

A polyethylene pipe

Description

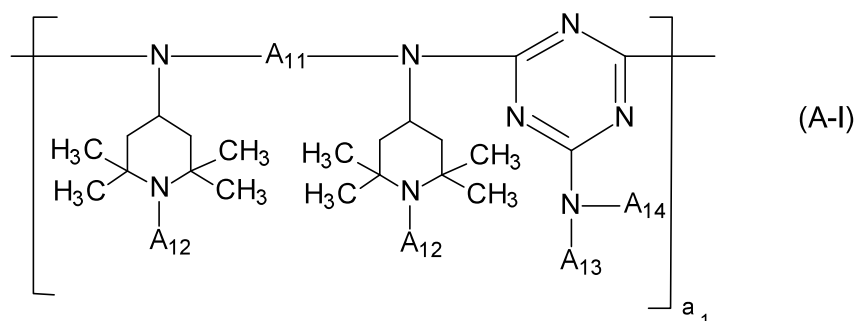
- 5 In an aspect, there is provided a polyethylene pipe comprising components A) and B), wherein component A) is a hindered amine light stabilizer containing a triazine residue, component B) is a natural or synthetic hydrotalcite and the weight ratio of component A) to component B) is 1:10 to 10:1, preferably 1:5 to 5:1.
- 10 In another aspect, there is provided the use of a mixture containing components A) and B) in a weight ratio of 1:10 to 10:1 as defined above for stabilizing a polyethylene pipe.

- In yet another aspect, there is provided a method for stabilizing a polyethylene pipe which comprises incorporating into the polyethylene components A) and B) in a weight
- 15 ratio of 1:10 to 10:1 as defined above.

In more detail, the pipe according to the present invention preferably consists of a polyethylene composition comprising the components A) and B) in a weight ratio of 1:10 to 10:1.

1a

Component A) is in particular at least one compound of the formula (A-I), (A-II) or (A-III)



wherein A_{11} is C_2 - C_{18} alkylene, C_5 - C_7 cycloalkylene or

5 C_1 - C_4 alkylenedi(C_5 - C_7 cycloalkylene),

the radicals A_{12} independently of one another are hydrogen, C_1 - C_{12} alkyl or

C_5 - C_{12} cycloalkyl,

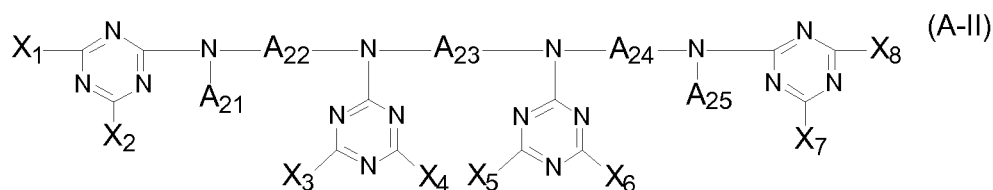
A₁₃ and A₁₄ independently of one another are hydrogen, C₁-C₁₂alkyl, C₅-C₁₂cycloalkyl or a group of the formula (a-1),



or the radicals A₁₃ and A₁₄, together with the nitrogen atom to which they are bonded,

5 form a 5- to 10-membered heterocyclic ring and

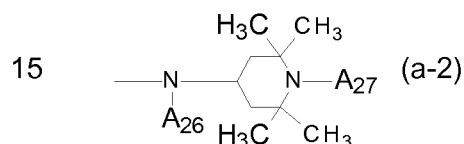
a₁ is a number from 1 to 20, preferably 2 to 20, and the repeating units are identical or different;



10 wherein A₂₁ and A₂₅ independently of one another are hydrogen, C₁-C₁₂alkyl, C₅-C₁₂cycloalkyl or a group of the formula (a-1),

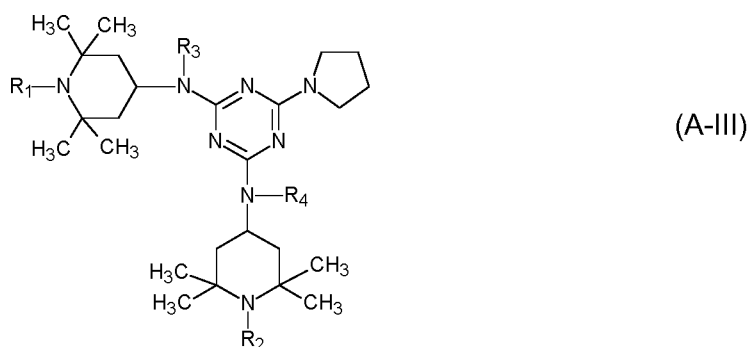
A₂₂, A₂₃ and A₂₄ independently of one another are C₂-C₁₀alkylene, and

X₁, X₂, X₃, X₄, X₅, X₆, X₇ and X₈ independently of one another are a group of the formula (a-2),



in which A₂₆ is hydrogen, C₁-C₁₂alkyl, C₅-C₁₂cycloalkyl or a group of the formula (a-1)

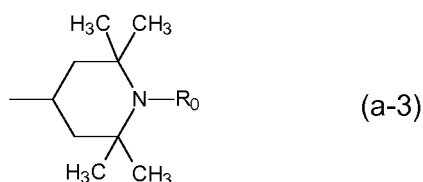
as defined above, and A₂₇ has one of the meanings of A₁₂;



wherein

- R_1 and R_2 independently of one another are hydrogen, C_1 - C_{22} alkyl, -O-, -OH, -CH₂CN, C_1 - C_{18} alkoxy, C_2 - C_{18} alkoxy substituted by -OH; C_5 - C_{12} cycloalkoxy, C_3 - C_6 alkenyl, C_3 - C_6 alkenyloxy, C_7 - C_9 phenylalkyl unsubstituted or substituted on the phenyl by 1, 2 or 3 C_1 - C_4 alkyl; or C_1 - C_8 acyl; and

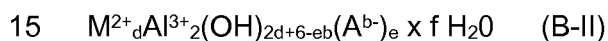
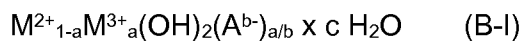
R_3 and R_4 independently of one another are C_1 - C_{22} alkyl or a group of the formula (a-3)



wherein R_0 has one of the meanings of R_1 and R_2 .

10

Component B) is preferably a mixed hydroxide of the formula (B-I) or (B-II).



M^{2+} is for example Ca^{2+} , Mg^{2+} , Sr^{2+} , Ba^{2+} , Zn^{2+} , Pb^{2+} , Sn^{2+} or Ni^{2+} .

M^{3+} is for example Al^{3+} , B^{3+} or Bi^{3+} .

a is for example a number up to 0.5.

A^{b-} is an anion of valency b, for example Cl^- , Br^- , NO_3^- , CO_3^{2-} , SO_4^{2-} or SeO_4^{2-} .

b is for example an integer from 1 to 4.

c is for example zero or a number up to 2.

5 d is for example a number up to 6.

e is for example a number up to 2.

f is for example zero or a number up to 15.

Hydrotalcites which are of interest are layered double hydroxides that contain positively
10 charged hydroxide layers and charge balancing anions located in the interlayer region.

Component B) is in particular at least one magnesium aluminum hydroxide carbonate hydrate which is for example commercially available as Hycite®713, ®DHT-4A, ®DHT-4V, ®DHT-4A-2, ®DHT-4C or Sorbacid®911, or zinc aluminum hydroxide carbonate hy-
15 drate which is for example commercially available as ®ZHT-4V or Sorbacid®944, or mixtures thereof.

Of particular interest is a magnesium aluminum hydroxide carbonate hydrate which is for example commercially available as Hycite®713 or DHT-4A.

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Examples of alkyl having up to 22 carbon atoms are methyl, ethyl, propyl, isopropyl, n-butyl, sec-butyl, isobutyl, tert-butyl, 2-ethylbutyl, n-pentyl, isopentyl, 1-methylpentyl, 1,3-dimethylbutyl, n-hexyl, 1-methylhexyl, n-heptyl, isoheptyl, 1,1,3,3-tetramethylbutyl, 1-methylheptyl, 3-methylheptyl, n-octyl, 2-ethylhexyl, 1,1,3-trimethylhexyl, 1,1,3,3-tetra-

methylpentyl, nonyl, decyl, undecyl, 1-methylundecyl, dodecyl, 1,1,3,3,5,5-hexamethylhexyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl and eicosyl.

C₁-C₁₈alkoxy is for example methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, pentoxy, isopentoxy, hexoxy, heptoxy, octoxy, decyloxy, dodecyloxy, tetradecyloxy,

5 hexadecyloxy or octadecyloxy.

C₂-C₁₈alkoxy substituted by -OH is for example 2-hydroxyethoxy.

C₅-C₁₂cycloalkyl is for example cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclodecyl or cyclododecyl. C₅-C₈Cycloalkyl, in particular cyclohexyl, is preferred.

C₅-C₁₂cycloalkoxy is for example cyclopentoxy, cyclohexoxy, cycloheptoxy, cyclooctoxy, cyclodecyloxy or cyclododecyloxy. C₅-C₈Cycloalkoxy, in particular cyclopentoxy and cyclohexoxy, is preferred.

C₃-C₆alkenyl is for example allyl, 2-methylallyl, butenyl, pentenyl or hexenyl. Allyl is preferred. The carbon atom in position 1 is preferably saturated.

C₃-C₆alkenyloxy is for example propenyloxy.

15 C₇-C₉phenylalkyl unsubstituted or substituted on the phenyl by 1, 2 or 3 C₁-C₄alkyl is for example benzyl, 2-phenylethyl, methylbenzyl, dimethylbenzyl, trimethylbenzyl or tert-butylbenzyl.

Examples of C₁-C₈acyl are formyl, acetyl, propionyl, butyryl, pentanoyl, hexanoyl, heptanoyl, octanoyl, acryloyl, methacryloyl and benzoyl. C₁-C₈Alkanoyl, C₃-C₈alkenoyl and benzoyl are preferred. Acetyl and acryloyl are especially preferred.

20 Examples of alkylene having up to 18 carbon atoms are ethylene, propylene, trimethylene, tetramethylene, pentamethylene, 2,2-dimethyltrimethylene, hexamethylene, trimethylhexamethylene and octamethylene. C₂-C₆alkylene, in particular hexamethylene is preferred.

An example of C₅-C₇cycloalkylene is cyclohexylene.

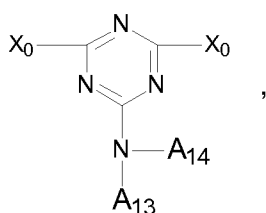
An example of C₁-C₄alkylenedi(C₅-C₇cycloalkylene) is methylenedicyclohexylene.

A preferred example of a 5-to 7-membered heterocyclic ring is a morpholine group.

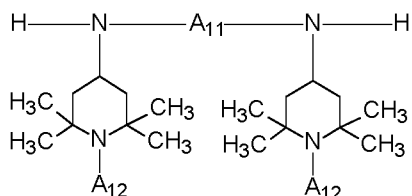
- 5 The meanings of the terminal groups which saturate the free valences in the compounds of the formula (A-I) depend on the processes used for their preparation. The terminal groups can also be modified after the preparation of the compounds.

If the compounds of the formula (A-I) are prepared by reacting a compound of the

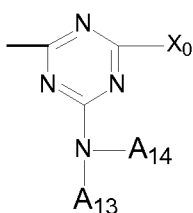
- 10 formula



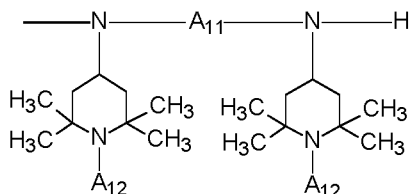
in which X₀ is, for example, halogen, in particular chlorine, and A₁₃ and A₁₄ are as defined above, with a compound of the formula



- 15 in which A₁₁ and A₁₂ are as defined above, the terminal group bonded to the diamino radical is for example hydrogen or

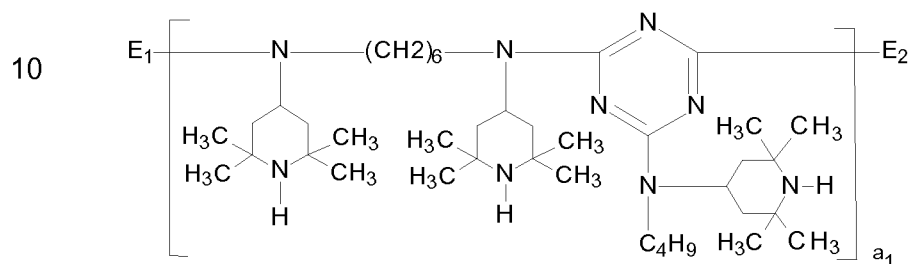


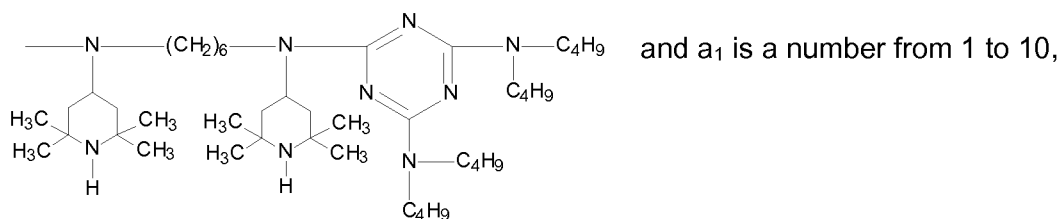
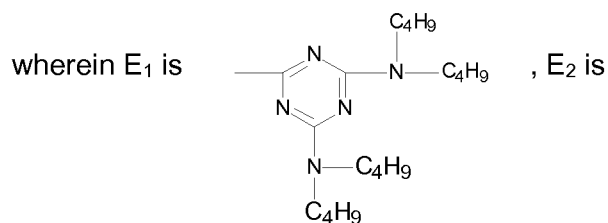
and the terminal group bonded to the triazine radical is for example X_0 or



- If X_0 is halogen, it is advantageous to replace this, for example, by -OH or an amino group when the reaction is complete. Examples of amino groups which may be mentioned are pyrrolidin-1-yl, morpholino, $-NH_2$, $-N(C_1-C_8\text{alkyl})_2$ and $-NR_0(C_1-C_8\text{alkyl})$, in which R_0 is hydrogen or a group of the formula (Ia).

One of the preferred compounds of the formula (I) is





preferably 2 to 10. The preparation of this compound is described in Example 10 of US-A-6,046,304.

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According to a preferred embodiment

A₁₁ is C₂-C₁₀alkylene,

the radicals A₁₂ independently of one another are hydrogen, C₁-C₄alkyl or cyclohexyl,

A₁₃ and A₁₄ independently of one another are hydrogen, C₁-C₄alkyl, cyclohexyl or a

10 group of the formula (a-1),



or the radicals A₁₃ and A₁₄, together with the nitrogen atom to which they are bonded, form a morpholino group and

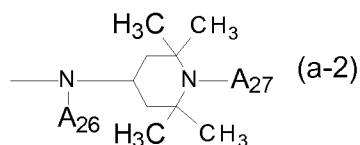
a₁ is a number from 1 to 10, preferably 2 to 10, and the repeating units are identical or

15 different;

A₂₁ and A₂₅ independently of one another are hydrogen, C₁-C₄alkyl or cyclohexyl,

A_{22} , A_{23} and A_{24} independently of one another are C_2 - C_{10} alkylene, and

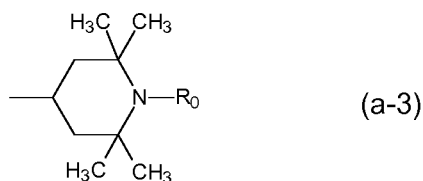
X_1 , X_2 , X_3 , X_4 , X_5 , X_6 , X_7 and X_8 independently of one another are a group of the formula (a-2),



- 5 in which A_{26} is hydrogen, C_1 - C_4 alkyl, cyclohexyl or a group of the formula (a-1) as defined above, and A_{27} has one of the meanings of A_{12} ;

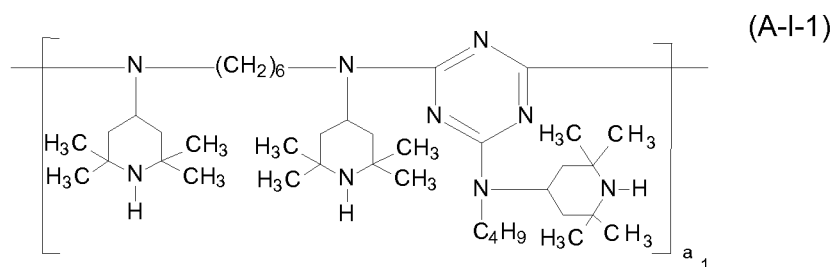
R_1 and R_2 independently of one another are hydrogen, C_1 - C_4 alkyl or cyclohexyl; and

R_3 and R_4 independently of one another are C_1 - C_4 alkyl or a group of the formula (a-3)

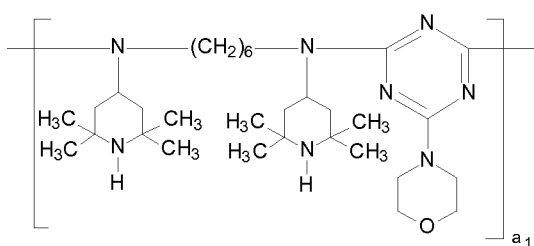


- 10 wherein R_0 has one of the meanings of R_1 and R_2 .

According to a further preferred embodiment component A) is a compound of the formula (A-I-1), (A-I-2), (A-II-1) or (A-III-1),

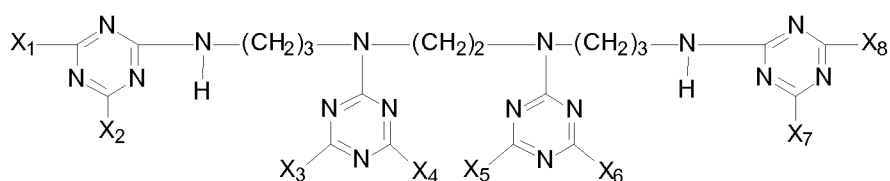


- 15 with a_1 being 2 to 10,



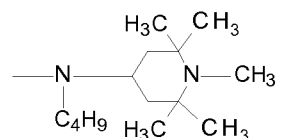
(A-I-2)

with a_1 being 2 to 10,

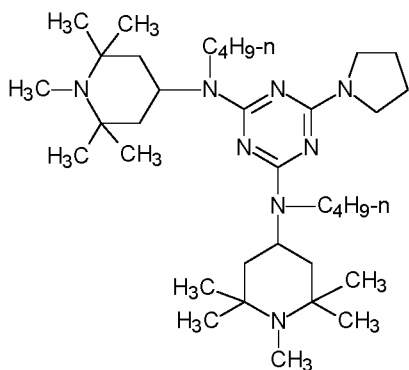


(A-II-1)

wherein X_1 , X_2 , X_3 , X_4 , X_5 , X_6 , X_7 and X_8 are the group



5



(A-III-1)

The polyethylene pipe may additionally comprise a component C) which is a phenolic antioxidant, in particular 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene (Irganox®1330), ethylene bis[3,3-bis(3-tert-butyl-4-hydroxyphenyl)butyrate] (Hostanox®03) or 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate (Irganox®3114).

10

The weight ratio of component A) to component C) is preferably 1:10 to 10:1, in particular 1:5 to 5:1.

The polyethylene pipe may further comprise a component D) which is at least one
 5 compound selected from the group consisting of phosphites, phosphonites, hydroxylamines, tocopherols and tocopherol acetates. A phosphite, for example tris(2,4-di-tert-butylphenyl) phosphite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[3-(3-methyl-4-hydroxy-5-tert.butyl-phenyl)-propyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-
 10 phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1-methyl-6-tert. butyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite or 6-[3-(3-tert-butyl-4-hydroxy-5-methylphenyl)propoxy]-2,4,8,10-tetra-tert-butylidibenzo[d,f][1,3,2]dioxaphosphin, is particularly preferred.

15 The weight ratio of component A) to component D) is preferably 1:10 to 10:1, in particular 1:5 to 5:1.

Of interest is a polyethylene pipe which comprises components A), B), C) and D). The compounds of components A), B), C) and D) are known and are in essential commercially
 20 cially available.

Component A) is preferably present in the polyethylene in an amount of 0.01% to 2% by weight relative to the weight of the polyethylene.

Component B) is preferably present in the polyethylene in an amount of 0.01% to 5% by weight relative to the weight of the polyethylene.

Component C) is preferably present in the polyethylene in an amount of 0.1% to 5% by weight relative to the weight of the polyethylene.

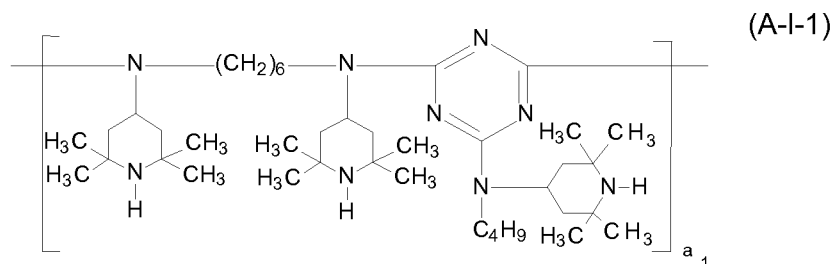
Component D) is preferably present in the polyethylene in an amount of 0.1% to 5% by weight relative to the weight of the polyethylene.

According to a preferred embodiment the polyethylene pipe may additionally comprise a pigment, preferably a blue pigment.

The polyethylene of the pipe is preferably selected from HD-PE, MD-PE, LD-PE, LLD-PE, metallocene PE, PE-X, mixture of PE, recycled PE, bi-modal PE, PE-RT, PE 32, PE 40, PE 63, PE 80, PE 100, PE 112, PE 125, PE 100 RC, PE 100 RT and PE 100 RD, in particular from high density polyethylene (HD-PE), medium density polyethylene (MD-PE), low density polyethylene (LD-PE), linear low density polyethylene (LLD-PE), metallocene polyethylene, crosslinked polyethylene (PE-X), recycled polyethylene, bi-modal polyethylene and mixtures of polyethylenes.

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A particularly preferred polyethylene pipe comprises the components (A), (B), (C) and (D), wherein component (A) is



with a_1 being 2 to 10,

component (B) is a natural or synthetic hydrotalcite,

component (C) is 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene,

5 and

component (D) is tris[2,4-di-tert-butylphenyl]phosphite.

The polyethylene of the pipe according to the present invention may further comprise

one or more conventional additives such as:

10

1. Antioxidants

1.1. Alkylated monophenols, for example 2,6-di-tert-butyl-4-methylphenol, 2-tert-butyl-

4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol,

15 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(α -

methylcyclohexyl)-4,6-dimethylphenol, 2,6-dioctadecyl-4-methylphenol, 2,4,6-

tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol, nonylphenols which are

linear or branched in the side chains, for example, 2,6-di-nonyl-4-methylphenol, 2,4-

dimethyl-6-(1'-methylundec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methylheptadec-1'-

20 yl)phenol, 2,4-dimethyl-6-(1'-methylpentadec-1'-yl)phenol, 2,4-dimethyl-6-(1'-

methyltridec-1'-yl)phenol and mixtures thereof.

1.2. Alkylthiomethylphenols, for example 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-didodecylthiomethyl-4-nonylphenol.

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1.3. Hydroquinones and alkylated hydroquinones, for example 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl
10 stearate, bis(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.

1.4. Tocopherols, for example α -tocopherol, β -tocopherol, γ -tocopherol, δ -tocopherol and mixtures thereof (vitamin E).

15 1.5. Hydroxylated thiodiphenyl ethers, for example 2,2'-thiobis(6-tert-butyl-4-methylphenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol), 4,4'-thiobis(3,6-di-sec-amylphenol), 4,4'-bis(2,6-dimethyl-4-hydroxyphenyl)disulfide.

20 1.6. Alkylidenebisphenols, for example 2,2'-methylenebis(6-tert-butyl-4-methylphenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(α -methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol),

2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(α , α -dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 5 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis-(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-10 di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra-(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

1.7. O-, N- and S-benzyl compounds, for example 3,5,3',5'-tetra-tert-butyl-4,4'-15 dihydroxydibenzyl ether, octadecyl-4-hydroxy-3,5-dimethylbenzylmercaptoacetate, tridecyl-4-hydroxy-3,5-di-tert-butylbenzylmercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide, isooctyl-3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetate.

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1.8. Hydroxybenzylated malonates, for example dioctadecyl-2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, di-octadecyl-2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)malonate, di-dodecylmercaptoethyl-2,2-bis (3,5-di-tert-butyl-4-

hydroxybenzyl)malonate, bis[4-(1,1,3,3-tetramethylbutyl)phenyl]-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.

1.9. Aromatic hydroxybenzyl compounds, for example 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol.

1.10. Triazine compounds, for example 2,4-bis(octylmercapto)-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)-hexahydro-1,3,5-triazine, 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl)isocyanurate.

1.11. Benzylphosphonates, for example dimethyl-2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, the calcium salt of the monoethyl ester of 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid.

1.12. Acylaminophenols, for example 4-hydroxylauranilide, 4-hydroxystearanilide, octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.

1.13. Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or poly-
 5 hydric alcohols, e.g. with methanol, ethanol, n-octanol, i-octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-
 10 phospho-2,6,7-trioxabicyclo[2.2.2]octane.

1.14. Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, n-octanol, i-octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospho-2,6,7-trioxabicyclo[2.2.2]octane; 3,9-bis[2-{3-(3-tert-butyl-4-hydroxy-5-methylphenyl)propionyloxy}-1,1-dimethylethyl]-2,4,8,10-tetraoxaspiro[5.5]undecane.

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1.15. Esters of β -(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate,

N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

- 5 1.16. Esters of 3,5-di-tert-butyl-4-hydroxyphenyl acetic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.
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- 1.17. Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid e.g. N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazide, N,N'-bis[2-(3-[3,5-di-tert-butyl-4-hydroxyphenyl]propionyloxy)ethyl]oxamide (Naugard[®]XL-1, supplied by Uniroyal).
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- 1.18. Aminic antioxidants, for example N,N'-di-isopropyl-p-phenylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine, N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine, N,N'-bis(1-methylheptyl)-p-phenylenediamine, N,N'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-bis(2-naphthyl)-p-phenylenediamine, N-isopropyl-N'-phenyl-p-phenylenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, N-(1-
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methylheptyl)-N'-phenyl-p-phenylenediamine, N-cyclohexyl-N'-phenyl-p-phenylenediamine, 4-(p-toluenesulfamoyl)diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-naphthylamine, N-phenyl-2-naphthylamine, octylated diphenylamine, for example p,p'-di-tert-octyldiphenylamine, 4-n-butylaminophenol, 4-butyrylaminophenol, 4-nonanoylaminophenol, 4-dodecanoylaminophenol, 4-octadecanoylaminophenol, bis(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethylphenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-bis[(2-methylphenyl)amino]ethane, 1,2-bis(phenylamino)propane, (o-tolyl)biguanide, bis[4-(1',3'-dimethylbutyl)phenyl]amine, tert-octylated N-phenyl-1-naphthylamine, a mixture of mono- and dialkylated tert-butyl/tert-octyldiphenylamines, a mixture of mono- and dialkylated nonyldiphenylamines, a mixture of mono- and dialkylated dodecyldiphenylamines, a mixture of mono- and dialkylated isopropyl/isohexyldiphenylamines, a mixture of mono- and dialkylated tert-butyldiphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- and dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- and dialkylated tert-octyl-phenothiazines, N-allylphenothiazine, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene.

20 2. UV absorbers and light stabilizers

2.1. 2-(2'-Hydroxyphenyl)benzotriazoles, for example 2-(2'-hydroxy-5'-methylphenyl)-benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-

tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chloro-benzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis-(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)-carbonylethyl]-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)phenyl)benzotriazole, 2,2'-methylene-bis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazole-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]-2H-benzotriazole with polyethylene glycol 300; $\left[\text{R}-\text{CH}_2\text{CH}_2-\text{COO}-\text{CH}_2\text{CH}_2 \right]_2$, where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl, 2-[2'-hydroxy-3'-(α,α -dimethylbenzyl)-5'-(1,1,3,3-tetramethylbutyl)-phenyl]benzotriazole; 2-[2'-hydroxy-3'-(1,1,3,3-tetramethylbutyl)-5'-(α,α -dimethylbenzyl)-phenyl]benzotriazole.

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2.2. 2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octyloxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-dimethoxy derivatives.

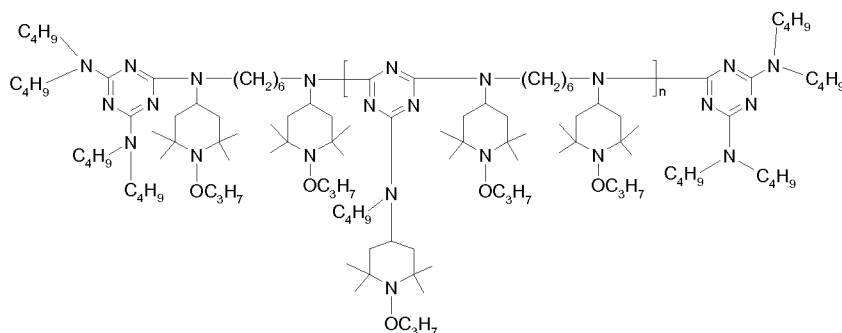
2.3. Esters of substituted and unsubstituted benzoic acids, for example 4-tert-butylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoyl resorcinol, bis(4-tert-butylbenzoyl)resorcinol, benzoyl resorcinol, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate.

2.4. Acrylates, for example ethyl α -cyano- β,β -diphenylacrylate, isooctyl α -cyano- β,β -diphenylacrylate, methyl α -carbomethoxycinnamate, methyl α -cyano- β -methyl-p-methoxycinnamate, butyl α -cyano- β -methyl-p-methoxy-cinnamate, methyl α -carbomethoxy-p-methoxycinnamate, N-(β -carbomethoxy- β -cyanovinyl)-2-methylindoline, neopentyl tetra(α -cyano- β,β -diphenylacrylate).

2.5. Sterically hindered amines, for example 1,6-Hexanediamine N, N'-bis(1-propyloxy-2,2,6,6-tetramethyl-4-piperidiny)- N, N'-bis-2-[4,5-bis-(N-n-butyl-N'-1-propyloxy-2,2,6,6-tetramethyl-4-piperidiny)-1,3,5-triazine], 1,6-Hexanediamine N, N'-bis(2,2,6,6-tetramethyl-4-piperidiny)- N, N'-bis-2-[4,5-bis-(N-n-butyl-N'-2,2,6,6-tetramethyl-4-piperidiny)-1,3,5-triazine], carbonic acid bis(1-undecyloxy-2,2,6,6-tetramethyl-4-piperidyl)ester, bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(2,2,6,6-tetramethyl-4-piperidyl)succinate, bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(1,2,2,6,6-pentamethyl-4-piperidyl) n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensates

of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl)nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl)-1,2,3,4-butanetetracarboxylate, 1,1'-(1,2-ethanediyl)-bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl)-2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)-malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)succinate, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, the condensate of 2-chloro-4,6-bis(4-n-butylamino-2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, the condensate of 2-chloro-4,6-di-(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidine-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, a mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, a condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, a condensate of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine as well as 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); a condensate of 1,6-hexanediamine and 2,4,6-trichloro-1,3,5-triazine as well as N,N-dibutylamine and 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [192268-64-7]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimide, N-(1,2,2,6,6-

pentamethyl-4-piperidyl)-n-dodecylsuccinimide, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxo-spiro[4,5]decane, a reaction product of 7,7,9,9-tetramethyl-2-cycloundecyl-1-oxa-3,8-diaza-4-oxospiro-[4,5]decane and epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyloxycarbonyl)-2-(4-methoxyphenyl)ethene, N,N'-bis-formyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, a diester of 4-methoxymethylenemalonic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, a reaction product of maleic acid anhydride- α -olefin copolymer with 2,2,6,6-tetramethyl-4-aminopiperidine or 1,2,2,6,6-pentamethyl-4-aminopiperidine, 2,4-bis[N-(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidine-4-yl)-N-butylamino]-6-(2-hydroxyethyl)amino-1,3,5-triazine, 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine, 5-(2-ethylhexanoyl)oxymethyl-3,3,5-trimethyl-2-morpholinone, Sanduvor (Clariant; CAS Reg. No. 106917-31-1), 5-(2-ethylhexanoyl)oxymethyl-3,3,5-trimethyl-2-morpholinone, the reaction product of 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidine-4-yl)butylamino]-6-chloro-s-triazine with N,N'-bis(3-aminopropyl)ethylenediamine), 1,3,5-tris(N-cyclohexyl-N-(2,2,6,6-tetramethylpiperazine-3-one-4-yl)amino)-s-triazine, 1,3,5-tris(N-cyclohexyl-N-(1,2,2,6,6-pentamethylpiperazine-3-one-4-yl)amino)-s-triazine,



2.6 Benzoxazinone derivatives such as e.g. 2,2'-(1,4-phenylene)bis[4H-3,1-benzoxazin-4-one] (CAS No. 018600-59-4).

2.7. Oxamides, for example 4,4'-dioctyloxyoxanilide, 2,2'-diethoxyoxanilide, 2,2'-
 5 dioctyloxy-5,5'-di-tert-butoxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butoxanilide, 2-ethoxy-
 2'-ethyloxanilide, N,N'-bis(3-dimethylaminopropyl)oxamide, 2-ethoxy-5-tert-butyl-2'-
 ethoxanilide and its mixture with 2-ethoxy-2'-ethyl-5,4'-di-tert-butoxanilide, mixtures of
 o- and p-methoxy-disubstituted oxanilides and mixtures of o- and p-ethoxy-
 disubstituted oxanilides.

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2.8. 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-
 octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-
 dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-
 1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-
 15 triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-
 hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-
 4-tridecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-
 hydroxy-3-butyloxypropoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-
 (2-hydroxy-3-octyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-
 20 (dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxyphenyl]-4,6-bis(2,4-
 dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-
 dodecyloxypropoxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-
 hexyloxy)phenyl-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-methoxyphenyl)-4,6-
 diphenyl-1,3,5-triazine, 2,4,6-tris[2-hydroxy-4-(3-butoxy-2-hydroxypropoxy)phenyl]-

1,3,5-triazine, 2-(2-hydroxyphenyl)-4-(4-methoxyphenyl)-6-phenyl-1,3,5-triazine, 2-{2-hydroxy-4-[3-(2-ethylhexyl-1-oxy)-2-hydroxypropyloxy]phenyl}-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(4-[2-ethylhexyloxy]-2-hydroxyphenyl)-6-(4-methoxyphenyl)-1,3,5-triazine, 2-(4,6-bis-biphenyl-4-yl-1,3,5-triazin-2-yl)-5-(2-ethyl-(n)-hexyloxy)phenol.

3. Metal deactivators, for example N,N'-diphenyloxamide, N-salicylal-N'-salicyloyl hydrazine, N,N'-bis(salicyloyl)hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoyl bisphenylhydrazide, N,N'-diacetyl adipoyl dihydrazide, N,N'-bis(salicyloyl)oxalyl dihydrazide, N,N'-bis(salicyloyl)thiopropionyl dihydrazide.

3a. Formamidines, for example Ethoxycarbonylphenyl)-N'-ethyl-N'-phenyl formamidine.

4. Phosphites and phosphonites, for example triphenyl phosphite, diphenylalkyl phosphites, phenyldialkyl phosphites, tris(nonylphenyl) phosphite, trilauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl)pentaerythritol diphosphite, bis(2,4-di-cumylphenyl)pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl)pentaerythritol diphosphite, diisodecyloxy pentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl)pentaerythritol diphosphite, bis(2,4,6-tris(tert-butylphenyl)pentaerythritol diphosphite, tristearyl sorbitol tri-

phosphite, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylene diphosphonite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[3-(3-methyl-4-hydroxy-5-tert.butyl-phenyl)-propyl]-phosphite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenz[d,g]-1,3,2-dioxaphosphocin, bis(2,4-di-tert-butyl-6-methylphenyl)methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl)ethyl phosphite, tris-[4-tert. butyl-2-(5-tert. butyl-3H-1-benzofuran-2-one)-phenyl]-phosphite, tris-[4-(1,1'3,3'-tetramethyl-butane)-2-(5-(1,1'3,3'-tetramethyl-butane-3H-1-benzofuran-2-one)-phenyl)-phenyl]-phosphite, tris-[2,6-dimethyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, bis-[2,6-dimethyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phenyl-phosphite, bis-[2,6-dimethyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-[2,4-di-tert. butyl-phenyl]-phosphite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[4-tert. butyl-(5-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[2,6-dimethyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [2,2'-methylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1-methyl-6-tert. butyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, bis-(2,6-dimethyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenol) pentaerythritol diphosphite, bis-(1-methyl-6-tert. butyl-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenol) pentaerythritol diphosphite, bis-(4-tert. butyl-(5-tert. butyl)-3H-1-benzofuran-2-one)-phenol) pentaerythritol diphosphite, bis-(4-(1,1'3,3'-tetramethyl-butane)-(5-(1,1'3,3'-tetramethyl-butane))-3H-1-benzofuran-2-one)-phenol) pentaerythritol diphosphite, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocin, 2,2',2''-nitrido[triethyltris(3,3',5,5'-tetra-tert-butyl-1,1'-

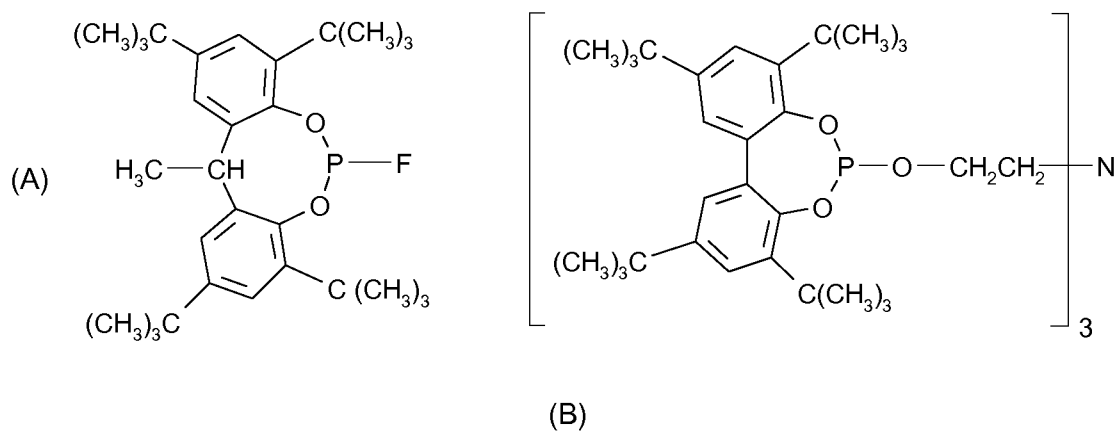
biphenyl-2,2'-diyl)phosphite], 2-ethylhexyl(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite, 5-butyl-5-ethyl-2-(2,4,6-tri-tert-butylphenoxy)-1,3,2-dioxaphosphirane.

The following phosphites are especially preferred:

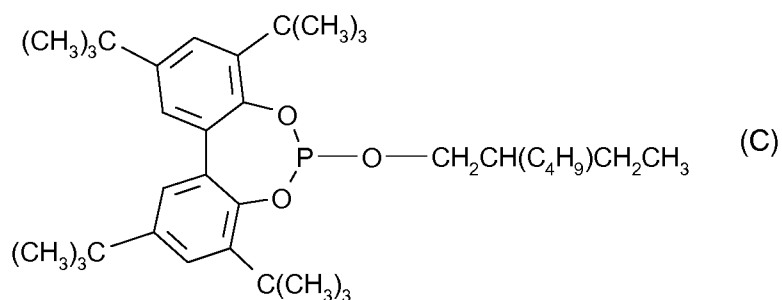
5

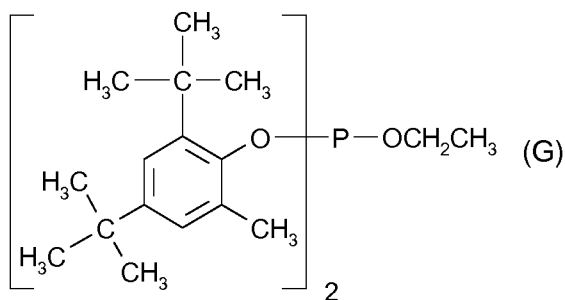
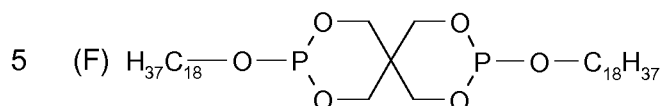
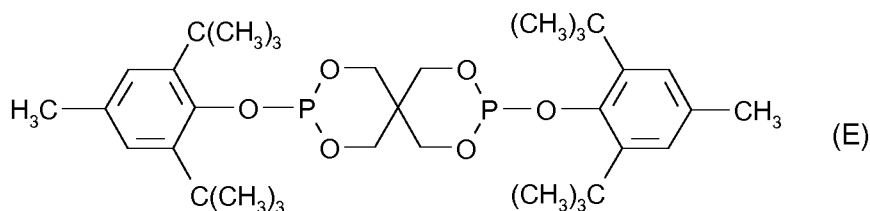
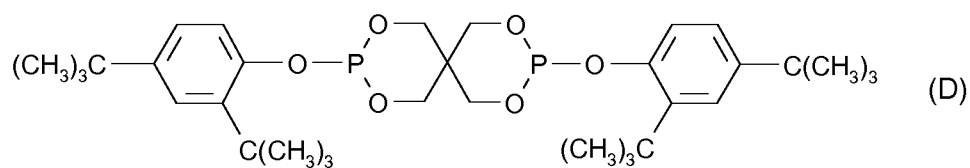
Tris(2,4-di-tert-butylphenyl) phosphite (Irgafos[®] 168, Ciba Specialty Chemicals Inc.), tris(nonylphenyl) phosphite, phosphorus acid mixed 2,4-bis(1,1-dimethylpropyl)phenyl and 4-(1,1-dimethylpropyl)phenyl triesters (CAS Reg. No. 939402-02-5), phosphorous acid triphenyl ester polymer with alpha-hydro-omega-hydroxypoly[oxy(methyl-1,2-ethanediyl) C10-16 alkyl esters (CAS Reg. No. 1227937-46-3).

10



15





[2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1-methyl-6-tert. butyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[3-(3-methyl-4-hydroxy-5-tert.butyl-phenyl)-propyl]-phosphite.

5. Hydroxylamines, for example N,N-dibenzylhydroxylamine, N,N-diethylhydroxylamine, N,N-dioctylhydroxylamine, N,N-dilaurylhydroxylamine, N,N-ditetradecylhydroxylamine, N,N-dihexadecylhydroxylamine, N,N-

dioctadecylhydroxylamine, N-hexadecyl-N-octadecylhydroxylamine, N-heptadecyl-N-octadecylhydroxylamine, N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

- 5 6. Amine oxides, for example N,N-dibenzylhydroxylamine oxide, N,N-diethylhydroxylamine oxide, N,N-dioctylhydroxylamine oxide, N,N-dilaurylhydroxylamine oxide, N,N-ditetradecylhydroxylamine oxide, N,N-dihexadecylhydroxylamine oxide, N,N-dioctadecylhydroxylamine oxide, N-hexadecyl-N-octadecylhydroxylamine oxide, N-heptadecyl-N-octadecylhydroxylamine oxide, N,N-dialkylhydroxylamine oxide derived from hydrogenated tallow amine.
- 10

7. Nitrones, for example, N-benzyl-alpha-phenylnitrone, N-ethyl-alpha-methylnitrone, N-octyl-alpha-heptylnitrone, N-lauryl-alpha-undecylnitrone, N-tetradecyl-alpha-tridecylinnitrone, N-hexadecyl-alpha-pentadecylnitrone, N-octadecyl-alpha-heptadecylnitrone, N-hexadecyl-alpha-heptadecylnitrone, N-octadecyl-alpha-pentadecylnitrone, N-heptadecyl-alpha-heptadecylnitrone, N-octadecyl-alpha-hexadecylnitrone, nitrone derived from N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.
- 15

- 20 8. Thiosynergists, for example dilauryl thiodipropionate, dimistryl thiodipropionate, distearyl thiodipropionate, pentaerythritol tetrakis[3-(dodecylthio)propionate] or distearyl disulfide.

9. Peroxide scavengers, for example esters of β -thiodipropionic acid, for example the lauryl, stearyl, myristyl or tridecyl esters, mercaptobenzimidazole or the zinc salt of 2-mercaptobenzimidazole, zinc dibutyldithiocarbamate, dioctadecyl disulfide, pentaerythritol tetrakis(β -dodecylmercapto)propionate.

5

10. Basic co-stabilizers, for example melamine, polyvinylpyrrolidone, dicyandiamide, triallyl cyanurate, urea derivatives, hydrazine derivatives, amines, polyamides, polyurethanes, alkali metal salts and alkaline earth metal salts of higher fatty acids, for example calcium stearate, zinc stearate, magnesium behenate, magnesium stearate, sodium ricinoleate and potassium palmitate, antimony pyrocatecholate or zinc pyrocatecholate, zeolithes, hydrotalcites, hydrocalumites.

11. Nucleating agents, for example inorganic substances, such as talcum, metal oxides, such as titanium dioxide or magnesium oxide, phosphates, carbonates or sulfates of, preferably, alkaline earth metals; organic compounds, such as mono- or polycarboxylic acids and the salts thereof, e.g. 4-tert-butylbenzoic acid, adipic acid, diphenylacetic acid, sodium succinate or sodium benzoate; polymeric compounds, such as ionic copolymers (ionomers). Especially preferred are 1,3:2,4-bis(3',4'-dimethylbenzylidene)sorbitol, 1,3:2,4-di(paramethyldibenzylidene)sorbitol, and 1,3:2,4-di(benzylidene)sorbitol. Beta-nucleating agents are also of interest.

20

12. Fillers and reinforcing agents, for example calcium carbonate, silicates, glass fibres, carbon fibers, glass beads, asbestos, talcum (preferably with a particle size of 0.01 to 20 μ m), kaolin, mica, barium sulfate, metal oxides and hydroxides, carbon

black, graphite, wood flour and flours or fibers of other natural products, synthetic fibers.

13. Other additives, for example plasticisers, lubricants, emulsifiers, pigments, rheology

5 additives, catalysts, flow-control agents, optical brighteners, flameproofing agents, anti-static agents and blowing agents.

14. Benzofuranones and indolinones, for example those disclosed in U.S. 4,325,863;

U.S. 4,338,244; U.S. 5,175,312; U.S. 5,216,052; U.S. 5,252,643; DE-A-4316611;

10 DE-A-4316622; DE-A-4316876; EP-A-0589839, EP-A-0591102; EP-A-1291384 or 3-[4-(2-acetoxyethoxy)phenyl]-5,7-di-tert-butylbenzofuran-2-one, 5,7-di-tert-butyl-3-[4-(2-stearoyloxyethoxy)phenyl]benzofuran-2-one, 3,3'-bis[5,7-di-tert-butyl-3-(4-[2-hydroxyethoxy]phenyl)benzofuran-2-one], 5,7-di-tert-butyl-3-(4-ethoxyphenyl)benzofuran-2-one, 3-(4-acetoxy-3,5-dimethylphenyl)-5,7-di-tert-
15 butylbenzofuran-2-one, 3-(3,5-dimethyl-4-pivaloyloxyphenyl)-5,7-di-tert-butylbenzofuran-2-one, 3-(3,4-dimethylphenyl)-5,7-di-tert-butylbenzofuran-2-one, 3-(2,3-dimethylphenyl)-5,7-di-tert-butylbenzofuran-2-one, 3-(2-acetyl-5-isooctylphenyl)-5-isooctylbenzofuran-2-one.

20 The conventional additive may be present in the polyethylene of the pipe according to the present invention in an amount of e.g. 0.001 to 10 %, relative to the weight of the polyethylene.

A further embodiment of the present invention is the polyethylene pipe as defined above, which is in contact with chlorinated (common chlorinated water disinfectants such as chlorine (hypo-chlorite), chlorine dioxide and chloramines) or non-chlorinated water.

5

Another embodiment of the present invention is the use of a mixture containing components A) and B) in a weight ratio of 1:10 to 10:1 for stabilizing a polyethylene pipe.

Still another embodiment of the present invention is a method for stabilizing a polyethylene pipe which comprises incorporating into the polyethylene components A) and B) in a weight ratio of 1:10 to 10:1.

The embodiments of the present invention include chlorinated or non-chlorinated water pipes for domestic, municipal or industrial applications, non-pressure up to high-pressure pipe applications used for drinkable or non-drinkable water, for general purpose water or waste water.

The examples below illustrate the invention in greater detail. All percentages and parts are by weight, unless stated otherwise.

20

Additives used on the following examples:

Irganox®1330:

(CAS number: 1709-70-2)

1,3,5-Tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene

Irgafos®168:

(CAS number: 31570-04-4)

5 Tris[2,4-di-tert-butylphenyl]phosphite

Sumilizer®GP:

(CAS number: 203255-81-6)

6-[3-(3-tert-Butyl-4-hydroxy-5-methylphenyl)propoxy]-2,4,8,10-tetra-tert-

10 butyldibenzo[d,f][1,3,2]dioxaphosphepin

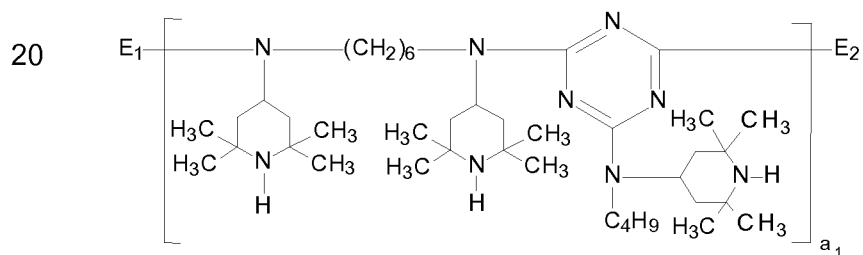
Compound D-1:

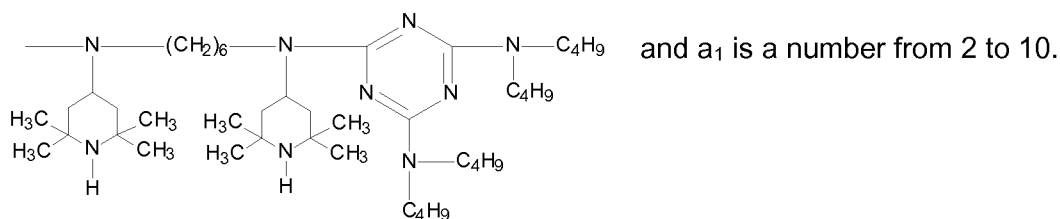
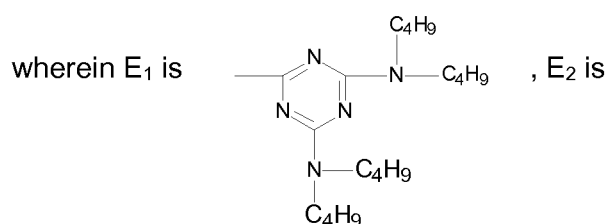
Compound (108) disclosed in Example S-8 of WO-A-2015/121445

15 [2,2'-Ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite

Chimassorb®2020:

(CAS number: 192268-64-7)





Hycite®713:

5 (CAS number: 012304-65-3 or 11097-59-9)

Hydrotalcite (Magnesium aluminum hydroxide carbonate hydrate)

Examples:

- Preparation of the test specimens: A mixture of a non-stabilised high density polyeth-
- 10 ylene (HD-PE; Hostalen®CRP-100; natural classified under PE 100 of LyondellBasell; Melt Flow Rate: 190°C/5.0 Kg: 0.23g/10 min (ISO 1133); Density: 0.95g/cm³ (ISO 1183)) and the additives listed in Table 1 is mixed with a Mixaco Lab CM12 high speed mixer device.
- 15 The obtained full formulation is then compounded on a Collin 25X42D extruder at 240°C and then injection molded on an Engel HL65 injection molding machine at 230°C.

The injection molded plaques 40 mm x 60 mm x 2 mm are exposed to chlorinated water under the following parameters: 40°C, pH 7, 2 mg/L NaClO and 50L/hours. The parameters measured are OIT Values using a DSC Q2000 von TA Instrument (Waters) at 200°C under O₂ after 0, 3 and 5 months exposition. The depletion results are listed in Table 2.

Table 1:

Additive Formulation	No.
0.3% of Irganox®1330 + 0.1% of Irgafos®168 + 0.2 % of Hycite®713	0
0.3% of Irganox®1330 + 0.1% of Irgafos®168 plus 0.2% of Chimassorb®2020 + 0.2% of Hycite®713	1
0.3% of Irganox®1330 + 0.1% of Sumilizer®GP plus 0.2% of Chimassorb®2020 + 0.2% of Hycite®713	2
0.3% of Irganox®1330 + 0.1% of Compound (D-1) plus 0.2% of Chimassorb®2020 + 0.2% of Hycite®713	3
0.3% of Irganox®1330 + 0.1% of a mixture of Compound (D-1) and Irgafos®168 in a weight ratio of 10/1 plus 0.2% of Chimassorb®2020 + 0.2% of Hycite®713	4

Table 2:

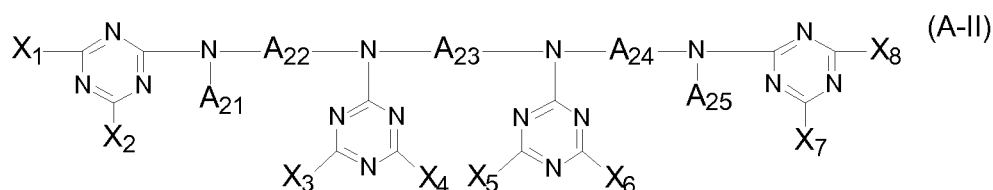
Formulation No.	OIT at time zero	OIT after 3 months	OIT after 5 months
0	50	50	50
1	240	200	190
2	220	180	160
3	280	200	200
4	230	190	180

High OIT-values are desired.

or the radicals A₁₃ and A₁₄, together with the nitrogen atom to which they are bonded, form a 5- to 10-membered heterocyclic ring and

a₁ is a number from 1 to 20, preferably 2 to 20, and the repeating units are identical or different;

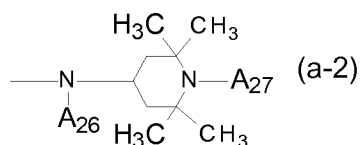
5



wherein A₂₁ and A₂₅ independently of one another are hydrogen, C₁-C₁₂alkyl, C₅-C₁₂cycloalkyl or a group of the formula (a-1),

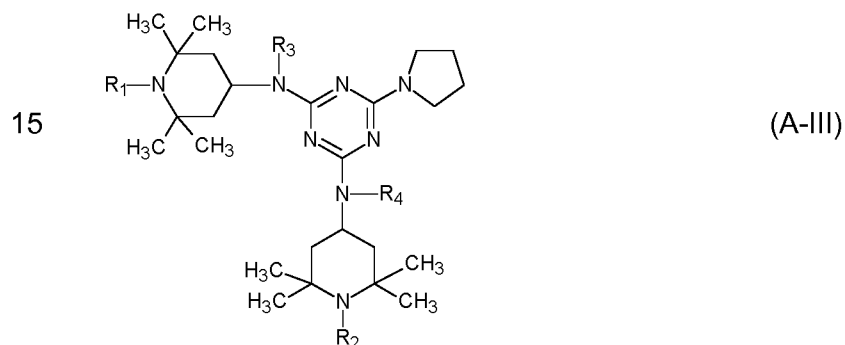
A₂₂, A₂₃ and A₂₄ independently of one another are C₂-C₁₀alkylene, and

10 X₁, X₂, X₃, X₄, X₅, X₆, X₇ and X₈ independently of one another are a group of the formula (a-2),



in which A₂₆ is hydrogen, C₁-C₁₂alkyl, C₅-C₁₂cycloalkyl or a group of the formula (a-1)

as defined above, and A₂₇ has one of the meanings of A₁₂;

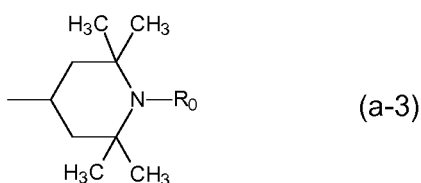


15

wherein

R_1 and R_2 independently of one another are hydrogen, C_1 - C_{22} alkyl, $-O$ ·, $-OH$, $-CH_2CN$, C_1 - C_{18} alkoxy, C_2 - C_{18} alkoxy substituted by $-OH$; C_5 - C_{12} cycloalkoxy, C_3 - C_6 alkenyl, C_3 - C_6 alkenyloxy, C_7 - C_9 phenylalkyl unsubstituted or substituted on the phenyl by 1, 2 or 3 C_1 - C_4 alkyl; or C_1 - C_8 acyl; and

- 5 R_3 and R_4 independently of one another are C_1 - C_{22} alkyl or a group of the formula (a-3)



wherein R_0 has one of the meanings of R_1 and R_2 .

3. The polyethylene pipe according to claim 2 wherein

- 10 A_{11} is C_2 - C_{10} alkylene,

the radicals A_{12} independently of one another are hydrogen, C_1 - C_4 alkyl or cyclohexyl,

A_{13} and A_{14} independently of one another are hydrogen, C_1 - C_4 alkyl, cyclohexyl or a group of the formula (a-1),



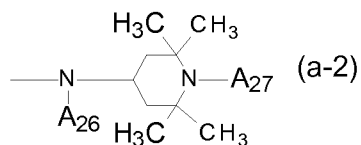
- 15 or the radicals A_{13} and A_{14} , together with the nitrogen atom to which they are bonded, form a morpholino group and

a_1 is a number from 1 to 10, preferably 2 to 10, and the repeating units are identical or different;

A_{21} and A_{25} independently of one another are hydrogen, C_1 - C_4 alkyl or cyclohexyl,

- 20 A_{22} , A_{23} and A_{24} independently of one another are C_2 - C_{10} alkylene, and

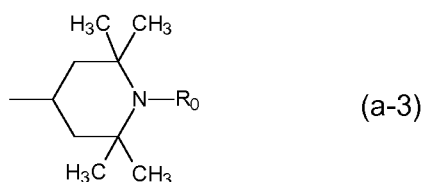
X₁, X₂, X₃, X₄, X₅, X₆, X₇ and X₈ independently of one another are a group of the formula (a-2),



in which A₂₆ is hydrogen, C₁-C₄alkyl, cyclohexyl or a group of the formula (a-1) as defined above, and A₂₇ has one of the meanings of A₁₂;

R₁ and R₂ independently of one another are hydrogen, C₁-C₄alkyl or cyclohexyl; and

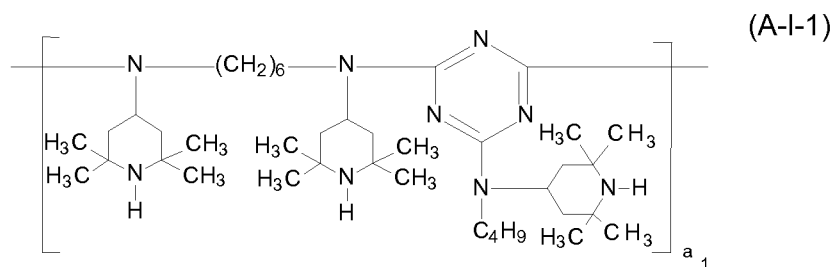
R₃ and R₄ independently of one another are C₁-C₄alkyl or a group of the formula (a-3)



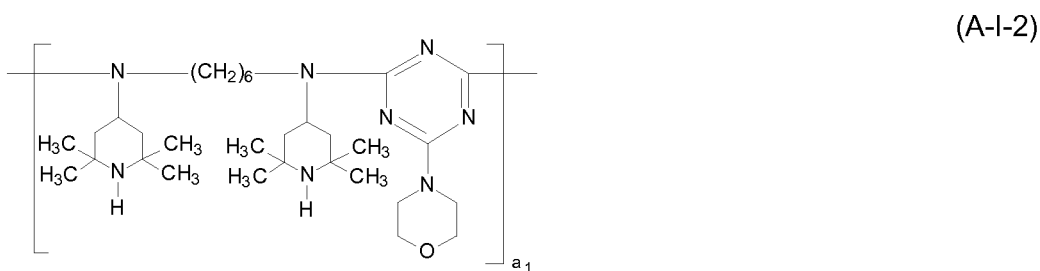
wherein R₀ has one of the meanings of R₁ and R₂.

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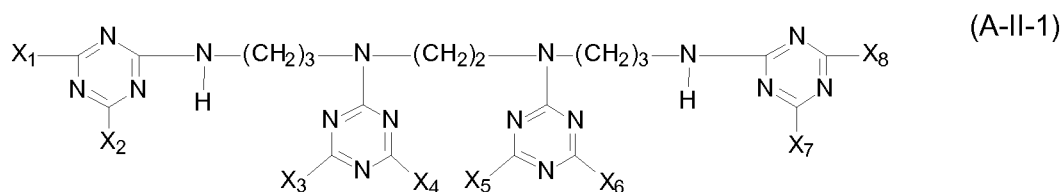
4. The polyethylene pipe according to claim 1, wherein component A) is a compound of the formula (A-I-1), (A-I-2), (A-II-1) or (A-III-1),



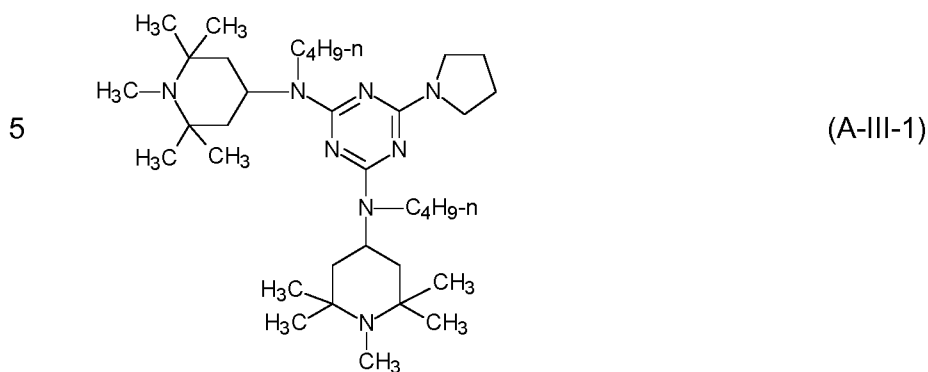
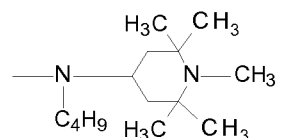
with a₁ being 2 to 10,



with a_1 being 2 to 10,



wherein $X_1, X_2, X_3, X_4, X_5, X_6, X_7$ and X_8 are the group



5. The polyethylene pipe according to any of claims 1 to 4, wherein Component B) is at least one magnesium aluminum hydroxide carbonate hydrate or zinc aluminum hydroxide carbonate hydrate.

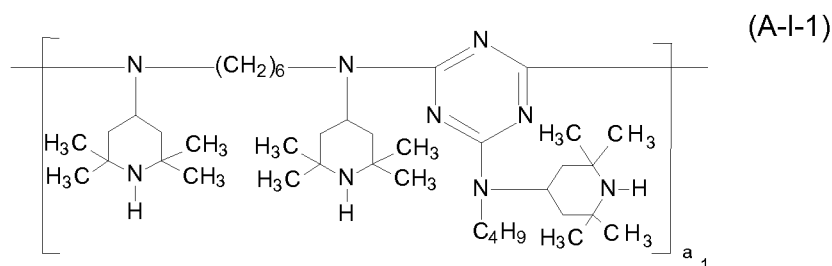
10

6. The polyethylene pipe according to any of claims 1 to 5 additionally comprising a component C) which is a phenolic antioxidant.

7. The polyethylene pipe according to any of claims 1 to 6 additionally comprising a component D) which is at least one compound selected from the group consisting of phosphites, phosphonites, hydroxylamines, tocopherols and tocopherol acetates.
- 5 8. The polyethylene pipe according to claim 6 wherein the phenolic antioxidant is 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, ethylene bis[3,3-bis(3-tert-butyl-4-hydroxyphenyl)butyrate] or 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate.
- 10 9. The polyethylene pipe according to claim 7, wherein component D) is a phosphite, preferably tris(2,4-di-tert-butylphenyl) phosphite, [3,3',5,5'-tetra-tert. butyl-1,1'biphenyl-2,2'-diyl]-[3-(3-methyl-4-hydroxy-5-tert.butyl-phenyl)-propyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1,6-dimethyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite, [2,2'-ethylene-bis-(4,6-di-tert. butyl-phenyl)-1,1'-diyl]-[1-methyl-6-tert. butyl-4-(5,7-di-tert. butyl)-3H-1-benzofuran-2-one)-phenyl]-phosphite or 6-[3-(3-tert-butyl-4-hydroxy-5-methylphenyl)propoxy]-2,4,8,10-tetra-tert-butyl-dibenzo[d,f][1,3,2]dioxaphosphin.
- 15 10. The polyethylene pipe according to any of claims 1 to 9 claim 1 additionally comprising a pigment, preferably a blue pigment.
- 20 11. The polyethylene pipe according to any of claims 1 to 10 wherein the polyethylene is selected from high density polyethylene (HD-PE), medium density polyethylene (MD-PE), low density polyethylene (LD-PE), linear low density polyethylene (LLD-

PE), metallocene polyethylene, crosslinked polyethylene (PE-X), recycled polyethylene, bi-modal polyethylene and mixtures of polyethylenes.

12. The polyethylene pipe according to any of claims 1, 10 and 11, comprising the
5 components (A), (B), (C) and (D), wherein component (A) is



with a_1 being 2 to 10,

component (B) is a natural or synthetic hydrotalcite,

component (C) is 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene,

10 and

component (D) is tris[2,4-di-tert-butylphenyl]phosphite.

13. The polyethylene pipe according to any of claims 1 to 12, which is in contact with chlorinated or non-chlorinated water.

15

14. The use of a mixture containing components A) and B) in a weight ratio of 1:10 to 10:1 as defined in claim 1 for stabilizing a polyethylene pipe.

15. A method for stabilizing a polyethylene pipe which comprises incorporating into the
20 polyethylene components A) and B) in a weight ratio of 1:10 to 10:1 as defined in claim

1.