CLAIMS

1 - A method for preparing a polyamide, having a viscosity index at least equal to 80 ml/g, by polycondensation from one or several monomers adapted for preparing a polyamide characterized in that:

- the selected monomer(s) are introduced without any preliminary reaction and without any preliminary preparation of the corresponding salt, into an extruder including at least two conveying screws rotating co-rotatively,

- all the reaction and polycondensation steps, initially starting with the selected monomer(s), and giving the possibility of ending up with the desired polyamide, are conducted in a single extruder including at least two conveying screws rotating co-rotatively,

- polycondensation is achieved by carrying out at least two operations for discharging the formed by-product(s) by the polycondensation reaction,

and in that it includes the following successive steps:

- a step for mixing the selected monomer(s),

- a polycondensation step conducted by successively carrying out shearing and depressurization operations on the material conveyed by the conveying screws,

- a step for forming a plug of material continuously renewed by conveyance of the material on the conveying screws, between the mixing and polycondensation steps; said material plug consisting of the advancing material filling the whole space available for the passage of the material and forming an area which is hermetic to vapors, and notably to monomer vapors which may be generated.

2 – The method for preparing a polyamide according to claim 1, characterized in that the average degree of polymerization (PD_n) of the obtained polyamide is at least equal to 50, preferably at least equal to 100.

3 – The method for preparing a polyamide according to claim 1 or 2, characterized in that the obtained polyamide has a mass average molar mass (Mw) at least equal to 14,000 g/mol, and preferably belonging to the range from 30,000 to 100,000 g/mol.

4 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the obtained polyamide has a viscosity index ~~at least equal to 80 ml/g, and preferably~~ belonging to the range from 120 to 250 ml/g.

5 – The method for preparing a polyamide according to any of the preceding claims, characterized in that, during the step for mixing the monomer(s), and during the step for forming the plug, the material is maintained at a temperature greater by at most 100°C than the melting temperature of the monomer having the highest melting point, and greater by more than 5°C than the melting temperature of the monomer having the highest melting point.

6 – The method for preparing a polyamide according to any of the preceding claims, characterized in that, during the polycondensation step, the material is maintained at a temperature greater than the temperatures applied during the mixing and forming steps for the material plug, which for example belongs to the range from 150 to 350°C, and preferably from 250 to 320°C.

7 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder used includes, for each conveying screw which makes it up, several, preferably at least four, shearing segments each linking at least two shearing elements and one retention element.

8 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder used includes several areas in succession in the direction of conveyance of the material, in order to produce according to a continuous method, the desired polyamide: an area ($\mathbf{Z_0}$) for introducing the monomer(s), followed by an area for mixing the monomer(s) ($\mathbf{Z_1}$), followed by a polycondensation area ($\mathbf{Z_3}$).

9 – The method for preparing a polyamide according to claim 8, characterized in that mixing area ($\mathbf{Z_1}$) and the polycondensation area ($\mathbf{Z_3}$) are separated by an isolation area ($\mathbf{Z_2}$), in order to avoid the passage of vapors of monomers.

10 – The method for preparing a polyamide according to claim 9, characterized in that the isolation area ($\mathbf{Z_2}$) on each conveying screw consists of at least one element for shrinking the passage for the material and of at least two retention elements.

11 – The method for preparing a polyamide according to any of claims 8 to 10, characterized in that the extruder used includes, in the mixing area ($\mathbf{Z_1}$), on each conveying screw which makes it up, several transport elements, followed by at least one, and notably one or two shearing segments linking at least one, preferably at least two shearing elements and one retention element.

12 – The method for preparing a polyamide according to any of claims 8 to 11, characterized in that the extruder used includes, in the polycondensation area ($\mathbf{Z_3}$), on each conveying screw which makes it up, at least three, and notably three, four, five or six shearing segments linking at least two shearing elements and one retention element.

13 – The method for preparing a polyamide according to claim 12, characterized in that the extruder used includes, also in its polycondensation area ($\mathbf{Z_3}$), on each conveying screw which makes it up, at least one, and notably one or two shearing segments linking at least three shearing elements and one retention element.

14 – The method for preparing a polyamide according to claim 11, 12 or 13, characterized in that in the shearing segment(s), the shearing elements include fins shifted by an increasing angle along the direction opposite to the direction of rotation of the conveying screws, in the conveying direction of the material.

15 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the operations for discharging the formed by-product(s) by the polycondensation reaction are accompanied by re-injection into the extruder of the monomer(s) carried away with the formed by-product(s).

16 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the operations for discharging the

formed by-product(s) are accompanied by the generation of a negative pressure area within the extruder.

17 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the operations for discharging the formed by-product(s) are preceded with an injection of inert gas into the extruder.

18 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder includes a sequence of elements giving the possibility of conducting the polycondensation reaction for sufficient time in order to attain the desired conversion rate at the output of the extruder.

19 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder is selected from:

- twin-screw extruders having a working length of at least 50D, typically greater than or equal to 70D, advantageously greater than or equal to 90D, and very advantageously greater than or equal to 120D,
- planar 3-screw extruders having a working length of at least 33D, typically greater than or equal to 40D, advantageously greater than or equal to 50D, and very advantageously greater than or equal to 80D,
- planar 4-screw extruders having a working length of at least 24D, typically greater than or equal to 30D, advantageously greater than or equal to 40D, and very advantageously greater than or equal to 60D,
- planar 6-screw extruders having a working length of at least 16D, typically greater than or equal to 20D, advantageously greater than or equal to 25D, and very advantageously greater than or equal to 40D,
- planar 8-screw extruders having a working length of at least 12D, typically greater than or equal to 15D, advantageously greater than or equal to 20D, and very advantageously greater than or equal to 30D,
- annular 4-screw extruders having a working length of at least 36D, typically greater than or equal to 44D, advantageously greater than or equal to 56D, and very advantageously greater than or equal to 88D,

- annular 6-screw extruders having a working length of at least 29D, typically greater than or equal to 36D, advantageously greater than or equal to 46D, and very advantageously greater than or equal to 72D,
- annular 8-screw extruders having a working length of at least 24D, typically greater than or equal to 28D, advantageously greater than or equal to 36D, and very advantageously greater than or equal to 56D,
- annular 10-screw extruders having a working length of at least 19D, typically greater than or equal to 24D, advantageously greater than or equal to 31D, and very advantageously greater than or equal to 48D, and
- annular 12-screw extruders having a working length of at least 14D, typically greater than or equal to 16D, advantageously greater than or equal to 32D, and very advantageously greater than or equal to 40D.

20 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder is an extruder including more than two conveying screws.

21 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the extruder includes, on each conveying screw which makes it up, at least 14 transport elements, and preferably at least 25 transport elements, at least 18 shearing elements, and preferably at least 37 shearing elements, and at least 6 retention elements, and preferably at least 15 retention elements.

22 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the dwelling time of the material in the extruder is greater than or equal to 3 or 4 minutes, and notably from 4 to 30 minutes and typically from 6 to 20 minutes.

23 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the monomer(s) introduced into the extruder preferably contain a water content of less than 5% by mass, preferentially less than 1% by mass, more preferentially less than 0.6% by mass.

24 – The method for preparing a polyamide according to any of the preceding claims, characterized in that a pair of monomers consisting of a diamine and of a diacid is introduced into the extruder and at least two operations for discharging the water formed by the polycondensation reaction are carried out.

25 – The preparation method according to claim 24, characterized in that it uses a stoichiometric excess of the most volatile monomer, preferably corresponding to a stoichiometric ratio which may range up to 1.2.

26 – The method for preparing a polyamide according to any of the preceding claims, characterized in that the monomer(s) is(are) introduced into the extruder in a liquid molten form.

27 – The method for preparing a polyamide according to any of preceding claims, characterized in that it uses a catalyst selected from the following:
a pentavalent phosphorus like phosphoric acid (H_3PO_4), phosphorous acid (H_3PO_3), hypophosphorous acid (H_3PO_2), phenylphosphinic acid (H_2PO_3Ph), poly-phosphoric acids like phosphoric anhydride, tetrapolyphosphoric acid, pyrophosphoric acid ($H_4P_2O_7$), trimetaphosphoric acid, phosphoric pentachloride, a phosphorus ester such as triphenyl phosphite ($P(OPh)_3$), a hypophosphite such as ammonium hypophosphite, sodium hypophosphite, boric acid and its derivatives like boric anhydride (B_2O_3), phosphoric anhydride (P_2O_5) and pyrophosphoric acid ($H_4P_2O_7$), capable of chemically absorbing water, being preferred.