

ENERGY-SAVING FOAMED POLYPROPYLENE BEAD AND PREPARATION METHOD THEREOF

Field of the Invention

The present invention relates to a foamed polypropylene bead, and in particular to an energy-saving foamed polypropylene bead and a preparation method thereof.

Background of the Invention

Foamed polypropylene is a chemical material with excellent performance, and has the advantages of light weight, high strength, high temperature resistance and excellent energy absorption characteristics and the like, thereby being widely used in automobiles, packaging, construction, aerospace and other fields. At present, the production process of foamed polypropylene beads mainly includes three procedures of particle prepressing, forming and bonding, and drying and setting. The entire production cycle is relatively long, and a lot of time and energy sources are consumed in the two procedures of particle prepressing and the drying and setting.

In terms of particle prepressing, since there is no in-depth study on the pore walls of bead pores at present, a required internal pressure in the particles is ensured just by purely prolonging the time in the particle prepressing process. The higher the internal pressure required in the particles is, the longer the prepressing time is.

In terms of drying and setting, since a foamed polypropylene granule is a thermoplastic material, there is a phenomenon of thermal expansion and contraction, and most of the interior of the foamed polypropylene bead is air, and the phenomenon of thermal expansion and contraction of the air is more obvious, such that a foamed polypropylene product occurs obvious shrinkage in a cooling process and is easily peeled off from a mold. The more severe the shrinkage is, the longer the drying and setting time is required, the more energy is consumed, and the turnover efficiency becomes lower.

At present, the prepressing time for producing foamed polypropylene takes about 12 hours, and the drying time takes 8 to 16 hours. Therefore, if the time consumed in the two procedures of particle prepressing and the drying and setting can be shortened, not only the production efficiency can be improved, but also the energy consumption in the drying and setting process can be greatly reduced. This is also the focus and concern of downstream customers of the foamed polypropylene beads in the production process.

Summary of the Invention

The technical problem to be solved by the present invention is to overcome the defects in the prior art, improve the production efficiency of foamed polypropylene and reduce the energy consumption. In order to achieve the above objective, the present invention provides the following technical solutions:

An energy-saving foamed polypropylene bead, having a formulation including the following ingredients in parts by weight:

85-99 parts of foamable polypropylene with a high melting point and 1-15 parts of polyolefin with a low melting point. More preferably, 90-99 parts of foamable polypropylene with the high melting point and 1-10 parts of polyolefin with the low melting point. The foamable polypropylene with the high melting point is a random copolymer, a comonomer is an ethylene-propylene copolymer or a propylene-butene copolymer, the melting point is 143-150 °C, the bending modulus is greater than 900 MPa, and auxiliary agents mainly include an antioxidant and a lubricant. More preferably, the foamable polypropylene with the high melting point is a propylene-butene copolymer, and the bending modulus is greater than 1200 MPa. The polyolefin with the low melting point includes polyethylene, polypropylene, a thermoplastic elastomer, and the like. The polyethylene is LDPE, HDPE or LLDPE, the density is 0.920-0.935 /cm³, the elongation at break is greater than 800%, the softening point is 100-110 °C, the melt index is 2-15, and the melting point is 120-130 °C. More preferably, the polyethylene is LDPE or LLDPE. More preferably, the polyethylene is LLDPE, and the melt index is 5-14. The polypropylene is a random copolymer combining ethylene, propylene and butene, the melting point is 115-140 °C, the melt index is 5-15, and the elongation at

break is greater than 500%.

Further, the foamable polypropylene with the high melting point includes a pore nucleating agent, which is one or more of calcium carbonate, talcum powder, kaolin, coarse whiting, zinc borate, silicon dioxide, titanium dioxide, calcium stearate and zinc stearate. More preferably, the pore nucleating agent is an inorganic particle having a diameter of 0.5-5 μm . More preferably, the diameter of the inorganic particle in the pore nucleating agent is 2-5 μm . More preferably, the inorganic particle in the pore nucleating agent includes crystal water substance. More preferably, an organic pore nucleating agent in the pore nucleating agent is a 15-40 carbon chain salt.

Further, the foamable polypropylene with the high melting point includes a gas storage auxiliary agent, and the gas storage auxiliary agent is one or two of porous silicon dioxide or porous titanium dioxide. More preferably, the porous silicon dioxide or the porous titanium dioxide has an aperture of 70-80 nm and a porosity of 65-86%.

Further, the other auxiliary agent in the foamable polypropylene with the high melting point is one or more of fire retardant, color master batch, dispersing agent, antioxidant, lubricant, antistatic agent, coupling agent, stabilizer and ultraviolet light absorber.

Another aspect of the present invention discloses a preparation method of an energy-saving foamed polypropylene bead, including the following steps:

step 1. performing mixing, extrusion and wire drawing on foamable polypropylene with a high melting point and polyethylene according to a proportion of parts by weight via an extruding machine, and performing grain cutting via a grain cutting device to form modified polypropylene microparticles, wherein the foamable polypropylene with the high melting point accounts for 85-99 parts, and polyolefin with a low melting point accounts for 1-15 parts. The foamable polypropylene with the high melting point is a random copolymer, a comonomer is an ethylene-propylene copolymer or a propylene-butene copolymer, the melting point is 143-150 $^{\circ}\text{C}$, the bending modulus is greater than 900 MPa, and auxiliary

agents mainly include an antioxidant and a lubricant. More preferably, the foamable polypropylene with the high melting point is a propylene-butene copolymer, and the bending modulus is greater than 1200 MPa. The polyolefin with the low melting point includes polyethylene, polypropylene, a thermoplastic elastomer, and the like. The polyethylene is LDPE, HDPE or LLDPE, the density is 0.920-0.935 /cm³, the elongation at break is greater than 800%, the softening point is 100-110 °C, the melt index is 2-15, and the melting point is 120-130 °C. More preferably, the polyethylene is LDPE or LLDPE. More preferably, the polyethylene is LLDPE, and the melt index is 5-14. The polypropylene is a random copolymer combining ethylene, propylene and butene, the melting point is 115-140 °C, the melt index is 5-15, and the elongation at break is greater than 500%.

Step 2, throwing the modified polypropylene microparticles into a reaction kettle, adding a dispersion medium, and then performing heating pressurization, so that the polypropylene microparticles generate an outwardly expanding internal pressure under high temperature and high pressure, and connecting a healthcare foaming channel in a pressure relief process, wherein hot air flows in the channel to maximally release the residual foaming gas in expanded particles so as to further expand a pore, and meanwhile the hot air performs fast convection current exchange with the foaming agent in the pore, and the pore is gradually filled with air in a slow setting process of the pore to avoid surface shrinkage of the bead during the expansion.

Further, in the step 1, the foamable polypropylene with the high melting point includes a pore nucleating agent, which is one or more of calcium carbonate, talcum powder, kaolin, coarse whiting, zinc borate, silicon dioxide, titanium dioxide, calcium stearate and zinc stearate. More preferably, the pore nucleating agent is an inorganic particle having a diameter of 0.5-5 μm. More preferably, the diameter of the inorganic particle in the pore nucleating agent is 2-5μm. More preferably, the inorganic particle in the pore nucleating agent includes crystal water substance. More preferably, an organic pore nucleating agent in the pore nucleating agent is a 15-40 carbon chain salt.

Further, in the step 1, the foamable polypropylene with the high melting point includes a gas storage auxiliary agent, and the gas storage auxiliary agent is one or two of porous silicon dioxide or porous titanium dioxide. More preferably, the porous silicon dioxide or the porous titanium dioxide has an aperture of 70-80 nm and a porosity of 65-86%.

Further, in the step 1, the other auxiliary agent in the foamable polypropylene with the high melting point is one or more of fire retardant, color master batch, dispersing agent, antioxidant, lubricant, antistatic agent, coupling agent, stabilizer and ultraviolet light absorber.

Further, in the step 1, double-layer coextrusion is performed by using two extruding machines, wherein the foamable polypropylene with the high melting point is located on a core layer, a polyethylene material is located on a skin layer, and the weight ratio of the skin layer is 1%-10%.

Further, in the step 1, the wire drawing diameter is 1-2 mm, and the grain cutting length is 1.8-2.5 mm. The single grain mass is 0.5-2 mg.

Further, in the step 2, the selected heating pressurization gas is carbon dioxide.

Further, in the step 2, the temperature of the reaction kettle is 145-160 °C, the pressure is 1.5-3 MPa, and the heating time is 45-65 minutes. More preferably, the temperature of the reaction kettle is 147-153 °C, the pressure is 1.8-2.4 MPa, and the heating time is 50-65 minutes.

Further, in the step 2, the dispersion medium is one or two of kaolin, calcium phosphate and butter. More preferably, the weight of the dispersion medium accounts of 0.2-1% of that of the polypropylene microparticles. More preferably, the ratio of the dispersion medium of kaolin: butter is 3:1 to 6:1 or calcium phosphate: butter is 3:1 to 6:1.

Further, in the step 2, the healthcare foaming channel is 2-4m, and the atmosphere temperature in the channel is controlled at 90-100 °C. The hot air atmosphere flowing in the healthcare foaming channel allows the maximal release of the residual foaming gas in expanded particles so as to further expand the pore, and meanwhile the hot air performs fast convection current exchange with the foaming agent in the pore, and the pore is gradually filled with air in the slow setting process of the pore to avoid surface shrinkage of the bead during the expansion.

Further, the draw ratio of the bead after the energy-saving foamed polypropylene bead is foamed is 0.5-2. More preferably, the draw ratio of the bead after being foamed is 0.8-1.5.

The present invention adopts co-extruded composite microparticle kettle foaming, the core layer of the present invention is a base layer for providing a light weight and high rigidity, the skin layer is a functional layer for providing a forming pressure and having the functions of being conductive, fusible, antistatic, flame retardant and low friction coefficient or the like. The foamed bead has no pore on the skin and has a low sintering temperature, the core layer of the foamed bead is high-rigidity polypropylene forming a closed-pore structure, the pore size is 190-350 μm , the wall thickness of the pore is 1-20 μm , the internal pore size of the bead is larger, few pores are formed, and the number of wall layers of the pore is relatively small, so that the air can enter the bead in an air prepressing process prior to the forming. Furthermore, since the composite bead in the present invention has no pore structure on the skin, less gas among the gas entering the bead overflows, and thus the prepressing time can be shortened. Finally, the present invention can control the prepressing time of the foamed bead within 6 hours. In a molding process, when the water vapor pressure does not exceed 2.2 bar and can be as low as 1.6 bar, the skin of the bead can be sintered, the internal pore structure is hardly destroyed by the high temperature, a molded product shrinks very little after being demolded, the subsequent drying and setting time can be obviously shortened, and then the drying and setting time is less than 4 hours. The present invention can realize the seamless docking of the EPS production process.

Brief Description of the drawings

The drawings are used for providing a further understanding of the present invention and constitute a part of the specification. The drawings, together with the following specific embodiments, are used for explaining the present invention, but are not intended to limit the present invention. In the drawings:

Fig.1 is a schematic diagram of a scanning electron microscope picture of a section structure of an energy-saving foamed polypropylene bead prepared in the present invention (a skin thickness is marked).

Fig.2 is a schematic diagram of a scanning electron microscope picture of a surface structure of an energy-saving foamed polypropylene bead prepared in the present invention (the skin has no pore and the surface is relatively smooth).

Fig.3 is a schematic diagram of a scanning electron microscope picture of a section of an energy-saving foamed polypropylene bead pore prepared in the present invention.

Detailed Description of the Embodiments

The preferred embodiments of the present invention are described below in combination with the drawings. It should be understood that, the preferred embodiments described herein are merely used for illustrating and explaining the present invention, rather than limiting the present invention.

Embodiment 1

A preparation method of an energy-saving foamed polypropylene bead according to the present invention includes the following steps:

step 1, performing mixing, extrusion and wire drawing on ethylene-propylene random copolymer polypropylene and ethylene-propylene-butene random copolymer polypropylene according to a proportion of parts by weight via an extruding machine, and performing grain cutting via a grain cutting device to form modified polypropylene microparticles, wherein the ethylene-propylene random copolymer polypropylene accounts for 95 parts, and the ethylene-propylene-butene random copolymer polypropylene accounts for 5 parts. With respect to the ethylene-propylene random copolymer polypropylene, the catalytic system is

ziegler-natta, the comonomer is ethylene, the monomer content is 3%, the density is 0.9g/cm³, the melting point is 145 °C, the melt index is 7, and the bending modulus is 1000 MPa. With respect to the ethylene-propylene-butene random copolymer polypropylene, the catalytic system is ziegler-natta, the comonomer is ethylene and butene, the density is 0.9g/cm³, the melt index is 7, the melting point is 130 °C, and the bending modulus is 650 MPa.

Step 2, throwing the modified polypropylene microparticles into a reaction kettle, adding a dispersion medium, and then performing heating pressurization, so that the polypropylene microparticles generate an outwardly expanding internal pressure under high temperature and high pressure, and connecting a healthcare foaming channel in a pressure relief process, wherein hot air flows in the channel to maximally release the residual foaming gas in expanded particles so as to further expand a pore, and meanwhile the hot air performs fast convection current exchange with the foaming agent in the pore, and the pore is gradually filled with air in a slow setting process of the pore to avoid surface shrinkage of the bead during the expansion.

According to a preferred embodiment of the present invention, in the step 1, the foamable polypropylene with the high melting point includes a pore nucleating agent, which is zinc borate.

According to a preferred embodiment of the present invention, in the step 1, double-layer coextrusion is performed by using two extruding machines, wherein the ethylene-propylene random copolymer polypropylene is located on a core layer, the ethylene-propylene-butene random copolymer polypropylene is located on a skin layer, and the thickness of the skin layer of the extruded microparticle is 10-11μm. The thickness uniformity of the obtained microparticles are medium, and the wire drawing stability is better.

According to a preferred embodiment of the present invention, in the step 1, the wire drawing diameter is 2.2 mm, and the single grain mass is 1.2 mg.

According to a preferred embodiment of the present invention, in the step 2, the temperature

of the reaction kettle is 149.5 °C, and the pressure is 2 MPa.

According to a preferred embodiment of the present invention, in the step 2, the dispersion medium is kaolin: butter=3:1.

The forming stability of the foamed bead produced according to the present embodiment is good, the bead size and color are relatively uniform, after the bead is formed, the bead has a smooth surface and less pinholes and pits. Table 1 shows comprehensive performance measurement results of the foamed polypropylene bead produced according to the present embodiment. As can be seen, the foamed polypropylene bead produced according to the present invention has good performance on various respects. The prepressing time in the present embodiment is 3 hours, and the drying time is 3 hours. Compared with the prior art, the production time of the foamed polypropylene is greatly shortened, the energy consumption is reduced, and the production efficiency of the foamed polypropylene is improved.

Table 1 comprehensive performance measurement results of a product of the embodiment 1

Comprehensive performance measurement results of the product		
Serial number	Measurement item	Measurement result
1	Stacking density	52g/l
2	High temperature enthalpy	18J/g
3	Pore size	190μm
4	Draw ratio of the bead	1
5	Forming prepressing	1Mpa
6	Prepressing time	3h
7	Forming pressure	2.2bar
8	Drying time	3h

9	Forming body density	63 g/l
10	Bonding state	100%
11	Compressive strength at 50% strain	780Kpa

Embodiment 2

The present invention discloses a preparation method of a foamed polypropylene bead at the same time, including the following steps:

step 1, performing mixing, extrusion and wire drawing on ethylene-propylene random copolymer polypropylene and LLDPE according to a proportion of parts by weight via an extruding machine, and performing grain cutting via a grain cutting device to form modified polypropylene microparticles, wherein the ethylene-propylene random copolymer polypropylene accounts for 95 parts, and the LLDPE accounts for 5 parts. With respect to the ethylene-propylene random copolymer polypropylene, the catalytic system is ziegler-natta, the comonomer is ethylene, the monomer content is 3%, the density is 0.9g/cm³, the melting point is 145 °C, the melt index is 7, and the bending modulus is 1000 MPa. With respect to the LLDPE, the catalytic system is a cadmium/titanium catalyst, the comonomer is C6, the monomer content is 8%, the density is 0.914 g/cm³, the melting point is 118 °C, the melt index is 11, and the bending modulus is 130 MPa.

Step 2, throwing the modified polypropylene microparticles into a reaction kettle, adding a dispersion medium, and then performing heating pressurization, so that the polypropylene microparticles generate an outwardly expanding internal pressure under high temperature and high pressure, and connecting a healthcare foaming channel in a pressure relief process, wherein hot air flows in the channel to maximally release the residual foaming gas in expanded particles so as to further expand a pore, and meanwhile the hot air performs fast convection current exchange with the foaming agent in the pore, and the pore is gradually filled with air in a slow setting process of the pore to avoid surface shrinkage of the bead during the expansion.

According to a preferred embodiment of the present invention, in the step 1, the ethylene-propylene random copolymer polypropylene includes a pore nucleating agent, which is zinc borate.

According to a preferred embodiment of the present invention, in the step 1, the ethylene-propylene random copolymer polypropylene includes a gas storage auxiliary agent, and the gas storage auxiliary agent porous silicon dioxide.

According to a preferred embodiment of the present invention, in the step 1, double-layer coextrusion is performed by using two extruding machines, wherein the ethylene-propylene random copolymer polypropylene is located on a core layer, the LLDPE is located on a skin layer, and the thickness of the skin layer of the extruded microparticle is 7-8 μ m. The thickness uniformity of the obtained microparticles are medium, and the wire drawing stability is better.

According to a preferred embodiment of the present invention, in the step 1, the wire drawing diameter is 2.2 mm, and the single grain mass is 1.2 mg.

According to a preferred embodiment of the present invention, in the step 2, the temperature of the reaction kettle is 149.5 °C, and the pressure is 1.9 MPa.

According to a preferred embodiment of the present invention, in the step 2, the dispersion medium is kaolin: butter=4:1.

The forming stability of the foamed bead produced according to the present embodiment is good, the bead size and color are relatively uniform, after the bead is formed, the bead has a smooth surface and less pinholes and pits. Table 2 shows comprehensive performance measurement results of the foamed polypropylene bead produced according to the present embodiment. As can be seen, the foamed polypropylene bead produced according to the

present invention has good performance on various respects. The prepressing time in the present embodiment is 5 hours, and the drying time is 4 hours. Compared with the prior art, the production time of the foamed polypropylene is greatly shortened, the energy consumption is reduced, and the production efficiency of the foamed polypropylene is improved.

Table 2 comprehensive performance measurement results of a product of the embodiment 2

Comprehensive performance measurement results of the product		
Serial number	Measurement item	Measurement result
1	Stacking density	58g/l
2	High temperature enthalpy	18J/g
3	Pore size	280μm
4	Draw ratio of the bead	1.05
5	Forming prepressing	1.2Mpa
6	Prepressing time	5h
7	Forming pressure	1.6bar
8	Drying time	4h
9	Forming body density	62 g/l
10	Bonding state	100%
11	Compressive strength at 50% strain	730Kpa

Embodiment 3

The present invention discloses a preparation method of a foamed polypropylene bead at the same time, including the following steps:

step 1. performing mixing, extrusion and wire drawing on foamable polypropylene with a high melting point and polyolefin with a low melting point according to a proportion of parts by weight via an extruding machine, and performing grain cutting via a grain cutting device to form modified polypropylene microparticles.

Step 2, throwing the modified polypropylene microparticles into a reaction kettle, adding a dispersion medium, and then performing heating pressurization, so that the polypropylene microparticles generate an outwardly expanding internal pressure under high temperature and high pressure, and connecting a healthcare foaming channel in a pressure relief process, wherein hot air flows in the channel to maximally release the residual foaming gas in expanded particles so as to further expand a pore, and meanwhile the hot air performs fast convection current exchange with the foaming agent in the pore, and the pore is gradually filled with air in a slow setting process of the pore to avoid surface shrinkage of the bead during the expansion.

According to one embodiment of the present invention, the materials and properties of the foamable polypropylene with the high melting point and the polyolefin with the low melting point that can be selected in the step 1 are shown in table 3-1 and table 3-2.

Table 3-1 polypropylene raw material of the embodiment 3

Category	Unit	Polypropylene			
Serial number	—	a1	a2	a3	a4
Type	—	Ethylene-propylene random copolymerization	Propylene-butene random copolymerization	Propylene-butene random copolymerization	Ethylene-propylene-butene random copolymerization
Catalytic system	—	ziegler-natta	ziegler-natta	ziegler-natta	ziegler-natta

Comonomer	—	Ethylene	Butene	Butene	Ethylene butene
Monomer content	—	3%	5.50%	4%	—
Density	g/cm ³	0.9	0.9	0.9	0.9
Melting point	°C	145	143	150	130
MFR	g/10min	7	7	7	7
Melt index	MPa	1000	900	1200	650

Table 3-2 polypropylene raw material of the embodiment 3

Category	Unit	Polypropylene					
Serial number	—	b1	b2	b3	b4	b5	b6
Type	—	LDPE	HDPE	LLDPE	LLDPE	LLDPE	mLLDPE
Catalytic system	—	Peroxide	Cadmium/titanium catalyst	Cadmium/titanium catalyst	Cadmium/titanium catalyst	Cadmium/titanium catalyst	Metallocene
Comonomer	—	—	—	C4	C4	C6	C6
Monomer content	—	—	—	6.50%	7%	8%	—
Density	g/cm ³	0.91	0.95	0.921	0.925	0.914	0.91
Melting point	°C	100	132	117	117	118	100
MFR	g/10min	7	1.1	2	15	11	10
Melt index	MPa	110	800	200	150	130	150

In the step 1, the foamable polypropylene with the high melting point and the polyolefin with the low melting point can be combined according to the proportion of parts by weight listed

in table 4, and the corresponding pore nucleating agent and the gas storage auxiliary agent are added in the foamable polypropylene with the high melting point to form a plurality of modified polypropylene microparticles.

Table 4 ingredient information of modified polypropylene microparticles of the embodiment

3

Microparticle embodiment	M1	M2	M4	M5	M9	M10	M11
Skin layer	a4	a4	a4	a4	b4	b5	b5
Core layer	a1	a1	a2	a3	a3	a1	a2
m skin: m core	1:99	5:95	5:95	5:95	5:95	5:95	5:95
Pore nucleating agent	Talcum powder	Zinc borate	Talcum powder	Coarse whiting	Zinc stearate	Zinc borate	Kaolin
Auxiliary storage gas	Porous silicon dioxide	—	—	Porous titanium dioxide	—	Porous silicon dioxide	—
Microparticle length/mm	1.8	2.2	1.5	2.2	2.2	2.2	2.2
Microarticle single weight/mg	1	1.2	0.5	1.2	1.2	1.2	1.2
$\Delta T_m/^\circ\text{C}$	15	15	13	20		27	25
T_m mixing/ $^\circ\text{C}$	147	146.2	144.3	152.4	152.1	146.7	145.1
Skin layer thickness/ μm	2-3	10-11	6-7	7-8	7-8	7-8	9-10
Thickness uniformity	Good	Medium	Good	Good	Medium	Medium	Good
Wire drawing stability	OK	OK	OK	OK	OK	OK	OK
Microparticle embodiment	M12	M13					
Skin layer	b5	b6					

Core layer	a3	a2					
m skin: m core	5:95	5:95					
Pore nucleating agent	Zinc stearate	Zinc borate					
Auxiliary storage gas	—	—					
Microparticle length/mm	2.2	2.2					
Microarticle single weight/mg	1.2	1.2					
$\Delta T_m/^\circ\text{C}$	32	43					
T_m mixing/ $^\circ\text{C}$	152.1	144.9					
Skin layer thickness/ μm	6-7	8-9					
Thickness uniformity	Medium	Medium					
Wire drawing stability	OK	OK					

Wherein the thickness uniformity of thickness means that the internal thickness of the bead is uniform during Scanning electron microscope observation.

The foaming working conditions and the corresponding comprehensive performance measurement results of the polypropylene beads formed according to various combined ratios in table 4 are shown in table 5 and table 6.

Table 5 foaming working condition and comprehensive performance measurement table of foamed polypropylene of the embodiment 3

Foaming sequence	B1	B2	B3	B4	B5	B6	B7
Microparticle code	M2	M2	M2	M4	M5	M10	M1

Dispersing agent	Kaolin: butter	Calcium phosphate: butter	Kaolin: butter	Kaolin: butter	Calcium phosphate: butter	Kaolin: butter	Calcium phosphate: butter
Proportion	3:1	4:1	6:1	3:1	4:1	4:1	2:1
Foaming temperature/°C	149.5	149.5	149.5	147.5	155.2	149,5	150.1
Foaming pressure/Mpa	2	2	2	2.2	1.8	1.9	2
Stacking density/ g/l	52	55	53	53	56	58	54
High temperature enthalpy/ J/g	18	21	20	20	17	18	21
Pore size/μm	190	210	200	250	210	280	300
Foaming stability	OK	OK	OK	OK	OK	OK	NG
Draw ratio of bead	1	1.1	1.5	0.9	1	1.05	1.2
Bead grade	A+	A+	A-	A+	A+	A+	A
Foaming sequence	B12	B13	B15				
Microparticle code	M9	M11	M13				
Dispersing agent	Kaolin: butter	Kaolin: butter	Kaolin: butter				
Proportion	4:1	3:1	5:1				
Foaming temperature/°C	155.4	148.3	148.2				
Foaming	1.7	2	2.2				

pressure/Mpa							
Stacking density/ g/l	55	56	54				
High temperature enthalpy/ J/g	21	19	21				
Pore size/ μm	230	200	245				
Foaming stability	OK	OK	OK				
Draw ratio of bead	1	1.1	1.3				
Bead grade	A+	A+	A				

Wherein, the foaming stability indicates whether agglomeration is generated during the foaming, and bead grade indicates whether the granules and colors of the bead are uniform.

Table 6 forming working condition and comprehensive performance measurement of foamed polypropylene of the embodiment 3

Forming sequence	F1	F2	F3	F4	F5	F6	F7	F8	F9
Bead code	B1	B1	B2	B2	B3	B4	B5	B6	B7
Forming prepressing/Mpa	0	1	0	1	1.3	1.5	1	1.2	1
Prepressing time/h	0	3	0	8	5	3	5	5	5
Forming pressure/bar	2	2.2	2	2.2	2.2	2.2	2.2	1.6	2.2
Drying time/h	5	3	4	3	4	4	4	4	4
Forming body density/ g/l	65	63	68	63	59	62	65	62	65
Surface state	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓
Bonding state	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓
50%compressive strength/Kpa	650	780	750	770	690	680	410	730	690

Forming sequence	F14	F15	F17						
Bead code	B12	B13	B15						
Forming prepressing/Mpa	1	1	1						
Prepressing time/h	5	5	5						
Forming pressure/bar	1.6	1.8	3.2						
Drying time/h	4	4	4						
Forming body density/ g/l	59	62	59						
Surface state	✓	✓✓	✓						
Bonding state	✓	✗	✗						
50%compressive strength/Kpa	560	—	—						

Wherein, surface state represents whether the bead surface is smooth and whether has pinholes and pits, ✓✓ represents there is no pinhole or pit on the surface, ✓ represents there are few pinholes and pits on the surface, and ✗ represents there are a large number of pinholes and pits on the surface; and in the bonding state, ✓✓ represents 100% bonding, ✓ represents 70% bonding, and ✗ represents no bonding.

It can be seen from the above tables that the foamed polypropylene particles formed by the material ratio and the process of the present invention have the technical characteristics of short prepressing time and short drying time under the premise that the performance is the same or higher, and compared with the prior art, the energy consumption is reduced, the production efficiency of foamed polypropylene is improved.

CLAIMS

1. An energy-saving foamed polypropylene bead, wherein the raw material comprises the following ingredients in parts by weight: 85-99 parts of foamable polypropylene with a high melting point, 1-15 parts of polyolefin with a low melting point and an auxiliary agent mainly comprising an antioxidant and a lubricant;

wherein the foamable polypropylene with high melting point is a random copolymer which is a propylene-butene copolymer, the foamable polypropylene has a melting point in a range of 143-150 °C, and the foamable polypropylene has a bending modulus ranging from 900 MPa to 1200 MPa;

wherein the polyolefin with the low melting point is polyethylene or polypropylene;

wherein the polyethylene is LDPE, HDPE or LLDPE, the density of the polyethylene is 0.920-0.935 g/cm³, the elongation at break of the polyethylene is greater than 800%, the softening point of the polyethylene is 100-110 °C, the melt index of the polyethylene is 2-15, and the melting point of the polyethylene is 100-140 °C; and

the polypropylene is a random copolymer of ethylene, propylene and butene, and has a melting point of 115-140 °C, a melt index of 5-15, and an elongation at break of greater than 500%.

2. The foamed polypropylene bead according to claim 1, wherein the foamable polypropylene with the high melting point is located on a core layer, and a polyethylene material is located on a skin layer.

3. The foamed polypropylene bead according to claim 1, wherein the foamable polypropylene with the high melting point comprises one or two of an inorganic pore nucleating agent and an organic pore nucleating agent, the inorganic pore nucleating agent is one or more of calcium carbonate, talcum powder, kaolin, coarse whiting, zinc borate, silicon dioxide and titanium dioxide, and the organic pore nucleating agent is one or more of calcium stearate and zinc stearate.

4. The foamed polypropylene bead according to claim 3, wherein the particle diameter of the inorganic pore nucleating agent is 0.5-5 μm .

5. The foamed polypropylene bead according to claim 3, wherein the particle diameter of the inorganic pore nucleating agent is 2-5 μm .

6. The foamed polypropylene bead according to claim 3, wherein the inorganic pore nucleating agent comprises crystal water substance.

7. The foamed polypropylene bead according to claim 3, wherein the organic pore nucleating agent is a 15-40 carbon chain salt.

8. The foamed polypropylene bead according to claim 1, wherein the polyolefin with the low melting point contains no pore nucleating agent.

9. The foamed polypropylene bead according to claim 1, wherein the melt index of the polyethylene is 5-14.

10. The foamed polypropylene bead according to claim 1, wherein the foamable polypropylene with the high melting point comprises a gas storage auxiliary agent, and the gas storage auxiliary agent is one or two of porous silicon dioxide or porous titanium dioxide.

11. The foamed polypropylene bead according to claim 10, wherein the porous silicon dioxide or the porous titanium dioxide has an aperture of 70-80 nm and a porosity of 65-86%.

12. The foamed polypropylene bead according to claim 1, wherein the other auxiliary agent in the foamable polypropylene with the high melting point is one or more of fire retardant, color master batch, dispersing agent, antioxidant, lubricant, antistatic agent, coupling agent, stabilizer and ultraviolet light absorber.

13. A preparation method of the foamed polypropylene bead according to any one of claims 1-12, comprising the following steps:

step 1, performing mixing, extrusion and wire drawing on a foamable polypropylene with a high melting point and a polyethylene according to a proportion of parts by weight via an extruding machine, and performing grain cutting via a grain cutting device to form modified polypropylene microparticles, wherein the foamable polypropylene with the high melting point accounts for 85-99 parts, and polyolefin with a low melting point accounts for 1-15 parts; the foamable polypropylene with the high melting point is a random copolymer which is a propylene-butene copolymer having a melting point of 143-150 °C, and a bending modulus greater than 900 MPa, and auxiliary agents mainly comprise an antioxidant and a lubricant; the polyolefin with the low melting point is polyethylene, or polypropylene; the polyethylene is LDPE, HDPE or LLDPE, the density of the polyethylene is 0.920-0.935 /cm³, the elongation at break of the polyethylene is greater than 800%, the softening point of the polyethylene is 100-110 °C, the melt index of the polyethylene is 2-15, and the melting point of the polyethylene is 100-140 °C; and the polypropylene is a random copolymer of ethylene, propylene and butene, the melting point of the polypropylene is 115-140 °C, the melt index of the polypropylene is 5-15, and the elongation at break of the polypropylene is greater than 500%; and

step 2, throwing the modified polypropylene microparticles into a reaction kettle, adding a dispersion medium, and then performing heating pressurization, so that the polypropylene microparticles generate an outwardly expanding internal pressure under high temperature and high pressure, and relieving the pressure to the barometric pressure to obtain a high-expansibility foamed polypropylene material.

14. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 1, double-layer coextrusion is performed by using two extruding machines.

15. The preparation method of the foamed polypropylene bead according to claim 13, wherein a core layer of the double-layer coextrusion is foamable polypropylene, a skin layer

is a polyolefin material with a low melting point, and the weight ratio of the skin layer is 1%-10%.

16. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 1, the wire drawing diameter is 1-2mm, the grain cutting length is 1.8-2.5 mm, and the single grain mass is 0.5-2 mg.

17. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 2, the selected heating pressurization gas is carbon dioxide.

18. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 2, the temperature of the reaction kettle is 145-160 °C, the pressure is 1.5-3 MPa, and the heating time is 45-65 minutes.

19. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 2, the temperature of the reaction kettle is 147-153 °C, the pressure is 1.8-2.4 MPa, and the heating time is 50-65 minutes.

20. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 2, the dispersion medium is one or two of kaolin and butter.

21. The preparation method of the foamed polypropylene bead according to claim 20, wherein in the step 2, the mass of the dispersion medium accounts of 0.2-1% of that of the polypropylene microparticles.

22. The preparation method of the foamed polypropylene bead according to claim 20, wherein in the step 2, in the dispersion medium, kaolin: butter is 3:1 to 6:1.

23. The preparation method of the foamed polypropylene bead according to claim 20, wherein in the step 2, in the dispersion medium, calcium phosphate: butter is 3:1 to 6:1.

24. The preparation method of the foamed polypropylene bead according to claim 13, wherein in the step 2, the pressure relief process is performed in a healthcare foaming tube connected with the reaction kettle.

25. The preparation method of the foamed polypropylene bead according to claim 24, wherein the foaming tube 2-4m.

26. The preparation method of the foamed polypropylene bead according to claim 24, wherein the atmosphere temperature in the channel is controlled at 90-100 ° C.

27. The preparation method of the foamed polypropylene bead according to claim 13, wherein the draw ratio of the bead after being foamed is 0.5-2.

28. The preparation method of the foamed polypropylene bead according to claim 13, wherein the draw ratio of the bead after being foamed is 0.8-1.5.