more. Therefore, e.g. in pressure pipes, the presence of a lower molecular weight carrier polymer as part of the MB can influence sagging negatively, i.e. increase sagging on account of melt viscosity reduction due to presence of lower molecular weight (higher MFR) carrier polymer. That problem cannot just be solved by using a higher Mw (lower MFR) carrier polymer in the MB, since, as discussed above, the combination of the higher Mw carrier polymer and the high pigment (e.g. carbon black) content present in MB increases markedly the viscosity of the MB mixture.

The present inventors therefore sought alternative ways of ensuring good dispersion of the masterbatch within a variety of final polyethylene compositions. The inventors also sought a solution to the specific problem caused by the incorporation of a low Mw pigment masterbatch to an otherwise high Mw polyethylene base resin, e.g. in terms of sagging in a pipe.

Summary ~~of Invention~~

Thus, ~~viewed from one aspect~~ the ~~invention~~ disclosure provides a masterbatch (MB) comprising, preferably consisting of,

(I) 20-50 wt% pigment based on the total amount of the masterbatch (100 wt%);

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, a density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20; and

(III) optionally further additives.

In one aspect, there is provided a masterbatch (MB) comprising, preferably consisting of,

(I) 20-50 wt% pigment based on the total amount of the masterbatch (100 wt%);

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, a density of 940 to 965 kg/m^3 (preferably 950 to 960 kg/m^3) and a Mw/Mn of 5.5 to 20; and

(I) optionally further additives.

The present inventors have surprisingly found that by using the claimed multimodal carrier polymer of the ~~invention~~ disclosure with higher molecular weight (lower MFR) instead of a conventional unimodal higher MFR polyethylene, the obtained MB is well dispersed in the base resin with which they are combined.

The inventors have also surprisingly found that using multimodal HDPE as claimed and described herein as a carrier polymer in a pigment masterbatch, such as a carbon black masterbatch, ensures that the filler wetting and dispersion of the

pigment in the carrier polymer is at least comparable with that of conventional masterbatches.

The MB of the ~~invention~~ disclosure is highly suitable for different base resins and for various end applications, preferably for pipe applications, W&C applications and for film applications.

This good dispersion also leads to mechanical properties which are at least comparable to those achieved using conventional unimodal carrier polymers, e.g. in terms of pipe failure performance.

The MB of the ~~invention~~ disclosure is highly suitable for base resins with various densities.

~~Viewed from another aspect t~~The ~~invention~~ disclosure provides a polyethylene composition suitable for pipe, a layer of a cable and film applications, preferably suitable for pipe applications, comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3; and

(ii) at least 1 wt% of a masterbatch as hereinbefore defined;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3.

In another aspect, there is provided a polyethylene composition suitable for pipe, a layer of a cable or film layer applications, preferably suitable for pipe applications, comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920-960 kg/m^3, preferably 940 to 955 kg/m^3; and

(ii) at least 1 wt% of masterbatch as defined herein;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3.

~~Viewed from another aspect t~~The ~~invention~~ disclosure provides a polyethylene composition suitable for pipe, a layer of a cable or film applications, preferably suitable for pipe applications, comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3; and

(ii) a masterbatch comprising a pigment and at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, a density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3 and wherein the polyethylene composition comprises 1 to 10 wt% of pigment.

In another aspect, there is provided a polyethylene composition suitable for pipe, a layer of a cable and or film applications, preferably suitable for pipe applications) comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3 preferably 940 to 955 kg/m^3; and

(ii) a masterbatch comprising a pigment and at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR2 of 1 to 20 g/10 min, density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3 and wherein the polyethylene composition comprises 1 to 10 wt% of pigment.

Furthermore, the use of the multimodal masterbatch enables also the use of a carrier polymer with lower MFR together with the same pigment loading as usually

used in high MFR unimodal MBs (i.e. without decreasing the amount of the pigment). Accordingly, the MB of the ~~invention~~ disclosure is suitable for use with polyethylene base resins with varying MFR. E.g. the lower MFR MB of the ~~invention~~ disclosure can be well dispersed with a pipe polyethylene base resin with low MFR and in the resulting polymer composition, wherein the difference between the MFR of the base resin and the MFR of the carrier polymer is advantageously small. That has additional benefits in pipe applications such as reduced sagging.

~~Viewed from another aspect t~~The ~~invention~~ disclosure provides an article comprising, preferably consisting of, the polyethylene composition as hereinbefore defined, preferably a pipe, layer, preferably jacketing layer, of a cable or a film layer, especially a pipe, most especially a pressure pipe comprising, preferably consisting of, the polyethylene composition as hereinbefore defined. In another aspect, there is provided an article comprising, preferably consisting of, the polyethylene composition as defined herein, preferably a pipe, a layer of a cable (e.g. the jacketing layer) or a film layer, especially a pipe, most especially a pressure pipe.

~~Viewed from another aspect t~~The ~~invention~~ disclosure provides a process for the production of a masterbatch as hereinbefore defined comprising blending

(I) 20-50 wt% of a pigment;

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20; and

melt compounding the same.

In another aspect, there is provided a process for the formation of a masterbatch as defined herein comprising blending

(I) 20-50 wt% of a pigment;

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20; and

melt compounding the same.

~~Viewed from another aspect t~~The ~~invention~~ disclosure provides a process for the production of a polyethylene composition as herein before defined comprising blending at least 1 wt% of a masterbatch as hereinbefore defined with at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3; and melt compounding the same. Preferably the ~~invention~~ disclosure further comprises conversion of that melt compounded material into an article such as a pipe, cable layer or film layer. In another aspect, there is provided a process for the preparation of a polyethylene composition as defined herein comprising blending a masterbatch as defined herein with at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3; and melt compounding the same.

Definitions

Claims

1. A masterbatch (MB) comprising, preferably consisting of,

(I) 20-50 wt% pigment based on the total amount of the masterbatch (100 wt%);

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, a density of 940 to 965 kg/m^3 (preferably 950 to 960 kg/m^3) and a Mw/Mn of 5.5 to 20; and

(I) optionally further additives.

2. A masterbatch as claimed in claim 1 wherein said pigment is carbon black.

3. A masterbatch as claimed in ~~any preceding~~ claim 1 or 2 wherein the HDPE carrier polymer is bimodal.

4. A masterbatch as claimed in any one of the preceding claims wherein the carrier polymer has an MFR_2 of 1.5 to 15 g/10min, preferably 1.8 to 10 g/10min.

5. A masterbatch as claimed in any one of the preceding claims wherein the multimodal HDPE comprises a LMW homopolymer component (A) and a HMW copolymer component (B), preferably an ethylene butene copolymer component (B).

6. A masterbatch as claimed in claim 5 wherein the ratio of the MFR_2 of the carrier polymer to the MFR_2 of the LMW homopolymer component (A) is 0.005 to 0.2.

7. A masterbatch as claimed in claim 5 or 6 wherein the multimodal HDPE comprises a LMW homopolymer component (A) and a HMW copolymer component (B), and wherein the weight ratio of component (A) to component (B) within the carrier polymer is 30:70 to 70:30.

8. A polyethylene composition suitable for pipe, a layer of a cable or film layer applications, preferably suitable for pipe applications, comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920-960 kg/m^3, preferably 940 to 955 kg/m^3; and

(ii) at least 1 wt% of masterbatch as claimed in any one of claims 1 to 7;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3.

9. A polyethylene composition suitable for pipe, a layer of a cable ~~and~~ or film applications, preferably suitable for pipe applications~~)~~ comprising, preferably consisting of,

(i) at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3 preferably 940 to 955 kg/m^3; and

(ii) a masterbatch comprising a pigment and at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20;

wherein the polyethylene composition has a density of 930 to 970 kg/m^3 and wherein the polyethylene composition comprises 1 to 10 wt% of pigment.

10. A polyethylene composition as claimed in ~~any one of~~ claim~~s~~ 8 ~~to~~or 9 wherein the base resin polyethylene polymer is multimodal, preferably bimodal.

11. A polyethylene composition as claimed in any one of claims 8 to 10 wherein the base resin polyethylene polymer is a copolymer.

12. A polyethylene composition as claimed in any one of claims 8 to 11 wherein the polymer composition comprises 1 to 10 wt% masterbatch.

13. A polyethylene composition as claimed in any one of claims 8 to 12 wherein the pigment, preferably carbon black, forms 1.8 to 7.0 wt% of the polymer composition.

14. A polyethylene composition as claimed in any one of claims 8 to 13 wherein the base resin polyethylene polymer is a multimodal HDPE comprising a homopolymer component (C) and a copolymer component (D), preferably an ethylene butene copolymer component or ethylene hexene copolymer component (D).

15. An article comprising, preferably consisting of, the polyethylene composition as claimed in any one of claims 8 to 14, preferably a pipe, a layer of a cable (e.g. the jacketing layer) or a film layer, especially a pipe, most especially a pressure pipe.

16. A process for the formation of a masterbatch as claimed in any one of claims 1 to 7 comprising blending

(I) 20-50 wt% of a pigment;

(II) at least 40 wt% of at least one carrier polymer which is a multimodal high density polyethylene (HDPE) polymer having an MFR_2 of 1 to 20 g/10 min, density of 940 to 965 kg/m^3 and a Mw/Mn of 5.5 to 20; and

melt compounding the same.

17. A process for the preparation of a polyethylene composition as claimed in any one of claims 8 to 14 comprising blending a masterbatch as claimed in any one of claims 1 to 7 with at least 80 wt% of a base resin which comprises, preferably consists of, a polyethylene polymer having MFR_5 of 0.05 to 5.0 g/10min and a density of 920 to 960 kg/m^3; and melt compounding the same.