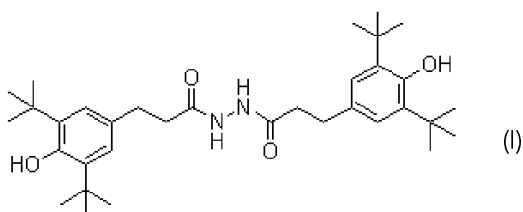


Polyolefin pipe comprising a hydrotalcite mineral and a hydrazide

The present invention relates to a method for transporting chlorinated water comprising the step of conveying the water through a pipe made of a polyolefin comprising a hydrotalcite mineral and a hydrazide of the formula (I) as defined herein. The present invention also relates to a pipe for transporting the chlorinated water where the pipe is made of the polyolefin comprising the hydrotalcite mineral and the hydrazide of the formula (I); to a method for preparing the pipe comprising contacting the polyolefin, the hydrotalcite mineral and the hydrazide of the formula (I); and to a use of the hydrotalcite mineral and the hydrazide of the formula (I) for stabilizing a pipe made of a polyolefin against chlorinated water.

The use of chlorine based disinfectants is extremely effective in eliminating waterborne disease for cold water transportation and for hot water pipe but they also degrade the stabilization system leading to early leakage after short time of installation. When polyolefin pipes come into contact with chlorinated water, there are some potential problems that can often arise: Chlorinated water can cause degradation of the polyolefin pipe material over time. This can lead to brittleness, cracking, and reduced overall strength of the pipe. Chlorinated water can chemically react with the polyolefin material, causing it to break down and weaken. This can result in leaks or bursts in the pipe. The combination of chlorine exposure and the resulting degradation and chemical reactions can significantly reduce the lifespan of polyethylene pipes in contact with chlorinated water. To mitigate these problems, it is essential to use properly designed and approved polyolefin pipes that are specifically designed for chlorinated water applications. Additionally, regular inspections, maintenance, and monitoring of the pipes can help identify any signs of degradation or damage and allow for timely repairs or replacements. Object of the present invention was to overcome such problems.

The object was solved by a method for transporting chlorinated water comprising the step of conveying the water through a pipe made of a polyolefin comprising a hydrotalcite mineral and a hydrazide of the formula (I)



The object was solved by a pipe for transporting the chlorinated water where the pipe is made of the polyolefin comprising the hydrotalcite mineral and the hydrazide of the formula (I).

The object was solved by a method for preparing the pipe comprising contacting the polyolefin, the hydrotalcite mineral and the hydrazide of the formula (I).

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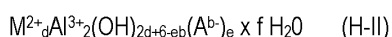
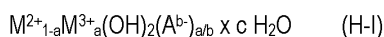
The object was solved by a use of the hydrotalcite mineral and the hydrazide of the formula (I) for stabilizing a pipe made of a polyolefin against the chlorinated water.

The **hydrazide** of the formula (I) may have the chemical names 2', 3-bis [[3-[3, 5-di-tert-butyl-4-hydroxyphenyl] propionyl]] propionohydrazide, N,N'-Bis[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionyl]hydrazine, 1,2-Bis(3,5-di-tert-butyl-4-hydroxyhydrocinnamoyl)hydrazine, 1,2-Bis(3,5-di-tert-butyl-4-hydroxyhydrocinnamoyl)hydrazide, 3,5-Bis(1,1-dimethylethyl)-4-hydroxybenzenepropionic acid 2-[3-[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]hydrazide, or CAS number 32687-78-8.

The concentration of the hydrazide in the polyolefin can be from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.

The weight ratio of the hydrotalcite mineral to the hydrazide can be from 5:1 to 1:5, preferably from 3:1 to 1:3, and in particular from 2:1 to 1:2.

Suitable **hydrotalcite minerals** are mixed hydroxide of the formula (H-I) or (H-II)



where

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,

d is for example a number up to 6,

e is for example a number up to 2, and

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

The hydrotalcite minerals can be layered double hydroxides that contain positively charged hydroxide layers and charge balancing anions located in the interlayer region. In another form the hydrotalcite mineral is selected from hydrotalcite, comblainit, desautelsit, pyroaurit, reevesit, sergeevit, stichtit und takovit or a synthetic hydrotalcite.

The hydrotalcite minerals is preferably 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 hydrate 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-4V.

The hydrotalcite mineral may have a heavy metal content of below 100 ppm, preferably below 10 ppm.

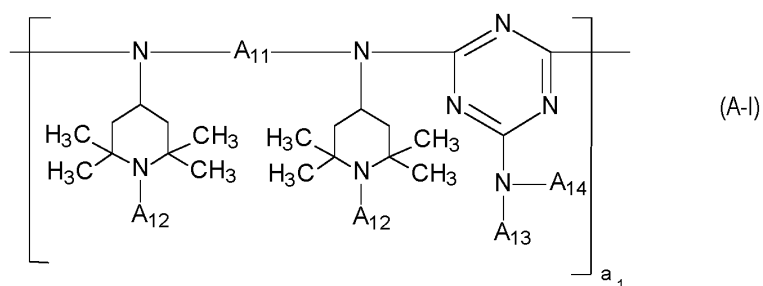
The hydrotalcite mineral may have a bulk density of 100 to 500 g/l, preferably 200 to 400 g/l, and in particular 250 to 350 g/l.

The hydrotalcite mineral can be in powder form.

The concentration of the hydrotalcite mineral in the polyolefin can be from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.

The polyolefin may comprise a hindered amine light stabilizer containing a **triazine** residue, which is also called **component A)** herein.

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 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,

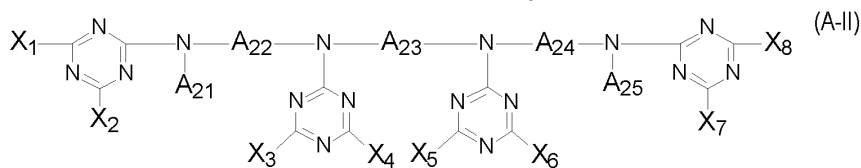
A_{13} and A_{14} independently of one another are hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1),



or the radicals A_{13} and A_{14} , together with the nitrogen atom to which they are bonded, form a 5- to 10-membered heterocyclic ring and

a_1 is a number from 1 to 20, preferably 2 to 20, and the repeating units are identical or different;

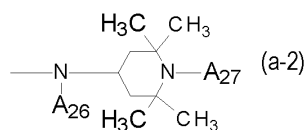
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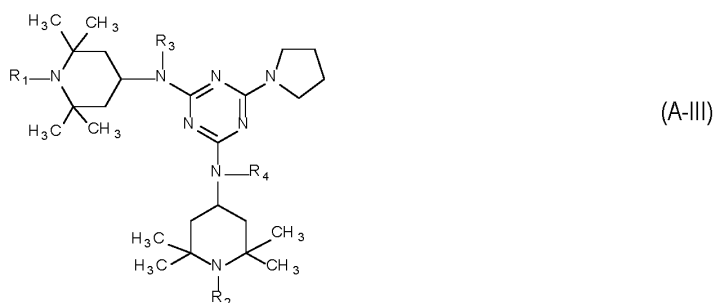
wherein A_{21} and A_{25} independently of one another are hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1),

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),



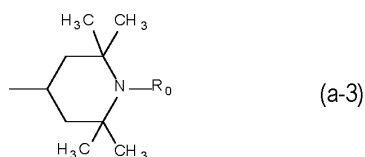
in which A_{26} is hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1) as defined above, and A_{27} has one of the meanings of A_{12} ;



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

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 .

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,

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1,1,3,3-tetramethylpentyl, 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, 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.

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.

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.

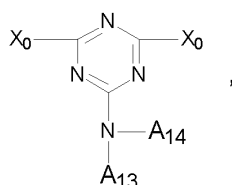
An example of C₅-C₇cycloalkylene is cyclohexylene.

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

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

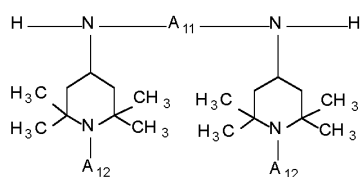
The meanings of the terminal groups which saturate the free valences in the compounds of the formula (A-I) depend on the processes used for their preparation. The terminal groups can also be modified after the preparation of the compounds.

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

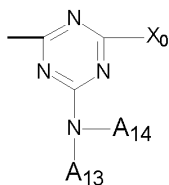


in which X₀ is, for example, halogen, in particular chlorine, and A₁₃ and A₁₄ are as defined above, with a compound of the formula

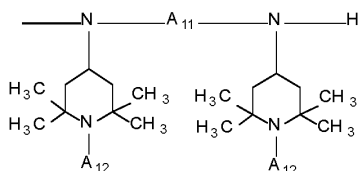
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in which A_{11} and A_{12} are as defined above, the terminal group bonded to the diamino radical is for example hydrogen or

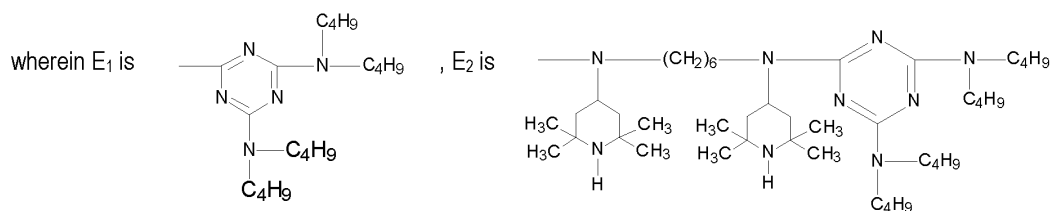
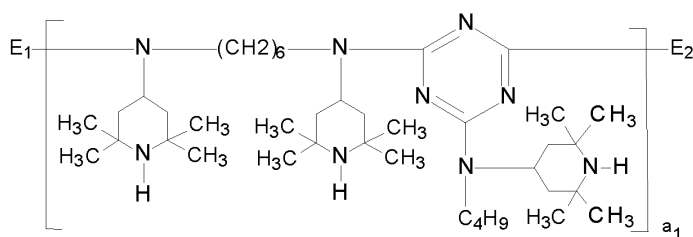


and the terminal group bonded to the triazine radical is for example X_0 or



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



and a_1 is a number from 1 to 10, preferably 2 to 10.

According to a preferred embodiment

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),



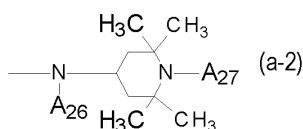
or the radicals A_{13} and A_{14} , together with the nitrogen atom to which they are bonded, form a morpholino group and

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,

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

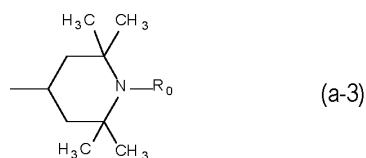
X_1 , X_2 , X_3 , X_4 , X_5 , X_6 , X_7 and X_8 independently of one another are a group of the formula (a-2),



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

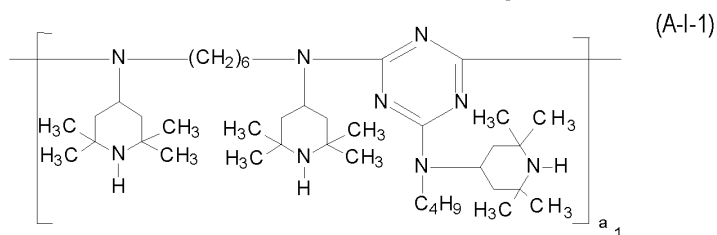
R_3 and R_4 independently of one another are C_1 - C_4 alkyl or a group of the formula (a-3)



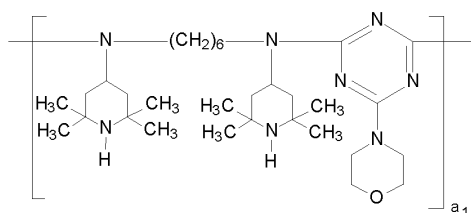
wherein R_0 has one of the meanings of R_1 and R_2 .

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),

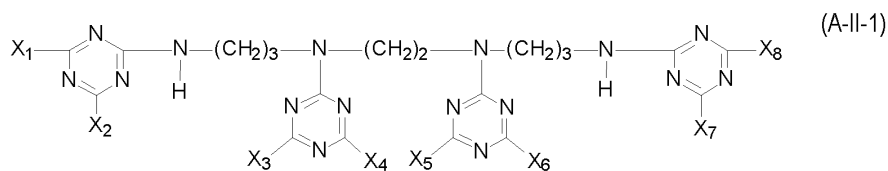
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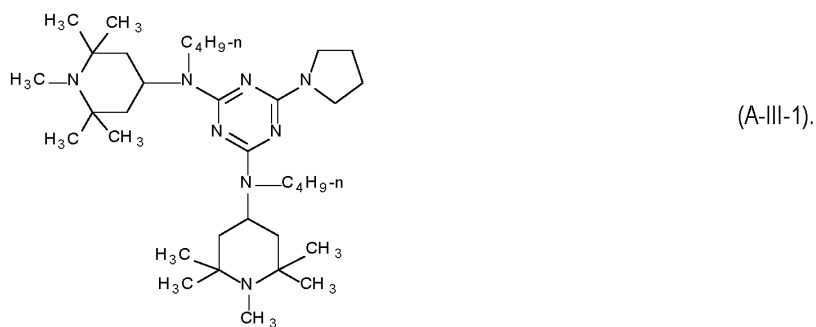
with a_1 being 2 to 10,



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



The weight ratio of the component A) to the hydrazide can be from 10:1 to 1:10, preferably 5:1 to 1:5, in particular 2:1 to 1:2.

The concentration of the component A) in the polyolefin can be from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.

The polyolefin pipe may additionally comprise a **phenolic antioxidant**, such as 1,3,5-trimethyl-2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)benzene, ethylene bis[3,3-bis(3-tert-butyl-4-hydroxyphenyl)butyrate], pentaerythritol tetrakis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate) or 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate.

The polyolefin pipe may additionally comprise a phenolic antioxidant, in particular 1,3,5-trimethyl-2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)benzene, ethylene bis[3,3-bis(3-tert-butyl-4-hydroxyphenyl)butyrate], or 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate.

The weight ratio of the phenolic antioxidant to the hydrazide can be from 10:1 to 1:2, preferably 6:1 to 1:1, in particular 4:1 to 2:1.

The concentration of the phenolic antioxidant in the polyolefin can be from 0.01 to 2 wt%, preferably from 0.05 to 0.8 wt%, and in particular from 0.1 to 0.5 wt%.

The polyolefin pipe may further comprise a **secondary antioxidant** which is at least one compound selected from the group consisting of phosphites, phosphonites, hydroxylamines, tocopherols and tocopherol acetates. Preferably, the secondary antioxidant is a phosphite or a phosphonite, in particular a phosphite.

A suitable phosphite is 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]-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]dioxaphosphepin, or bis(2,4-dicumylphenyl) pentaerythritol diphosphite.

Preferably the secondary antioxidant is a phosphite which is bis(2,4-dicumylphenyl) pentaerythritol diphosphite or tris(2,4-di-tert-butylphenyl) phosphite.

Preferably the secondary antioxidant is a phosphite which is tris(2,4-di-tert-butylphenyl) phosphite.

The weight ratio of the secondary antioxidant to the hydrazide can be from 10:1 to 1:10, preferably 5:1 to 1:5, in particular 2:1 to 1:2.

The concentration of the secondary antioxidant in the polyolefin can be from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.

The polyolefin may comprise

- from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hydrazide;
- from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hydrotalcite mineral;
- from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hindered amine light stabilizer containing a triazine residue;
- from 0.01 to 2 wt%, preferably from 0.05 to 0.8 wt%, and in particular from 0.1 to 0.5 wt% of the phenolic antioxidant; and
- from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the secondary antioxidant.

According to a preferred embodiment the polyethylene pipe may additionally comprise a **pigment**, preferably a white (e.g. titanium dioxide), blue or black (e.g. carbon black) pigment. Typically the pigment is used in a final amount of from 0.5 to 5 % by weight, preferably from 1.5 to 3.0 % by weight.

The polyethylene of the pipe according to the present invention may further comprise one or more **conventional additives** such as:

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, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(1-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'-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-di-dodecylthiomethyl-4-nonylphenol.

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 stearate, bis(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.

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

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.

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, 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, 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-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'-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.

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 1,4-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.

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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(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 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-phospha-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-phospha-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.

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.

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-phospho-2,6,7-trioxabicyclo[2.2.2]octane.

1.17. Amides of π -(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[2-(3-[3,5-di-tert-butyl-4-hydroxyphenyl]propionyloxy)ethyl]oxamide (Naugard®XL-1, supplied by Uniroyal).

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-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.

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-(π , π -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)ethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)-

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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'-(1,1-dimethylbenzyl)-5'-(1,1,3,3-tetramethylbutyl)-phenyl]-benzotriazole; 2-[2'-hydroxy-3'-(1,1,3,3-tetramethylbutyl)-5'-(1,1-dimethylbenzyl)-phenyl]benzotriazole.

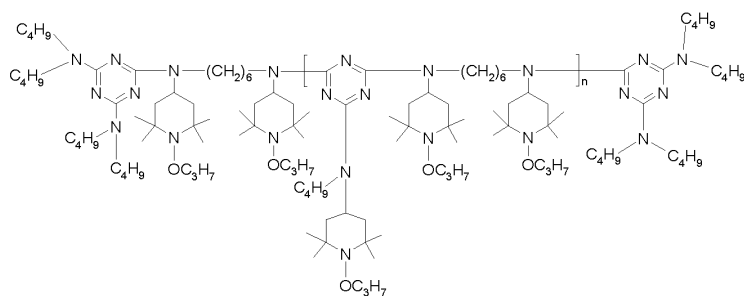
2.2. 2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octyloxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-dimethoxy derivatives.

2.3. Esters of substituted and unsubstituted benzoic acids, for example 4-tert-butyl-phenyl 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 1-cyano-1,1-diphenylacrylate, isooctyl 1-cyano-1,1-diphenylacrylate, methyl 1-carbomethoxycinnamate, methyl 1-cyano-1-methyl-p-methoxycinnamate, butyl 1-cyano-1-methyl-p-methoxycinnamate, methyl 1-carbomethoxy-p-methoxycinnamate, N-(1-carbomethoxy-1-cyanovinyl)-2-methylindoline, neopentyl tetra(1-cyano-1,1-diphenylacrylate).

2.5. Sterically hindered amines, for example 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, tris(2,2,6,6-tetramethyl-4-piperidyl)nitritoltriacetate, 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, 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, as well as 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); 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-piperidyl)oxycarbonyl-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-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],



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'-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.

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-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-(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. Formamidines and Oxamides, for example Ethoxycarbonylphenyl)-N'-ethyl-N'-phenyl formamidine or N,N'-diphenyloxamide.

5. Hydroxylamines, for example N,N-dibenzylhydroxylamine, N,N-diethylhydroxylamine, N,N-dioctylhydroxylamine, N,N-dilaurylhydroxylamine, N,N-ditetradecylhydroxylamine, N,N-dihexadecylhydroxylamine, N,N-diocetadecylhydroxylamine, N-hexadecyl-N-octadecylhydroxylamine, N-heptadecyl-N-octadecylhydroxylamine, N,N-dialkylhydroxylamine derived from hydrogenated tallow amine and vegetable source.

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

7. Nitrones, for example, N-benzyl-alpha-phenylnitron, N-ethyl-alpha-methylnitron, N-octyl-alpha-heptylnitron, N-lauryl-alpha-undecylnitron, N-tetradecyl-alpha-tridecylinnitron, N-hexadecyl-alpha-pentadecylnitron, N-octadecyl-alpha-heptadecylnitron, N-hexadecyl-alpha-heptadecylnitron, N-octadecyl-alpha-pentadecylnitron, N-heptadecyl-alpha-heptadecylnitron, N-octadecyl-alpha-hexadecylnitron, nitron derived from N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

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

9. Peroxide scavengers, for example esters of l-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(l-dodecylmercapto)propionate.

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10. Basic co-stabilizers, for example melamine, polyvinylpyrrolidone, dicyandiamide, triallyl cyanurate, urea 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.

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(paramethyl-dibenzylidene)sorbitol, and 1,3:2,4-di(benzylidene)sorbitol. Beta-nucleating agents are also of interest.

12. Fillers and reinforcing agents, for example calcium carbonate, silicates, glass fibers, carbon fibers, glass beads, asbestos, talcum (preferably with a particle size of 0.01 to 20 μm), kaolin, mica, barium sulfate, metal oxides and hydroxides, graphite, wood flour and flours or fibers of other natural products, synthetic fibers.

13. Other additives, for example plasticisers, lubricants, emulsifiers, rheology additives, catalysts, flow-control agents, optical brighteners, flameproofing agents, antistatic 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; 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-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. Suitable benzofuranones also include compounds identified in WO2015/121445.

The **polyolefin** of the pipe can be polyethylene or polypropylene, preferably polyethylene, in particular crosslinked polyethylene, such polyethylene crosslinked with peroxides. 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. Cross-linked

polyethylene pipes are often used for domestic cold and hot water (10°C - 115°C) as well as in radiant heating applications.

The **chlorinated water** is usually treated with chlorine dioxide, chlorine, hypochlorite, chloramines, and mixtures thereof, in a typical concentration of 0.01 mg/L to 4 mg/L, preferably 0.1 to 0.8 mg/L chlorine content in the chlorinated water.

The chlorine content can be analyzed by a potentiometric method which typically uses an electrode to generate a potential difference that is proportional to the chlorine concentration, which can be measured using a pH meter or a voltmeter.

The chlorinated water can be used for domestic, municipal or industrial applications. The chlorinated water can be used in non-pressure up to high-pressure pipe applications. The chlorinated water can be used for drinkable or non-drinkable water, for general purpose water or waste water.

The improved stability of the pipes made of the polyolefin can be tested in accelerated aging test such as the **oxidation induction time** OIT, e.g. according to DIN EN ISO 11357-6. During a typical OIT test, a small sample of the material is heated in the presence of air or an oxygen-rich atmosphere. The temperature is gradually increased, and the time taken for the material to undergo oxidative degradation, as indicated by a significant increase in heat release, is recorded as the OIT.

The chlorinated water can be conveyed through a pipe by usual means such as applying high pressure (e.g. by hydrostatic pressure) or low-pressure at one point of the pipe.

Water can be **conveyed** through a pipe using various methods, including gravity flow, pressure-driven flow, suction or vacuum, and hydraulic systems. The choice of method depends on factors such as the desired flow rate, pressure requirements, distance, elevation changes, and the purpose of water conveyance. Gravity flow can be used when there is a natural slope or elevation difference, allowing water to flow through a pipe under the force of gravity. Pressure-driven flow involves usually pumping water into a pipe under pressure, creating a driving force that propels the water through the pipe. Suction or vacuum pressure can be used to convey water through a pipe in some cases, such as siphoning or certain industrial processes. Hydraulic systems use often pumps, valves, and controls to control the flow and direction of water through pipes, and are commonly used in large-scale industrial applications.

The present invention also relates to the **pipe for transporting chlorinated water** where the pipe is made of the polyolefin comprising the hydrotalcite mineral and the hydrazide of the formula (I). Preferably, the weight ratio of the hydrotalcite mineral and the hydrazide is from 5:1 to 1:5, preferably from 3:1 to 1:3, and in particular from 2:1

to 1:2. Preferably, the concentration of the hydrazide in the polyolefin is from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.

The **pipes** can have common dimensions for water pipes commonly used in residential plumbing, such as 16mm, 20mm, 25mm, 32mm, 40mm, and 50mm diameter. The length of these pipes usually varies between 25 meters to 100 meters. However, the required size and length of the polyethylene pipes for plumbing projects depend on factors such as water pressure, flow rate, and distance between the water source and the fixtures being supplied.

The sizes of pipes commonly used in industrial plumbing typically range from 20mm to 1200mm or even larger. These pipes are designed to handle high-pressure applications and are available in different pressure ratings (such as PN6, PN10, PN16, etc.) to suit specific needs. The length of polyethylene pipes used in industrial applications can vary significantly. They are typically available in standard lengths of 6 meters or 12 meters.

The present invention also relates to a method for preparing the pipe comprising contacting the polyolefin, the hydrotalcite mineral and the hydrazide of the formula (I). The contacting can be achieved by conventional means such as extrusion.

The present invention also relates to a use of the hydrotalcite mineral and the hydrazide of the formula (I) for stabilizing a pipe made of a polyolefin against chlorinated water.

Examples

Chimassorb® 2020: 1,6-Hexanediamine, N,N'-bis(2,2,6,6-tetramethyl-4-piperidiny)-polymer with 2,4,6-trichloro-1,3,5-triazine, reaction products with N-butyl-1-butanamine and N-butyl-2,2,6,6-tetramethyl-4-piperidinamine, mol weight 2600-3400 g/mol.

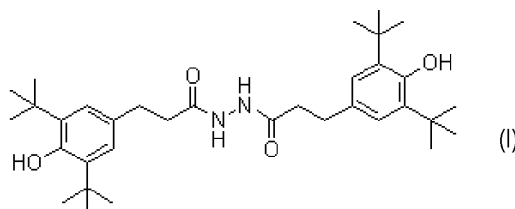
Hydrotalcite A: magnesium/aluminum-hydrotalcite.

Irganox® 1330: 1,3,5-Trimethyl-2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)benzene.

Irganox® 3114: 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate

Irgafos® 168: Tris(2,4-di-tert-butylphenyl)phosphite.

Hydrazide of the formula (I):



Example 1: Preparation of the test specimens

A mixture of a non-stabilised high-density polyethylene (HDPE) and one of the following Blend A or Blend B were mixed with a high-speed mixer device. The given concentrations refer to the concentration of the respective additive in the polyethylene.

Blend A:

- 0.3% Irganox® 1330
- 0.1% Hydrotalcite A
- 0.1% Chimassorb® 2020
- 0.1% Irgafos® 168
- 0.1% Hydrazide of the formula (I)

Blend B:

- 0.3% Irganox® 3114
- 0.1% Hydrotalcite A
- 0.1% Chimassorb® 2020
- 0.1% Irgafos® 168
- 0.1% Hydrazide of the formula (I)

The obtained full formulation was then compounded on an extruder at 240°C and then injection molded on an injection molding machine at 230°C to prepare molded plaques (40 mm x 60 mm x 2 mm).

For comparison, the Sample 2-4 were prepared with the composition as described in Table 1.

Example 2: Exposure to chlorinated water

The injection molded plaques (40 mm x 60 mm x 2 mm) were exposed to 60 °C hot chlorinated water (pH = 7, chlorine content 2,5 ppm) at a flow rate of 100 l/h. The initial OIT values and after one month of exposure were determined. The percentage of retention was summarized in Table 1.

The data showed that the Blend A and Blend B kept the desired high OIT retention after one month. For comparison, when certain components were removed or substituted in the Blend A, then the OIT retention dropped.

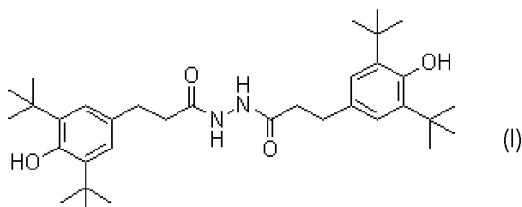
Table 1

Sample	Composition of Sample	OIT Retention after 1 month
1	Blend A	64.4
2 ^{a)}	Blend A without the Hydrotalcite A	23.1
3 ^{a)}	Blend A where the Hydrazide of the formula (I) was substituted by Hostanox OSP	21.5
4 ^{a)}	Blend A where the Hydrotalcide A was substituted by calcium stearate	41.5
5	Blend B	65.5

a) Comparative data

b) Claims

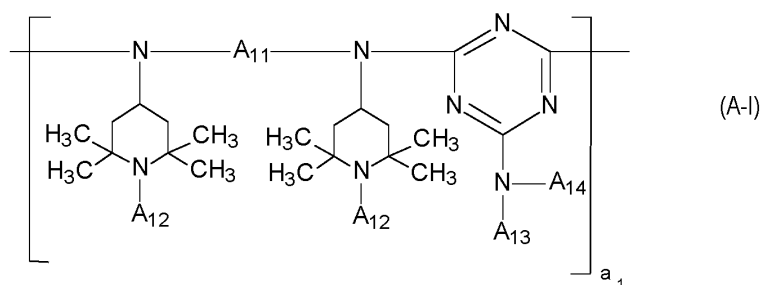
1. A method for transporting chlorinated water comprising the step of conveying the water through a pipe made of a polyolefin comprising a hydrotalcite mineral and a hydrazide of the formula (I)



2. The method according to claim 1 where the weight ratio of the hydrotalcite mineral and the hydrazide is from 5:1 to 1:5, preferably from 3:1 to 1:3, and in particular from 2:1 to 1:2.
3. The method according to claim 1 or 2 where the concentration of the hydrazide in the polyolefin is from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.
4. The method according to any of claims 1 to 3 where the concentration of the hydrotalcite mineral in the polyolefin is from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.
5. The method according to any of claims 1 to 4 where the polyolefin comprises a secondary antioxidant, which is preferably a phosphite, more preferably bis(2,4-dicumylphenyl) pentaerythritol diphosphite or tris(2,4-di-tert-butylphenyl) phosphite, and in particular tris(2,4-di-tert-butylphenyl) phosphite.
6. The method according to any of claims 1 to 5 where the weight ratio of the secondary antioxidant to the hydrazide is from 10:1 to 1:10, preferably 5:1 to 1:5, in particular 2:1 to 1:2.
7. The method according to any of claims 1 to 6 where the polyolefin comprises a phenolic antioxidant, preferably 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], pentaerythritol tetrakis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate) or 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-isocyanurate.
8. The method according to any of claims 1 to 7 where the weight ratio of the phenolic antioxidant to the hydrazide is from 10:1 to 1:2, preferably 6:1 to 1:1, in particular 4:1 to 2:1.
9. The method according to any of claims 1 to 8 where the polyolefin comprises a hindered amine light stabilizer containing a triazine residue.

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10. The method according to any of claims 1 to 9 where the hindered amine light stabilizers containing a triazine residue is 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 C_1 - C_4 alkylenedi(C_5 - C_7 cycloalkylene),

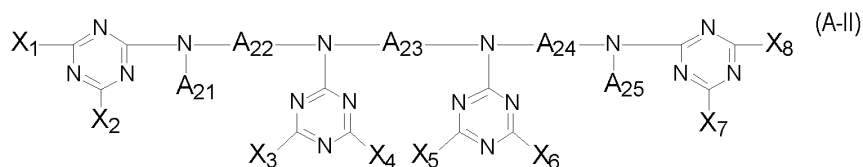
the radicals A_{12} independently of one another are hydrogen, C_1 - C_{12} alkyl or C_5 - C_{12} cycloalkyl,

A_{13} and A_{14} independently of one another are hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1),



or the radicals A_{13} and A_{14} , together with the nitrogen atom to which they are bonded, form a 5- to 10-membered heterocyclic ring and

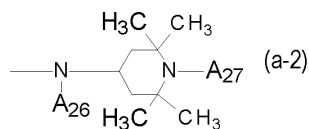
a_1 is a number from 1 to 20, preferably 2 to 20, and the repeating units are identical or different;



wherein A_{21} and A_{25} independently of one another are hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1),

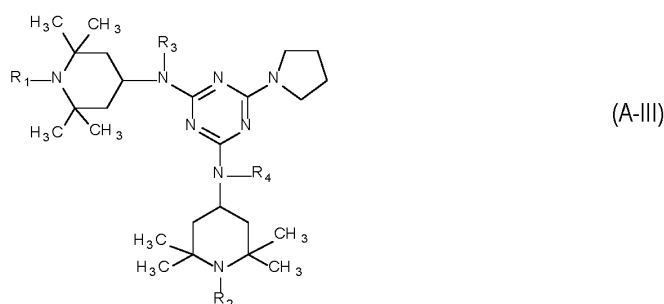
A_{22} , A_{23} and A_{24} independently of one another are C_2 - C_{10} alkylene, and

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),



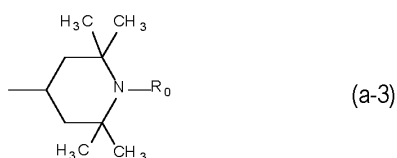
in which A_{26} is hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl or a group of the formula (a-1) as defined above, and

A_{27} has one of the meanings of A_{12} ;



wherein

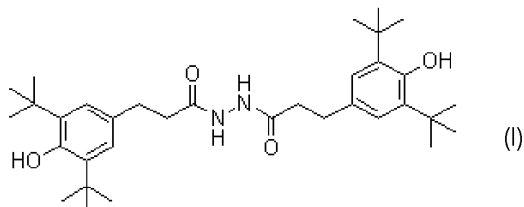
R_1 and R_2 independently of one another are hydrogen, C_1 - C_{22} alkyl, -O-, -OH, -CH₂CN, C_1 - C_{18} alkoxy, C_2 - C_{18} alkoxy substituted by -OH; C_5 - C_{12} cycloalkoxy, C_3 - C_6 alkenyl, C_3 - C_6 alkenyloxy, C_7 - C_9 phenylalkyl unsubstituted or substituted on the phenyl by 1, 2 or 3 C_1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

11. The method according to any of claims 1 to 10 where the weight ratio of the hindered amine light stabilizer containing a triazine residue to the hydrazide can be from 10:1 to 1:10, preferably 5:1 to 1:5, in particular 2:1 to 1:2.
12. The method according to any of claims 1 to 11 where the polyolefin comprises a pigment, preferably a blue or black pigment.
13. The method according to any of claims 1 to 12 where the polyolefin may comprise
 - from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hydrazide;
 - from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hydrotalcite mineral;
 - from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the hindered amine light stabilizer containing a triazine residue;
 - from 0.01 to 2 wt%, preferably from 0.05 to 0.8 wt%, and in particular from 0.1 to 0.5 wt% of the phenolic antioxidant; and
 - from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt% of the secondary antioxidant.

14. A pipe for transporting chlorinated water as defined in any of claims 1 to 13 where the pipe is made of a polyolefin comprising a hydrotalcite mineral and a hydrazide of the formula (I)



15. The pipe according to claim 14 where the weight ratio of the hydrotalcite mineral and the hydrazide is from 5:1 to 1:5, preferably from 3:1 to 1:3, and in particular from 2:1 to 1:2.
16. The pipe according to claim 14 or 15 where the concentration of the hydrazide in the polyolefin is from 0.01 to 1 wt%, preferably from 0.02 to 0.5 wt%, and in particular from 0.05 to 0.3 wt%.
17. A method for preparing the pipe as defined in any of claims 1 to 16 comprising contacting the polyolefin, the hydrotalcite mineral and the hydrazide of the formula (I).
18. A use of the hydrotalcite mineral and the hydrazide of the formula (I) as defined in any of claims 1 to 13 for stabilizing a pipe made of a polyolefin against chlorinated water.