Claims

1. Reactor for the continuous preparation of polymers, in particular synthetic rubbers, comprising at least one essentially tubular reactor housing (16) having at least

   - one drive (38) which is connected to at least one scraper or wiper (36) which is arranged so as to be rotatable within the reactor housing (16), where the scraper or wiper (36) has at least one scraper or wiper blade (42) to run along an interior side of the reactor housing (44)
   - at least one inlet (20)
   - at least one outlet (24).

2. Reactor according to Claim 1, characterized in that it comprises a central shaft running essentially along the geometric central axis (12).

3. Reactor according to Claim 1 or 2, wherein the outlet (24) is configured such that the outlet orifice (25) is aligned essentially tangentially to the circumferential direction of the drive (38).

4. Reactor according to Claim 3, wherein the outlet (24) is configured in such a way that the cross-sectional face of the outlet orifice (25) within the reactor housing (16) forms an angle γ with the geometric central axis (12) of the reactor housing (16) of not more than 45°, preferably not more than 30°, more preferably between 0 and 20°, and an angle δ with the radius (11), i.e. the shortest connecting line between the geometric central axis and the essentially tubular reactor housing, of not more than 45°, preferably not more than 30°, more preferably between 0 and 20°.

5. Reactor according to Claim 3 or 4, wherein the outlet (24) is arranged such that the geometric centre of the outlet orifice (25) in radial direction is closer to the outer limit of the drive (39) than to the inside of the reactor housing (44).

6. Reactor according to any of Claims 1 to 5, characterized in that the reactor (10) is designed with an external pumped circulation system (23), said pumped circulation system being connected to the reactor housing (16) via a circulation outlet (27) and a circulation inlet (21), and said pumped circulation system (23) having a conveying unit (29).

7. Reactor according to Claim 6, characterized in that the pumped circulation system is coolable.

8. Reactor according to Claim 6 or 7, characterized in that the conveying unit has dispersing elements (33), preferably has at least one row, preferably at least two rows, of rotor teeth, and at least one row, preferably at least two rows, of stator teeth with different, preferably decreasing gap dimensions.

9. Reactor according to any of Claims 1 to 8, characterized in that the reactor (10) has at least two inlets (20), the first inlet in flow direction (22) being arranged at a distance from a further inlet in axial direction of at least 5%, preferably 10 to 45% and more preferably 10 to 40%, based on the axial path length from the first inlet in flow direction (22) to the first outlet within the reactor housing (16).

10. Reactor according to any of Claims 1 to 9, characterized in that it further comprises at least one stator (75).

11. Reactor according to Claim 10, characterized in that the stators are configured such that they have a distance from the central shaft of 0 or more than 0 to 5% based on the radial diameter of the reactor housing.

12. Reactor according to any of Claims 2 to 11, characterized in that it comprises a central shaft running along the geometric central axis through which temperature control media can flow .

13. Reactor according to any of Claims 1 to 12, characterized in that the scrapers or wipers (36) are configured such that the distance of the scrapers or wipers from the reactor housing is 0 or more than 0 to 5% based on the radial diameter of the reactor housing.

14. Reactor according to any of Claims 1 to 13, characterized in that the reactor housing (16) is connected to a transport device for transporting starting materials into the reactor housing (16) and/or for transporting products out of the reactor housing (16).

15. Reactor according to any of Claims 1 to 14, characterized in that at least two heat exchangers (26, 28) for setting the temperature of a flow provided within the reactor housing (16) are arranged in the axial direction of the reactor housing (16), where the heat exchangers (26, 28) are separated from one another in such a way that a different temperature can be set for each heat exchanger (26, 28).

16. Reactor according to any of Claims 1 to 15, characterized in that the heat exchanger (26, 28) has an outer wall (30) surrounding part of the reactor housing (16) and in

particular a spiral dividing wall (32) is arranged between the outer wall (30) and the reactor housing (16) to form a spiral heat exchanger channel (34).

17. Reactor according to any of Claims 1 to 16, characterized in that a ratio of an inner area A of the tubular reactor housing (16) to a volume V of the tubular reactor housing (16) is such that $0.1\ m^2/m^3 \leq A/V \leq 100\ m^2/m^3$.

18. Reactor according to any of Claims 1 to 17, characterized in that the scraper or wiper (36) has at least two subscrapers or subwipers (54) which are connected to one another in an articulated manner in the axial direction.

19. Reactor according to any of Claims 1 to 18, characterized in that the scraper or wiper (36) can be driven via a drive (38) and the drive (38) is sealed by means of a double-acting sliding ring seal arranged between the drive (38) and the reactor housing (16), where the sliding ring seal contains, in particular, a barrier medium which is inert under the polymerization conditions.

20. Reactor according to any of Claims 1 to 19, characterized in that the scraper or wiper blade (42) has a surface having a coefficient of friction which is lower than that of 1.4571 stainless steel.

21. Reactor according to any of Claims 1 to 20, characterized in that the surfaces within the reactor housing (16) are produced or treated such that the adhesion of solids, such as synthetic rubbers in particular, is reduced in comparison with 1.4571 stainless steel.

22. Reactor according to any of Claims 1 to 21, characterized in that the scraper or wiper blade (42) is inclined and/or curved relative to a radially directed line running through the geometric central axis (12), where the scraper or wiper blade (42) has a fastening head (46) directed radially inward and a radially outward-directed force, in particular spring force, can be applied to the scraper or wiper blade (42), in particular to the fastening head (46).

23. Reactor according to any of Claims 1 to 22, characterized in that at least two scraper or wiper blades (42) are arranged in the axial direction, where the scraper or wiper blades (42) are offset by an angle α in the circumferential direction and the angle α is in particular such that $30° \leq \alpha \leq 150°$, preferably $45° \leq \alpha \leq 135°$, more preferably $60° \leq \alpha \leq 120°$ and particularly preferably $\alpha = 90° \pm 2°$.

24. Reactor according to any of Claims 1 to 23, characterized in that the tube reactor is

connected in the upstream direction to at least one mixing chamber (72) which has a housing surrounding the mixing chamber and at least one mixing element (70) arranged within the mixing chamber.

25. Reactor according to Claim 24, characterized in that the mixing element (70) is an impeller.

26. Reactor according to any of Claims 1 to 25, characterized in that the scrapers or wipers (36) and the optionally present stators (75) are configured to promote redispersion of the scraped-off or wiped-off material.

27. Reactor according to any of Claims 1 to 26, characterized in that the at least one outlet (24) is equipped with dispersing elements (33).

28. Use of a reactor according to any of Claims 1 to 27 for polymerization of polymerizable monomers.

29. Use according to Claim 28, characterized in that the polymers are synthetic rubbers.

30. Process for the continuous preparation of polymers by polymerization of polymerizable monomers, characterized in that the polymerization is carried out in a reactor according to any of Claims 1 to 27.

31. Process according to Claim 30, characterized in that in a reactor according to any of Claims 1 to 27

- essentially plug flow in the axial direction is imparted to the starting materials and the products or
- essentially circulation flow or loop flow is imparted to the starting materials and the products and

any solids or gels deposited are mechanically removed from an interior side (44) of a reactor housing (16) of the tube reactor (10) during the polymerization.

32. Process according to either of Claims 30 and 31, wherein different heat exchanger temperatures are established in the flow direction in order to set a predetermined molecular weight taking into account the heat balances, residence times and concentrations occurring during the polymerization.

33. Process according to any of Claims 30 to 32, wherein the mechanical removal of any

deposited solids or gels is carried out at a velocity v at the interior side (44) of the reactor housing (16) such that 0.05 m/s ≤ v ≤ 10 m/s.

34. Process according to any of Claims 30 to 33, characterized in that the starting materials are mixed by means of a mixing element (70) with a mixing energy of from 0.001 to 120 J/l in a mixing chamber (72) before entering the reactor (10).

35. Process according to any of Claims 30 to 34, characterized in that solids or gels obtained by polymerization of polymerizable monomers in the preparation of polymers in a reactor (10) according to any of Claims 8 to 27 are comminuted to particle sizes of less than 1 mm, more preferably of less than 0.1 mm.

36. Process according to any of Claims 30 to 35, characterized in that synthetic rubbers are produced.

CLAIMS

1. Reactor for the continuous preparation of polymers, in particular synthetic rubbers, comprising at least one essentially tubular reactor housing (16) having at least
   - one drive (38) which is connected to at least one scraper or wiper (36) which is arranged so as to be rotatable within the reactor housing (16), where the scraper or wiper (36) has at least one scraper or wiper blade (42) to run along an interior side of the reactor housing (44)
   - at least one inlet (20)
   - at least one outlet (24)

   wherein the outlet (24) is configured such that the outlet orifice (25) is aligned essentially tangentially to the circumferential direction of the drive (38).

2. Reactor according to Claim 1, characterized in that it comprises a central shaft running essentially along the geometric central axis (12).

3. Reactor according to Claim 2, wherein the outlet (24) is configured in such a way that the cross-sectional face of the outlet orifice (25) within the reactor housing (16) forms an angle γ with the geometric central axis (12) of the reactor housing (16) of not more than 45°, preferably not more than 30°, more preferably between 0 and 20°, and an angle δ with the radius (11), i.e. the shortest connecting line between the geometric central axis and the essentially tubular reactor housing, of not more than 45°, preferably not more than 30°, more preferably between 0 and 20°.

4. Reactor according to any of Claims 1 to 3, wherein the outlet (24) is arranged such that the geometric centre of the outlet orifice (25) in radial direction is closer to the outer limit of the drive (39) than to the inside of the reactor housing (44).

5. Reactor according to any of Claims 1 to 4, characterized in that the reactor (10) is designed with an external pumped circulation system (23), said pumped circulation system being connected to the reactor housing (16) via a circulation outlet (27) and a circulation inlet (21), and said pumped circulation system (23) having a conveying unit (29).

6. Reactor according to Claim 5, characterized in that the pumped circulation system is coolable.

7. Reactor according to Claim 5 or 6, characterized in that the conveying unit has dispersing elements (33), preferably has at least one row, preferably at least two rows, of rotor teeth, and at least one row, preferably at least two rows, of stator teeth with different, preferably decreasing gap dimensions.

8. Reactor according to any of Claims 1 to 7, characterized in that the reactor (10) has at least two inlets (20), the first inlet in flow direction (22) being arranged at a distance from a further inlet in axial direction of at least 5%, preferably 10 to 45% and more preferably 10 to 40%, based on the axial path length from the first inlet in flow direction (22) to the first outlet within the reactor housing (16).

9. Reactor according to any of Claims 1 to 8, characterized in that it further comprises at least one stator (75).

10. Reactor according to Claim 9, characterized in that the stators are configured such that they have a distance from the central shaft of 0 or more than 0 to 5% based on the radial diameter of the reactor housing.

11. Reactor according to any of Claims 2 to 10, characterized in that it comprises a central shaft running along the geometric central axis through which temperature control media can flow .

12. Reactor according to any of Claims 1 to 11, characterized in that the scrapers or wipers (36) are configured such that the distance of the scrapers or wipers from the reactor housing is 0 or more than 0 to 5% based on the radial diameter of the reactor housing.

13. Reactor according to any of Claims 1 to 12, characterized in that the reactor housing (16) is connected to a transport device for transporting starting materials into the reactor housing (16) and/or for transporting products out of the reactor housing (16).

14. Reactor according to any of Claims 1 to 13, characterized in that at least two heat exchangers (26, 28) for setting the temperature of a flow provided within the reactor housing (16) are arranged in the axial direction of the reactor housing (16), where the heat exchangers (26, 28) are separated from one another in such a way that a different

temperature can be set for each heat exchanger (26, 28).

15. Reactor according to claim 14, characterized in that the heat exchanger (26, 28) has an outer wall (30) surrounding part of the reactor housing (16) and in particular a spiral dividing wall (32) is arranged between the outer wall (30) and the reactor housing (16) to form a spiral heat exchanger channel (34).

16. Reactor according to any of Claims 1 to 15, characterized in that a ratio of an inner area A of the tubular reactor housing (16) to a volume V of the tubular reactor housing (16) is such that $0.1\ m^2/m^3 \leq A/V \leq 100\ m^2/m^3$.

17. Reactor according to any of Claims 1 to 16, characterized in that the scraper or wiper (36) has at least two subscrapers or subwipers (54) which are connected to one another in an articulated manner in the axial direction.

18. Reactor according to any of Claims 1 to 17, characterized in that the scraper or wiper (36) can be driven via a drive (38) and the drive (38) is sealed by means of a double-acting sliding ring seal arranged between the drive (38) and the reactor housing (16), where the sliding ring seal contains, in particular, a barrier medium which is inert under the polymerization conditions.

19. Reactor according to any of Claims 1 to 18, characterized in that the scraper or wiper blade (42) has a surface having a coefficient of friction which is lower than that of 1.4571 stainless steel.

20. Reactor according to any of Claims 1 to 19, characterized in that the surfaces within the reactor housing (16) are produced or treated such that the adhesion of solids, such as synthetic rubbers in particular, is reduced in comparison with 1.4571 stainless steel.

21. Reactor according to any of Claims 1 to 20, characterized in that the scraper or wiper blade (42) is inclined and/or curved relative to a radially directed line running through the geometric central axis (12), where the scraper or wiper blade (42) has a fastening head (46) directed radially inward and a radially outward-directed force, in particular spring force, can be applied to the scraper or wiper blade (42), in particular to the fastening head (46).

22. Reactor according to any of Claims 1 to 21, characterized in that at least two scraper or wiper blades (42) are arranged in the axial direction, where the scraper or wiper blades (42) are offset by an angle α in the circumferential direction and the angle α is $30° \leq \alpha \leq 150$.

23. Reactor according to any of Claims 1 to 22, characterized in that the tube reactor is connected in the upstream direction to at least one mixing chamber (72) which has a housing surrounding the mixing chamber and at least one mixing element (70) arranged within the mixing chamber.

24. Reactor according to Claim 23, characterized in that the mixing element (70) is an impeller.

25. Reactor according to any of Claims 1 to 24, characterized in that the scrapers or wipers (36) and the optionally present stators (75) are configured to promote redispersion of the scraped-off or wiped-off.

26. Reactor according to any of Claims 1 to 25, characterized in that the at least one outlet (24) is equipped with dispersing elements (33).

27. Use of a reactor according to any of Claims 1 to 26 for polymerization of polymerizable monomers.

28. Use according to Claim 27, characterized in that the polymers are synthetic rubbers.

29. Process for the continuous preparation of polymers by polymerization of polymerizable monomers, characterized in that the polymerization is carried out in a reactor according to any of Claims 1 to 26.

30. Process according to Claim 29, characterized in that in a reactor according to any of Claims 1 to 26

- essentially plug flow in the axial direction is imparted to the starting materials and the products or
- essentially circulation flow or loop flow is imparted to the starting materials and the products and

any solids or gels deposited are mechanically removed from an interior side (44) of a reactor housing (16) of the tube reactor (10) during the polymerization.

31. Process according to either of Claims 29 and 30, wherein different heat exchanger temperatures are established in the flow direction in order to set a predetermined molecular weight taking into account the heat balances, residence times and concentrations occurring during the polymerization.

32. Process according to claim 31, wherein the mechanical removal of any deposited solids or gels is carried out at a velocity v at the interior side (44) of the reactor housing (16) such that 0.05 m/s $\leq v \leq 10$ m/s.

33. Process according to any of Claims 29 to 32, characterized in that the starting materials are mixed by means of a mixing element (70) with a mixing energy of from 0.001 to 120 J/l in a mixing chamber (72) before entering the reactor (10).

34. Process according to any of Claims 29 to 33, characterized in that solids or gels obtained by polymerization of polymerizable monomers in the preparation of polymers in a reactor (10) according to any of Claims 8 to 27 are comminuted to particle sizes of less than 1 mm, more preferably of less than 0.1 mm.

35. Process according to any of Claims 29 to 34, characterized in that synthetic rubbers are produced.