

Description

This invention relates to a method for recovering solid polymer from a slurry of solid polymer and liquid diluent. In another aspect the present invention relates to the employment of a flash line heater in conjunction with the periodic operation of a settling leg of a loop type continuous type polymerization reactor.

Background of the Invention

In many polymerization processes for the production of normally solid polymer, a stream is formed which is a slurry of particular polymer solid suspended in a liquid medium, ordinarily the reaction diluent. Many of these polymerization processes employ a continuous reactor, such as a loop reactor, having a downwardly depending settling leg wherein polymer accumulates. In such polymerization processes the settling leg is periodically opened and the slurry contained therein is passed on to further processing steps wherein the polymer and diluent are separated. Typically the separation involves the passing of the slurry from the settling leg into a flash tank.

A typical example of such a process is disclosed in U.S. 4,424,341.

US-A-3 428 619 discloses a process for transferring a suspension of polymer particles in a liquid from a zone of elevated pressure to a zone of lower pressure for separating the liquid from the polymer particles, by use of a plurality of externally heated zones of varying size and by controlling the rate of flow of materials through the zones.

As noted in the afore mentioned U.S. 4,424,341, it has been known in the past to employ a flash line heater to supply vaporization heat to the slurry as it is transferred from the settling leg to the flash chamber.

The term flash line heater as used herein refers to an elongated conduit the interior of which is heated indirectly. Generally, most flash line heaters are double pipe heat exchangers. The reaction diluent is vaporized in the inner pipe utilizing the heat supplied from condensing steam in the annulus between the inner and outer pipes. The design of flash line heaters is more complicated than a simple heat exchanger because the flash line operates intermittently, co-transporting a multiphase mixture (solid, liquid, and vapor), and the flow velocity in the line varies over a wide range. One problem in the design and use of flash line heaters is controlling the flow rate in the flash line independent of the polymer slurry discharge rate. Since the flash line should not limit the process flow they have been typically designed to have a flow capacity greatly in excess of what flows from the reactor.

Typically only 5 to 15% of the flow capacity has been used. When a flash line heater is designed in this fashion the low utilization of flow capacity results in a large heat transfer area that is used for a short period of time. An object of the present invention is to provide for a more effective use of the heat transfer capabilities of a flash line heater.

A further object of the present invention is to provide more compact flash line heater systems for polymer recovery.

Still another object of the present invention is to provide for more efficient use of the indirect heat exchange fluid, such as steam.

Other aspects, objects, and advantages of the present invention will be apparent from the following disclosure and FIG. 1.

Brief Summary of the Invention

In accordance with the present invention there is provided a process wherein monomers are polymerized in a liquid diluent at super atmospheric pressure to produce a liquid slurry containing particles of normally solid polymers. Periodically the port of a product take off (PTO) valve is opened to allow a charge of the liquid slurry to flow into an elongated confined zone comprising a flash line heater and then into a flash chamber wherein the lighter components are separated from said particles. The process is characterized by the fact that the elongated confined zone is constructed such that the flow time of said charge of slurry in said elongated confined zone is equal to at least 25% of the time between the closing of the settling leg valve and the next opening of the settling leg valve, wherein the ratio of the internal cross-sectional area of the settling leg to the internal cross-sectional area of the port of the PTO valve is no greater than 25.

Brief Description of the Drawing

FIG. 1 is a schematic diagram illustrating a process for separating polymer from diluent in accordance with the present invention.

Detailed Description of the Invention

While the present invention is applicable to any mixture which comprises a slurry of polymer solid and diluent, it is particularly applicable to slurries resulting from olefin polymerizations. The olefin monomers generally employed in such reactions are 1-olefins having up to 8 carbon atoms per molecule and no branching nearer the double bond than the four position. Typical examples include ethylene, propylene, butene-1, 1-pentene, and 1,3-butadiene. The present invention is particularly

useful in the polymerization of ethylene with or without the addition of small amounts of other comonomers such as hexene-1 or other monomers which are known to be useful for modifying the density of polyethylene.

Typical diluent employed in such olefin polymerizations include hydrocarbons having 3 to 12, preferably 3 to 8 carbon atoms per molecule, such as propane, propylene, and butane and pentane, isopentane, N-hexane, toluene, isooctane, isobutane and 1-butene.

In some cases, naphthene hydrocarbons having 5 to 6 carbon atoms in the naphthene ring are also used. Examples of such naphthene hydrocarbons include cyclohexane, cyclopentane, methylcyclopentane and ethylcyclohexane.

In accordance with the invention the polymerization is conducted at super atmospheric pressure and the polymer solids preferably accumulate in a settling leg. The settling leg is provided with a PTO valve having a port which opens into an elongated confined zone which comprises a flash line heater. The elongated confined zone is in turn connected to a flash tank which exposes the contents of the flash line heater to a reduced pressure.

The polymerization reaction temperature will vary depending upon the particular liquid diluent, the type of catalyst, and the type of olefin reactants. Usually, however polymerization is carried out at a temperature of no more than about 110°C (230°F), more generally between 107 to 60°C (225°F and 140°F).

Due to the fact the PTO valve of the settling leg is only periodically opened the flow of slurry in the flash line is intermittent. The present invention is based upon the discovery that if one restricts the flow in the elongated confined zone, one can obtain equivalent vaporization with smaller diameter and shorter flash line heaters.

Generally the elongated confined zone should be constructed such that the flow time of a charge of slurry in the elongated confined zone is equal to at least about 25% of the time between the closing of the PTO valve and the next opening of the PTO valve. More preferably the flow time of the slurry in the elongated confined zone is equal to an amount of at least 40 to at least 70% of the time between the closing of the settling leg valve and the next opening of the settling leg valve. Particularly, said flow time of the slurry in the elongated confined zone is equal to at least 50 %, more preferably to at least 60 %, of the time between the closing of the PTO valve and the next opening of the PTO valve.

The restriction of the flow in the elongated confined zone can be accomplished by any suitable means including areas of varying cross section or an area containing an adjustable orifice. If

an adjustable orifice is employed the potential for polymer plugging must be taken into account. In a preferred embodiment the restriction is provided solely by the internal cross sectional area of the inner pipe of the flash line heater, most preferably this inner pipe has an internal cross-sectional area which is substantially uniform throughout its length. The section of the elongated confined zone that has choke flow is the last part of the zone for elongated conduit having uniform diameter. The restrictive, choke flow point, can also be at the outlet of a smaller diameter conduit connected to a larger diameter conduit, or it could be a smaller diameter conduit located at any convenient location in said elongated confined zone.

The determination of the flow time of liquid in the flash line heater can be obtained in any suitable manner. One technique involves recording the pressure in the elongated confined zone just after the port of the PTO valve. The equipment for making such a determination is available in the art, an example of which is disclosed in U.S. 4,211,124. The period of slurry flow can be viewed as the time during which the pressure in the elongated confined zone adjacent the settling leg remains above the normal lowest pressure in the flash tank.

Typically the elongated confined zone has a substantially uniform internal diameter 1.3 to 25.4 cm (0.5 to 10.0 inches), more preferably 1.3 to 10.2 cm (0.5 to 4.0 inches), and still more preferably 1.9 to 5.1 cm (.75 to 2.0 inch). In a preferred embodiment the internal diameter of the elongated confined zone is substantially constant and is about 5 cm. In another preferred embodiment the internal diameter of said zone is substantially constant and is about 1.9 cm.

It has further been found that the ratio of the internal cross sectional area of a settling leg to the internal cross sectional area of the product take off port of the settling leg valve, as well as the ratio of the internal cross sectional area of the product take off port of the settling leg valve to the internal cross sectional area of the elongated confined zone can affect the results obtained with such a system.

Generally, it has been found that the ratio of the cross sectional area of the settling leg to the internal cross sectional area of the product take off port may be no greater than 25. The larger the leg and the smaller the port size, the less turbulence induced in the leg when the PTO valve opens. Low turbulence can lead to build of polymer on the settling leg wall and eventually plugging of the settling leg. In addition as the ratio of the settling leg to the product take off port increases more time is required in order to dump a certain percentage of the settling leg volume.

A PTO to elongated confined zone internal cross-sectional ratio of less than 0.17 is not recom-

mended because the smaller ratios can lead to plugging of the flash lines. This is believed to be due to the fact that the smaller PTO valve ports do not provide sufficient fluid velocity to transport the solids to the flash tank in effective manner. More preferably the internal cross sectional ratio of the PTO to the elongated confined zone is not less than about 0.25.

Typically the ratio of the internal cross sectional area of the settling leg to the internal cross sectional area of the elongated confined zone is in the range of 4 to 25. The term "internal cross-sectional area" as used herein refers to the average internal cross-sectional area over the length of the subject item.

The exact heating conditions employed in the flash line heater will vary depending on the particular results desired and the particular polymer and diluent being processed. Generally it is preferred to operate the flash line heater under conditions such that substantially all of the liquid of said slurry is vaporized by the time the material in the flash line heater reaches the flash tank. Often it is desirable to operate the flash line heater so that the effluent from the flash line heater is at a temperature of 54 to 93°C (130 to 200°F), more generally 71 to 77°C (160 to 170°F), when the effluent passes into the flash chamber.

The conditions maintained in the flash tank can also vary widely depending upon the results desired, the polymers being employed, and the diluent involved. Sequential flash steps can be employed, however, it is general preferable to employ a single flash step. Typically when a single flash chamber is to be employed the pressure would be in the range of 0.11 to 0.24 MPa (1 to 20 psig).

A further understanding of the present invention will be provided by referring to FIG. 1 which illustrates a system employing an embodiment of the invention.

In the embodiment illustrated in FIG. 1 a polymerization is carried out in a loop reactor 10. The polymerization mixture is circulated by an agitator 11. Monomer and diluent are introduced through conduits 14 and 16, respectively connected to conduit 13. Catalyst is added through conduit 17. Normally the catalyst is introduced as a suspension in hydrocarbon diluent.

As the polymerization progresses polymer slurry accumulates in the settling leg 18. The settling leg is provided with a valve providing a product takeoff port (PTO) which is connected to a conduit 19 which in turn opens into a flash chamber 20. The conduit 19 includes a surrounding conduit 21 which is provided with a heated fluid which provides indirect heating to the material in conduit 19. The flash chamber 20 can optionally include in its lower end a gas distribution plate 22. In such a

case heated diluent vapor provided via conduit 23 can be passed into the flash chamber 20 and through the distributor plate 22 in such a fashion as to cause a fluidized bed of polymers' solids to occur in the flash chamber to assist in the drying of the polymer.

Vaporized diluent exits the flash chamber 20 via conduit 24 as further processing as shown in U.S. 4,424,341. Polymer particles are withdrawn from the chamber 20 via line 28. The polymer from line 28 can be further processed using techniques known in the art. For example, it can be passed to a secondary flash chamber 27 and from there to a conveyer dryer 42. One of the advantages of the present invention is that it is capable of raising the temperature of the polymerization effluent to such an extent that the conveyor dryer can be replaced with a simple purge column.

Preferably the conduit 19 is of sufficient length and diameter to permit the transporting fluid to expand by pressure reductions and vaporization so that the mixture obtains a sonic velocity (or acoustic velocity) in at least one point in the conduit system. Preferably the diameter and length are chosen so as to permit the complete vaporization of the diluent prior to the introduction of the slurry into the flash chamber.

The reactor discharge slurry flow can be spread in time by having the flow restricted at the discharge of the elongated confined zone 19 by reaching choke (sonic) flow at some place in the flash line heater. The slurry that is dumped in batch fashion into the elongated confined zone 19, by the settling leg product take off valve (PTO) is held back to various extents in the initial section of the flash line by back pressure caused by choke flow. The reduced flow rate in the remainder of the flash line heater uses the heat transfer capacity to a much larger extent so that less surface area for heat transfer is needed to accomplish the vaporization of the reactor liquid in the slurry coming from the PTO valve.

The present invention is based in part on a surprising discovery that due to the intermittent operation of the PTO valves a smaller diameter conduit 19 can give higher slurry discharge temperatures and larger diameter conduit of the same length for equal volume of slurry flow. This is surprising since large diameter conduits have more surface area per unit length for heat transfer than smaller diameter conduits. By using smaller diameter conduits which cause sonic (choke) velocity the time of contact of fluid in the flash line heater, i.e. the flow time, is increased and thus allows one to obtain more heat transfer even though the heat transfer area is smaller for the smaller diameter flash lines.

With proper design a flash line heater in accordance with the present invention it may be possible to do away with polymer dryers or at least reduce the utility cost involved with such polymer dryers.

Representative Example

In a process where polyethylene is produced and the slurry of hydrocarbon and polyethylene that is removed from the settling leg needs to be heated to 88°C (190°F) by the time it enters the flash chamber, if choke flow is not used the elongated confined zone would need to be 397 to 427m (1300 to 1400 feet) of 20.3cm (8 inch) line. Such an arrangement would use only about 6% of the flash line heater flow and heat transfer. In contrast by using a 5.1cm (2 inch) line only 115m (376 feet) of line would be needed to provide approximately the same temperature for product entering the flash tank, i.e. about 88°C (190°F).

Claims

1. A polymerization process comprising polymerizing monomers in a liquid diluent at super atmospheric pressure to produce a liquid slurry containing particles of normally solid polymer periodically opening a port of a product takeoff valve (PTO valve) of a settling leg to allow a charge of said liquid slurry of particles to flow into an elongated confined zone comprising a flash line heater and then into a flash chamber wherein the lighter components are separated from said particles, characterized in that the elongated confined zone is constructed such that the flow time of said charge of slurry in said elongated confined zone is equal to at least 25 % of the time between the closing of the PTO valve and the next opening of the PTO valve, and wherein the ratio of the internal cross-sectional area of the settling leg to the internal cross-sectional area of the port of the PTO valve is no greater than 25.
2. The process of claim 1 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 40 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
3. The process of claim 2 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 50 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
4. The process of claim 3 wherein the flow time of said charge of slurry in said elongated con-

fined zone is equal to at least 60 % of the time between the closing of the PTO valve and the next opening of the PTO valve.

5. The process of claim 4 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 70 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
6. The process of claim 1 wherein the internal diameter of the elongated confined zone is substantially constant and is 1.3 to 10.2 cm.
7. The process of claim 6 wherein the internal diameter of the elongated confined zone is substantially constant and is about 5 cm.
8. The process of claim 7 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 40 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
9. The process of claim 1 wherein the internal diameter of the elongated confined zone is substantially constant and is about 1.9 cm.
10. The process of claim 9 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 70 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
11. The process of any of the preceding claims wherein the ratio of the internal cross-sectional area of the port of the PTO valve to the internal cross-sectional area of the elongated confined zone is at least 0.17.
12. The process of any of the preceding claims wherein substantially all of the liquid of said slurry is vaporized within said elongated confined zone.
13. The process of any of the preceding claims wherein said polymer consists essentially of polyethylene.
14. The process of claim 13 wherein said flash line heater is operated under such conditions as to assure that the effluent from the flash line heater is at a temperature of 71 to 77 °C when said effluent passes into the flash chamber.
15. The process of claim 14 wherein said PTO valve is located at the lower end of the settling leg and the ratio of the internal cross-section of



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Representative Example

In a process where polyethylene is produced and the slurry of hydrocarbon and polyethylene that is removed from the settling leg needs to be heated to 88°C (190°F) by the time it enters the flash chamber, if choke flow is not used the elongated confined zone would need to be 397 to 427m (1300 to 1400 feet) of 20.3cm (8 inch) line. Such an arrangement would use only about 6% of the flash line heater flow and heat transfer. In contrast by using a 5.1cm (2 inch) line only 115m (376 feet) of line would be needed to provide approximately the same temperature for product entering the flash tank, i.e. about 88°C (190°F).

Claims

1. A polymerization process comprising polymerizing monomers in a liquid diluent at super atmospheric pressure to produce a liquid slurry containing particles of normally solid polymer periodically opening a port of a product takeoff valve (PTO valve) of a settling leg to allow a charge of said liquid slurry of particles to flow into an elongated confined zone comprising a flash line heater and then into a flash chamber wherein the lighter components are separated from said particles, characterized in that the elongated confined zone is constructed such that the flow time of said charge of slurry in said elongated confined zone is equal to at least 25 % of the time between the closing of the PTO valve and the next opening of the PTO valve, and wherein the ratio of the internal cross-sectional area of the settling leg to the internal cross-sectional area of the port of the PTO valve is no greater than 25.
2. The process of claim 1 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 40 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
3. The process of claim 2 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 50 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
4. The process of claim 3 wherein the flow time of said charge of slurry in said elongated con-

finied zone is equal to at least 60 % of the time between the closing of the PTO valve and the next opening of the PTO valve.

5. The process of claim 4 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 70 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
6. The process of claim 1 wherein the internal diameter of the elongated confined zone is substantially constant and is 1.3 to 10.2 cm.
7. The process of claim 6 wherein the internal diameter of the elongated confined zone is substantially constant and is about 5 cm.
8. The process of claim 7 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 40 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
9. The process of claim 1 wherein the internal diameter of the elongated confined zone is substantially constant and is about 1.9 cm.
10. The process of claim 9 wherein the flow time of said charge of slurry in said elongated confined zone is equal to at least 70 % of the time between the closing of the PTO valve and the next opening of the PTO valve.
11. The process of any of the preceding claims wherein the ratio of the internal cross-sectional area of the port of the PTO valve to the internal cross-sectional area of the elongated confined zone is at least 0.17.
12. The process of any of the preceding claims wherein substantially all of the liquid of said slurry is vaporized within said elongated confined zone.
13. The process of any of the preceding claims wherein said polymer consists essentially of polyethylene.
14. The process of claim 13 wherein said flash line heater is operated under such conditions as to assure that the effluent from the flash line heater is at a temperature of 71 to 77 °C when said effluent passes into the flash chamber.
15. The process of claim 14 wherein said PTO valve is located at the lower end of the settling leg and the ratio of the internal cross-section of



a settling leg to the internal cross-section of the elongated confined zone is 4 to 25.

Patentansprüche

1. Polymerisationsverfahren, umfassend die Polymerisation von Monomeren in einem flüssigen Verdünnungsmittel bei überatmosphärischem Druck unter Bildung einer flüssigen Aufschlammung, die Teilchen eines im Normalzustand festen Polymeren enthält, das periodische Öffnen einer Öffnung eines Produktentnahmeventils (PTO-Ventils) an einem Absetzstrang, um eine Charge der flüssigen Aufschlammung von Teilchen in eine längliche begrenzte Zone, die eine Flash-Leitungsheizvorrichtung umfaßt, und sodann in eine Flash-Kammer, in der die leichteren Komponenten von diesen Teilchen getrennt werden, strömen zu lassen, dadurch gekennzeichnet, daß die längliche begrenzte Zone so konstruiert ist, daß die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 25% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt, wobei das Verhältnis der inneren Querschnittfläche des Absetzstrangs zur inneren Querschnittfläche der Öffnung des PTO-Ventils nicht mehr als 25 beträgt.
2. Verfahren nach Anspruch 1, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 40% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
3. Verfahren nach Anspruch 2, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 50% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
4. Verfahren nach Anspruch 3, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 60% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
5. Verfahren nach Anspruch 4, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 70% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
6. Verfahren nach Anspruch 1, wobei der Innendurchmesser der länglichen begrenzten Zone im wesentlichen konstant ist und 1,3 bis 10,2 cm beträgt.
7. Verfahren nach Anspruch 6, wobei der Innendurchmesser der länglichen begrenzten Zone im wesentlichen konstant ist und etwa 5 cm beträgt.
8. Verfahren nach Anspruch 7, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens etwa 40% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
9. Verfahren nach Anspruch 1, wobei der Innendurchmesser der länglichen begrenzten Zone im wesentlichen konstant ist und etwa 1,9 cm beträgt.
10. Verfahren nach Anspruch 9, wobei die Strömungszeit der Charge der Aufschlammung in der länglichen begrenzten Zone mindestens 70% der Zeitspanne zwischen dem Schließen des PTO-Ventils und der nächsten Öffnung des PTO-Ventils beträgt.
11. Verfahren nach einem der vorstehenden Ansprüche, wobei das Verhältnis der inneren Querschnittfläche der Öffnung des PTO-Ventils zur inneren Querschnittfläche der länglichen begrenzten Zone mindestens 0,17 beträgt.
12. Verfahren nach einem der vorstehenden Ansprüche, wobei im wesentlichen die gesamte Flüssigkeit der Aufschlammung innerhalb der länglichen begrenzten Zone verdampft wird.
13. Verfahren nach einem der vorstehenden Ansprüche, wobei das Polymere im wesentlichen aus Polyethylen besteht.
14. Verfahren nach Anspruch 13, wobei die Flash-Leitungsheizvorrichtung unter solchen Bedingungen betrieben wird, daß gewährleistet wird, daß das ausströmende Produkt aus der Flash-Leitungsheizvorrichtung eine Temperatur von 71 bis 77 °C aufweist, wenn das ausströmende Produkt in die Flash-Kammer gelangt.
15. Verfahren nach Anspruch 14, wobei sich das PTO-Ventil am unteren Ende des Absetzstranges befindet und das Verhältnis des inneren Querschnitts eines Absetzstrangs zum inneren Querschnitt der länglichen begrenzten Zone 4 bis 25 beträgt.



Revendications

1. Un processus de polymérisation comprenant la polymérisation de monomères dans un diluant liquide à une pression suratmosphérique pour produire une bouillie liquide contenant des particules d'un polymère normalement solide, l'ouverture périodique d'un orifice d'une vanne de prélèvement de produit (vanne PTO) d'une branche de décantation afin de permettre à une charge de cette bouillie liquide de particules de s'écouler jusque dans une zone confinée allongée comprenant un réchauffeur de ligne de détente puis dans une chambre de détente où les composants plus légers sont séparés desdites particules, caractérisé en ce que la zone confinée allongée est construite de manière que le temps d'écoulement de la charge de bouillie dans la zone confinée allongée soit égal à au moins 25 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO et où le rapport de la surface interne en section droite de la branche de décantation à la surface interne en section droite de l'orifice de la vanne PTO n'est pas supérieur à 25.
2. Le processus de la revendication 1, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 40 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
3. Le processus de la revendication 2, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 50 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
4. Le processus de la revendication 3, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 60 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
5. Le processus de la revendication 4, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 70 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
6. Le processus de la revendication 1, où le diamètre interne de la zone confinée allongée est pratiquement constant et vaut 1,3 à 10,2 cm.
7. Le processus de la revendication 6, où le diamètre interne de la zone confinée allongée est pratiquement constant et vaut environ 5 cm.
8. Le processus de la revendication 7, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 40 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
9. Le processus de la revendication 1, où le diamètre interne de la zone confinée allongée est pratiquement constant et vaut environ 1,9 cm.
10. Le processus de la revendication 9, où le temps d'écoulement de la charge de bouillie dans la zone confinée allongée est égal à au moins 70 % du temps compris entre la fermeture de la vanne PTO et l'ouverture suivante de la vanne PTO.
11. Le processus de l'une des revendications précédentes, où le rapport de la surface interne en section droite de l'orifice de la vanne PTO à la surface interne en section droite de la zone confinée allongée est d'au moins 0,17.
12. Le processus de l'une des revendications précédentes, où pratiquement la totalité du liquide de la bouillie est vaporisée à l'intérieur de la zone confinée allongée.
13. Le processus de l'une des revendications précédentes, où le polymère est essentiellement constitué de polyéthylène.
14. Le processus de la revendication 13, où l'on fait fonctionner le réchauffeur de ligne de détente dans des conditions telles que l'on soit sûr que l'effluent provenant du réchauffeur de ligne de détente soit à une température de 71 à 77 °C lorsque cet effluent passe dans la chambre de détente.
15. Le processus de la revendication 14, où la vanne PTO est située à l'extrémité inférieure de la branche de décantation et le rapport de la section droite interne d'une branche de décantation à la section droite interne de la zone confinée allongée est de 4 à 25.