CLAIMS

1. A method for depolymerization of polymers, in particular polyesters, polyamides, polyurethanes, polycarbonates, comprising: a reagent supplying step, in which a reaction chamber (10), defined inside a reactor vessel (9) and extending along and around an axis (A), is supplied with a polymer to be treated and a liquid reacting composition for a depolymerization reaction of the polymer; a depolymerization reaction step, in which microwaves are sent into the reaction chamber (10) by means of a guide device (38) housed in the reaction chamber (10) to distribute the microwaves in the reaction chamber (10) along and around the axis (A) and activate the depolymerization reaction; in the reaction step, the polymer and the reacting composition contained in the reaction chamber (10) being mixed and kept stirred by means of a mixing device (3) rotating around the axis (A) so as to dynamically distribute within the reaction chamber (10), both along the axis (A) and radially with respect to the axis (A), a mixture formed by the polymer and the reacting composition, and so as to ensure constant uniform mixing of the liquid and solid components contained in the reaction chamber (10) and to guarantee that the pieces of polymer to be depolymerized are always wetted by the reagents and accumulations in particular areas of the reaction chamber (10) are avoided, avoiding dynamic accumulations of liquid parts having characteristic dimension greater than the penetration capacity of the microwaves; the reaction chamber (10) being pressurized at a predefined pressure during the reaction step.

2. A method according to claim 1, wherein the polymer is first introduced into the reaction chamber (10), at atmospheric pressure; and then the reacting composition is introduced into the reaction chamber (10), after having pressurized the reaction chamber (10), in particular by introducing nitrogen or other inert gas into the reaction chamber (10).

3. A method according to claim 1 or 2, wherein the pressure of the reaction chamber (10) at the time of supplying the reacting composition and during the reaction step is higher than or equal to 7 barg.

4. A method according to one of claims 1 to 3, comprising an initial supplying step, in which the reaction chamber (10) is supplied with the whole amount of polymer to be treated and a first dose of reacting composition; and a plurality of reaction steps alternating with liquid phase extraction and reintegration steps; and wherein in each liquid phase extraction and reintegration step a liquid phase, containing reaction residues, is extracted from the reaction chamber (10) and a new dose of fresh reacting composition is introduced into the reaction chamber (10).

5. A method according to claim 4, wherein in each liquid phase extraction and reintegration step an extraction duct (24), provided with a filter (25), is opened, so that the pressure inside the reaction chamber (10) pushes the liquid phase contained in the reaction chamber (10) out of the reaction chamber (10) and the filter (25) separates solid residues, which are retained in the reaction chamber (10), from a liquid stream.

6. A method according to claim 4 or 5, comprising, after a sequence of reaction steps alternating with liquid phase extraction and reintegration steps, a final liquid phase extraction step, in which the entire liquid phase present in the reaction chamber (10) is removed from the reaction chamber (10).

7. A method according to one of claims 1 to 6, comprising, after the reaction step, a drying step for drying post-reaction solid components remaining in the reaction chamber (10); the drying step being performed in the reaction chamber (10), using one or more of: extracting gas from the reaction chamber (10) by means of a vacuum pump (29) until an operating pressure well below

atmospheric pressure is reached, for example less than or equal to 0.05 atm; providing heat to the reaction chamber (10) by means of a thermal control system (4) operating in heating mode; sending microwaves into the reaction chamber (10), at a power not necessarily equal to that used for the depolymerization reaction and optionally modulated during the drying step, for providing energy directly to the residual liquid component inside the reaction chamber (10); mixing the content of the reaction chamber (10) by means of the mixing device (3).

8. A method according to claim 7, comprising, after the drying step, a water dissolution step of the post-reaction solid components, in which water is introduced into the reaction chamber (10) to dissolve solid components still present in the reaction chamber (10) and obtain an aqueous solution containing solid residues, which is then removed from the reaction chamber (10) by bringing the pressure inside the reaction chamber (10) back to atmospheric conditions or slight overpressure conditions, for a new production cycle.

9. A method according to one of claims 1 to 8, comprising a step of drawing a gas phase from the reaction chamber (10) by means of a vacuum pump (29), and sending said gas phase to a condenser (30) to separate a condensate and a gas.

10. A method according to one of claims 1 to 3, wherein the reaction step is performed by feeding a continuous flow of liquid phase to the reactor (2); and the method comprises a step of recirculating to the reactor (2) a liquid phase recovered stream taken from the reactor (2).

11. A method according to claim 10, comprising a step of controlling the temperature of the reacting composition fed to the reactor (2) upstream of the reactor (2).