SPECIFICATION

TITLE OF THE INVENTION

METHOD FOR FABRICATING RUBBER BALE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method for fabricating a rubber bale.

[0002] A synthetic rubber such as a styrene butadiene rubber or an ethylene propylene diene rubber is shipped in the form of a bale in many cases. A bale herein means a rubber compression molded into a substantially rectangular parallelepiped shape.

[0003] As a method for fabricating a bale of a synthetic rubber, for example, Patent Document 1 discloses the following method: An ethylene/α-olefin/non-conjugated polyene polymer rubber and a polyolefin resin are fed to an extruder for melting and mixing, and a resultant rubber composition extruded from the extruder through an extruder die is continuously cut by a rotary knife into the shape of pellets, the pellets are transported with transport water at 60°C through 100°C, and the transported pellets are subjected to compression molding to give a bale.

[0004] Patent Document 1 is Japanese Laid-Open Patent Publication No. 11-90926.

SUMMARY OF THE INVENTION

[0005] In the aforementioned method, however, since the compression molding is performed immediately after separating the transport water, fusion strength among the pellets is lowered due to moisture remaining on the surfaces of the pellets, which may change the shape of the bale during storage, and hence, the method is not sufficiently satisfactory from the viewpoint of stability in the bale shape.

[0006] Under the aforementioned circumstances, an object to be attained by the present invention is to provide a method for fabricating a rubber bale with excellent stability in the bale shape by melting and mixing a synthetic rubber such as a styrene butadiene rubber with an extruder, producing pellets by cutting the extruded rubber, and compression molding the pellets.

[0007] The present invention provides a method for fabricating a rubber bale, comprising: melting and mixing a rubber by using an extruder provided with an extruder die; extruding the rubber in a melted state through the extruder die; producing pellets by cutting the extruded rubber; cooling the pellets in cooling water for a cooling time of 5 seconds or more and 20 seconds or less; separating the pellets from the cooling water; drying the pellets in an

air stream of 5°C or more and 40°C or less; weighing a desired amount of pellets; and compression molding the weighed pellets for a time in which an average elapsed time after the separation of the weighed pallets is 30 seconds or more and 100 seconds or less.

[0008] The present invention can provide a method for fabricating a rubber bale with excellent stability in the bale shape by melting and mixing a synthetic rubber such as a styrene butadiene rubber with an extruder, producing pellets by cutting the extruded rubber, and compression molding the pellets.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic diagram illustrating an example of a process embodiment to be employed in the present invention.

FIG. 2 is a schematic diagram illustrating another example of the process embodiment to be employed in the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Examples of a rubber to be used in the present invention are an aromatic vinyl compound/conjugated diene copolymer rubber, a conjugated diene polymer rubber, and an ethylene/α-olefin/non-conjugated diene copolymer rubber.

An example of the aromatic vinyl compound/conjugated diene copolymer rubber is a styrene butadiene copolymer rubber. Examples of the conjugated diene polymer rubber are a polybutadiene rubber, a polyisoprene rubber, and a polychloroprene rubber. Examples of the ethylene/α-olefin/non-conjugated diene copolymer rubber are an ethylene/propylene/ethylidene norbornene copolymer rubber, and an ethylene/propylene/dicyclopentadiene copolymer rubber. One of these rubbers may be singly used, or two or more of them may be blended to be used. Furthermore, a rubber other than the aforementioned rubbers, a resin, and an additive such as a stabilizing agent may be added as far as the properties of the rubber are not spoiled.

[0011] As a method for producing any of the aforementioned polymer rubbers, any of known methods including solution polymerization, block polymerization, suspension polymerization, and emulsion polymerization may be employed.

[0012] The rubber is fed to an extruder provided with an extruder die to be melt and mixed. The rubber to be fed to the extruder may be in the form of a powder, pellets, or crumbs. Alternatively, in the case where the rubber is produced by the solution polymerization, the rubber still containing a solvent may be fed to an extruder to perform deaeration simultaneously with melting and mixing. Further alternatively, a rubber still containing a moisture

component may be fed to an extruder to perform dehydration simultaneously with melting and mixing.

[0013] As the extruder, a twin screw extruder is preferably used for improving the mixing performance. When the twin screw extruder is used, rotation directions of screws may be the same or different. Alternatively, a tandem extruder may be used. In the case where a rubber still dissolved in a solvent is fed, the extruder is provided with a vent, through which deaeration is conducted. Furthermore, a gear pump may be provided if necessary.

[0014] After melting and mixing the rubber with the extruder, the rubber in a melt state is extruded through the extruder die, and the thus extruded rubber is cut for producing pellets, which are cooled in cooling water. As a method for producing and cooling pellets, what is called "under water cut method", namely, a method in which a rubber in a melt state extruded through an extruder die is cut and immediately cooled in cooling water, is preferably employed.

[0015] In order to increase the fusion strength among pellets for improving the stability in the bale shape by setting the surface temperature of the pellets to be higher than a prescribed temperature during the fabrication of the bale, the temperature of the rubber in being extruded through the extruder die is preferably 100°C or more, more

preferably 110°C or more, and further more preferably 120°C or more. Furthermore, in order to improve bale-taking easiness in taking out a bale from a box storing bales by lowering adhesion among the stored bales, or in order to reduce process troubles such as plugging a pipe caused by pellets adhered to one another during a drying process or a weighing process, the temperature of the rubber in being extruded is preferably 160°C or less, more preferably 150°C or less and further more preferably 140°C or less.

[0016] Moreover, in order to increase the fusion strength among the pellets for improving the stability in the bale shape by setting the surface temperature of the pellets to be higher than a prescribed temperature during the fabrication of the bale, the mass of each pellet to be produced is preferably 0.3 g or more and more preferably 0.4 g or more. Furthermore, in order to improve the bale-taking easiness in taking out a bale from a box storing bales by lowering adhesion among the stored bales, or in order to reduce process troubles such as plugging a pipe caused by pellets adhered to one another during the drying process or the weighing process, the mass of each pellet is preferably 0.7 g or less and more preferably 0.6 g or less. As a method for adjusting the mass of each pellet, for example, the rotation speed of a rotary knife may be changed.

[0017] The thus produced pellets are cooled in cooling water, and thereafter, the pellets are separated from the cooling water. A cooling time from the cut of a pellet to the separation from the cooling water is 20 seconds or less. When the cooling time is too long, the pellets are excessively cooled, and hence, the fusion strength among the pellets attained after the fabrication of the bale is so lowered that the stability in the bale shape is lowered. Furthermore, in order to further improve the stability in the bale shape, the cooling time is preferably 18 seconds or less and more preferably 15 seconds or less. Furthermore, in order to improve the bale-taking easiness in taking out a bale from a box storing bales by lowering adhesion among the stored bales, or in order to reduce process troubles such as plugging a pipe caused by pellets adhered to one another during the drying process or the weighing process, the cooling time is preferably 5 seconds or more, more preferably 7 seconds or more, and further preferably 10 seconds or more.

[0018] In order to increase the fusion strength among pellets for improving the stability in the bale shape by setting the surface temperature of the pellets to be higher than a prescribed temperature during the fabrication of the bale, the temperature of the cooling water is preferably 10°C or more and more preferably 20°C or more. Furthermore,

in order to improve the bale-taking easiness in taking out a bale from a box storing bales by lowering adhesion among the stored bales, or in order to reduce process troubles such as plugging a pipe caused by pellets adhered to one another during the drying process or the weighing process, the temperature of the cooling water is preferably 40°C or less and more preferably 35°C or less.

[0019] While the pellets are cooled in the cooling water, the pellets may be allowed to stand or may be moved. An example of a state where the pellets are allowed to stand is a state where the pellets are held in a cooling bath. Alternatively, an example of a state where the pellets are moved is a state where the pellets are carried through a pipe together with cooling water flowing therethrough.

[0020] As a method for separating the pellets from the cooling water, any of known methods including separation with a screen and centrifugal separation may be employed.

[0021] After the separation, the pellets are subjected to a drying treatment in an air stream. The temperature of the air stream is 5°C or more and 40°C or less. When the temperature of the air stream is too low, the pellets are excessively cooled, and hence the fusion strength among the pellets attained after the fabrication of the bale is lowered, so that the stability in the bale shape is lowered. In order to further improve the stability in the bale shape,

the temperature of the air stream is preferably 10°C or more. Also, when the temperature of the air stream is too high, the pellets are insufficiently cooled, and hence, the bale-taking easiness in taking out a bale from a box storing bales may be lowered, or the probability of occurrence of the process troubles such as plugging a pipe caused by pellets adhered to one another during the drying process or the weighing process may be increased. Furthermore, in order to improve the bale-taking easiness in taking out a bale from a box storing bales, or in order to further reduce process troubles such as plugging a pipe caused by pellets adhered to one another during the drying process or the weighing process, the temperature of the air stream is preferably 35°C or less.

[0022] As a method for performing the drying treatment, a method in which the pellets are blown with the air inside a blowing dryer or a method in which the air is allowed to flow in a pipe and the pellets are allowed to flow in the pipe together with the air flowing therethrough may be employed.

[0023] After drying the pellets in the air stream, a desired amount of pellets is weighed, and the thus weighed pellets are subjected to compression molding for a time in which an average elapsed time after the separation of the weighed pellets is 30 seconds or more and 100 seconds or

less, thereby a rubber bale was obtained. When the elapsed time is too long, the pellets are excessively cooled, and hence the fusion strength among the pellets attained after the fabrication of the bale is lowered, so that the stability in the bale shape is lowered. The elapsed time is preferably 90 seconds or less and more preferably 80 seconds or less. Alternatively, when the elapsed time is too short, the heat inside the pellets is not sufficiently diffused to the surfaces of the pellets, and hence, the surface temperature of the pellets attained in the fabrication of the bale is not increased, so that the fusion strength among the pellets is lowered and the stability in the bale shape is lowered. The elapsed time is preferably 45 seconds or more and more preferably 60 seconds or more. A molding pressure is preferably 50 kg/cm^2 to 150 kg/cm^2, and a molding time is preferably 5 seconds to 20 seconds.

[0024] At this point, the average elapsed time after the separation of the weighed pellets is an average, obtained among the whole pellets to be subjected to the compression molding, of times elapsed from the separation of the pellets from the cooling water by a separating device to the fabrication of the bale through the compression molding. In the case where there are a plurality of processes between the separation of the pellets and the compression

molding, the elapsed time is calculated by obtaining holding times of each pellet in the respective processes and summing up the holding times. For example, a holding time in a transporting process is obtained on the basis of a moving speed of each pellet. Also, a holding time in the weighing process is obtained on the basis of a molding cycle time and a pellet feeding speed.

[0025] In the molding, a bale larger than a desired bale may be molded so as to obtain the desired bale by cutting the larger bale. Furthermore, in order to protect the surface of the bale, the surface of the molded bale may be wrapped with a film.

[0026] The rubber bale fabricated in accordance with the present invention may be suitably applied in various uses including vehicle tires and sealing materials.

[0027] The rubber bale fabricated in accordance with the present invention is good at the shape stability. Furthermore, process troubles are minimally caused in the drying process and the weighing process. A suitable method employed in the present invention does not include a step of heating the pellets before the compression molding of the pellets, and this method is economically superior.

[0028] FIG. 1 shows the outline of an example of a process embodiment to be employed in the invention. A rubber corresponding to a raw material is fed to an extruder (1),

extruded through a die with a hole, and cut and cooled in a pelletizer (2), thereby pellets are obtained. The thus obtained pellets are immediately discharged from the pelletizer and carried through a pipe (9) together with cooling water to a separating device (3). The pellets separated from the cooling water in the separating device are allowed to pass through a blowing dryer (4) and molded into a bale in a compression molding machine (5).

[0029] FIG. 2 shows the outline of another example of the process embodiment to be employed in the invention. This example is same as that shown in FIG. 1 from the feed of the raw material to the extruder (1) up to the conveyance of the pellets to the separating device (3). The pellets discharged from the separating device (3) are dropped inside a vertical pipe (12) while exposed to the air, carried in a pipe (13) together with the air sent by a blower (6) through a cyclone (7) and a vertical pipe (14) to the compression molding machine (5), where they are molded into a bale.

[Example]

[0030] EXAMPLE 1

A styrene butadiene polymer rubber was fed to an extruder, cut it with a rotating cutter blade, and cooled the resultant with cooling water, thereby pellets were obtained. The temperature of an extruder cylinder was

adjusted so that the temperature of the melted rubber in a die might be 130°C. The temperature of the cooling water was approximately 30°C. Ten pellets thus obtained were taken out and an average of the mass per one pellet was found to be 0.43 g.

[0031] The obtained pellets were immediately discharged from a pelletizer and carried to a separating device together with cooling water flowing in a pipe. The cooling time from the cut of the rubber to the input of the pellets into the separating device was approximately 14 seconds.

[0032] The pellets having input into the separating device were immediately separated from the cooling water, moved in a pipe by the air of 30°C flowing through the pipe, and then weighed by a prescribed amount. In 67 seconds of an average elapsed time after the separation of the weighed pellets, the weighed pellets were compression molded into a rubber bale. The molding pressure was 150 kg/cm^2, and the molding time was 10 seconds. The thus molded bale was good at the shape stability. Furthermore, no process trouble such as clogging a pipe was caused in any of the drying process and the pellet weighing process.

WHAT IS CLAIMED IS:

1. A method for fabricating a rubber bale, comprising:

melting and mixing a rubber by using an extruder provided with an extruder die;

extruding the rubber in a melted state through the extruder die;

producing pellets by cutting the extruded rubber;

cooling the pellets in cooling water for a cooling time of 5 seconds or more and 20 seconds or less;

separating the pellets from the cooling water;

drying the pellets in an air stream of 5°C or more and 40°C or less;

weighing a desired amount of pellets; and

compression molding the weighed pellets for a time in which an average elapsed time after the separation of the weighed pallets is 30 seconds or more and 100 seconds or less.

2. The method for fabricating the rubber bale according to claim 1,

wherein the mass of each pellet is 0.3 g or more and 0.7 g or less.

3. The method for fabricating the rubber bale according to claim 1 or 2,

wherein the rubber is an aromatic vinyl compound/conjugated diene copolymer rubber or a conjugated diene polymer rubber.

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