

CLAIMS

1. An apparatus for carrying out a catalytic gas-phase olefin polymerization comprising
 - 5 at least a first polymerization zone (1) adapted and arranged for growing polymer particles to flow upward under fast fluidization or transport conditions and at least a second polymerization zone (2) adapted and arranged for the growing polymer particles to flow downward; and a gas/solid separation zone (4) having a cylindrical shape; wherein the second polymerization zone (2) has an upper part (5) being connected to the separation zone (4), a
 - 10 lower part (6) being connected to the upper part (5) and a line (13) for feeding a gas and/or liquid into the second polymerization zone (2); the first polymerization zone (1) being connected to the separation zone (4) by a connecting part (3); the lower part (6) of the second polymerization zone (2) being connected to the lower part of the first polymerization zone (1) by a connecting part (9);
 - 15 wherein the ratio of the diameter D01 of the separation zone (4) to the diameter D03 of the upper part (5) of the second polymerization zone (2) is 1.02 to 1.5, preferably 1.05 to 1.4, more preferably 1.08 to 1.3;
 - 20 wherein the ratio of the height H01 of the separation zone (4) to the diameter D01 of the separation zone (4) is 2.5 to 4.5, preferably 2.8 to 4.2, more preferably 2.9 to 4; and
 - 25 wherein the ratio of the diameter D03 of the upper part (5) of the second polymerization zone (2) to the diameter D04 of the lower part (6) of the second polymerization zone (2) is 1.2 to 2, preferably 1.3 to 1.8, more preferably 1.4 to 1.7.
 2. The apparatus of claim 1 or 2, wherein the height H05 of the upper part (5) of the second polymerization zone (2) is 5000 to 10000 mm, preferably 6000 to 8000 mm, more preferably 6800 to 7200 mm.
 3. The apparatus of claim 1 or 2, wherein the ratio of the height H05 of the upper part (5) of the second polymerization zone (2) to the diameter D03 of the upper part (5) of the second polymerization zone (2) is 2 to 4, preferably 2 to 3.8, more preferably 2 to 3.6.
 4. The apparatus of any of the forgoing claims, wherein the separation zone (4) and the upper part (5) of the second polymerization zone (2) are connected by a first connecting part (7a) having a height H02, wherein the diameter of the connecting part (7a) constantly decreases from the diameter D01 of the separation zone (4) to the diameter D03 of the upper part (5) of the second polymerization zone (2).

5. The apparatus of any of the forgoing claims, wherein the upper part (5) of the second polymerization zone (2) and the lower part (6) of the second polymerization zone are connected by way of a second connecting part (7b) having a height H06 wherein the diameter of the connecting part (7b) constantly decreases from the diameter D03 of the upper part (5) of the second polymerization zone (2) to the diameter D04 of the lower part (6) of the second polymerization zone (2).
6. The apparatus of any of the forgoing claims, wherein the angle A01 of the first connecting part (7a) connecting the separation zone (4) to the upper part (5) of the second polymerization zone (2) is 5 to 25°, preferably 8 to 20° and more preferably 10 to 15°.
7. The apparatus of any of the forgoing claims, wherein the angle A02 of the second connecting part (7b) connecting the upper part (5) of the second polymerization zone (2) to the lower part (6) of the second polymerization zone (2) is 5 to 25°, preferably 8 to 20° and more preferably 10 to 15°.
8. The apparatus of any of the forgoing claims, wherein the height H05' from the bottom tangent line of the upper part (5) of the second polymerization zone (2) to the entrance of the feeding line (13) into the second polymerization zone (2) is 2000 to 6000 mm, preferably 2500 to 5000 mm, more preferably 3000 to 4500 mm.
9. The apparatus of any of the forgoing claims, wherein the apparatus further comprises at least one of the following:
 - i) a recycle line (8) connecting the separation zone (4) to one or more points of reintroduction into the connecting part (9) or into the first polymerization zone (1);
 - ii) a line (10) for feeding a catalyst into the first polymerization zone (1);
 - iii) a line (11) for feeding monomers into the apparatus;
 - iv) a discharge system (12) for discharging polymer from the second polymerization zone (2).
10. A process for carrying out a catalytic gas-phase olefin polymerization in the apparatus of any of claims 1 to 9, comprising feeding one or more olefins into the apparatus, contacting the olefins and a catalyst under reaction conditions in the at least first polymerization zone (1) and the at least second polymerization zone (2) and collecting the polymer product from the at least second polymerization zone (2), wherein the growing polymer particles flow upward through the first polymerization zone (1) under fast fluidization or transport conditions,

5 leave the first polymerization zone (1), pass through the gas/solid separation zone (4) and enter the second polymerization zone (2) where the polymer particles flow downward under the action of gravity, leave the second polymerization zone (2) and are at least partially re-introduced into the first polymerization zone (1), thus establishing a circulation of polymer between the first polymerization zone (1) and the second polymerization zone (2), wherein the second polymerization zone (2) comprises a bed of densified polymer particles.

10 11. The process of claim 10, wherein the gas mixture present in the first polymerization zone (1) is completely or partially prevented from flowing down the upper part (5) of the second polymerization zone (2) by introducing a gas or liquid into the second polymerization zone (2) via feeding line (13); and wherein the gas mixture present in the second polymerization zone (2) differs from the gas mixture present in the first polymerization zone (1).

15 12. The process of claim 11, wherein the surface of the bed of densified polymer particles is located in the upper part (5) of the second polymerization zone (2).

20 13. The process of claim 11 or 12, wherein the gas mixture present in the first polymerization zone (1) is prevented from entering the second polymerization zone (2) by introducing the gas or liquid into the upper part (5) of the second polymerization zone (2) over or below the surface of the bed of densified polymer particles.

25 14. The process of any of claims 10 to 13, wherein the polymerization is a homopolymerization of ethylene or a copolymerization of ethylene and one or more other olefins selected from the group consisting of 1-butene, 1-hexene and 1-octene or the polymerization is a homopolymerization of propylene or a copolymerization of propylene and one or more other olefins selected from the group consisting of ethylene, 1-butene and 1-hexene.

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