

(12) UK Patent Application (19) GB (11) 2 412 375 (13) A

(43) Date of A Publication 28.09.2005

(21) Application No: 0404620.7

(22) Date of Filing: 02.03.2004

(71) Applicant(s):
Croda International plc
(Incorporated in the United Kingdom)
Cowick Hall, Snaith, GOOLE,
North Humberside, DN14 9AA,
United Kingdom

(72) Inventor(s):
David Andrew Parker
Adam Maltby
Martin Read
Philip McCoy

(74) Agent and/or Address for Service:
Marks & Clerk
45 Grosvenor Road, ST ALBANS,
Hertfordshire, AL1 3AW, United Kingdom

(51) INT CL⁷:
C08K 5/10 , C08G 63/00

(52) UK CL (Edition X):
C3K KLA K296 K297
C3V VEH
C3W W314 W317 W319

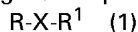
(56) Documents Cited:

GB 2302543 A	GB 2152061 A
GB 1244917 A	EP 0947543 A2
EP 0577091 A1	WO 1993/011206 A1
JP 110071506 A	JP 080059974 A
JP 060157879 A	JP 050255577 A
JP 040342766 A	JP 010207344 A
JP 2004012610 A	

(58) Field of Search:
UK CL (Edition W) **C3K**
INT CL⁰ **C08K, C08L**
Other: **ONLINE: WPI, EPODOC, JAPIO**

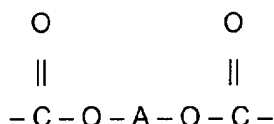
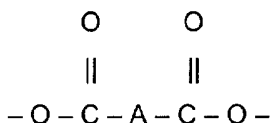
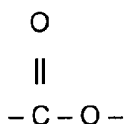
(54) Abstract Title: **Ester slip agents**

(57) A compound of formula 1 is used as a slip agent in a polymer:



wherein: R and R¹ represent hydrocarbon moieties comprising 6 to 24 carbon atoms;

X represents one of the moieties:



wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms.

Preferably, the compound is stearyl stearate, stearyl behenate, behenyl behenate or ethylene glycol distearate. The polymer may be a polyester. A container or film formed from the polymer containing the slip agent is also disclosed.

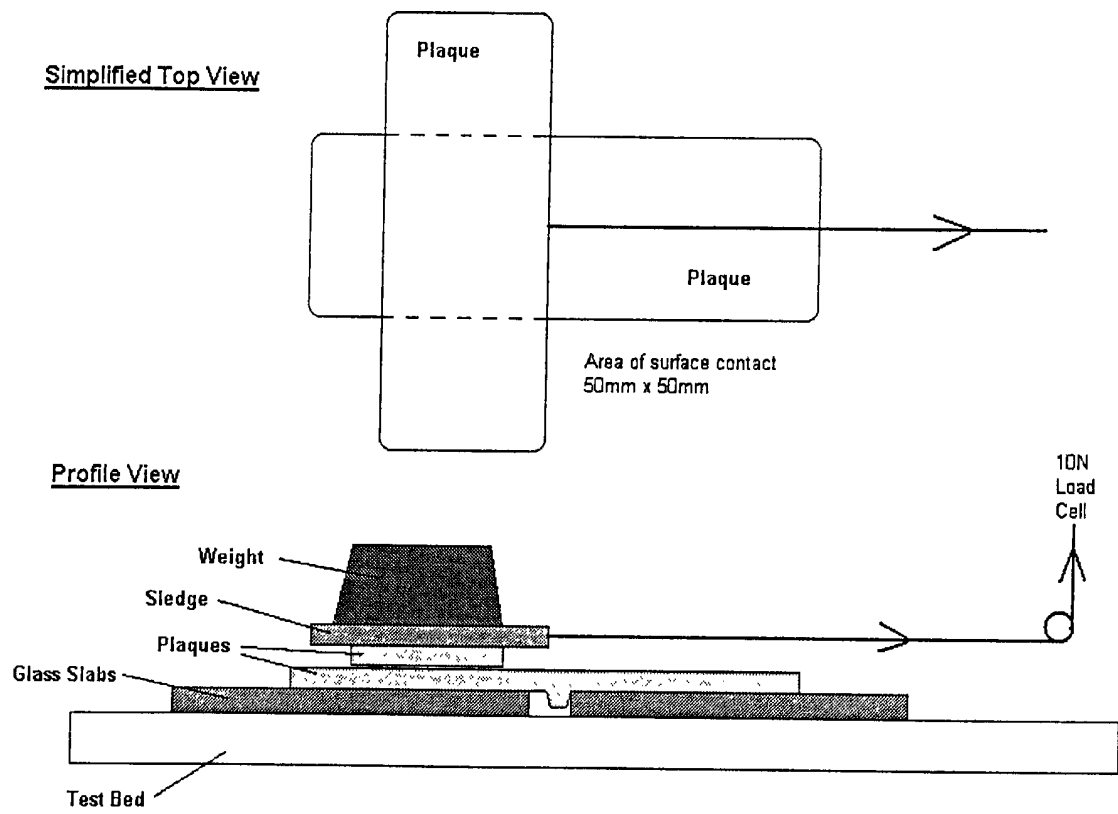


Figure 1

COMPOUNDS

The present invention relates to polymer additives. It is particularly applicable to additives which reduce the coefficient of friction of a polymer, such as
5 a polyester.

Poly(ethylene terephthalate) (PET) is an important plastics material, widely used in the manufacture of moulded polyester articles and films. The key advantages of using PET are:

10

- High clarity
- Light weight
- Good processability
- Excellent barrier properties against oxygen and carbon dioxide
- 15 • Good impact resistance
- Tough – virtually unbreakable
- Economic

Largely as a consequence of the above properties, the most important plastic application for PET homopolymer and copolymers is in the manufacture of
20 bottles.

PET bottles are produced predominantly using a two stage stretch blow moulding process. Firstly a preform is produced by injection moulding. This is a
25 relatively thick – walled part with the neck features moulded during this process. The preform is then reheated in a reheat blow machine which stretches the preform by a stretching pin and inflates it by blowing air into the mould to the desired shape. This gives a biaxially orientated container which provides improved properties such as clarity and gas barrier performance. This is especially important for carbonated drink
30 containers.

PET bottles may also be manufactured by injection blow moulding which is a 2-stage technique performed on a single machine. The preform is injection moulded and whilst still hot is moved to a blowing station where it is blown up to the desired
35 shape. This is the preferred technique for small containers requiring specific neck detail or finish and produces containers that are less biaxially orientated.

A major difficulty in fabricating articles from PET is the relatively high coefficient of friction of the polymer. In the manufacture of bottles this problem can manifest itself in a number of ways:

- 5 • Less than optimum packing density when performs are packed into a box with concomitant higher storage and transportation costs.
- Poor flow on conveying equipment and hence reduced throughput
- Surface defects due to poor scratch resistance

10 There is thus a need for an effective additive system for PET which reduces the coefficient of friction of the polymer and thus overcomes the above deficiencies.

Additives that are effective in reducing the coefficient of friction of polymers are known in the industry as slip additives. However, in order to be acceptable for
15 beverage containers, the fabricated PET bottle must exhibit low colour and high clarity, with low taste and odour and be non-toxic. This imposes other important requirements on a slip agent in addition to its friction-reducing properties.

The conventional slip agents of choice in the plastics industry are fatty
20 amides. These additives are widely used in polyolefins such as polyethylene, polypropylene, and related copolymers. Fatty amides employed as slip additives are generally manufactured from fatty acids containing between 16 and 22 carbon atoms and are characterised by a variety of structural forms:

- 25 • Primary amides which can be either monounsaturated (as exemplified by erucamide and oleamide) or saturated (as exemplified by stearamide and behenamide)
- Secondary amides as exemplified by stearyl erucamide and oleyl palmitamide
- Bis amides such as ethylene bis stearamide

30

In view of their widespread usage in polymer systems, it is clearly logical to consider fatty amides as slip agents for polyesters such PET. However we have established that although fatty amides do demonstrate some friction reducing properties in PET, the lowering of the coefficient of friction is much less than in
35 polyolefins. Moreover all amides cause discolouration in injection moulded PET which will severely restrict their utility in this polymer.

Conventional slip agent technology cannot therefore be readily applied to in PET. This is particularly the case in bottle (preform) manufacture where in addition to low coefficient of friction, other strict requirements with regard to colour, taste and odour must be met.

5

It is therefore an object of the present invention to provide compositions having improved slip and anti-block characteristics when used in polymers such as PET and wherein other properties of the polymer are not adversely affected.

10

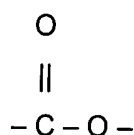
According to a first aspect of the present invention there is provided use of a compound of general formula 1 as a slip agent in a polymer:



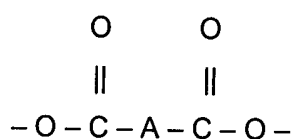
15 wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

X represents one of the moieties:

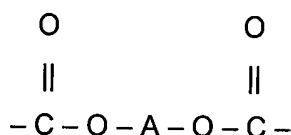
20



25



30



wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and may be linear, branched chain, saturated or contain one or more double bonds.

35

Preferably the total number of carbon atoms in R, R¹ and X is greater than 25.

In a particularly preferred embodiment the total number of carbon atoms in R, R¹ and X is greater than 35.

Preferably X represents the moiety



and the total number of carbon atoms in R, R¹ and X is between 36 and 44.

In a particularly preferred embodiment the composition of general Formula 1 is selected from the group comprising stearyl stearate, stearyl behenate, behenyl behenate and ethylene glycol distearate.

Preferably said polymer comprises a polyester.

In a particularly preferred embodiment the polymer is selected from the group comprising:-

poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
poly(ethylene terephthalate).

Preferably said composition of general Formula 1 is present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

In a particularly preferred embodiment said composition is present in said polymer in an amount of between 0.2% to 0.75% wt/wt.

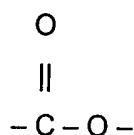
According to a second aspect of the invention there is provided a polymer incorporating one or more slip agents of general Formula 1:



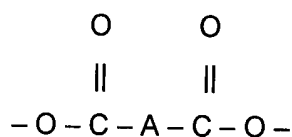
5

wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

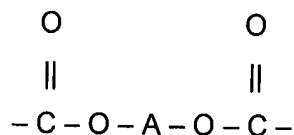
10 X represents one of the moieties:



15



20



25 wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and may be linear, branched chain, saturated or contain one or more double bonds.

Preferably the total number of carbon atoms in R, R¹ and X is greater than 25.

30 In a particularly preferred embodiment the total number of carbon atoms in R, R¹ and X is greater than 35.

Preferably X represents the moiety



and the total number of carbon atoms in R, R¹ and X is between 36 and 44.

In a particularly preferred embodiment the slip agent of general Formula 1 is selected from the group comprising stearyl stearate, stearyl behenate, behenyl behenate and ethylene glycol distearate.

Preferably said polymer is a polyester.

Preferably said polymer is selected from a group comprising:-

poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
poly(ethylene terephthalate)
and co-polymers thereof.

Preferably said slip agent(s) are present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

In a particularly preferred embodiment said slip agent(s) are present in said polymer in an amount of between 0.2% to 0.75% wt/wt.

According to a third aspect of the present invention there is provided a method of treating a polymer to increase the slip of said polymer said method comprising incorporating into said polymer a composition of general Formula 1 as defined above.

Preferably said polymer is a polyester.

Preferably said polymer is selected from a group comprising:-

- poly(butylenes terephthalate)
- poly(cyclohexanedimethylene terephthalate)
- 5 poly(ethylene isophthalate)
- poly(ethylene 2,6-naphthalenedicarboxylate)
- poly(ethylene phthalate)
- poly(ethylene terephthalate)
- and co-polymers thereof.

10

Preferably the said composition of general Formula 1 is present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

- 15 In a particularly preferred embodiment said polymer in an amount of between 0.2% to 0.75% wt/wt.

According to a fourth aspect of the present invention there is provided a container made from a polymer as described herein, incorporating a slip agent of general Formula 1.

20

Preferably said container is formed from a polyester.

Preferably said container is formed from a polymer selected from a group comprising:-

25

- poly(butylenes terephthalate)
- poly(cyclohexanedimethylene terephthalate)
- poly(ethylene isophthalate)
- poly(ethylene 2,6-naphthalenedicarboxylate)
- 30 poly(ethylene phthalate)
- poly(ethylene terephthalate)
- and co-polymers thereof.

- 35 According to a fifth aspect of the present invention there is provided a film made from a polymer as described herein incorporating a slip agent of general Formula 1.

Preferably said film is formed from a polyester.

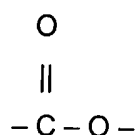
Preferably said film is formed from a polymer selected from a group comprising:-

- 5 poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
- 10 poly(ethylene terephthalate)
and co-polymers thereof.

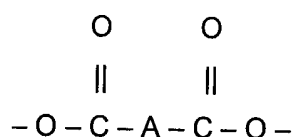
The present invention also extends to include a composition comprising a copolymer of a polyester and a compound of general Formula 1 wherein: R and R¹
15 represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

X represents one of the moieties:

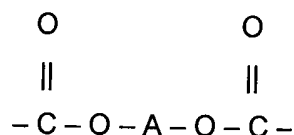
20



25



30



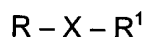
wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and may be linear, branched chain, saturated or contain one or more double bonds.

35

The present invention therefore relates to the discovery of a novel slip additive for PET which is highly effective in lowering the coefficient of friction of the fabricated article whilst maintaining low colour and high clarity. More particularly, additives conforming to this invention afford a rapid reduction in the coefficient of friction that is maintained during long-term storage of the moulded part. This is particularly critical in the production of preforms and bottles from PET.

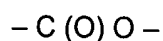
The term PET as used herein in describing this invention includes all polymeric and copolymeric forms of poly (ethyleneterephthalate). The compounds of this invention are also effective slip agents for other polyester polymers and copolymers as exemplified by polybutylene terephthalate and poly (ethylene naphthalate).

The additives of this invention conform to the general structure:



where R and R' are hydrocarbon moieties, each comprising 6 to 24 carbon atoms, and may be linear or branched and be fully saturated or contain one or more double bonds.

X conforms to one of the following structures:



or



or



where A is a hydrocarbon moiety comprising 2 to 36 carbon atoms, and may be linear or branched and be fully saturated or contain one or more double bonds.

In a preferred embodiment of the invention the total number of carbon atoms contained within R, R' and X is greater than 25 and preferably greater than 35.

Examples of preferred additives conforming to this invention are stearyl
5 stearate, stearyl behenate, behenyl behenate and ethylene glycol distearate.

To achieve the required level of slip performance in PET, the additives of this invention are incorporated at levels of between 0.1% and 1% and preferably between 0.2% and 0,75% wt/wt.

10

The slip additives of this invention may be incorporated into the polymer by a number of processes well known to those skilled in the art. For example they may be added directly to the resin by melt dosing at the point of extrusion, by conventional masterbatch addition or by incorporation using liquid colour systems.

15

Examples

To demonstrate the effectiveness of the aforementioned additives in reducing the friction of PET surfaces the following procedure was adopted.

20

A PET co-polymer (IV 0.8) suitable for the manufacture of bottles and other food packaging containers by injection moulding, blow moulding or a combination of both was used. The PET was dried for 8 hours at 145°C and the additive coated directly onto the surface of the polymer by tumble mixing whilst the polymer was still
25 hot.

The PET was moulded into 100 x 50 x 2 mm plaques on a 35 tonne lock injection-moulding machine using the following conditions:

30	Temperature:	All zones at 270°C
	Injection Pressure:	85 Bar
	Shotsize:	29.0mm
	Pack:	20 Bar; 3 secs
	Hold:	75 Bar; 3 secs
	Cooling:	20 secs
35	Tool Temp:	10°C

The Coefficient of Friction (static and kinetic) of the resulting plaques were then measured on a Lloyd LRX tensile tester and a 10N load cell at the following time intervals after moulding – 1 hour, 24 hours, 1 week and 2 weeks. The friction method was adapted from ASTM 1894. The sledge weight including the plaque was 5 1000g and the area of surface contact between the two plaques was 50mm x 50mm (see diagram). The test was run over a distance of 60mm at 150mm/min. Each test was conducted 5 times for each time interval using new plaques on each run. A diagram of the test apparatus is given below.

A summary of the slip additives tested is given below:

TABLE 1

	Name	Addition level (%)	Colour CIELab b value	Slip (dynamic CoF)				Appearance (visual inspection)	Comments
				Initial	1 day	1 week	2 weeks		
1	Natural PET	N/A	1.6	0.454	0.503	0.364	0.461	Neutral colour, transparent	Moulded well
2	Stearamide	0.5	3.2	-	0.473	0.397	0.347	Yellow, transparent	Some scratch resistance
3	Stearyl erucamide	0.5	2.7	-	0.383	-	0.327	Yellow, transparent	Some scratch resistance
4	erucamide	0.5	3.5	0.38	0.35	0.32	0.31	Yellow, transparent	Some scratch resistance
5	Behenamide	0.5	3.3	0.341	-	0.408	0.265	Yellow, transparent	Some scratch resistance
6	Behenamide/erucamide	0.5	3.1	0.379	-	0.374	0.329	Yellow, transparent	Some scratch resistance
7	Butyl Stearate	0.5	2	0.335	0.400	0.302	0.316	Neutral colour, transparent	Poor scratch resistance
8	Butyl Behenate	0.5	1.7	0.33	0.34			Neutral colour, transparent	Moulded well little plate out
9	Ethyl hexyl Stearate	0.5	1.9	0.299	0.420	0.266	0.358	Neutral colour, transparent	No moulding issues, reasonable scratch
10	Lauryl Palmitate	0.5	1.7	0.301	0.307	0.259	0.290	Neutral colour, transparent	No moulding issues, poor scratch, greasy to touch
11	Myristyl palmitate	0.5	1.8	0.356	0.288	0.202	0.268	Neutral colour, transparent	Some plateout on tool Some scratch resistance
12	Stearyl Behenate	0.2	1.4	0.288	0.309	0.245	0.283	Neutral colour, transparent	Small amount of plate out otherwise good.
13	Stearyl Behenate	0.5	-	0.361	0.218	0.200	0.199	Neutral colour, milky white	Moderate plate out, Good scratch resistance
14	Oleyl Behenate	0.5	-	0.38	0.41	0.48		Neutral colour, milky white	Greasy feel

	Name	Addition level (%)	Colour CIELab b value	Slip (dynamic CoF)				Appearance (visual inspection)	Comments
15	Behenyl behenate	0.5	-	0.56	0.37			Neutral colour, milky white	Moulded well, low plate out
16	Calcium Stearate	0.5	3.1	-	0.554	0.451	0.428	Yellow Transparent	No slip
17	Zinc Stearate	0.5	3.4	-	0.558	0.496	0.461	yellow, transparent	No slip
18	Penta Tetra Behenate	0.5	-	0.516	0.329	0.310	0.450	Milky white	Moderate scratch resistance
19	Pentaerthritol dioleate	0.5	1.7	-	-	-	-	Neutral colour, transparent	Excessive Stick Slip
20	Pentaerthritol tetrastearate	0.5	-	-	0.437	-	0.351	Milky white	
21	Pentaerthritol monooleate	0.5	2	-	-	-	-	Neutral colour transparent	Excessive Stick Slip
22	Glycerol monostearate 40% mono	0.5	1.5	-	0.478	0.450	0.414	Neutral colour, transparent	Little or no slip
23	Glycerol monobehenate	0.5	2.5	-	0.518	0.447	0.449	Slight yellow colour, transparent	Little or no slip
24	Glycerol monostearate 90% mono	0.5	1.8	-	-	-	-	Neutral colour, transparent	Excessive Stick Slip
25	Behenic Acid	0.5	1.7	-	0.448	0.428	0.354	Neutral colour, transparent	May react with polymer
26	PEG 200 dierucate	0.5	1.1	0.347	-	0.508	0.431	Neutral colour, transparent	No slip
27	PEG 400 dierucate	0.5	0.9	0.378	-	0.509	0.464	Neutral colour, transparent	No slip
28	PEG 200 dioleate	0.5	1.4	-	0.574	-	0.484	Neutral colour, transparent	No slip
29	PEG 400 monolaurate	0.5	1.9	-	0.576	-	-	Neutral colour, transparent	Excessive Stick Slip
30	Sorbitan monostearate	0.5	2.6	-	-	-	-	Slight yellow colour	Excessive Stick Slip

	Name	Addition level (%)	Colour CIELab b value	<u>Slip (dynamic CoF)</u>				Appearance (visual inspection)	Comments
31	2 mol ethoxylated stearyl alcohol	0.5	2	-	-	-	-	Neutral colour, transparent	Excessive Stick Slip
32	10 mol ethoxylated stearyl alcohol	0.5	2.1	-	-	-	-	Neutral colour, transparent	Excessive Stick Slip

- Indicates a value was not measurable.

5 The superior performance of the additives of this invention can be readily appreciated by reference to the above results.

Natural PET with no additive (1) gave an average coefficient of friction over the 14-day test period of 0.445 with a recorded maximum of 0.503.

10 Conventional amide slip agents as exemplified by erucamide (4) lowered the coefficient of friction to between 0.38 and 0.31 but resulted in severe yellowing of the polymer.

15 Additives conforming to this invention (7 to 15) afforded an equivalent or greater reduction in the coefficient of friction compared with conventional amide slip agents but the polymer plaques remained clear and transparent. In the case of stearyl behenate (12,13) which represents a preferred embodiment of this invention (in that it contains a total of 40 carbon atoms), a very low coefficient was achieved (average 0.281) at a much reduced addition level.

20 It is of note that some esters of polyethylene glycol (not conforming to this invention) as exemplified by PEG 200 dierucate (26) afforded an initial reduction in the coefficient of friction but this effect diminished over the 14-day test period. This renders compounds of this nature of little value as a long-term slip agents for PET.

25 It is envisaged that mixtures of slip agents of general formula 1 can be used in polymers and co-polymers and that such agents may also be used in combination with known slip agents.

Thus it can be clearly seen that additives conforming to this invention provide the unique combination of a rapid and long-lasting reduction in the coefficient of friction of PET whilst maintaining low colour and high transparency.

5 PREPARATION 1

Materials

85/90% behenic acid, AV=163.7 mg KOH/g, (mwt 342.7 g/mol), 200.0 g (0.584 mole).

n-butanol (butan-1-ol) 99.4+%(Aldrich), (mwt 74.12 g/mol), 400.0 g (5.397 mole).
sulphuric acid (98% min) catalyst, 4.0 g, or 1% on wt of butanol.

Procedure

A flask equipped with a stirrer and vertical water-cooled reflux condenser, was charged with the materials above and heated to and maintained at 110-120°C under air at atmospheric pressure with constant reflux of butanol for approximately 4.5 hours. The resulting mixture was transferred to a separating funnel then 1 L of n-heptane @ 60°C added, followed by 2 L of saturated brine solution. The whole mixture was shaken and the phases allowed to separate. The aqueous phase was run off, and the heptane phase retained. The heptane phase was then repeatedly washed with ca. 1 L of warm (60°C) distilled water until washings were pH 6. The heptane phase was then dried over anhydrous sodium sulphate and filtered. The filtrate was evaporated to constant weight on a rotary evaporator @ 70°C under 700 mmHg vacuum. Finally, the headspace of the vessel was blown with nitrogen for ca. 15 minutes to remove traces of butanol smell.

Yield 186g (theoretical maximum yield=232.9 g) 80% yield.

Analysis of final product:

AV	4.6	mg KOH/g
OHV	10.0	mg KOH/g
Sap value	137.3	mg KOH/g
moisture	0.02	% wt
colour	156	Hazen

Claims:

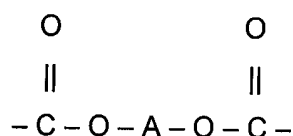
1. Use of a compound of general formula 1 as a slip agent in a polymer:



wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

10

X represents one of the moieties:



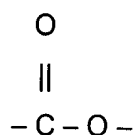
- 25 wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and may be linear, branched chain, saturated or contain one or more double bonds.

2. Use of a compound of general Formula 1 as a slip agent in a polymer as claimed in Claim 1 wherein the total number of carbon atoms in R, R¹ and X is greater than 25.
- 30

3. Use of a composition of general Formula 1 as a slip agent as claimed in Claim 1 or Claim 2 wherein the total number of carbon atoms in R, R¹ and X is greater than 35.

35

4. Use of a composition of general Formula 1 as a slip agent in a polymer as claimed in any preceding claim wherein X represents the moiety



5

and the total number of carbon atoms in R, R¹ and X is between 36 and 44.

5. Use of a composition of general Formula 1 as a slip agent in a polymer as claimed in any preceding claim wherein the composition of general Formula 1 is selected from the group comprising stearyl stearate, stearyl behenate, behenyl behenate and ethylene glycol distearate.

10

6. Use of a composition of general Formula 1 as a slip agent in a polymer as claimed in any preceding claim wherein said polymer comprises a polyester.

15

7. Use of a composition of general Formula 1 as a slip agent in a polymer as claimed in Claim 6 wherein the polymer is selected from the group comprising:-

poly(butylenes terephthalate)

20 poly(cyclohexanedimethylene terephthalate)

poly(ethylene isophthalate)

poly(ethylene 2,6-naphthalenedicarboxylate)

poly(ethylene phthalate)

poly(ethylene terephthalate)

25 and co-polymers thereof.

8. Use of a composition of general Formula 1 as a slip agent in a polymer according to any preceding claim wherein said composition of general Formula 1 is present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

30

9. Use of a composition of general Formula 1 as a slip agent in a polymer according to Claim 8 wherein said composition is present in said polymer in an amount of between 0.2% to 0.75% wt/wt.

- 35 10. Use of a composition of general Formula 1 as a slip agent in a polymer substantially as herein described.

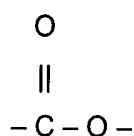
11. A polymer incorporating one or more slip agents of general Formula 1:



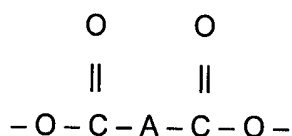
5

wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

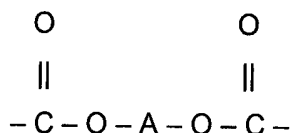
- 10 X represents one of the moieties:



15



20



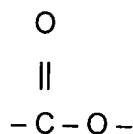
- 25 wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and may be linear, branched chain, saturated or contain one or more double bonds.

12. A polymer as claimed in Claim 11 wherein incorporating one or more slip agents of general Formula 1 wherein the total number of carbon atoms in R, R¹ and X is greater than 25.

30

13. A polymer as claimed in Claim 11 or Claim 12 incorporating one or more slip agents of general Formula 1 wherein the total number of carbon atoms in R, R¹ and X is greater than 35.

- 35 14. A polymer as claimed in any of Claims 11, 12 or 13 incorporating one or more slip agents of general Formula 1 wherein X represents the moiety



5 and the total number of carbon atoms in R, R¹ and X is between 36 and 44.

15. A polymer as claimed in any of claims 11, 12, 13 or 14 incorporating one or more slip agents of general Formula 1 wherein the composition is selected from the group comprising stearyl stearate, stearyl behenate, behenyl behenate and ethylene glycol distearate.

16. A polymer as claimed in any of Claims 11 to 15 inclusive incorporating one or more slip agents of general Formula 1 wherein said polymer is selected from a group comprising:-

15 poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
20 poly(ethylene phthalate)
poly(ethylene terephthalate)
or co-polymer thereof.

17. A polymer as claimed in any of Claims 11 to 16 inclusive incorporating one or more slip agents of general Formula 1 wherein said slip agent(s) are present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

18. A polymer as claimed in Claim 17 wherein said slip agent(s) are present in said polymer in an amount of between 0.2% to 0.75% wt/wt.

19. A polymer incorporating one or more slip agents of general Formula 1 substantially as herein described.

20. A method of treating a polymer to increase the slip of said polymer said method comprising incorporating into said polymer a composition of general Formula 1.

21. A method of treating a polymer as claimed in Claim 20 wherein said polymer is selected from a group comprising:-

- 5 poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
10 poly(ethylene terephthalate)
or co-polymer thereof.

22. A method according to Claim 21 wherein said composition of general Formula 1 is present in said polymer in an amount of between 0.1% to 1.0% wt/wt.

15

23. A method according to Claim 22 wherein said composition of general Formula 1 is present in said polymer in an amount of between 0.2% to 0.75% wt/wt.

24. A container made from a polymer as claimed in any of Claims 11 to 19 inclusive.

20

25. A container as claimed in Claim 24 wherein said container is formed from a polymer selected from a group comprising:-

- 25 poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
30 poly(ethylene terephthalate)
or co-polymer thereof.

26. A film made from a polymer as claimed in any of Claims 11 to 19 inclusive.

35 27. A film as claimed in Claim 26 wherein said film is formed from a polymer selected from a group comprising:-

poly(butylenes terephthalate)

poly(cyclohexanedimethylene terephthalate)

poly(ethylene isophthalate)

5 poly(ethylene 2,6-naphthalenedicarboxylate)

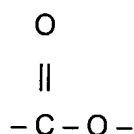
poly(ethylene phthalate)

poly(ethylene terephthalate)

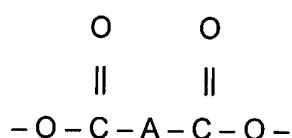
or co-polymer thereof.

10 28. A composition comprising a copolymer of a polyester and a compound of general Formula 1 wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds;

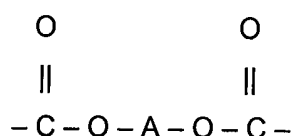
15 X represents one of the moieties:



20



25



wherein A represents a hydrocarbon moiety comprising 2 to 36 carbon atoms and
30 may be linear, branched chain, saturated or contain one or more double bonds.

Amendments to the claims have been filed as follows

22

Claims:

1. Use of a compound of general Formula 1 as a slip agent in a PET polymer:

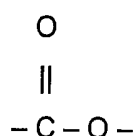


wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds and wherein;

10

X represents:

15



20

2. Use of a compound of general Formula 1 as a slip agent in a PET polymer as claimed in Claim 1 wherein the total number of carbon atoms in R, R¹ and X is greater than 25.

3. Use of a composition of general Formula 1 as a slip agent as claimed in Claim 1 or Claim 2 wherein the total number of carbon atoms in R, R¹ and X is greater than 35.

- 25 4. Use of a composition of general Formula 1 as a slip agent in a polymer as claimed in any preceding claim wherein the total number of carbon atoms in R, R¹ and X is between 36 and 44.

- 30 5. Use of a composition of general Formula 1 as a slip agent in a PET polymer as claimed in any preceding claim wherein the composition of general Formula 1 is selected from the group comprising stearyl stearate, stearyl behenate and behenyl behenate.

- 35 6. Use of a composition of general Formula 1 as a slip agent in a PET polymer as claimed in Claim 6 wherein the PET polymer is selected from the group comprising:-

- poly(butylenes terephthalate)
 poly(cyclohexanedimethylene terephthalate)
 poly(ethylene isophthalate)
 5 poly(ethylene 2,6-naphthalenedicarboxylate)
 poly(ethylene phthalate)
 poly(ethylene terephthalate)
 and co-polymers thereof.

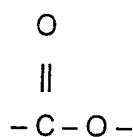
- 10 7. Use of a composition of general Formula 1 as a slip agent in a PET polymer according to any preceding claim wherein said composition of general Formula 1 is present in said PET polymer in an amount of between 0.1% to 1.0% wt/wt.
8. Use of a composition of general Formula 1 as a slip agent in a PET polymer
 15 according to Claim 7 wherein said composition is present in said PET polymer in an amount of between 0.2% to 0.75% wt/wt.
9. Use of a composition of general Formula 1 as a slip agent in a PET polymer substantially as herein described.
- 20 10. A PET polymer incorporating one or more slip agents of general Formula 1:



- 25 wherein: R and R¹ represent hydrocarbon moieties, each hydrocarbon moiety comprising 6 to 24 carbon atoms and wherein R and/or R¹ may be linear, branched chain, saturated or contain one or more double bonds; and wherein

X represents:

30



11. A PET polymer as claimed in Claim 11 wherein incorporating one or more slip agents of general Formula 1 wherein the total number of carbon atoms in R, R¹ and X is greater than 25.
- 5 12. A PET polymer as claimed in Claim 10 or Claim 11 wherein the total number of carbon atoms in R, R¹ and X is greater than 35.
13. A PET polymer as claimed in any of Claims 10, 11 or 12 wherein the total number of carbon atoms in R, R¹ and X is between 36 and 44.
- 10 14. A PET polymer as claimed in any of claims 11, 12, 13 or 14 incorporating one or more slip agents of general Formula 1 wherein the composition is selected from the group comprising stearyl stearate, stearyl behenate, and behenyl behenate.
- 15 15. A PET polymer as claimed in any of Claims 10 to 14 inclusive wherein said PET polymer is selected from a group comprising:-
- poly(butylenes terephthalate)
- 20 poly(cyclohexanedimethylene terephthalate)
- poly(ethylene isophthalate)
- poly(ethylene 2,6-naphthalenedicarboxylate)
- poly(ethylene phthalate)
- poly(ethylene terephthalate)
- 25 or co-polymer thereof.
16. A PET polymer as claimed in any of Claims 10 to 15 inclusive incorporating one or more slip agents of general Formula 1 wherein said slip agent(s) are present in said PET polymer in an amount of between 0.1% to 1.0% wt/wt.
- 30 17. A PET polymer as claimed in Claim 16 wherein said slip agent(s) are present in said PET polymer in an amount of between 0.2% to 0.75% wt/wt.
18. A PET polymer incorporating one or more slip agents of general Formula 1
- 35 substantially as herein described.

19. A method of treating a PET polymer to increase the slip of said PET polymer said method comprising incorporating into said PET polymer a composition of general Formula 1.
- 5 20. A method of treating a PET polymer as claimed in Claim 19 wherein said PET polymer is selected from a group comprising:-
- poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
10 poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
poly(ethylene terephthalate)
or co-polymer thereof.
- 15 21. A method according to Claim 20 wherein said composition of general Formula 1 is present in said PET polymer in an amount of between 0.1% to 1.0% wt/wt.
- 20 22. A method according to Claim 21 wherein said composition of general Formula 1 is present in said PET polymer in an amount of between 0.2% to 0.75% wt/wt.
23. A container made from a PET polymer as claimed in any of Claims 10 to 18
25 inclusive.
24. A container as claimed in Claim 23 wherein said container is formed from a PET polymer selected from a group comprising:-
- 30 poly(butylenes terephthalate)
poly(cyclohexanedimethylene terephthalate)
poly(ethylene isophthalate)
poly(ethylene 2,6-naphthalenedicarboxylate)
poly(ethylene phthalate)
35 poly(ethylene terephthalate)
or co-polymer thereof.

25. A film made from a PET polymer as claimed in any of Claims 10 to 18 inclusive.

5 26. A film as claimed in Claim 25 wherein said film is formed from a PET polymer selected from a group comprising:-

poly(butylenes terephthalate)

poly(cyclohexanedimethylene terephthalate)

10 poly(ethylene isophthalate)

poly(ethylene 2,6-naphthalenedicarboxylate)

poly(ethylene phthalate)

poly(ethylene terephthalate)

or co-polymer thereof.

15



INVESTOR IN PEOPLE

— 21

Application No: GB0404620.7

Examiner: Dr Paul Minton

Claims searched: 1-28

Date of search: 4 April 2005

Patents Act 1977

Amended Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-5,8-15,17-20	GB2302543 A (FMC) see particularly Examples 2-5 & 7-8 and claims 1-3 & 5.
X	1-5,8-15,17-20	JP01207344 A (NIPPON OILS AND FATS) see particularly WPI Abstract Accession No. 1989-282594 [25].
X	1-3,5-13,15-23,28	EP0577091 A1 (HOECHST CELANESE) see particularly lines 9-10, page 4 and claims 1, 3, 4, 9 & 10.
X	1-3,5,6,8-13,15,17-20,24,25,28	GB1244917 A (CINNATI MILACRON) see particularly lines 29-31 & 96-115, page 2 and claims 1, 3 & 6.
X	1-3,5,10-13,15,19,20,26	WO93/11206 A1 (DU PONT) see particularly claims 1, 5 & 10.
X	1-3,5,8-13,15,17-20	JP04342766 A (NIPPON WAX POLYMER) see particularly WPI Abstract Accession No. 1993-014157 [02].
X	11-19,28	GB2152061 A (SNIA FIBRE) see particularly line 65, page 1 to line 4, page 2 and Example 1.
X	11-15,17-20,28	JP08059974 A (SEKISUI) see particularly WPI Abstract Accession No. 1996-185015 [31].
X	1-23,26-28	JP 2004012610 A (TORAY) see particularly WPI Abstract Accession No. 2004-286625 [27].
X	1-23,28	JP 11071506 A (MITSUBISHI ENG PLASTICS) see particularly WPI Abstract Accession No. 1999-248573 [21].



INVESTOR IN PEOPLE

X	1-23,28	JP 05255577 A (MATSUSHITA) see particularly WPI Abstract Accession No. 1993-348601 [44].
X	1,2,6- 12,16-28	EP 0947543 A2 (SUMITOMO BAKELITE) see particularly paragraph [0002] and claims 1 & 9.
X	11- 19,24,25, 28	JP 06157879 A (KANEBO) see particularly WPI Abstract Accession No. 1994-222162 [27].

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^x :

C3K

Worldwide search of patent documents classified in the following areas of the IPC⁰⁷

C08K; C08L

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, JAPIO



29



INVESTOR IN PEOPLE

Application No: GB 0404620.7
Claims searched: 1-28

Examiner: Dr Paul R Minton
Date of search: 29 March 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1-5,8-15, 17-20	GB 2302543 A	(FMC). See particularly Examples 2-5 & 7-8 and claims 1-3 & 5.
X	1-5,8-15, 17-20	JP 010207344 A	(NIPPON OILS AND FATS). See particularly WPI Abstract Accession No. 1989-282594 [25].
X	1-3,5-13, 15-23,28	EP 0577091 A1	(HOECHST CELANESE). See particularly lines 9-10, page 4 and claims 1, 3, 4, 9 & 10.
X	1-3,5,6,8-13, 15,17-20, 24,25,28	GB 1244917 A	(CINCINNATI MILACRON). See particularly lines 29-31 & 96-115, page 2 and claims 1, 3 & 6.
X	1-3,5,10-13, 15,19,20,26	WO 93/11206 A1	(DU PONT). See particularly claims 1, 5 & 10.
X	1-3,5,8-13, 15,17-20	JP 040342766 A	(NIPPON WAX POLYMER). See particularly WPI Abstract Accession No. 1993-014157 [02].
X	11-23,28	GB 2152061 A	(SNIA FIBRE). See particularly line 65, page 1 to line 4, page 2 and Example 1.
X	11-15, 17-20,28	JP 080059974 A	(SEKISUI). See particularly WPI Abstract Accession No. 1996-185015 [31].

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^W:

C3K

Worldwide search of patent documents classified in the following areas of the IPC⁷:



INVESTOR IN PEOPLE

Application No: GB 0404620.7
Claims searched: 1-28

Examiner: Dr Paul R Minton
Date of search: 29 March 2004

The following online and other databases have been used in the preparation of this search report :

WPI, EPODOC, JAPIO