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(54) Title: EXTERNAL LUBRICANT COMPOSITIONS FOR RIGID VINYL POLYMERS		
(57) Abstract <p>The present invention provides an external lubricant composition for lead stabilized vinyl polymer. The external lubricant functions as both an external lubricant and a processing aid by speeding fusion and thus, obviates the need for a separate processing aid. The external lubricant comprises an effective amount for lubricating vinyl polymer of polyethylene having a Brookfield viscosity at a temperature of 150 °C of between about 1 000 and about 100,000 centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40.</p>		

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EXTERNAL LUBRICANT COMPOSITIONS FOR
RIGID VINYL POLYMERS

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This application is a continuation-in-part of U.S. Serial 08/105,826 filed on August 11, 1993.

10 The present invention relates to external lubricant compositions for rigid vinyl polymers and more particularly, to external lubricant compositions for rigid polyvinyl chloride.

Background of the Invention

15 Rigid vinyl polymer compositions, such as polyvinyl chloride compositions, are utilized for producing a variety of structural articles such as plastic pipe, siding, containers, and sheets. These rigid compositions are substantially unplasticized.

20

In order to stabilize vinyl polymer against the decomposing influence of heat and light, basic lead compounds such as tribasic lead sulfate, dibasic lead phosphite, or dibasic lead phosphite sulfite are used. To
25 enhance the effect of these lead compounds, typically metal soaps such as neutral or basic lead stearate and/or calcium stearate are added.

Lubricants are also added to vinyl polymers to facilitate
30 the extrusion or other melt processing of the structural articles produced. Lubricants are generally classified as external or internal lubricants. An external lubricant provides a lubricating layer between the plastic melt and the metallic surfaces of the processing equipment. The external lubricant
35 serves to coat the individual particles of the polymeric resin and inhibits their adherence to the metallic surfaces. In

contrast, an internal lubricant reduces the effective melt viscosity of the vinyl polymer at the processing temperatures in order to improve its flow properties during processing as well as to promote fusion. An internal lubricant is generally
5 needed only for thin extrusions such as films and thin-walled pipe.

The suitability of lubricants for vinyl polymer is determined by the type of stabilizer used in the vinyl
10 polymer. For example, the PLASTICS ADDITIVE HANDBOOK, 3rd Edition (Hanser Publishers 1990) teaches that calcium stearate, stearic acid, hydroxystearic acid, unoxidized polyethylene waxes, paraffin waxes, microwaxes, and FT-waxes (synthetic wax produced by Fischer Trosch
15 process) are suitable lubricants for lead stabilized polyvinyl chloride thick-walled pipes.

As discussed by Kosior et al., "Processing Aids: The Effect of Polymethyl Methacrylate on the Fusion of Rigid
20 Poly(vinyl chloride)", British Polymer Journal 18(2), 94 (1986), lubricants, in addition to preventing adhesion to metal surfaces, have been shown to retard the progress of fusion of polyvinyl chloride. Processing aids based on polymethyl methacrylate are effective in accelerating the
25 rate of fusion of polyvinyl chloride and are currently used in such compositions. For example, Kosior et al. teach a lead stabilized polyvinyl chloride which used a polymethyl methacrylate processing aid. See also Cogswell, "Influence of Acrylic Processing Aids on the Rheology and Structure of
30 Polyvinyl Chloride", Pure & Appl. Chem, 55(1), 177 (1983).

Known lead stabilized rigid polyvinyl chloride pipe formulations include compositions such as:

Resin	PVC	100 phr
Pigment	Titanium Dioxide	1.0
Filler	Coated CaCO ₃	5.0
Stabilizer	Tribasic lead sulfate	1.0
Co-Stabilizer	Lead stearate	0.8
Co-Stabilizer/ Lubricant	Calcium Stearate	0.4
Internal Lubricant	SteryI Stearate	0.6
External Lubricant	A-C [®] 6A (unoxidized homopolymer polyethylene wax, Brookfield viscosity at 140°C of 350 cps)	0.2
External Lubricant	A-C [®] 629 (oxidized polyethylene wax, Brookfield viscosity at 140°C of 200 cps)	0.15

5 which is disclosed in TECHNICAL DATA FOR LOW MOLECULAR WEIGHT POLYETHYLENES AND DERIVATIVES by AlliedSignal Inc., a chapter of the POLYMER ADDITIVE HANDBOOK (1992);

Rigid 4-Cell Resin	100 phr
Lead Stabilizer	5.0
Calcium Carbonate	1.5
Titanium Dioxide	2.0
Acrylic Processing Aid	3.0
Calcium Stearate	1.0
A-C [®] 629A (oxidized polyethylene wax, Brookfield viscosity at 140°C of 200 centipoises)	0 to 1

10 which is disclosed by David Hurwitz, "The Use of Low Molecular Weight Polyethylene in Rigid PVC Lubrication",

Society of Plastics Engineers, 31st Annual Technical Conference, 349 (May 1973), and

PVC	100 phr
Tribasic Lead Sulfate	0.5
Dibasic Lead Stearate	1.0
Calcium Stearate	0.4
Stearic Acid	0.4
A-C [®] 617A (unoxidized homopolymer polyethylene wax, Brookfield viscosity at 140°C of 180 centipoises)	0.2-0.4

- 5 which is disclosed in A-C[®] POLYETHYLENES FOR PVC by AlliedSignal Inc. (1986). See also Technical Data on A-C[®] Polyethylenes and Copolymers for Plastics by AlliedSignal Inc. (1973) which teaches that A-C[®] 629A (low density oxidized polyethylene wax) is useful for lead stabilized
 10 polyvinyl chloride.

Additives which speed fusion in polyvinyl chloride compositions are desired in the art. ASTM D 2538 defines fusion time as the time from the point of loading the
 15 composition into the torque rheometer to the point of maximum torque. See also Robert A. Lindner, "External Lubricants that Speed Fusion", Plastics Compounding (September/October 1989). The first and third formulations above are undesirable because the unoxidized homopolymer polyethylene wax having a Brookfield viscosity at 140°C of
 20 180 or 350 centipoises delays fusion and thus, increases fusion time. Additionally, the unoxidized homopolymer polyethylene wax serves as more of a fusion control rather than an external lubricant and thus, it is necessary to add an
 25 additional external lubricant such as oxidized polyethylene wax having a Brookfield viscosity at 140°C of 200 centipoises or stearic acid to the composition. Although the

first and third formulations above have good lubricity, the fusion times are too long. Additionally, stearic acid has a low melting point which means that it evaporates during normal processing conditions.

5

The second formulation above is undesirable because a processing aid is used which increases the cost of the final composition. Also, the presence of an acrylic processing aid in the final product may cause high viscosity and poor flow.

10

U.S. Patent 4,203,880 discloses tin stabilized polyvinyl chloride having a lubricant package comprising oxidized polyethylene wax and a known external lubricant such as paraffin oils, paraffin waxes, liquid and solid hydrocarbons, unoxidized polyethylene waxes, montan ester waxes, lead stearate, mineral oil, 12-hydroxystearic acid, ethylene bis-stearamide, and glycol esters of fatty acids that contain 10 to 20 or more carbon atoms and cites two articles which teach the preceding known external lubricants: Illmann, "Waxes as Lubricants in Plastics Processing", SPE Journal, 71 (June 1967) and King et al., "Characterization of Lubricants for Polyvinyl Chloride", Polymer Engineering and Science 12(2), 112 (March 1972).

25

U.S. Patent 4,203,880 also discloses that other heat stabilizers useful with polyvinyl chloride include organosulfur-containing antimony compounds and alkaline earth metal salts of carboxylic acids. The reference further states that the known external lubricants and oxidized polyethylene waxes should be compatible with most, if not all, of the conventional heat stabilizers used for polyvinyl chloride. However, Illmann, "Waxes as Lubricants in Plastics Processing", SPE Journal, 71 (June 1967) and King et al., "Characterization of Lubricants for Polyvinyl Chloride", Polymer Engineering and Science 12(2), 112 (March 1972) only teach tin, calcium/zinc, and barium/cadmium stabilizers

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in combination with the known external lubricants. Additionally, although the PLASTICS ADDITIVE HANDBOOK 3rd Edition (Hanser Publishers 1990) teaches that oxidized polyethylene waxes are suitable for tin stabilized thick-walled polyvinyl chloride, the reference does not teach that oxidized polyethylene waxes are suitable for lead stabilized thick-walled polyvinyl chloride.

It would be desirable to have a lead stabilized vinyl polymer composition which has improved fusion time, i.e. reduced fusion time. It would also be desirable to have a lead stabilized vinyl polymer composition which has improved fusion time, i.e. reduced fusion time, in the absence of a resinous processing aid such as an acrylic processing aid.

Summary of the Invention

We have found a composition which responds to the foregoing need in the art. Surprisingly, we have found an external lubricant composition for lead stabilized vinyl polymer wherein the external lubricant not only functions as an external lubricant but also functions as a processing aid to speed fusion. Thus, the need for a processing aid is obviated and as a result, the cost of the final product is reduced. In addition, the amount of the present external lubricant required is less than the combined amount of currently used lubricant and processing aid.

The present external lubricant composition for lead stabilized vinyl polymer wherein the external lubricant eliminates the need for a resinous processing aid comprises: an effective amount for lubricating the vinyl polymer of polyethylene having a Brookfield viscosity at a temperature of 150°C of between about 1000 and about 100000

centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40.

5 The present invention also provides a composition comprising: (a) vinyl polymer; (b) an effective amount for stabilizing the vinyl polymer of lead stabilizer and metallic stearate; and (c) an effective amount for lubricating the vinyl
10 polymer of polyethylene having a Brookfield viscosity at a temperature of 150°C of between about 1000 and about 100000 centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40.

15 The present invention also provides a method for decreasing Brabender fusion time in a lead stabilized vinyl polymer comprising the step of: adding an effective amount for lubricating the vinyl polymer of polyethylene having a Brookfield viscosity at a temperature of 150°C of between
20 about 1000 and about 100000 centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40.

25 Other advantages of the present invention will be apparent from the following description and attached claims.

Detailed Description of the Preferred Embodiments

30 Vinyl polymers useful in the present invention include polyvinyl chloride and polymerized forms of vinyl acetate, vinyl chloride-vinyl acetate copolymers, vinylidene halides such as vinylidene chloride vinyl pyridine, vinyl carbazole styrene, vinylbenzene, acrylic esters such as methyl acrylate,
35 ethyl acrylate, or methylmethacrylate as well as acrylonitrile. The preferred vinyl polymer is polyvinyl chloride which

includes both homopolymers of vinyl chloride and both copolymers and terpolymers of vinyl chloride with comonomers such as vinyl acetate, vinyl formate, alkyl vinyl ethers, ethylene, propylene, butylene, vinylidene chloride, alkyl acrylates and methacrylates, alkyl maleates, and alkyl fumarates. Preferably, at least 80% and more preferably 100% of the monomer to be polymerized will be a vinyl chloride monomer. Vinyl polymers useful in the present invention are commercially available.

10

Lead stabilizers useful in the present invention include tribasic lead sulfate, tetrabasic lead sulfate, dibasic lead phosphite, dibasic lead phosphite sulfite, and lead phthalate. The preferred lead stabilizer is tribasic lead sulfate. Lead stabilizers useful in the present invention are commercially available.

15

In order to enhance the effect of the lead compounds, typically metal soaps such as metallic stearates are also added. Preferred metallic stearates include cadmium stearate, manganese stearate, cesium stearate, lead stearate, lithium stearate, strontium stearate, sodium stearate, calcium stearate, barium stearate, and magnesium stearate. The more preferred metallic stearates are lead stearate, calcium stearate, and barium stearate. The most preferred metallic stearate is lead stearate. Metallic stearates useful in the present invention are commercially available.

20

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An effective amount for stabilizing the vinyl polymer of the lead stabilizer and metallic stearate is used. Typically, the lead stabilizer and metallic stearate are present in an amount of about 0.25 to about 5 parts by weight per 100 parts of vinyl polymer. Typically, the ratio of lead stabilizer to metallic stearate is about 1:10 to about 10:1.

35

The polyethylene of the present invention has a Brookfield viscosity at a temperature of 150°C of between about 1000 and about 100000 centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40. Suitable polyethylenes may be characterized as oxidized high density homopolymers of ethylene, copolymers containing acrylates and ethylene, terpolymers containing acrylates, esters, and ethylene. Preferably, oxidized high density homopolymers of ethylene are used. These polyethylenes have been oxidized to an acid number as determined by a standardized titration of KOH of more preferably between about 5 and about 40, and most preferably between about 5 and about 35. These polyethylenes typically have a density as determined by ASTM D-1505 in the range of about 0.85 to about 1.05, more preferably in the range of about 0.98 to about 1.05, and most preferably in the range of about 0.98 to about 1.00. These oxidized polyethylenes exhibit a Brookfield viscosity at a temperature of 150°C of more preferably in the range of between about 2000 and about 90000 centipoises and most preferably in the range of between about 2500 and about 85000 centipoises.

Suitable oxidized polyethylenes are available from AlliedSignal Inc., Morristown, New Jersey. Preferred oxidized polyethylenes are listed in the following Table:

Oxidized Polyethylene	Acid Number (mgKOH/gram)	Density (grams/cc)	Brookfield Viscosity (cps at 150°C)
A-C® 307A	5 - 9	0.98	> 80000
A-C® 316A	15 - 18	0.98	8500
A-C® 330	28 - 32	0.99	3600
A-C® 392	28 - 32	0.99	4500

The more preferred oxidized polyethylenes are A-C[®] 307A and A-C[®] 316A oxidized polyethylenes. The most preferred oxidized polyethylene is A-C[®]307A oxidized polyethylene.

5

These oxidized polyethylenes as well as others which are useful in the practice of the present invention may be obtained by oxidizing polyethylenes with air or oxygen by convention procedures. Suitable methods are described in U.S. Patents 3,060,163 and 3,322,711 which are incorporated herein by reference. As those skilled in the art know, the oxidation results in the scission of the polymer and the formation of acid groups. In addition to the formation of acid groups on the polymer chain, esters, aldehydes, ketones, hydroxides, and peroxides are also found in various quantities along the polymer chains.

If too little lubricant is present in the final vinyl polymer composition, the melt viscosity of the vinyl polymer composition may be too high or the fusion time may be too short. An extremely short fusion time is undesirable for extrudable compositions because this may result in prolonged exposure of the polymer melt to elevated temperatures which results in premature degradation. If too much lubricant is present in the final vinyl polymer composition, a condition referred to as "plate out" may occur. The excess lubricant rises to the surface of the vinyl polymer composition and remains in contact with the heated wall of the extruder, mill, or calendar roll for a sufficient time to become charred. The char is either carried along with the molten polymer causing discoloration, or the char may form deposits along the inner wall or in the die of an extruder, thereby altering the shape of the extruder article.

35 An effective amount for lubricating the vinyl polymer of oxidized polyethylene is used. Typically, the oxidized

polyethylene is present in an amount of about 0.01 to about 10 parts by weight per 100 parts of vinyl polymer. The oxidized polyethylene is present preferably in an amount of about 0.05 to about 5 parts by weight per 100 parts of vinyl polymer, more preferably in an amount of about 0.05 to about 1 part by weight per 100 parts of vinyl polymer, and most preferably in an amount of about 0.1 to about 1 part by weight per 100 parts of vinyl polymer.

10 In addition to the heat stabilizer, metallic stearate, and external lubricant, the present compositions may contain one or more additives conventionally employed in moldable or extrudable polymer compositions. These additives include fillers such as alkaline earth metal carbonates, pigments such as titanium dioxide, antioxidants such as sterically hindered phenols or bis-phenols, impact modifiers such as methyl methacrylate-butadiene-styrene terpolymers, and adsorbents such as the alkaline earth metal silicates and diatomaceous earth if the composition contains a significant amount of liquid ingredients.

The vinyl compositions to which the present external lubricants are added are rigid which means that they contain essentially no plasticizer. Such vinyl resins are useful in the production of rigid articles, principally rigid pipe, siding, containers, and sheets.

It is known that the effectiveness of lubricants on resin formulations may be evaluated by measurement of rheological properties of the formulation. These properties are typically studied by means of a torque rheometer consisting of a miniature mixer and a torque meter which measure the load on the mixer. The mixing forces developed within a sample of material at a certain temperature cause a deflection of a recording dynamometer. This deflection is recorded on a strip chart. This torque, which is expressed

in meter-grams, is directly related to the viscosity of the melt being mixed. When a polymer of the vinyl type degrades, it crosslinks rapidly and shows a sharp rise in its melt viscosity. The time for this to occur is a measure of the thermal stability under dynamic shear conditions. A typical torque rheometer curve provides one skilled in the art with information as to melting, fusion, flow, and crosslinking in the processing of the polymer tested. This procedure is set forth in ASTM D 2538-88 - "Standard Practice for Fusion of Poly(Vinyl Chloride)(PVC) Compounds Using a Torque Rheometer".

The most generally used rheometer is the Brabender Plasticorder which essentially consists of an oil-heated roller mixing head driven by a variable speed motor equipped with means to measure the torque developed in the head. The machine is fitted with a mixing head equipped with a melt thermocouple. To determine the fusion time of a polyvinyl chloride powder blend, for example, an accurately weighed quantity of the blend is charged into the mixing head with the aid of a quick-loading chute. A graph of the torque against time is produced and the point when fusion is complete is shown by an initial peak in torque. The dynamic heat stability is measured in minutes from the start of the graph until the decomposition point which is marked by a rise in torque.

The present invention is more fully illustrated by the following non-limiting Examples. Unless otherwise stated, all parts are by weight.

COMPARATIVES AND EXAMPLES

For each Example, the effect of the present external lubricants for polyvinyl chloride pipe compounds was

determined utilizing a Brabender Plasticorder at 190°C jacket temperature, at 60 RPM, and sample size of 40xSPG. Each composition was prepared by blending in a Henschel mixer for 10 minutes at 3800 RPM and for an additional 10
 5 minutes at 2600 RPM. The fusion time and torque fusion were determined from the plastogram and are recorded below. The present lubricants used were A-C® 307A and A-C® 316A oxidized polyethylenes which are commercially available from AlliedSignal Inc., Morristown, New Jersey,
 10 United States of America. The properties of these oxidized polyethylenes are as follows:

Oxidized Polyethylene	Acid Number (mgKOH/gram)	Density (grams/cc)	Brookfield Viscosity (cps at 150°C)
A-C® 307A	5 - 9	0.98	> 80000
A-C® 316A	15 - 18	0.98	8500

15 The Comparatives were run in the same manner as the Examples except that currently used lubricants with or without processing aids were used instead of the present lubricants.

20 For each Comparative and Example, the resin used was Shintech 950 PVC and the filler used was Atomite CaCO₃. The pigment used was Titanox 201 TiO₂ and the lead stabilizer used was Baerostab V220MC Tribasic Lead Stabilizer (abbreviated as TBLS below). The lead stearate
 25 used was Baerostab Pb28F and the paraffin used had a melting point of 72°C. The stearic acid used was Unichema 4911 stearic acid. The acrylic processing aid used was Kaheka PA-20 (abbreviated as PA 1 below) or Metablend P501 (abbreviated as PA 2 below). The oxidized
 30 polyethylene wax used was A-C® 629 oxidized polyethylene

wax having a Brookfield viscosity at 140°C of 200 centipoises and the unoxidized polyethylene wax used was A-C® 617 unoxidized polyethylene wax having a Brookfield viscosity at 140°C of 180 centipoises.

5

COMPARATIVES A THROUGH C

Component	COMP. A	COMP. B	COMP. C
PVC	100	100	100
CaCO ₃	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0
TBLS	0.35	0.35	0.35
Lead Stearate	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4
Stearic Acid	0.3	0.1	0.8
Total Weight (grams)	58.1	58.2	57.9
Brabender Fusion Time (minutes)	15.5	12.8	15.7
Maximum Torque (meter-grams)	1850	1800	1725

COMPARATIVES D THROUGH G

Component	COMP. D	COMP. E	COMP. F	COMP. G
PVC	100	100	100	100
CaCO ₃	3.0	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0	1.0
TBLS	0.35	0.35	0.35	0.35
Lead Stearate	1.5	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4	0.4
Stearic Acid	0.3	0.3	0.3	0.3
PA1	0.3	0.8	1.5	2.0
Total Weight (grams)	57.7	57.7	57.6	57.5
Brabender Fusion Time (minutes)	17.4	17.5	19.1	16.8
Maximum Torque (meter-grams)	1875	2000	2150	2250

5 Unlike Comparatives A through C, Comparatives D through G contained a processing aid (PA1). Comparing Comparatives D through G with Comparative A because they all contained 0.3 phr stearic acid, the fusion time increased when the processing aid (PA1) was added in Comparatives D through G.

COMPARATIVES H THROUGH K

Component	COMP. H	COMP. I	COMP. J	COMP. K
PVC	100	100	100	100
CaCO ₃	3.0	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0	1.0
TBLS	0.35	0.35	0.35	0.35
Lead Stearate	1.5	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4	0.4
Stearic Acid	0.3	0.3	0.3	0.3
PA2	0.3	0.8	1.5	2.0
Total Weight (grams)	58.1	58.0	57.9	57.8
Brabender Fusion Time (minutes)	12.5	10.5	9.0	6.8
Maximum Torque (meter-grams)	1850	1950	2000	2075

5 Unlike Comparatives A through C, Comparatives H through K contained a processing aid (PA2). Comparing Comparatives H through K with Comparative A because they all contained 0.3 phr stearic acid, the fusion time decreased when the processing aid (PA2) was added in Comparatives H through K.

COMPARATIVES L THROUGH Q

Component	COMP . L	COMP . M	COMP . N	COMP . O	COMP . P	COMP . Q
PVC	100	100	100	100	100	100
CaCO ₃	3.0	3.0	3.0	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0	1.0	1.0	1.0
TBLS	0.35	0.35	0.35	0.35	0.35	0.35
Lead Stearate	1.5	1.5	1.5	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4	0.4	0.4	0.4
A-C® 617A	0.3	0.1	---	---	---	---
A-C® 629A	---	---	---	0.3	0.1	0.8
Total Weight (grams)	57.8	57.8	57.9	58.2	58.2	58.0
Brabender Fusion Time (minutes)	18.1	15.7	9.8	10.4	9.6	9.6
Maximum Torque (meter- grams)	1775	1750	1825	1725	1800	1625

5 Comparing Comparative L with Comparative A because they both contained 0.3 phr external lubricant, the fusion time increased with the unoxidized polyethylene having a Brookfield viscosity at 140°C of 180 centipoises.

10 Comparing Comparative M with Comparative B because they both contained 0.1 phr external lubricant, the fusion time increased with the unoxidized polyethylene having a Brookfield viscosity at 140°C of 180 centipoises.

Comparing Comparative O with Comparative A because they both contained 0.3 phr external lubricant, the

fusion time decreased with the oxidized polyethylene having a Brookfield viscosity at 140°C of 200 centipoises.

Comparing Comparative P with Comparative B because they both contained 0.1 phr external lubricant, the fusion time

5 decreased with the oxidized polyethylene having a Brookfield viscosity at 140°C of 200 centipoises. Comparing

Comparative Q with Comparative C because they both contained 0.8 phr external lubricant, the fusion time

10 decreased with the oxidized polyethylene having a Brookfield viscosity at 140°C of 200 centipoises.

EXAMPLES 1 THROUGH 6

Component	EX. 1	EX. 2	EX. 3	EX. 4	EX. 5	EX. 6
PVC	100	100	100	100	100	100
CaCO ₃	3.0	3.0	3.0	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0	1.0	1.0	1.0
TBLS	0.35	0.35	0.35	0.35	0.35	0.35
Stearate	1.5	1.5	1.5	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4	0.4	0.4	0.4
A-C® 307A	0.3	0.1	0.8	---	---	---
A-C® 316A	---	---	---	0.3	0.1	0.8
Total Weight (grams)	57.8	57.8	57.7	58.1	58.2	58.0
Brabender Fusion Time (minutes)	3.5	8.4	1.0	1.7	4.6	1.0
Maximum Torque (meter-grams)	1700	1750	1800	1825	1800	1900

Comparing Examples 1 and 4 with Comparatives A, D through G, H through K, L, and O because they all contained 0.3 phr external lubricant, the fusion time decreased dramatically when the present external lubricant was used and thus, the need for a processing aid is eliminated with the present invention. Comparing Examples 2 and 5 with Comparatives B, M, and P because they all contained 0.1 phr external lubricant, the fusion time decreased dramatically when the present external lubricant was used and thus, the need for a processing aid is eliminated with the present invention. Comparing Examples 3 and 6 with Comparatives C and Q because they all contained 0.8 phr external lubricant, the fusion time decreased dramatically when the present external lubricant was used and thus, the need for a processing aid is eliminated with the present invention.

EXAMPLES 7 THROUGH 12

Component	EX. 7	EX. 8	EX. 9	EX. 10	EX. 11	EX. 12
PVC	100	100	100	100	100	100
CaCO ₃	3.0	3.0	3.0	3.0	3.0	3.0
TiO ₂	1.0	1.0	1.0	1.0	1.0	1.0
TBLS	0.35	0.35	0.35	0.35	0.35	0.35
Barium Stearate	1.5	1.5	1.5	---	---	---
Calcium Stearate	---	---	---	1.5	1.5	1.5
Paraffin	0.4	0.4	0.4	0.4	0.4	0.4
A-C® 307A	0.3	0.1	0.8	0.3	0.1	0.8
Total Weight (grams)	57.0	57.1	56.9	56.8	56.9	56.7
Brabender Fusion Time (minutes)	0.7	0.7	0.6	0.75	0.8	0.6
15 Min Torque (meter-grams)	2050	2100	2050	2075	2100	2050

5 These results indicate that the use of barium stearate or calcium stearate with the present lubricant also provided decreased fusion time.

10 For the following Comparatives and Examples, the resin used was Solvic 264GA polyvinyl chloride (abbreviated as PVC below). The lead stabilizer used was Akcros' HaroChem PDF dibasic lead phosphite (abbreviated as DBLP below) and the lead stearate used was Akcros' HaroChem P51 dibasic lead stearate (abbreviated as DBLS below). The

calcium stearate used was Akcros' HaroChem CGL calcium stearate. The palmityl stearyl phthalate used was Henkel's Loxiol G60 palmityl stearyl phthalate (abbreviated as PSP below). The titanium dioxide used was Kronos Titan-
 5 GmbH's Kronos 2220 titanium dioxide and the filler used was Solvay's Socal 3121 calcium carbonate. The impact modifier used was Rohm & Haas' Paraloid KM334 acrylic impact modifier (abbreviated as AIM below). The pigment used was Sandoz's Rubin Graphtol BP organic red pigment.
 10 The processing aid used was Rohm & Haas' Paraloid K120N acrylic processing aid (abbreviated as PA below). The oxidized polyethylene wax used was A-C® 629 oxidized polyethylene wax having a Brookfield viscosity at 140°C of 200 centipoises. The ethylene-vinyl acetate copolymer used
 15 was A-C® 400 ethylene-vinyl acetate copolymer which has 13 percent vinyl acetate.

The present lubricants used were A-C® 307A, A-C® 316A, and A-C® 392 oxidized polyethylenes which are
 20 commercially available from AlliedSignal Inc., Morristown, New Jersey, United States of America. The properties of these oxidized polyethylenes are as follows:

Oxidized Polyethylene	Acid Number (mgKOH/gram)	Density (grams/cc)	Brookfield Viscosity (cps at 150°C)
A-C® 307A	5 - 9	0.98	> 80000
A-C® 316A	15 - 18	0.98	8500
A-C® 392A	28 - 32	0.99	4500

25 The purpose of the following test was to evaluate the plate-out or residue of a PVC formulation using a red organic pigment as indicator. For each Comparative and Example, each formulation was mixed in a high speed Papenmeier mixer up to 120°C. After cooling down to room

temperature, 250 grams of each formulation were mixed in a high speed Braun mixer (Type MX32) with an addition of 2.5 grams of Sicored WPC organic pigment during a two minute period.

5

Each formulation was then processed on a two-roll mill for 5 minutes at 190°C with a gap of 0.4 mm. The sheet formed was then thrown away. The result was that the plate-out/residue in addition to some pigment stuck to the cylinder. In order to recuperate this material, the following formulation (250 grams) was processed on the two-roll mill for 3 minutes at 190°C and with a gap of 0.7 mm. The lead sulphate used was Akcros' HaroChem PTS-E tribasic lead sulphate and the lead stearate used was Akcros' HaroChem P28G neutral lead stearate. The calcium carbonate used was Solvay's Socal 3121 calcium carbonate and the titanium dioxide used was Kronos Titan GmbH's Kronos 2220 titanium dioxide. The di-octyl phthalate used was an Exxon product (abbreviated as DOP below) and the stearic acid used was Oleofina's Radiacid 423 stearic acid.

10
15
20

PVC-S-K64	100
Tribasic Lead Sulphate	3
Neutral Lead Stearate	0.2
CaCO ₃	1
TiO ₂	1
DOP	25
Stearic Acid	0.1
A-C® 629A	0.3

Plate-out was determined by this second compound (color) which was directly proportional to the intensity of the residue. If no plate-out occurred, the color was white. If some plate-out occurred, the color was pink. If more plate-out occurred, the color was red. If alot of plate-out occurred, the color was dark red.

25

COMPARATIVES R THROUGH T

Component	COMP. R	COMP. S	COMP. T
PVC	100	100	100
DBLP	3	3	3
DBLS	1	1	1
Ca Stearate	0.5	0.5	0.5
PSP	0.5	0.5	0.5
TiO ₂	5	5	5
CaCO ₃	5	5	5
AIM	8	8	8
Pigment	1	1	1
PA	---	0.6	---
A-C® 629A	---	---	0.4
Plate-Out	None.	None.	None.

EXAMPLES 13 THROUGH 17

Example	13	14	15	16	17
PVC	100	100	100	100	100
DBLP	3	3	3	3	3
DBLS	1	1	1	1	1
Ca Stearate	0.5	0.5	0.5	0.5	0.5
PSP	0.5	0.5	0.5	0.5	0.5
TiO ₂	5	5	5	5	5
CaCO ₃	5	5	5	5	5
AIM	8	8	8	8	8
Pigment	1	1	1	1	1
A-C®316	0.6	---	0.6	---	---
A-C®392	---	0.6	---	---	---
A-C®400	---	---	0.2	---	0.2
A-C®307A	---	---	---	0.6	0.6
Plate-Out	High.	High.	High.	Light.	Light.

5 The results indicate that the compositions of Examples 16 and 17 showed the lightest plate-out. As indicated by the compositions of Examples 13 through 15, plate-out increases proportionally with the value of the acid number of the external lubricant.

WHAT IS CLAIMED IS:

1. A composition comprising:
 - (a) vinyl polymer;
 - 5 (b) an effective amount for stabilizing said vinyl polymer of lead stabilizer and metallic stearate; and
 - (c) an effective amount for lubricating said vinyl polymer of polyethylene having a Brookfield viscosity at a temperature of 150°C of between about 1000 and about
10 100000 centipoises and an acid number as determined by standardized titration of KOH of between about 1 and about 40.

2. The composition of claim 1 wherein said vinyl
15 polymer is polyvinyl chloride.

3. The composition of claim 1 wherein said polyethylene is present in an amount of about 0.01 to about 10 parts by weight per 100 parts of said vinyl polymer.
20

4. The composition of claim 1 wherein said polyethylene has a Brookfield viscosity of between about 2000 and about 90000 centipoises.

- 25 5. The composition of claim 1 wherein said polyethylene has an acid number as determined by standardized titration of KOH of between about 5 and about 40.

- 30 6. The composition of claim 1 wherein said polyethylene has an acid number of between about 5 and about 9, a density as determined by ASTM D-1505 of about 0.98 grams/cc, and a Brookfield viscosity at a temperature of 150°C of greater than about 80000 centipoises.
35

7. The composition of claim 1 wherein said polyethylene has an acid number of between about 15 and about 18, a density as determined by ASTM D-1505 of about 0.98 grams/cc, and a Brookfield viscosity at a
5 temperature of 150°C of about 8500 centipoises.

8. The composition of claim 1 wherein said polyethylene has an acid number of between about 28 and about 32, a density as determined by ASTM D-1505 of
10 about 0.99 grams/cc, and a Brookfield viscosity at a temperature of 150°C of about 3600 centipoises.

9 The composition of claim 1 wherein said polyethylene has an acid number of between about 28 and
15 about 32, a density as determined by ASTM D-1505 of about 0.99 grams/cc, and a Brookfield viscosity at a temperature of 150°C of about 4500 centipoises.

10. The composition of claim 1 wherein said
20 composition has a Brabender fusion time of less than about ten minutes.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 94/08985

A. CLASSIFICATION OF SUBJECT MATTER

C 08 L 27/06, C 08 K 5/09, //(C 08 L 27/00; C 08 L 27:06;
C 08 L 23:30)

According to International Patent Classification (IPC) or to both national classification and IPC 6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C 08 L, C 08 K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP, A, 0 011 455 (M & T CHEMICALS, INC.) 28 May 1980 (28.05.80), page 4, line 10 - page 5, line 25; page 13, lines 8-21; examples; claims & US, A, 4 203 880 --	1-10
A	EP, A, 0 044 616 (IMPERIAL CHEMICAL INDUSTRIES LIMITED) 27 January 1981 (27.01.81), page 3, lines 11-26; examples; claims. -----	1, 3-9

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

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ANHANG

zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.

ANNEX

to the International Search Report to the International Patent Application No.

ANNEXE

au rapport de recherche international relatif à la demande de brevet international n°

PCT/US 94/08985 SAE 95304

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentedokumente angegeben. Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The Office is in no way liable for these particulars which are given merely for the purpose of information.

La présente annexe indique les membres de la famille de brevets relatifs aux documents de brevets cités dans le rapport de recherche international visée ci-dessus. Les renseignements fournis sont donnés à titre indicatif et n'engagent pas la responsabilité de l'Office.

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