

SPECIFICATION

RUBBERY POLYMER EXTRUSION-DRYING APPARATUS AND PROCESS FOR PRODUCING RUBBERY POLYMER

TECHNICAL FIELD

[0001]

The present invention relates to a rubbery polymer extrusion dryer and a process for producing a rubbery polymer. Specifically, the present invention relates to a rubbery polymer extrusion dryer which overcomes the disadvantage of formation of string-shaped crumb in expansion drying of the rubbery polymer.

BACKGROUND ART

[0002]

In the case of producing a rubbery polymer via solution polymerization, a polymer aggregate (water-containing crumb) containing water in an amount of about 10% to 50% by weight, a small amount of a polymerization solvent and an unreacted monomer is dried using a dryer after completion of polymerization to obtain a product. The product is normally required to have a water content of 1% or less by weight. Examples of the dryer include a band dryer, a vent-type extrusion dryer, an expansion-type extrusion dryer, and the like. Among these, the expansion-type extrusion dryer is widely used to dry various rubbery polymers due to a compact drying system configuration and excellent energy efficiency.

[0003]

The expansion-type extrusion dryer is configured so that a water-containing crumb (that may be predried using a press or the like) as a drying target, which is supplied from a hopper of the extrusion dryer is transferred toward the downstream side and compressed inside a cylinder due to rotation of a screw named worm. In this case, the temperature and pressure of the rubbery polymer become high due to a heat applied

from the cylinder of the extrusion dryer and a heat by a worm shear heat, and the rubbery polymer is extruded to the atmosphere through a die nozzle while water vapor and the like are explosively discharged to the atmosphere. The water content in the drying target thus decreases rapidly, so that drying (i.e., expansion drying) is conducted.

[0004]

In the case of drying a rubbery polymer using such an expansion-type extrusion dryer, the shape of the crumb discharged through the die nozzle at the end of the extrusion dryer is normally granular. A string-shaped crumb may be formed depending on the properties of the rubbery polymer. If the string-shaped crumb is formed, in the subsequent stage of the extrusion dryer (e.g., a conveying equipment including a vibration-type conveyer, a belt conveyer, or the like, or a drying equipment), aggregation of the crumb may be occurred, volatile components (mainly water) remained in the polymer may not be evaporated, and an average drying speed may not be reached. As a result, a large amount of water may be remained in the product. Moreover, a conveying machine (e.g., belt conveyer) may be clogged by the aggregated string-shaped crumb, and the transfer operation may be hindered.

[0005]

Therefore, attempts have been made to provide a cutter device similar to that used for a resin extrusion/granulation production process or the like at the end of the extrusion dryer in order to cut string-shaped crumb into granules. Patent Document 1 discloses an extrusion dryer provided with such a cutter device.

PRIOR TECHNICAL LITERATURE

PATENT DOCUMENT

[0006]

Patent Document 1: JP-A H09-207199

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007]

In the case of cutting a string-shaped crumb using a related-art cutter device, the string-shaped crumb may twine around the blade, and the cutting operation may be hindered. Moreover, the string-shaped crumb may not be sufficiently cut into granules, aggregation of the crumb may be occurred, volatile components (mainly water) remained in the polymer may not be evaporated, and a large amount of water may be remained in the product in the subsequent stage of the extrusion dryer (e.g., conveying equipment or drying equipment). Additionally, stainless steel is normally used as the material for the blade, however, when a cutter blade made of stainless steel for the expansion-type extrusion dryer is used, the cutter blade may be worn out or broken due to insufficient hardness due to the pressure of water vapor and the impact of the rubber discharged through the die nozzle at a high speed.

[0008]

Therefore, it has been desired to provide a rubbery polymer extrusion dryer including a cutter device that can advantageously cut crumb into granules even if the shape of a crumb by expansion drying becomes string-shaped, and that can uniformly and sufficiently dry a rubbery polymer having a wide range of properties.

[0009]

The present invention was conceived in view of the above situation, and an object thereof is to provide a rubbery polymer extrusion dryer which overcomes the disadvantage of formation of string-shaped crumb in expansion drying of the rubbery polymer.

MEANS FOR SOLVING THE PROBLEMS

[0010]

The present invention is as follows.

(1) An expansion-type extrusion dryer for a rubbery polymer, characterized in that a cutter device for cutting an extruded rubbery polymer is disposed near an extrusion part through which a rubbery polymer is extruded, and that the cutter device comprises a

blade part having a plated blade.

(2) The expansion-type extrusion dryer for a rubbery polymer according to (1) above, wherein the plating treatment of the plated blade is a hard chromium plating treatment or a nickel-phosphorus plating treatment.

(3) The expansion-type extrusion dryer for a rubbery polymer according to (1) or (2) above, wherein the extrusion part comprises a die, and wherein the blade part and the die are disposed at a clearance of 2 mm to 100 mm.

(4) An expansion-type extrusion dryer for a rubbery polymer, characterized in that a cutter device for cutting an extruded rubbery polymer is disposed near an extrusion part through which a rubbery polymer is extruded, and that the cutter device comprises a center part and a blade part having 2 to 10 blades radially extending from the center part.

(5) The expansion-type extrusion dryer for a rubbery polymer according to (4) above, wherein the blades are plated.

(6) The expansion-type extrusion dryer for a rubbery polymer according to (5) above, wherein the plating treatment of the plated blade is a hard chromium plating treatment or a nickel-phosphorus plating treatment.

(7) The expansion-type extrusion dryer for a rubbery polymer according to any one of (4) to (6) above, wherein the extrusion part comprises a die, and wherein the blade part and the die are disposed at a clearance of 2 mm to 100 mm.

(8) A method for producing a rubbery polymer using the extrusion dryer according to any one of (1) to (3) above, characterized by comprising an extrusion process in which the rubbery polymer is subjected to drying and extruding, and a cutting process in which an extruded rubbery polymer is subjected to cutting.

(9) A method for producing a rubbery polymer using the extrusion dryer according to any one of (4) to (7) above, characterized by comprising an extrusion process in which the rubbery polymer is subjected to drying and extruding, and a cutting process in which an extruded rubbery polymer is subjected to cutting.

EFFECT OF THE INVENTION

[0011]

Since the extrusion dryer according to the present invention includes a specific cutter device having a blade part that exhibits excellent wear resistance, it is possible to sufficiently suppress wear and breakage of the blade (particularly the blade edge) due to the impact of the rubbery polymer (crumb) and water vapor discharged during expansion drying. Additionally, the crumb can be more easily cut into granules even if the discharged crumb during expansion drying is in a string-shaped.

Moreover, since the extrusion dryer according to another present invention includes a specific cutter device having 2 to 10 blades, the crumb hardly twine around the blade part and can be more easily cut into granules even if the discharged crumb during expansion drying is in a string-shaped.

Since the method for producing a rubbery polymer of the present invention utilizes a specific rubbery polymer extrusion dryer, a uniformly and sufficiently dried rubbery polymer can be easily obtained regardless of the properties of the rubbery polymer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a schematic view illustrating an extrusion dryer according to Example.

FIG. 2 is an enlarged view showing the main part of the extrusion dryer shown in FIG. 1.

FIG. 3 is a schematic front view showing a blade part of an extrusion dryer according to Example 1.

FIG. 4 is a schematic rear view showing a blade part of an extrusion dryer according to Example 1.

FIG. 5 is a schematic side view showing a blade part of an extrusion dryer according to Example 1.

FIG. 6 is an enlarged view showing the main part of the blade part shown in FIG.

5.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0013]

Hereinafter, the present invention is described in detail.

1. Rubbery polymer extrusion dryer

The rubbery polymer extrusion dryer in the present invention (hereinafter, also referred to as “extrusion dryer (I)”) is characterized in that a cutter device for cutting an extruded rubbery polymer is disposed near an extrusion part through which a rubbery polymer is extruded, and that the cutter device comprises a blade part having a plated blade.

The rubbery polymer extrusion dryer in another present invention (hereinafter, also referred to as “extrusion dryer (II)”) is characterized in that a cutter device for cutting an extruded rubbery polymer is disposed near an extrusion part through which a rubbery polymer is extruded, and that the cutter device comprises a center part and a blade part having 2 to 10 blades radially extending from the center part.

[0014]

The expansion-type extrusion dryers (I) and (II) in the present invention generally include, as shown schematically extrusion dryer 1 in FIG. 1, a cylinder 21 that includes therein a screw 22 for extruding a water-containing crumb containing a rubbery polymer as a drying target; a hopper 3 that is disposed on one end of the cylinder 21 and is used to supply the water-containing crumb to the cylinder 21; an extrusion part 4 that is disposed on the other end of the cylinder 21 and includes a die 41 having a die nozzle; and a cutter device 5 that is disposed near the extrusion part 4 and cuts the rubbery polymer (crumb) that is extruded through the extrusion part 4.

[0015]

The extrusion dryer 1 shown in FIG. 1 is configured so that the water-containing crumb supplied to the cylinder 21 through the hopper 3 is transferred due to rotation of the screw 22 to the extrusion part 4 while compressing. In this case, the temperature

and pressure of the water-containing crumb become high due to a heat applied from the cylinder 21 and a shear heat applied by the screw 22. Then, the crumb is extruded to the atmosphere through the die nozzle formed in the die 41 while water vapor and the like are explosively discharged to the atmosphere, and at the same time the crumb is cut into small pieces by the cutter device 5. Thereby, water content in the water-containing crumb decreases rapidly to complete drying (i.e., expansion drying).

[0016]

The cutter device of the extrusion dryer (I) in the present invention includes a blade part and the blade part has a plated blade. Therefore, the blade part exhibits excellent wear resistance, so that it is possible to sufficiently suppress wear and breakage of the blade (particularly the blade edge) due to the impact of the crumb and water vapor discharged during expansion drying.

[0017]

The plating treatment applied to the blade (cutter blade) is not particularly limited so long as excellent wear resistance can be obtained. For example, a hard chromium plating treatment, a nickel-phosphorus (Ni-P) plating treatment, or the like may be used.

It is preferable that the plating treatment be applied to at least the edge of the cutter blade.

[0018]

The blade part in the cutter device of the extrusion dryer (I) generally includes a center part that is secured on a rotary shaft extending from a drive part of the cutter device, and a blade (plated blade above) that is arranged in the center part.

It is preferable that a plurality of cutter blades extend radially. The number of cutter blades is not particularly limited. It is preferably in the range from 2 to 10, more preferably from 3 to 8, and further preferably from 3 to 6. When the number of cutter blades is 2 to 10, the crumb hardly twine around the blade part and can be more easily cut into granules even if the discharged crumb during expansion drying is in a string-shaped.

[0019]

In addition, the cutter device of the extrusion dryer (II) according to the present invention includes a blade part. The blade part includes a center part that is secured on a rotary shaft extending from a drive part of the cutter device, and 2 to 10 blades radially extending from the center part. Therefore, the crumb can be more easily cut into granules even if the discharged crumb during expansion drying is in a string-shaped.

The number of cutter blades is preferably in the range from 2 to 10, more preferably from 3 to 8, and further preferably from 3 to 6. When the number of cutter blades is 2 to 10, the crumb hardly twine around the blade part and can be more easily cut into granules even if the discharged crumb during expansion drying is in a string-shaped.

[0020]

The cutter blade in the blade part of the cutter device in the extrusion dryer (II) is preferably plated. This makes it possible to sufficiently suppress wear and breakage of the blade (particularly the blade edge) due to the impact of the crumb and water vapor discharged during expansion drying. The wear resistance of the cutter blade can be improved more.

The description given above in connection with the plating treatment for the cutter blade in the extrusion dryer (I) may be applied.

[0021]

In the blade part of the cutter device in the extrusion dryers (I) and (II), the angle (angle θ_1) formed by a surface 512A of the cutter blade that faces the extrusion part and a plane P (virtual plane) that is perpendicular to an axis 21c of the cylinder 21 (i.e., the tilt angle of the surface 512A of the cutter blade that faces the extrusion part with respect to the plane P that is perpendicular to the axis 21c of the cylinder 21), as shown in FIG. 6, is preferably in the range from 3° to 20°, more preferably from 5° to 15°, and further preferably from 7° to 10°. When the angle θ_1 is in the range from 3° to 20°, impacts of the crumb and water vapor discharged from the extrusion part are not

directly given to the cutter blade, that is to say, impacts given to the cutter blade are reduced. As a result, damage to the blade can be suppressed. Additionally, the crumb can be efficiently cut even if the crumb is in a string-shaped. Moreover, a situation in which the space between the extrusion part and the blade part is clogged by the crumb can be sufficiently suppressed.

[0022]

In the blade part of the cutter device in the extrusion dryers (I) and (II), the angle (angle θ_2) formed by a surface 512B of the cutter blade that is opposite to the extrusion part and the plane P that is perpendicular to the axis 21c of the cylinder 21 (i.e., the tilt angle of the surface 512B of the cutter blade with respect to the plane P that is perpendicular to the axis 21c of the cylinder 21), as shown in FIG. 6, is preferably in the range from 5° to 50° , more preferably from 15° to 40° , and further preferably from 30° to 35° . When the angle θ_2 is in the range from 5° to 50° , the crumb can be efficiently cut even if the crumb is in a string-shaped.

[0023]

In the cutter device in the extrusion dryers (I) and (II), the blade part and the die of the extrusion part are preferably disposed at a given clearance (see, the clearance “x” of the blade part 51 and the die 41 shown in FIG. 2). The clearance is preferably in the range from 2 to 100 mm, and more preferably from 5 to 20 mm. When the blade part and the die are disposed at a given clearance, and particularly when the blade part and the die are disposed at a clearance of 2 to 100 mm, the impact of the water vapor discharged can be dissipated from the surface of the cutter blade during expansion drying while cutting the extruded rubbery polymer discharged through the die. Moreover, a situation in which the space around the die nozzle is clogged by the crumb can be sufficiently suppressed.

[0024]

The cutter device of the extrusion dryers (I) and (II) may utilize an arbitrary cutting method. For example, the cutter device may utilize a center cutting method in which the center of the cutter shaft coincides with the center of the die in the extrusion

dryer, or a side cutting method in which the center of the cutter shaft is offset from the center of the die in the extrusion dryer. It is desirable to use the center cutting method that can implement an efficient cutting operation when the die nozzles are circumferentially formed in the die.

[0025]

The cutter device in the extrusion dryers (I) and (II) preferably include an inverter device that can control the rotational speed of the cutter blade.

[0026]

The configurations of the cylinder and the screw in the extrusion dryers (I) and (II) are not particularly limited. The cylinder and the screw may be configured in the same manner as those provided in a known extruder or the like. A heating means or a cooling means may be provided outside the cylinder. Additionally, the number of the screw provided in the extrusion dryer is not particularly limited. The extrusion dryer of the present invention may be a single-screw extrusion dryer, or a multi-screw extrusion dryer.

[0027]

The configurations of the hopper and the die in the extrusion dryers (I) and (II) are not particularly limited. The hopper and the die may be configured in the same manner as those provided in a known extruder or the like. The shape, number, position, and the like of the die nozzle formed in the die may be appropriately determined depending on the properties of the rubbery polymer. Specific examples of the shape of the die nozzle include a circular hole, a cross hole, a rectangular hole (slot), and the like.

[0028]

Additionally, the rubbery polymer that may be dried using the extrusion dryer of the present invention is not particularly limited. Example thereof includes a diene-based rubber such as a styrene butadiene rubber (SBR), a butadiene rubber (BR), an isoprene rubber (IR), a styrene isoprene block polymer (SIS), a styrene butadiene block polymer (SBS), a nitrile butadiene rubber (NBR), and a chloroprene rubber (CR); an olefin rubber such as a butyl rubber (IIR), an ethylene propylene rubber (EPM or

EPDM), an acrylic rubber, a chlorosulfonated polyethylene rubber, and a fluororubber; a silicone rubber, a polyurethane rubber, and the like.

[0029]

2. Method for producing rubbery polymer

The method for producing a rubbery polymer in the present invention (hereinafter, referred to as “rubbery polymer production method (I)”) is a method for producing a rubbery polymer using the above-mentioned extrusion dryer (I), and is characterized by comprising an extrusion process in which the rubbery polymer is subjected to drying and extruding, and a cutting process in which an extruded rubbery polymer is subjected to cutting.

The method for producing a rubbery polymer in the present invention (hereinafter, referred to as “rubbery polymer production method (II)”) is a method for producing a rubbery polymer using the above-mentioned extrusion dryer (I), and is characterized by comprising an extrusion process in which the rubbery polymer is subjected to drying and extruding, and a cutting process in which an extruded rubbery polymer is subjected to cutting.

[0030]

In the extrusion process according to the rubbery polymer production methods (I) and (II), the water-containing crumb (rubbery polymer) obtained by polymerization process is subjected to expansion drying using the extrusion dryer. Specifically, the water-containing crumb is supplied as a drying target into the cylinder in the extrusion dryer through the hopper, and then transferred due to rotation of the screw to the extrusion part while compressing. In this case, the temperature and pressure of the water-containing crumb become high due to a heat applied from the cylinder and a shear heat applied by the screw. Then, the crumb is extruded to the atmosphere through the die nozzle formed in the die while water vapor and the like are explosively discharged to the atmosphere.

[0031]

In the cutting process according to the rubbery polymer production methods (I)

and (II), the discharged crumb through the die nozzle during expansion drying is subjected to cutting using the cutter device included in the extrusion dryer.

[0032]

In the cutting process, the rotational speed of the blade part (cutter blade) of the cutter device may be appropriately adjusted depending on the properties of the rubbery polymer, processing amount, number of the die nozzle, and the like. The dimension of the granular crumb obtained in the cutting process is preferably in the range from 1 to 20 cm, and more preferably from 1 to 3 cm.

In the case of using an expansion-type extrusion dryer in which the nominal size of the cylinder is 10B, the rotational speed of the blade part is preferably in the range from 400 to 1,800 rpm, more preferably from 500 to 1,600 rpm, and further preferably from 600 to 1,000 rpm. Additionally, in the case of using an expansion-type extrusion dryer in which the nominal size of the cylinder is 14B, the rotational speed of the blade part is preferably in the range from 300 to 1,600 rpm, more preferably from 400 to 1,400 rpm, and further preferably from 500 to 1,200 rpm.

EXAMPLES

[0033]

Hereinafter, the present invention is specifically explained by Examples using some drawings. Note that the invention is not limited to the following Examples.

[0034]

Example 1

(1) Expansion-type extrusion dryer

(1-1) Configuration of expansion-type extrusion dryer

An expansion-type extrusion dryer 1 according to Example 1 is provided, as shown in FIG. 1, with a cylinder 21 (nominal size: 14B) including a screw 22 therein, a hopper 3 disposed on one end of the cylinder 21, an extrusion part 4 disposed on the other end of the cylinder 21, and a cutter device 5 (for center cutting method) disposed near the extrusion part 4.

[0035]

The extrusion part 4 includes a die 41 in which a number of die nozzles (hole shape: rectangular (slot)) (not shown) are formed. As shown in FIG. 2, the cutter device 5 is provided so that the extrusion part 4 and the cutter device 5 are disposed at a clearance x ($x=2$ to 100 mm).

[0036]

The cutter device 5 has a blade part 51 as shown in FIGS. 1 to 6. The blade part 51 includes a center part 511 that is secured on a rotary shaft 52 extending from a drive part of the cutter device 5, and four stainless steel cutter blades 512 extending radially from the center part 511.

An edge 513 of each cutter blade 512 is plated by hard chromium plating treatment.

The cutter blade 512 is configured, as shown in FIG. 6, so that the tilt angle (angle θ_1) of a surface 512A of the cutter blade 512 that faces the extrusion part with respect to a plane P that is perpendicular to an axis 21c of the cylinder 21 is 7.5° , and the tilt angle (angle θ_2) of a surface 512B of the cutter blade 512 that is opposite to the extrusion part with respect to the plane P that is perpendicular to the axis 21c of the cylinder 21 is 30° .

[0037]

(1-2) Function of expansion-type extrusion dryer

The function of the expansion-type extrusion dryer 1 is described below.

A water-containing crumb (rubbery polymer) synthesized by polymerization process is supplied as a drying target to the hopper 3 of the extrusion dryer 1, and supplied to the cylinder 21 through the hopper 3. The water-containing crumb is transferred due to rotation of the screw 22 to the extrusion part 4 while compressing. In this time, the temperature and pressure of the water-containing crumb become high due to a heat applied from the cylinder 21 and a shear heat applied by the screw 22. The crumb is extruded into a duct 6 of atmosphere through the die nozzles formed in the die 41 while water vapor and the like are explosively discharged to the atmosphere, and

at the same time the crumb is cut into small pieces by the cutter device 5. Thereby, water content in the water-containing crumb decreases rapidly to complete drying (i.e., expansion drying). The crumb (fragment) after the expansion drying and cutting into granules is transferred to a conveyor including a drying equipment through the duct 6.

[0038]

(2) Drying experiment using expansion-type extrusion dryer

(2-1) Drying method

A drying experiment for a water-containing crumb was performed using the expansion-type extrusion dryer described in (1). The water-containing crumb is a rubbery polymer (styrene-butadiene (SBR) copolymer) for which the water content (residual volatile content) was adjusted to 8% to 10% by weight using a drainer and a screw-type dryer.

The goal in the drying experiment was to obtain a product having a water content of 1% or less by weight, by expansion drying the water-containing crumb, cutting the crumb using the cutter device, and using a vibration-type conveyor and a ventilation-type belt conveyor. The blade part 51 and the extrusion part 4 shown in FIG. 2 were disposed at a clearance of 8 to 10 mm. The rotational speed of the blade part 51 was set to 600 to 1,000 rpm, the processing amount was 5 t/h, and the rotational speed of the screw was set to 250 rpm. A heated air was blown, as shown in FIG. 1, from the extrusion part in the extrusion dryer to the crumb discharged through the die nozzle formed in the die through the duct, and the crumb was transferred to the subsequent conveyor.

The shape and water content of the resultant product, and the operation stability of the extrusion dryer were evaluated. The evaluation results are shown in Table 1.

[0039]

The water content in the product was calculated by the following equation.

$$\text{Water content in product (\%)} = (\text{water content}) / (\text{weight of dried polymer} + \text{water content}) \times 100$$

[0040]

Example 2

The rubbery polymer was dried in the same manner as those in Example 1, except that a blade part including a center part and twenty cutter blades by a hard chromium plating treatment and extending radially from the center part was used as the blade part of the cutter device, and the rotational speed of the blade part was set to 100 to 800 rpm. The resultant product was evaluated in the same manner as those in Example 1. The evaluation results are shown in Table 1.

[0041]

Example 3

The rubbery polymer was dried in the same manner as those in Example 1, except that a blade part including a center part and four non-plated cutter blades extending radially from the center part was used as the blade part of the cutter device. The resultant product was evaluated in the same manner as those in Example 1. The evaluation results are shown in Table 1.

[0042]

Comparative Example 1

The rubbery polymer was dried in the same manner as those in Example 1, except that expansion drying was performed without providing the cutter device (i.e., without cutting the discharged crumbs). The resultant product was evaluated in the same manner as those in Example 1. The evaluation results are shown in Table 1.

[0043]

Comparative Example 2

The rubbery polymer was dried in the same manner as those in Example 1, except that a blade part including a center part and twenty non-plated cutter blades extending radially from the center part was used as the blade part of the cutter device, the blade part and the extrusion part were disposed at a clearance of 2 to 4 mm, and the rotational speed of the blade part was set to 100 to 250 rpm. The resultant product was evaluated in the same manner as those in Example 1. The evaluation results are shown in Table 1.

[0044]

TABLE 1

		Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2
Extrusion dryer	Processing amount (t/h)	5	5	5	5	5
	Rotational speed of screw (rpm)	250	250	250	250	250
Cutter device	Number of cutter blades	4	20	4	-	20
	Edge treatment	Hard chromium plating	Hard chromium plating	None		None
	Clearance between extrusion part and blade part (mm)	8 to 10	8 to 10	8 to 10		2 to 4
	Rotational speed of blade part (rpm)	600 to 1000	100 to 800	600 to 1000		100 to 250
	Product shape	Granular	Granular and string-like shape	Granular		Granular and string-like shape
Evaluation results	Water content (% by mass)	0.5 or less	0.5 to 1.0	0.5 or less	0.5 to 2.0	0.5 to 1.0
	Operation stability	Excellent	Acceptable	Acceptable	Unacceptable String-shaped crumb twined around conveyer	Unacceptable String-shaped crumb twined around cutter blade

[0045]

(2-2) Experimental results

Clearly from Table 1, since expansion drying was performed without providing the cutter device in Comparative Example 1, the discharged string-shaped crumb during expansion drying twined around the kicker of the belt conveyor in the subsequent stage of the duct. As a result, the crumb could not be transferred, and it was necessary to stop processing. Moreover, since the string-shaped crumb was aggregated, the volatile components (mainly water) remaining in the rubbery polymer could not be evaporated, so that the water content (residual volatile content) in the product increased, and did not meet the standard (1% or less by weight) in some cases.

[0046]

In Comparative Example 2 in which expansion drying was performed using the dryer provided with the blade part including twenty non-plated cutter blades, a part of the string-shaped crumb was cut into granules by the cutter device, the water content in the resultant product was decreased as compared with Comparative Example 1, and the conveying operation was not hindered.

In Comparative Example 2, however, the string-shaped crumb twined around the cutter blades, a space around the extrusion part in the extrusion dryer was clogged, and it was necessary to stop processing. The cutter blades will break due to an increase in contact frequency with the discharged crumb if the rotational speed of the blade part of the dryer of Comparative Example 2 is increased to 600 to 1,000 rpm, and metal foreign matter will be mixed into the product.

[0047]

On the other hand, in Example 1 in which expansion drying was performed using the dryer provided with the blade part including four plated cutter blades described in (1), the discharged string-shaped crumb could be sufficiently cut into a crumb having a dimension of about 1 to 10 cm using the cutter device. Therefore, a smooth drying process could be implemented without causing a problem in which the string-shaped crumb twine around the cutter blade, or the conveying operation is

hindered. Since the discharged crumb was not aggregated, and could be supplied to the conveyer while maintaining a high specific surface area, the drying process subsequent to expansion drying could be efficiently performed, and the water content in the resultant product could be reduced to 0.5% or less by weight.

[0048]

In Example 2 in which expansion drying was performed using the dryer provided with the blade part including twenty plated cutter blades, when the rotational speed of the blade part was 100 to 250 rpm (low-speed operation), a part of the string-shaped crumb was cut into granules by the cutter device, the water content in the resultant product was decreased as compared with Comparative Example 1, and the conveying operation was not hindered. Moreover, since the cutter blades were plated, the string-shaped crumb could be cut into granules without causing breakage of the cutter blades even when the rotational speed of the blade part was 250 to 800 rpm (high-speed operation).

Note that the string-shaped crumb twined around the cutter blades to some extent when the rotational speed of the blade part was 100 to 250 rpm (low-speed operation). Therefore, a space around the extrusion part in the extrusion dryer may be clogged and the processing may be stopped depending on the processing amount and the like. When the rotational speed of the blade part is 250 to 800 rpm (high-speed operation), the discharged crumb from the extrusion part may clog the blade part due to an increase in contact frequency between the cutter blades and the discharged crumb depending on the processing amount and the like.

[0049]

In Example 3 in which expansion drying was performed using the dryer provided with the blade part including four non-plated cutter blades, the string-shaped crumb could be sufficiently cut into a crumb having a dimension of about 1 to 10 cm in the same manner as those in Example 1 without causing clogging due to the discharged rubber even when the blade part was rotated at a high speed. The drying process subsequent to expansion drying could be efficiently performed, and the water content in

the resultant product could be reduced to 0.5% or less by weight in the same manner as those in Example 1.

The wear resistance of the blade part was low as compared with Example 1 since the cutter blades were not plated.

[0050]

It was thus confirmed that a rubbery polymer can be efficiently dried using the expansion-type dryer according to the present invention even if the crumb discharged from the extrusion part is in a string-shaped.

INDUSTRIAL APPLICATION

[0051]

The extrusion drying apparatus of the present invention is suitably used for the production of a rubbery polymer having a wide range of properties.

EXPLANATION OF THE REFERENCE NUMBERS

[0052]

1: extrusion drying apparatus, 21: cylinder, 22: screw, 3: hopper, 4: extrusion part, 41: die, 5: cutter device, 51: blade part, 511: center part, 512: cutter blade, 512: plated part, 52: rotary shaft, 6: duct

CLAIMS

1. An expansion-type extrusion dryer for a rubbery polymer, characterized in that a cutter device for cutting an extruded rubbery polymer is disposed near an extrusion part through which a rubbery polymer is extruded, and that said cutter device comprises a center part and a blade part having 2 to 10 blades radially extending from said center part,
wherein said blade is plated.
2. The expansion-type extrusion dryer for a rubbery polymer according to Claim 1,
wherein said extrusion part comprises a die, and wherein said blade part and said die are disposed at a clearance of 2 mm to 100 mm.
3. The expansion-type extrusion dryer for a rubbery polymer according to Claim 1 or 2,
wherein angle θ_1 formed by a surface of said blade that faces said extrusion part and a virtual plane that is perpendicular to an axis of a cylinder is in the range from 3° to 20° .
4. The expansion-type extrusion dryer for a rubbery polymer according to any one of Claims 1 to 3,
wherein angle θ_2 formed by a surface of said blade that is opposite to said extrusion part and a plane that is perpendicular to an axis of a cylinder is in the range from 5° to 50° .
5. The expansion-type extrusion dryer for a rubbery polymer according to any one of Claims 1 to 4,
wherein the plating treatment of said plated blade is a hard chromium plating treatment or a nickel-phosphorus plating treatment.
6. A method for producing a rubbery polymer using said extrusion dryer according to

any one of Claims 1 to 5, characterized by comprising an extrusion process in which said rubbery polymer is subjected to drying and extruding, and a cutting process in which an extruded rubbery polymer is subjected to cutting.