

DESCRIPTION

PROCESS FOR PRODUCTION OF GRANULATED POLYMER

5 TECHNICAL FIELD

The present invention relates to a process for producing polymer granules and a granulator, more specifically, a process for producing polymer granules and a granulator, which can produce polymer granules having a uniform size.

10 BACKGROUND ART

Resin polymers such as a polycarbonate are normally produced as polymer granules by carrying out a polymerization reaction or another reaction in a producing device and performing the addition of an additive or the like in an extruder, followed by being extruded as strands by a die head, being cooled and being formed so as to have a pellet shape or another shape by a cutter or the like.

15 In a case where polymer pellets as final products are not produced in a uniform size, when the polymer pellets are plasticized again so as to be formed into a certain shape, the uniformity in the distribution of the lengths or the diameters of the pellets significantly affects the fluidity or the plasticization time of the pellets. In other words, the more uniform the distribution of the lengths or the diameters of the pellets is, the more stable rate of supply the pellets have, and the more uniform
20 the plasticization time is.

From this point of view, it is preferred that the distribution of each of the lengths and the diameters of the pellets be as uniform as possible. With respect to precision, when the pellets are formed in a pillar shape, it is required that the pellets have a length in a range of ± 0.1 mm with respect to an average length, and that the proportion of pellets having a diameter in a range of ± 0.1
25 mm with respect to an average diameter in terms of perfect circle be 85% or more of the entire pellets when the diameters of the pellets are converted to those of equivalent perfect circles.

As one of the measures to solve this problem, it is pointed out that e.g. the melt extrusion temperature is important (see, e.g. Patent Document 1).

Patent Document 1: JP-A-2004-114486

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DISCLOSURE OF THE INVENTION

PROBLEMS THAT THE INVENTION IS TO SOLVE

However, the distribution of each of the lengths and the diameters of the pellets is not made uniform in a sufficient way by simply controlling only the melt extrusion temperature, which has
35 caused a problem of failing to attain the required precision.

The present invention is proposed in consideration of the above-mentioned problem of the prior art.

In summary, it is an object of the present invention to provide a process for producing polymer granules having a uniform size in a pellet shape or another shape, and a granulator, which
40 can produce such polymer granules.

MEANS TO SOLVE THE PROBLEMS

In order to solve the above-mentioned problem, the inventors have been dedicated to make research and have found that it is possible to produce polymer granules having a uniform size by
45 controlling outlet temperatures within a certain temperature range when passing a molten polymer from a plurality of holes to form the polymer in strands. The inventors have completed the present invention based on this finding.

The present invention provides a process for producing polymer granules, comprising

passing a molten polymer through a die head having a plurality of holes to obtain strands, and cutting the strands in granules; further comprising making such control that the difference between a maximum value and a minimum value of outlet temperatures of the molten polymer at the die head falls within a range of 5°C.

5 It is preferred that the molten polymer extruded from the die head have a resin temperature of 250 to 370°C.

It is preferred that the molten polymer extruded from the die head have a flow rate of 100 to 1000 s⁻¹ in shear velocity.

10 The control is preferably individually made for each of a plurality of sections, into which the die head is divided. The strands of the molten polymer have a pulling speed of preferably 50 m/min to 250 m/min.

It is preferred that the molten polymer be a polycarbonate produced by melt-polycondensation of an aromatic dihydroxy compound and a carbonic diester by transesterification reaction.

15 The present invention also provides a granulator, which passes a molten polymer through a die head with a plurality of holes so as to obtain strands of the molten polymer and cuts the strands in granules; including a heater disposed on outer sides of the die head; a plurality of temperature sensors for measuring temperatures of the molten polymer at outlets of the die head; and a controller for controlling the heater based on the temperatures of the molten polymer measured by the temperature sensors; wherein the controller makes such control that the difference between a maximum value and a minimum value of the temperatures of the molten polymer measured by the temperature sensors falls within a range of 5°C.

EFFECTS OF THE INVENTION

25 In accordance with the present invention, it is possible to produce, from strands of molten polymer, polymer granules having a uniform size.

BRIEF DESCRIPTION OF THE DRAWINGS

30 Fig. 1 is a perspective view explaining a die head forming a part of a granulator with an embodiment of the present invention applied thereto;

Fig. 2 is a rear view of the die head seen from a direction A in Fig. 1;

Fig. 3 is a schematic view explaining the structure of a die head plate; and

Fig. 4 is a schematic view explaining a granulator with an embodiment of the present invention applied thereto.

EXPLANATION OF REFERENCES

11: Die head, 12: Projection of die head 11, 13: Die head plate, 14a, 14b and 14c: Thermocouple, 15a, 15b, 15c, 16a, 16b, 17a, 17b, 17c, 18a and 18b: Heater, 19: Hole, 20: Cooling device for strands, 30: Cutter

BEST MODE FOR CARRYING OUT THE INVENTION

40 Now, the best mode for carrying out the present invention (hereinbelow, referred to as embodiments of the present invention) will be described in detail. It should be noted that the present invention is not limited to the embodiments described later, and that variations and modifications may be made in the invention without departing from the spirit and scope of the present invention. It should be also noted that the accompanied drawings have the purpose of simply explaining the embodiments and do not show actual sizes.

The embodiments of the present invention will be described about a case where the polymer

used in the present invention is a polycarbonate.

In recent years, a polycarbonate has been widely utilized as materials for parts of office automation equipment and automobile parts, building materials and the like because being an engineering plastics, which is excellent not only in mechanical strength such as impact resistance, but also in heat resistance, transparency or the like.

As the method for producing such a polycarbonate, there have been known a so-called interfacial method which utilizes phosgene and an aromatic diol such as a bisphenol compound, as materials and a so-called melt method which obtains an aromatic polycarbonate by transesterification of an aromatic dihydroxy compound and a carbonic diester in the melt and removal of a low-molecular-weight substance as a by-product from the reaction system.

When the polycarbonate is produced by such a melt method, such an aromatic dihydroxy compound, such a carbonic diester and the transesterification catalyst may be, for example, 2,2-bis(4-hydroxyphenyl)propane (normally called "bisphenol A"), diphenyl carbonate, and an alkali metal compound such as cesium carbonate, respectively. The polycarbonate may be produced by melting a mixture of these materials and polycondensing the melt in plural stages using a plurality of reactors (polycondensation steps).

After polycondensation reaction, various types of additives are added to the produced polycarbonate by a kneading machine such as an extruder, and then the polycarbonate with such additives added thereto is extruded as strands from a die head, is cooled by cooling water, followed by being cut as pellets.

The conditions required for forming a polymer as strands may be set, for example, in such a way that a molten polymer extruded from die holes has a flow rate of 100 to 1000 s⁻¹ in shear velocity and has a resin temperature normally ranging from 250 to 370°C so as to have a melting viscosity of 200 to 2,000 Pa·s.

The granulator with an embodiment of the present invention applied thereto is utilized at this stage.

The pellets are dewatered by a dewaterer, followed by being introduced into a storage silo as a storage container.

Now, a process for producing polymer granules and a granulator, to which an embodiment of the present invention is applied, will be described in detail, referring to the accompanying drawings.

Fig. 1 is a perspective view explaining a die head forming a part of a granulator with an embodiment of the present invention applied thereto.

Fig. 2 is a rear view of the die head seen from a direction A in Fig. 1.

The granulator shown in Fig. 1 includes the die head 11 for receiving a supply of a molten polymer, a die head plate 13 for extruding the molten polymer as strands, thermocouples 14a, 14b and 14c as temperature sensors for measuring the temperature of the molten polymer extruded from the die head 11, and heaters 15a, 15b, 15c, 16a, 16b, 17a, 17b, 17c, 18a and 18b disposed on the outer sides of the die head 11 so as to heat the die head 11.

The heaters 15a, 15b and 15c are disposed side by side on a front side of the die head 11 as shown in Fig. 1. The heaters 16a and 16b are disposed on lateral sides of a projection 12 of the die head 11, respectively, as shown in Fig. 2. The heaters 17a, 17b and 17c are disposed side by side on a rear side of the die head 11 as shown in Fig. 2. The heaters 18a and 18b are disposed on both lateral sides of the die head 11 as shown in Fig. 2.

A molten polymer is supplied to the projection 12 of the die head 11 from a direction indicated by an arrow A and is extruded from the die head plate 13.

Fig. 3 is a schematic view showing the structure of the die head plate 13. The die head plate 13 has forty holes 19 formed therethrough so as to extrude the molten polymer and form the molten polymer as strands through the holes 19, and the strands are pulled.

The three thermocouples 14a, 14b and 14c shown in Fig. 1 measure, at three different points, the outlet temperatures of the molten polymer extruded from the die head plate 13. In this case, the temperature of the molten polymer, which is extruded from each of three sections of a left section, a central section and a right section of the die head 11 as seen from the front side of the die head 11, is measured.

The temperature data of the molten polymer, which have been measured by the three thermocouples 14a, 14b and 14c, are forwarded to an unshown controller, and the controller individually controls the ten heaters 15a, 15b, 15c, 16a, 16b, 17a, 17b, 17c, 18a and 18b so that the difference between the maximum value and the minimum value among the temperatures of the molten polymer measured by the thermocouples 14a, 14b and 14c falls within a range of 5°C.

In other words, the die head is divided a plurality of sections, and control is independently made for the respective sections. It is more preferred that the difference between the maximum value and the minimum value among the measured outlet temperatures falls within a range of 3°C. Since the die head 11 has a large heat release at both end portions, control may be made so that both end portions have a higher temperature than the remaining portions within the above-mentioned temperature range.

Temperature control may be manually made without a controller.

A polymer, which is extruded from the die head 11 in Fig. 1, is cooled and pulled, and is cut in polymer granules by a cutter.

Fig. 4 is a schematic view explaining a granulator with an embodiment of the present invention applied thereto.

In Fig. 4, the strands extruded from the die head 11 are transferred in a cooling device for strands 20 and are cooled by cooling water.

After that, the strand is cut by the cutter 30. It is preferred that the strands have a pulling speed of 50 m/min to 250 m/min during cutting.

By employing a granulator with the die head 11 having such a structure, it is possible to produce polymer granules having a uniform size. More specifically, the variations in the outlet temperatures of a molten polymer are reduced to decrease the variations in the pulling speeds of the respective strands pulled from the holes 19 of the die head plate 13. Thus, the polymer granules have a uniform shape.

Although a polycarbonate is employed as the molten polymer in the above-mentioned case, there is no limitation to the kind of the molten polymer as long as the molten polymer is produced by a process which has a step for obtaining strands by use of the above-mentioned die head and cutting the strands to produce polymer granules. Other examples of the molten polymer include polyethylene terephthalate and nylon.

Although the polymer granules are produced as pellets or are formed in a pillar shape in the above-mentioned case, there is no limitation to the shape of the polymer granules. The polymer granules may be formed in any shape that can be realized by cutting polymer strands by a cutter. Examples of the shape include a circular shape, an ellipsoidal shape and a quadrilateral shape in section.

Although there is no limitation to the size of the polymer granules, it is preferred that the polymer granules be processed so as to have a length of 10 mm or less when being produced as pellets having a pillar shape.

Although there is no limitation to the melt viscosity of the polymer extruded from an extruder, it is preferred that the extruded polymer have a melt viscosity of 200 to 2,000 Pa·s.

EXAMPLE

Although the present invention will be described in detail based on an example, it should be

understood that there is no intent to limit the invention to the Example.

EXAMPLE 1

A polycarbonate was employed as the polymer to be processed. A granulator, which had a die head shown in Fig. 1 with thermocouples having a different allocation, was employed. The polymerized polycarbonate (having a viscosity average molecular weight (Mv) of 26,000) dropped onto a water-cooled strand-cooling chute (cooling device for strands), being extruded as strands from the die plate, which had dimensions of 500 mm x 120 mm and forty holes with a diameter of 7 mm. The pulling speed at this case was 150 m/min.

The temperatures of the molten polymer at respective outlets were measured by the thermocouples, which were disposed side by side at five locations and at equal intervals on a top side of the die head.

The outlet temperatures were controlled in such a way that a certain central temperature was set, and that when a thermocouple detected that its detected temperature was excessively lower than the certain central temperature, the heating intensity of the heater near to the thermocouple increased while a thermocouple detected that its detected temperature was excessively higher than the certain central temperature, the heating intensity of the heater near to the thermocouple decreased.

By this temperature control, the measured outlet temperatures were 350°C, 352°C, 353°C, 352°C and 350°C in this order from the outlet at the left end of a front side of the die head. It is revealed that all outlet temperatures fell within a range of 5°C in difference.

When the polymer strands were pulled and cut into pellets by a cutter, it was found that the obtained pellets had an average length of 3.0 mm and an average diameter of 2.9 mm when the diameters of the pellets are converted to those of equivalent perfect circles. The proportion of pellets having a size apart from one of both average values by 0.1 mm was 10%. The number of the pellets used for measuring the lengths and the diameters was 1,000.

COMPARATIVE EXAMPLE 1

The polycarbonate was employed as the polymer to be processed. The granulator, which had a die head shown in Fig. 1 with the thermocouples having such a different allocation, was employed. The polymerized polycarbonate (having a viscosity average molecular weight (Mv) of 26,000) dropped onto a water-cooled strand-cooling chute (cooling device for strands), being extruded as strands from the die plate, which had dimensions of 500 mm x 120 mm and forty holes with a diameter of 7 mm. The pulling speed at this case was 150 m/min.

The temperatures of the molten polymer at respective outlets were measured by the thermocouples, which were disposed side by side at five locations and at equal intervals on the top side of the die head.

No control was made to the outlet temperatures. The measured outlet temperatures were 345°C, 349°C, 352°C, 348°C and 344°C in this order from the outlet at the left end of the front side of the die head. It was revealed that all outlet temperatures do not fall within a range of 5°C in difference and that the difference between the minimum temperature and the maximum temperature was 8°C.

When the pulled polymer strands were cut into pellets by the cutter, it was found that the obtained pellets had an average length of 3.1 mm and an average diameter of 2.85 mm when the diameters of the pellets are converted to those of equivalent perfect circles. The proportion of pellets having a size apart from one of both average values by 0.1 mm was 20%. The number of the pellets used for measuring the lengths and the diameters was 1,000.

INDUSTRIAL APPLICABILITY

The present invention can produce polymer granules having a uniform size, such as pellets,

and is industrially useful in having a stable supply rate of pellets and an equalized plasticization time when producing the polymer granules.

5 The entire disclosure of Japanese Patent Application No. 2007-086877 filed on March 29, 2007 including specification, claims, drawings and summary is incorporated herein by reference in its entirety.

CLAIMS

1. A process for producing polymer granules, comprising passing a molten polymer through a die head having a heater and a plurality of outlet holes to obtain strands, and cutting the strands in granules;
further comprising measuring outlet temperatures of the molten polymer at the outlet holes, the molten polymer supplied to the die head and extruded from the outlet holes of the die head; and temperature-controlling the die head by the heater so that a difference between a maximum value and a minimum value of the measured outlet temperatures of the molten polymer falls within a range of 5°C.
2. The process according to Claim 1, wherein the heater is disposed on outer sides of the die head.
3. The process according to Claim 1, wherein the temperature-controlling of the die head by the heater is individually made for each of a plurality of sections, into which the die head is divided.
4. The process according to Claim 1 or 3, wherein the strands of the molten polymer extruded from the outlet holes of the die head have a pulling speed of 50 m/min to 250 m/min.
5. The process according to any one of Claims 1, 3 or 4, wherein the molten polymer supplied to the die head comprises a polycarbonate, which is produced by melt-polycondensation of an aromatic dihydroxy compound and a carbonic diester by transesterification reaction.
6. A process for granulating a polymer,
comprising using a granulator comprising
a die head, to which a molten polymer is supplied,
a heater disposed on outer sides of the die head and configured to heat the die head,
a plurality of temperature sensors for measuring outlet temperatures of the molten polymer extruded from a plurality of outlets holes of the die head heated by the heater,
a controller for controlling the heater based on the outlet temperatures of the molten polymer measured by the temperature sensors, and
comprising controlling that a difference between a maximum value and a minimum value of the outlet temperatures of the molten polymer measured by the temperature sensors falls within a range of 5°C, and passing a molten polymer through a die head with the plurality of outlet holes so as to obtain strands of the molten polymer and cuts the strands.