[Brief description]

[0013] To this end, one subject of the disclosure is a process for treating a gaseous effluent obtained from a pyrolytic decomposition of a polymer or of a polymer blend, for recovering one or more monomers contained in said gaseous effluent, said process being characterized in that it comprises the following steps:

- a condensation step which consists in injecting the gaseous effluent into a condensation chamber maintained at a first pressure p_1, and in placing it in contact with an absorbent liquid, the temperature of said absorbent liquid being below the temperature of the gaseous effluent, so that said monomer(s) condense(s) in the absorbent liquid by heat exchange,
- a step of partial vaporization of the condensate obtained on conclusion of the condensation step, by expansion of the condensate in a chamber maintained at a second pressure p_2 below the first pressure p_1,
- a reinjection step which consists in at least partly redirecting a first liquid or vapor fraction, obtained on conclusion of the partial vaporization step, to the condensation chamber to once again absorb the monomer(s) contained in the gaseous effluent; preferably, where appropriate, the vapor fraction is recondensed before it is introduced into the condensation chamber, and
- a recovery step including purification of a second liquid or vapor fraction, obtained on conclusion of the partial vaporization step and charged with monomer(s).

[0013a] In one aspect, there is provided a process (200) for treating a gaseous effluent obtained from a pyrolytic decomposition of a polymer or of a polymer blend, for recovering one or more monomers contained in said gaseous effluent, said process being characterized in that it comprises the following steps:

- a condensation step (210) which consists in injecting the gaseous effluent into a condensation chamber (110) maintained at a first pressure p_1 of between 0.1 and 5 bar, and in placing it in contact

with an absorbent liquid, the temperature of said absorbent liquid is at least 50 °C and not more than 450 °C below the temperature of the gaseous effluent, so that said monomer(s) condense(s) in the absorbent liquid by heat exchange,

- a step of partial vaporization (230) of the condensate obtained on conclusion of the condensation step, by expansion of the condensate in a chamber (130) maintained at a second pressure p_2 below the first pressure p_1 and pressure p_2 is between 0.001 and 0.8 bar, the pressure difference as an absolute value between the first chamber (110) and the second chamber (130) is greater than or equal to 0.5 bar,
- a reinjection step (240) which consists in at least partly redirecting a first liquid or vapor fraction, obtained on conclusion of the partial vaporization step (230), to the condensation chamber (110) to once again absorb the monomer(s) contained in the gaseous effluent, and
- a recovery step (250) including purification of a second liquid or vapor fraction, obtained on conclusion of the partial vaporization step (230) and charged with monomer(s).

[0013b] In another aspect, there is provided a system for treating a gaseous effluent obtained from a pyrolytic decomposition of a polymer or of a polymer blend, for recovering one or more monomers contained in said gaseous effluent, said system being characterized in that it comprises:

- a condensation chamber (110) which can be maintained at a first pressure p_1, said chamber comprising, in its side wall, an inlet orifice (111) for the gaseous effluent and an absorption device (112) capable of enabling contact of said gaseous effluent with an absorbent liquid whose temperature is below that of the gaseous effluent, said chamber also comprising a gas outlet orifice (113) at its upper end and an outlet orifice (114) for the condensate obtained, in its lower part,
- a second chamber (130) in fluid communication with the condensation chamber (110) and intended to receive the condensate obtained on conclusion of the condensation step,

said second chamber (130) being able to be maintained at a second pressure p_2 below the first pressure p_1, so as to bring about expansion of the condensate and adiabatic partial vaporization thereof,

- a pump (140) for recovering a fraction obtained from the second chamber (130) to reinject it into the first condensation chamber (110) via the absorption device (112),

a purification device (150) or (170) for the absorbent liquid.

[0014] Thus, it has been discovered that condensation, using an absorption device for placing the gaseous effluent in contact with an absorbent liquid whose temperature is well below that of the effluent, followed by partial vaporization of the condensate obtained notably in the presence of a pressure differential, makes it possible to efficiently isolate the monomer(s) contained in the gaseous effluent obtained from the decomposition of one or more polymers.

[0015] According to other optional features of the process:

end and an outlet orifice for the condensate obtained, in its lower part,

- a second chamber in fluid communication with the condensation chamber and intended to receive the liquid containing the condensate obtained on conclusion of the condensation step, said second chamber being able to be maintained at a second pressure p_2 below the first pressure p_1, so as to bring about expansion of the condensate and adiabatic partial vaporization thereof,
- a pump for recovering a liquid fraction obtained from the second chamber to reinject it into the first condensation chamber via the absorption device.

CLAIMS

1. A process (200) for treating a gaseous effluent obtained from a pyrolytic decomposition of a polymer or of a polymer blend, for recovering one or more monomers contained in said gaseous effluent, said process being characterized in that it comprises the following steps:

- a condensation step (210) which consists in injecting the gaseous effluent into a condensation chamber (110) maintained at a first pressure p_1 of between 0.1 and 5 bar, and in placing it in contact with an absorbent liquid, the temperature of said absorbent liquid is at least 50 °C and not more than 450 °C below the temperature of the gaseous effluent, so that said monomer(s) condense(s) in the absorbent liquid by heat exchange,
- a step of partial vaporization (230) of the condensate obtained on conclusion of the condensation step, by expansion of the condensate in a chamber (130) maintained at a second pressure p_2 below the first pressure p_1 and pressure p_2 is between 0.001 and 0.8 bar, the pressure difference as an absolute value between the first chamber (110) and the second chamber (130) is greater than or equal to 0.5 bar,
- a reinjection step (240) which consists in at least partly redirecting a first liquid or vapor fraction, obtained on conclusion of the partial vaporization step (230), to the condensation chamber (110) to once again absorb the monomer(s) contained in the gaseous effluent, and
- a recovery step (250) including purification of a second liquid or vapor fraction, obtained on conclusion of the partial vaporization step (230) and charged with monomer(s).

2. The process as claimed in claim 1, characterized in that the first pressure p_1 is between 0.5 and 2 bar absolute.

3. The process as claimed in claim 1, characterized in that the temperature of the absorbent liquid is at least 60°C below the temperature of the gaseous effluent.

4. The process as claimed in claim 1, characterized in that the temperature of the absorbent liquid is at least 80°C below the temperature of the gaseous effluent.

5. The process as claimed in claim 1, characterized in that the temperature of the absorbent liquid is at least 60°C and not more than 450°C below the temperature of the gaseous effluent.

6. The process as claimed in claim 1, characterized in that the second chamber (130) is maintained at a pressure p_2 of between 0.01 and 0.5 bar.

7. The process as claimed in claim 1, characterized in that the pressure difference as an absolute value between the first chamber (110) and the second chamber (130) is greater than or equal to 0.6 bar.

8. The process as claimed in claim 1, characterized in that the recovery step (250) includes condensation of the vapor fraction obtained on conclusion of the partial vaporization step (230) if the second fraction charged with monomer(s) is a vapor fraction.

9. The process as claimed in claim 1, characterized in that the recovery step (250) includes filtration or decantation of the liquid fraction obtained on conclusion of the partial vaporization step (230) if the second fraction charged with monomer(s) is a liquid fraction.

10. The process as claimed in any one of the preceding claims, characterized in that during the reinjection step (240), the first fraction reinjected is a liquid fraction and during the recovery step (250), the second fraction recovered is a vapor fraction.

11. The process as claimed in any one of the preceding claims, characterized in that the absorbent liquid is selected so that the ratio between its latent heat of vaporization ΔHv in the standard state and its molar specific heat Cp in the standard state is greater than that of the monomer(s) to be recovered.

12. The process as claimed in any one of the preceding claims, characterized in that the absorbent liquid is chosen from one of the following compounds: benzene, benzonitrile, a compound of formula R–COOH, and a compound of formula R–OH, in which R may be

chosen from alkyls, the carbon number of which is between 1 and 5, a phenyl or a hydrogen.

13. The process as claimed in any one of the preceding claims, characterized in that the absorbent liquid is chosen from one of the following compounds: a compound of formula R–OH, a compound of formula R–COOH, in which R may be chosen from alkyls, the carbon number of which is between 1 and 5, or a hydrogen.

14. The process as claimed in any one of the preceding claims, characterized in that the absorbent liquid is chosen from dihydrogen monoxide, methanol, ethanol, propanol, butanol, formic acid, acetic acid or mixtures thereof.

15. The process as claimed in any one of the preceding claims, characterized in that the absorbent liquid is chosen so that its boiling point is of the order of magnitude of that of the monomer(s) to be recovered ± 80°C.

16. The process as claimed in claim 15, characterized in that the absorbent liquid has a boiling point above or substantially equal to that of the monomer(s) to be recovered and/or of the azeotrope which it forms with the monomer(s) to be recovered.

17. The process as claimed in any one of the preceding claims, characterized in that the polymer is selected from: polyethylenes such as high-density polyethylene (HDPE) or polyethylene terephthalate (PET); a homopolymer and copolymer of olefins such as acrylonitrile–butadiene–styrene copolymers, styrene–butadiene–alkyl methacrylate (or SBM) copolymers; polypropylene, polybutadiene and polybutylene; acrylic homopolymers and copolymers and polyalkyl methacrylates such as poly(methyl methacrylate); a polyhydroxyalkanoate; homopolyamides and copolyamides; polycarbonates; polyesters including poly(ethylene terephthalate) and poly(butylene terephthalate); polyethers such as poly(phenylene ether), poly(oxymethylene), poly(oxyethylene) or poly(ethylene glycol) and poly(oxypropylene); polystyrene; copolymers of styrene and maleic anhydride; poly(vinyl chloride); fluoropolymers such as poly(vinylidene fluoride), polyethylene tetrafluoride and polychlorotrifluoroethylene; natural or synthetic rubbers; thermoplastic polyurethanes; polyaryl ether

ketones (PAEK) such as polyether ether ketone (PEEK) and polyether ketone ketone (PEKK); polyetherimide; polysulfone; poly(phenylene sulfide); cellulose acetate; poly(vinyl acetate); polypropiolactone or a mixture of two or more of these polymers.

18. The process as claimed in any one of the preceding claims, characterized in that the monomer(s) are selected from the following compounds: methyl methacrylate, methyl acrylate, ethyl acrylate, acrylic acid, methacrylic acid, styrene, crotonic acid, gamma-butyrolactone, delta-valerolactone and mixtures thereof.

19. The process as claimed in any one of the preceding claims, characterized in that the injection of the gaseous effluent during the condensation step (210) is performed co-currentwise or count-currentwise relative to the absorbent liquid.

20. The process as claimed in any one of the preceding claims, characterized in that it also includes a separation step (220) on the condensate obtained on conclusion of the condensation step before the partial vaporization step (230).

21. The process as claimed in any one of the preceding claims, characterized in that it also includes a step of adjusting the temperature (260) of the fraction redirected to the condensation chamber (110) to once again absorb the monomer(s) contained in the gaseous effluent.

22. The process as claimed in any one of the preceding claims, characterized in that at the moment of the condensation step (210), additives are added to the absorbent liquid, said additives possibly being chosen from polymerization inhibitors.

23. The process as claimed in any one of the preceding claims, characterized in that at the moment of the partial vaporization step (230), additives are added to the circuit, said additives possibly being chosen from polymerization inhibitors.

24. A system for treating a gaseous effluent obtained from a pyrolytic decomposition of a polymer or of a polymer blend, for recovering one or more monomers contained in said gaseous effluent, said system being characterized in that it comprises:

- a condensation chamber (110) which can be maintained at a first pressure p_1, said chamber comprising, in its side wall, an inlet

orifice (111) for the gaseous effluent and an absorption device (112) capable of enabling contact of said gaseous effluent with an absorbent liquid whose temperature is below that of the gaseous effluent, said chamber also comprising a gas outlet orifice (113) at its upper end and an outlet orifice (114) for the condensate obtained, in its lower part,

- a second chamber (130) in fluid communication with the condensation chamber (110) and intended to receive the condensate obtained on conclusion of the condensation step, said second chamber (130) being able to be maintained at a second pressure p_2 below the first pressure p_1, so as to bring about expansion of the condensate and adiabatic partial vaporization thereof,
- a pump (140) for recovering a fraction obtained from the second chamber (130) to reinject it into the first condensation chamber (110) via the absorption device (112),
- a purification device (150) or (170) for the absorbent liquid.

25. The system as claimed in claim 24, characterized in that it also comprises a heat exchanger (131), located downstream of the second chamber (130), for condensing the gaseous fraction obtained from the partial vaporization brought about by the expansion of the condensate in the second chamber (130), and a means (150) for purifying the constituents of said condensed gaseous fraction.

26. The system as claimed in claim 24 or 25, characterized in that it also comprises a separation device (120) located upstream of the second chamber (130), which is preferably capable of separating compounds by filtration, decantation, centrifugation or esterification.

27. The system as claimed in one of the preceding claims, characterized in that it also comprises a heat exchanger (160) upstream of the first chamber (110), which is capable of adjusting the temperature of the liquid fraction obtained from the second chamber (130) before it is injected into the first chamber (110).

28. The system as claimed in one of the preceding claims, characterized in that the purification device (170) is located downstream of the

second chamber (130), and is capable of purifying part of the liquid fraction obtained from the second chamber (130).

29. The system as claimed in one of the preceding claims, characterized in that it also comprises an absorbent liquid injection point (116).

30. The system as claimed in one of the preceding claims, characterized in that the first pressure p_1 is between 0.1 and 5 bar; and in that the temperature of the absorbent liquid is at least 50°C and not more than 450°C below the temperature of the gaseous effluent; and the second chamber (130) is maintained at a pressure p_2 of between 0.001 and 0.8 bar, the pressure difference as an absolute value between the first chamber 110 and the second chamber 130 is greater than or equal to 0.5 bar.