mixed forms of the abovementioned forms.

29. Process according to any of Claims 24 to 28, characterized in that the polymer-containing medium contains from 3 to 98% by weight of a polymer and from 2 to 97% by weight of volatile compounds where the polymer and the volatile compounds make up up to 90-100% by weight of the total mass of the polymer-containing medium.

30. Process according to any of Claims 24 to 29, characterized in that the pressure in the devolatilisation openings (16) and devolatilisation domes (17) is in the range from 1 hPa to 2000 hPa.

31. Process according to any of Claims 24 to 30, characterized in that stripping agents are introduced into the extruder of the devolatilisation apparatus.

32. Use of screw elements having a pitch t which are configured so that the three following conditions are satisfied:

S1) the cross-sectional profile has at least one relative maximum $R^m_{max\ n}$ based on the radial dimension of the profile curve, for which:

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S3) the cross-sectional profile of the respective screw element has no tangential angle β greater than 25° on the active flanks located at the front in the direction of rotation in the range of the radial dimension from $0.90\ R_{max}$ to R_{max} whereby the tangential angle β is defined as

- the smaller of the two angles formed on drawing the tangents at any point on the cross-sectional profile of the screw element at which the cross-sectional profile cannot be continually differentiated
- and is 0° at any point on the cross-sectional profile of the screw element at which the cross-sectional profile can always be differentiated,

in an extruder.