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(54) Titre : ADDITIF POUR POLYETHYLENE
(54) Title: POLYETHYLENE ADDITIVE

(57) Abrégé/Abstract:
A new additive for plastics (especially polyethylene) is prepared by reacting a fatty acid ester of glycerol (such as glycerol monostearate) with a source of a reactive divalent metal selected from the group consisting of zinc, calcium, and magnesium. Zinc oxide is the preferred reactive divalent metal and the reaction is preferably conducted in the presence of an acid (such as zinc acetate). A molar excess of zinc oxide (compared to the fatty acid ester) is preferred. The additive is suitable for use in the preparation of injection molded parts, rotomolded parts, and films.

POLYETHYLENE ADDITIVE

ABSTRACT OF THE DISCLOSURE

A new additive for plastics (especially polyethylene) is prepared by reacting a fatty acid ester of glycerol (such as glycerol monostearate) with a source of a reactive divalent metal selected from the group consisting of zinc, calcium, and magnesium. Zinc oxide is the preferred reactive divalent metal and the reaction is preferably conducted in the presence of an acid (such as zinc acetate). A molar excess of zinc oxide (compared to the fatty acid ester) is preferred. The additive is suitable for use in the preparation of injection molded parts, rotomolded parts, and films.

POLYETHYLENE ADDITIVE

FIELD OF THE INVENTION

This invention relates to a novel additive for extruded polyethylene compositions.

BACKGROUND OF THE INVENTION

Polyethylene may be classified into two broad families, namely "random" (which is commercially prepared by initiation with free radicals under polymerization conditions that are characterized by the use of very high ethylene pressures) and "linear" (which is commercially prepared with a transition metal catalyst, such as a "Ziegler Natta" catalyst, or a "chromium" catalyst, or a single site catalyst or a "metallocene catalyst").

Most "random" polyethylene which is commercially sold is a homopolymer of ethylene. This type of polyethylene is also known as “high pressure low density polyethylene” because the random polymer structure produces a lower polymer density. In contrast, most "linear" polyethylene which is commercially sold is copolymer of ethylene with at least one alpha olefin (especially butene, hexene or octene). The incorporation of a comonomer into linear polyethylene reduces the density of the resulting copolymer. For example, a linear ethylene homopolymer generally has a very high density (typically greater than 0.955 grams per cubic centimeter (g/cc)) - but the incorporation of small amounts of comonomer results in the production of so-called "high density polyethylene" (or "HDPE" - typically, having densities greater than 0.940 g/cc) and the incorporation of further comonomer produces so-called "linear low density polyethylene" (or "lldpe" - typically having a density of from about 0.905 g/cc to 0.940 g/cc).

Linear polyethylene is converted into finished goods using a variety of molding and extrusion processes. Additives are typically used to improve the conversion process and/or to modify the properties of the finished good.

One widely used family of additives may be described as the mono– and di-esters of glycerol with higher fatty acids. Examples of these additives include glycerol monostearate (also known as glyceryl monostearate and/or "GMS") and glycerol monooleate.

GMS may be used as a i) mold release agent (including rotational molding); ii) an anti-static agent (especially for film); or iii) as a blowing co-agent for the preparation of foams.

GMS is very polar in comparison to the host polyethylene resin. Accordingly, GMS tends to migrate from the resin and form a coating on the surface of the finished polyethylene goods. This is desirable in some respects (as this coating is believed to be responsible for the "mold release" and "anti-static" properties) but it is also undesirable because the GMS can also leave a greasy residue on surfaces that come into contact with the molded polyethylene part or film (such as the mold shell and/or film extrusion equipment).

It would be desirable to reduce the amount of greasy residue that is transferred to polyethylene conversion equipment when GMS is used as an additive.

SUMMARY OF THE INVENTION

In one embodiment, the present invention provides a polyethylene additive prepared by the reaction of

a) a fatty acid ester of glycerol; with

b) a divalent metal selected from the group consisting of zinc, calcium, and magnesium.

In another embodiment, the present invention provides a process to prepare a polyethylene additive by the reaction of a fatty acid ester of glycerol with a divalent metal, said process comprising reacting said fatty acid ester with said divalent metal in the presence of an acid catalyst.

In a third embodiment, the present invention provides

a) polyethylene;

b) from 100 to 5000 parts per million by weight of the above described additive.

In a fourth embodiment, the present invention provides a polyethylene film prepared by the blown film extrusion of a blend of HDPE with from 100 to 5000 parts per million by weight, preferably from 500 to 2000 parts per million by weight of the present additive. Preferred blown films of this invention have an improvement in WVTR of at least 20% in comparison to films made in the absence of the additive.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Additive

The additive of this invention is prepared from a fatty acid ester of glycerol. These esters are commercially available and are typically derived from natural sources. The mono esters are generally referred to by the names glycerol monostearate and glycerol monooleate although it will be recognized by those skilled in the art that the esters often contain a mixture of fatty acids – i.e. the esters do not contain only stearic acid or oleic acid (as the common name might imply). It will also be recognized that a product sold as a "monostearate" or "monooleate" will typically also contain some di-esters (in fact, it is not uncommon for a "monostearate" to be sold with a specification that allows for the presence of di-esters). Commercially available glycerol monostearate (GMS) and glycerol monooleate are preferred for reasons of cost and availability. The GMS used in the Examples was a commercially

available product (sold under the trade name ATMER 129) and was used as received.

The above described ester is reacted with a source of a reactive divalent metal selected from the group consisting of zinc, calcium, and magnesium. It is preferred to use an oxide or hydroxide of these metals. Zinc is the preferred metal and zinc oxide is the preferred source of zinc.

A catalytic amount of an acid is used to initiate the reaction (with zinc acetate being the preferred acid).

The reaction may be conducted in a stirred reactor. Elevated temperatures (from 40 to 200°C) assist the reaction.

The relative amounts of the glycerol ester and metal are preferably from 1/3 to 3/1 on a molar basis. In general, it is preferred to use a molar excess of the metal, especially when the metal source is zinc oxide (as zinc oxide is widely used as a polyethylene additive – so the presence of "unreacted" zinc oxide will not be problematic for many applications).

High Density Polyethylene (HDPE)

The polyethylene used in this invention is preferably a high density polyethylene (HDPE). As used herein, the term high density polyethylene means that the density is greater than 0.935 grams per cubic centimeter (g/cc) as measured by ASTM D1505.

The composition of this invention is suitable for use in the preparation of molded goods (such as extruded profiles/pipes or injection molded parts such as caps or closures); rotomolded parts and films. It is preferred to use a HDPE having a melt index, I_2, of from 0.2 to 20 grams per 10 minutes and a density of from 0.950 to 0.970 g/cc when preparing film. I_2 is measured by ASTM D 1238, (when conducted at 190°C, using a 2.16 kg weight). Molded goods are preferably prepared from a

HDPE having a density of from 0.935 g/cc to 0.955 g/cc and a melt index of from 0.2 to 200 grams per 10 minutes.

The use of the present additive has been found to improve the barrier property of polyethylene film.

It is especially preferred to use blends of HDPE when preparing films having enhanced barrier properties. Preferred blends are described in more detail below.

Plastic films are widely used as packaging materials for foods. Flexible films, including multilayer films, are used to prepare bags, wrappers, pouches and other thermoformed materials.

The permeability of these plastic films to gases (especially oxygen) and moisture is an important consideration during the design of a suitable food package.

The permeability of linear polyethylene film to moisture is typically described by a "water vapor transmission rate" (or "WVTR"). In certain applications some vapor transmission is desirable - for example, to allow moisture out of a package which contains produce. The use of linear low density polyethylene (lldpe) which may be filled with calcium carbonate (to further increase vapor transmission) is common for this purpose.

Conversely, for packages which contain crispy foods such as breakfast cereals or crackers, it is desirable to limit WVTR to very low levels to prevent the food from going stale. The use of HDPE to prepare "barrier film" is common for this purpose.

The manufacture of "barrier" food packaging from plastic resins involves two basic operations.

The first operation involves the manufacture of plastic film from the plastic resin. Most "barrier films" are prepared by "blown film" extrusion, in which the plastic is melted in an extruder, then forced through an annular die. The extrudate from the

annular die is subjected to blown air, thus forming a plastic bubble. The use of multiple extruders and concentric dies permits multilayer structures to be co-extruded by the blown film process. The "product" from this operation is "barrier film" which is collected on rolls and shipped to the manufacturers of food packaging.

The manufacturer of the food packaging generally converts the rolls of blown film into packaged foods. This typically involves three basic steps:

1) forming the package;

2) filling the package;

3) sealing the food in the finished package.

Although the specific details will vary from manufacturer to manufacturer, it will be readily appreciated that the film needs to have a balance of physical properties in order to be suitable for food packaging. In addition to low WVTR, it is desirable for the film to "seal" well and to have sufficient impact strength and stiffness (or film "modulus") to allow easy handling of the package. Multilayer coextrusions are often used to achieve this balance of properties, with 3 and 5 layer coextrusions being well known. Sealant layers may be prepared with ethylene - vinyl acetate (EVA) ionomers (such as those sold under the trademark SURLYN™ by E.I. DuPont), very low density polyethylene (polyethylene copolymers having a density of less than 0.910 grams per cubic centimeter) and blends with small amounts of polybutene. It is known to use sealant compositions in both "skin" layers of a coextrusion or in only one of the skin layers.

HDPE Blends for Barrier Films

In an especially preferred embodiment, a blend of two HDPE resins is used for barrier films, as discussed below.

Blend Component a)

Blend component a) of a preferred polyethylene composition used in this invention comprises an HDPE with a comparatively high melt index. As used herein, the term "melt index" is meant to refer to the value obtained by ASTM D 1238 (when conducted at 190°C, using a 2.16 kg weight). This term is also referenced to herein as "I_2" (expressed in grams of polyethylene which flow during the 10 minute testing period, or "gram/10 minutes"). As will be recognized by those skilled in the art, melt index, I_2, is in general inversely proportional to molecular weight. Thus, blend component a) has a comparatively high melt index (or, alternatively stated, a comparatively low molecular weight) in comparison to blend component b).

The absolute value of I_2 for blend component a) is preferably greater than 5 grams/10 minutes. However, the "relative value" of I_2 for blend component a) is also important – it is preferably at least 10 times higher than the I_2 value for blend component b) [which I_2 value for blend component b) is referred to herein as I_2']. Thus, for the purpose of illustration: if the I_2' value of blend component b) is 1 gram/10 minutes, then the I_2 value of blend component a) should be at least 10 grams/10 minutes.

A preferred blend component a) is further characterized by:

i) density – it should have a density of from 0.95 to 0.97 g/cc; and

ii) weight % of the overall polyethylene composition – it should be present in an amount of from 5 to 60 weight % of the total HDPE composition (with blend component b) forming the balance of the total polyethylene) with amounts of from 10 to 40 weight %, especially from 20 to 40 weight %, being preferred. It is permissible to use more than one high density polyethylene to form blend component a).

The molecular weight distribution [which is determined by dividing the weight average molecular weight (Mw) by number average molecular weight (Mn) where Mw and Mn are determined by gel permeation chromatography, according to ASTM

D 6474-99] of component a) is preferably from 2 to 20, especially from 2 to 4. While not wishing to be bound by theory, it is believed that a low Mw/Mn value (from 2 to 4) for component a) may improve the nucleation rate and overall barrier performance of blown films prepared according to the process of this invention.

Blend Component b)

Blend component b) is also a high density polyethylene which has a density of from 0.950 to 0.970 g/cc (preferably from 0.955 to 0.965 g/cc).

The melt index of blend component b) is also determined by ASTM D 1238 at 190°C using a 2.16 kg load. The melt index value for blend component b) (referred to herein as I_2') is lower than that of blend component a), indicating that blend component b) has a comparatively higher molecular weight. The absolute value of I_2' is preferably from 0.1 to 2 grams/10 minutes.

The molecular weight distribution (Mw/Mn) of component b) is not critical to the success of this invention, though a Mw/Mn of from 2 to 4 is preferred for component b).

As noted above, the ratio of the melt index of component b) divided by the melt index of component a) is preferably greater than 10/1.

Blend component b) may also contain more than one HDPE resin.

Overall HDPE Blend Composition for Film

The overall high density blend composition is formed by blending together blend component a) with blend component b). This overall HDPE composition preferably has a melt index (ASTM D 1238, measured at 190°C with a 2.16 kg load) of from 0.5 to 10 grams/10 minutes (preferably from 0.8 to 8 grams/10 minutes). The preferred density is from 0.955 to about 0.970 (especially 0.960 to 0.967 g/cc).

The blends may be made by any blending process, such as: 1) physical blending of particulate resin; 2) co-feed of different HDPE resins to a common

extruder; 3) melt mixing (in any conventional polymer mixing apparatus); 4) solution blending; or, 5) a polymerization process which employs 2 or more reactors.

One preferred HDPE blend composition is prepared by melt blending the following two blend components in an extruder:

from 10 to 30 weight % of component a): where component a) is a conventional HDPE resin having a melt index, I_2, of from 15-30 grams/10 minutes and a density of from 0.950 to 0.960 g/cc with

from 90 to 70 weight % of component b): where component b) is a conventional HDPE resin having a melt index, I_2, of from 0.8 to 2 grams/10 minutes and a density of from 0.955 to 0.965 g/cc.

An example of a commercially available HDPE resin which is suitable for component a) is sold under the trademark SCLAIR™ 79F, which is an HDPE resin that is prepared by the homopolymerization of ethylene with a conventional Ziegler Natta catalyst. It has a typical melt index of 18 grams/10 minutes and a typical density of 0.963 g/cc and a typical molecular weight distribution of about 2.7.

Examples of commercially available HDPE resins which are suitable for blend component b) include (with typical melt index and density values shown in brackets):

SCLAIR™ 19G (melt index = 1.2 grams/10 minutes, density = 0.962 g/cc);

MARFLEX™ 9659 (available from Chevron Phillips, melt index = 1 grams/10 minutes, density = 0.962 g/cc); and

ALATHON™ L 5885 (available from Equistar, melt index = 0.9 grams/10 minutes, density = 0.958 g/cc).

A highly preferred HDPE blend composition is prepared by a solution polymerization process using two reactors that operate under different polymerization conditions. This provides a uniform, in situ blend of the HDPE blend

components. An example of this process is described in published U.S. patent application 20060047078 (Swabey et al.). These blends have a density as high as 0.967 g/cc. The overall HDPE blend composition preferably has a MWD (Mw/Mn) of from 3 to 20.

Masterbatch

The use of a "master batch" (which is prepared by melt mixing the present additive and a small amount of HDPE) is especially preferred. A typical master batch would contain about 80-98% by weight of HDPE, with the remaining 20-2% being the additive. The master batch is then added to the remaining HDPE during the final extrusion process in order to provide the desired amount of additive in the final product.

Other Additives

The HDPE may also contain other conventional additives, especially (1) primary antioxidants (such as hindered phenols, including vitamin E); (2) secondary antioxidants (especially phosphites and phosphonites); and (3) process aids (especially fluoroelastomer and/or polyethylene glycol bound process aid). In addition, the use of particulate antiblocking agents (such as silica) is contemplated. The use of silica may help to disperse the additive. However, as a general rule, a particular advantage of the additive of this invention is that it is readily dispersed in polyethylene without the need for dispersing agents. While not wishing to be bound by theory, it is believed that the alkyl group of the fatty acid helps to disperse the additive.

Film Extrusion Process

Blown Film Process

The extrusion-blown film process is a well known process for the preparation of plastic film. The process employs an extruder which heats, melts and conveys the

molten plastic and forces it through an annular die. Typical extrusion temperatures are from 330 to 500°F, especially 350 to 460°F.

The polyethylene film is drawn from the die and formed into a tube shape and eventually passed through a pair of draw or nip rollers. Internal compressed air is then introduced from the mandrel causing the tube to increase in diameter forming a "bubble" of the desired size. Thus, the blown film is stretched in two directions, namely in the axial direction (by the use of forced air which "blows out" the diameter of the bubble) and in the lengthwise direction of the bubble (by the action of a winding element which pulls the bubble through the machinery). External air is also introduced around the bubble circumference to cool the melt as it exits the die. Film width is varied by introducing more or less internal air into the bubble thus increasing or decreasing the bubble size. Film thickness is controlled primarily by increasing or decreasing the speed of the draw roll or nip roll to control the draw-down rate.

The bubble is then collapsed into two doubled layers of film immediately after passing through the draw or nip rolls. The cooled film can then be processed further by cutting or sealing to produce a variety of consumer products. While not wishing to be bound by theory, it is generally believed by those skilled in the art of manufacturing blown films that the physical properties of the finished films are influenced by both the molecular structure of the polyethylene and by the processing conditions. For example, the processing conditions are thought to influence the degree of molecular orientation (in both the machine direction and the axial or cross direction).

A balance of "machine direction" ("MD") and "transverse direction" ("TD" - which is perpendicular to MD) molecular orientation is generally considered most desirable for key properties associated with the invention (for example, Dart Impact strength, Machine Direction and Transverse Direction tear properties).

Thus, it is recognized that these stretching forces on the "bubble" can affect the physical properties of the finished film. In particular, it is known that the "blow up ratio" (i.e. the ratio of the diameter of the blown bubble to the diameter of the annular die) can have a significant effect upon the dart impact strength and tear strength of the finished film.

The above description relates to the preparation of monolayer films. Multilayer films may be prepared by 1) a "co-extrusion" process that allows more than one stream of molten polymer to be introduced to an annular die resulting in a multi-layered film membrane or 2) a lamination process in which film layers are laminated together. The films of this invention are preferably prepared using the above described blown film process.

An alternative process is the so-called cast film process, wherein the polyethylene is melted in an extruder, then forced through a linear slit die, thereby "casting" a thin flat film. The extrusion temperature for cast film is typically somewhat hotter than that used in the blown film process (with typically operating temperatures of from 450 to 550°F). In general, cast film is cooled (quenched) more rapidly than blown film.

Further details are provided in the following examples.

EXAMPLES

Example 1

Additive Synthesis

A mixture of zinc oxide (5 g, 0.06 mol) GMS (22g, 0.06 mol) and a catalytic amount of zinc acetate (0.5g) were thoroughly mixed in a beaker. The smell of acetic acid was quite noticeable during the reaction. The solids were heated to 150°C for 2 – 3 hours before the suspension was cooled to room temperature. The white solid was removed from the beaker and ground using a mortar and pestle.

Characterization of the product (i.e. the additive of this invention) is not trivial because the product was not highly crystalline and because of limited solubility. FTIR spectra of the starting material (GMS) and the product (additive) showed several differences that confirm a reaction did occur. In particular, the starting GMS shows a broad peak at a wavelength of about 3300 cm^{-1} and this peak is generally regarded as indicating the presence of hydroxyl (-OH) functionality. The FTIR spectrum of the additive shows the loss of most of this peak, indicating that the hydroxyl group participates in the reaction. The FTIR spectrum of the additive also shows a new broad peak at a wavelength of about 1900 cm^{-1}, suggesting the presence of a reaction product of ZnO with the hydroxyl group.

Example 2

HDPE barrier film compositions were prepared on a blown film line manufactured by Macro Engineering Company of Mississauga, Ontario, Canada.

The blown film bubble is air cooled. Typical blow up ratio (BUR) for barrier films prepared on this line are from 1.5/1 to 4/1.

The films of this example were prepared using a film thickness aiming point of 1.5 mils.

Water Vapor Transmission Rate ("WVTR", expressed as grams of water vapor transmitted per 100 square inches of film per day at a specified film thickness (mils), or g/100 in^2/day) was measured in accordance with ASTM F1249-90 with a MOCON permatron developed by Modern Controls Inc. at conditions of 100°F (37.8°C) and 100% relative humidity.

A HDPE blend was used in all experiments. This HDPE blend was prepared in a dual reactor solution polymerization process in accordance with the disclosure of published U.S. patent application 20060047078 (Swabey et al.). The HDPE blend had a melt index, I_2, of 1.2 grams/10 minutes, a density of 0.967 g/cc and a

molecular weight distribution, Mw/Mn, of 8.9. The HDPE blend had two distinct fractions which varied according to molecular weight. The low molecular weight fraction (or component a)) was about 55 weight % of the total composition and had a melt index, I_2, which was estimated to be greater than 5000 grams/10 minutes. The high molecular weight fraction was about 45 weight % of the total composition and had a melt index which was estimated to be less than 0.1 grams/10 minutes.

As noted above, melt index (I_2) is generally inversely proportional to molecular weight for polyethylene resins. This was confirmed for homopolymer HDPE resins having a narrow molecular weight distribution (of less than 3) by preparing a plot of log (I_2) versus log (weight average molecular weight, Mw). In order to prepare this plot, the melt index (I_2) and weight average molecular Mw) of more than 15 different homopolymer HDPE resins was measured. These homopolymer HDPE resins had a narrow molecular weight distribution (less than 3) but had different Mw – ranging from about 30,000 to 150,000. (As will be appreciated by those skilled in the art, it is difficult to obtain reproducible I_2 values for polyethylene resins having a molecular weight which is outside of this range).

A log/log plot of these I_2 and Mw values was used to calculate the following relation between I_2 and Mw for such homopolymer HDPE resins:

$$I_2 = (1.774 \times 10^{-19}) \times (Mw^{-3.86}).$$

Extrapolation (based on the above relation) was used to estimate the I_2 values of component a) and component b) of the HDPE blend. That is, the molecular weight of component a) and component b) was measured and the Mw values were used to estimate the I_2 values. It will be appreciated by those skilled in the art that it can be difficult to physically blend these HDPE blend components (due to the very different viscosities of these HDPE blend components). Accordingly, solution

blending or an in-situ blending (i.e. prepared by a polymerization process) are preferred methods to prepare such HDPE compositions.

A first comparative film was prepared from the above described HDPE blend. The HDPE blend did contain conventional antioxidants (a hindered phenol and a hindered phosphite) but did not contain the additive of this invention. A film having a thickness of 1.5 mils was prepared (on the "Macro" line); tested (on the "MOCON" instrument) and observed to have a WVTR of 0.18 g/100in^2/day (Ex 1-C in Table 1).

Additional films that contain the inventive additive (from example 1, above) in the amounts shown in Table 1 were also prepared.

Table 1

Ex		WVTR (g/ 100 in^2/d)
1-C	0 ppm	0.18
2	750 ppm	0.1106
3	1500 ppm	0.0832
4	2500 ppm	0.0708

As shown in Table 1, WVTR is greatly improved (reduced) with the use of this additive. Optical properties were also observed to improve. The film of comparative example 1-C had a measured haze of 77% and a gloss of 6%. A film prepared with 2000 ppm of the present additive had an improved (lower) haze of 36% and improved (higher) gloss of 20%. Haze was determined according to ASTM D1003 and gloss according to ASTM D1894.

Comparative films were also prepared using 1) GMS as the comparative additive (in an amount of 2000 ppm of GMS) and 2) GMS and ZnO as the comparative additives (in amounts of about 4000 ppm and about 1000 ppm, respectively).

The comparative film prepared using the GMS had a surface layer of a greasy residue. This residue could be easily removed by rubbing the surface of the film. The comparative film prepared with the GMS and ZnO was tested for WVTR. The WVTR of this comparative film was not improved.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A polyethylene additive prepared by the reaction of

a) a fatty acid ester of glycerol; with

b) a divalent metal selected from the group consisting of zinc, calcium, and magnesium, wherein said fatty acid ester of glycerol is selected from the group consisting of glycerol monostearate and glycerol monooleate.

2. The additive of claim 1 wherein said fatty acid ester of glycerol is glycerol monostearate and said divalent metal is zinc.

3. The additive of claim 1 wherein said reaction is conducted in the presence of zinc acetate and said zinc is provided in the form of zinc oxide.

4. The additive of claim 3 wherein the molar ratio of said glycerol monostearate to said zinc oxide is from 1/3 to 3/1.

5. A process to prepare a polyethylene additive by the reaction of a fatty acid ester of glycerol with a divalent metal oxide, said process comprising reacting said fatty acid ester of glycerol with said divalent metal oxide in the presence of an acid catalyst, wherein said fatty acid ester of glycerol is selected from the group consisting of glycerol monostearate and glycerol monooleate.

6. The process of claim 5 wherein said fatty acid ester of glycerol is glycerol monostearate, said divalent metal oxide is zinc oxide and said catalyst is zinc acetate, with the further provisio that the molar ratio of said glycerol monostearate to said zinc oxide is from 1/3 to 3/1.

7. A polyethylene composition comprising

a) high density polyethylene; and

b) from 500 to 5000 parts per million by weight of the additive of claim 1.

8. A polyethylene composition comprising

a) high density polyethylene; and

b) from 500 to 5000 parts per million by weight of the additive of claim 4.

9. The polyethylene composition of claim 8, with the further provisio that said high density polyethylene is characterized by

1) having a melt index of from 0.5 to 10 grams per 10 minutes;

2) a density of from 0.955 to 0.970 g/cc.

10. A blown film prepared from the composition of claim 8, characterized in that said blown film has at least a 20% improvement in WVTR compared to a film made without said additive.