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(54) Title: USE OF METAL HYDRAZIDE COMPLEX COMPOUNDS AS OXIDATION CATALYSTS

(57) Abstract: The present invention relates to the use of selected metal complex compounds and ligands as oxidation catalysts as well as to a process for removing stains and soil on textiles and hard surfaces. The metal complex compounds have hydrazide ligands, preferably with electron withdrawing groups in the phenyl ring adjacent to the acyl group. Further aspects of the invention are formulations comprising such metal complex compounds, novel metal complex compounds and novel ligands.



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Use of Metal Hydrazide Complex Compounds as Oxidation Catalysts

The present invention relates to the use of selected metal complex compounds as oxidation catalysts as well as to a process for removing stains and soil on textiles and hard surfaces. The metal complex compounds have hydrazide ligands, preferably with electron withdrawing groups or moieties adjacent to the acyl group. Further aspects of the invention are formulations comprising such metal complex compounds, novel metal complex compounds and novel ligands.

Metal complex catalysts with hydrazide ligands have in general been described as oxidation catalysts, for example, in DE 196 39 603. However, the compounds disclosed are not active enough. The instant invention solves this problem by introducing electron withdrawing groups in the phenyl ring adjacent to the acyl group.

The instant metal complex compounds are used especially for enhancing the action of peroxides, for example in the treatment of textile material, without at the same time causing any appreciable damage to fibres and dyeings. There is also no appreciable damage to fibres and dyeings if these metal complexes are used in combination with an enzyme or a mixture of enzymes.

The instant metal complex compounds may also be used as catalysts for oxidation using molecular oxygen and/or air, that is, without peroxide compounds and/or peroxide-forming substances. The bleaching of the fabric can happen during and/or after the treatment of the fibre with the formulation, which comprises the metal complexes.

Peroxide-containing bleaching agents have long been used in washing and cleaning processes. They have an excellent action at a liquor temperature of 90°C and above, but their performance noticeably decreases with lower temperatures. Various transition metal ions added in the form of suitable salts, and coordination compounds containing such cations are known to activate H₂O₂. In that manner it is possible for the bleaching effect, which is unsatisfactory at lower temperatures, of H₂O₂ or precursors that release H₂O₂ and of other peroxo compounds, to be increased. They are important for practical purposes, in that respect, especially combinations of transition metal ions and ligands of which the peroxide activation is manifested in an increased tendency towards oxidation in relation to substrates

and not only in a catalase-like disproportionation. The latter activation, which in the present case tends rather to be undesirable, could even impair the bleaching effects, which are inadequate at low temperatures, of H₂O₂ and its derivatives.

- 5 In terms of H₂O₂ activation having effective bleaching action, mononuclear and polynuclear variants of manganese complexes having various ligands, especially 1,4,7-trimethyl-1,4,7-triazacyclononane and optionally oxygen-containing bridging ligands, are currently regarded as being especially effective. Such catalysts are adequately stable under practical conditions and, with Mnⁿ⁺, contain an ecologically acceptable metal cation, but their use is unfortunately
10 associated with considerable damage to dyes and fibres.

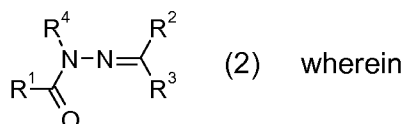
The aim of the present invention is accordingly to provide improved metal complex catalysts for oxidation processes that meet the above requirements and, especially, enhance the action of peroxide compounds in the most varied fields of application without causing any
15 appreciable damage.

One aspect of the invention is the use, as a catalyst for oxidation reactions, of at least one complex of formula (1)



wherein

- Me is manganese, titanium, iron, cobalt, nickel or copper;
X is a coordinating or bridging radical;
25 n is an integer from 1 to 4;
m is an integer from 0 to 2;
p is an integer having a value of from 0 to 10;
z is the charge of the metal complex,
Y is a counter-ion,
30 q = z/(charge of Y), and
L is a ligand of formula (2)



R₁ denotes CF₃ or C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl which are substituted by one or more electron withdrawing substituents; or

phenyl or naphthyl which are substituted by one or more electron withdrawing substituents;

- 5 R₄ denotes hydrogen, C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

R₂ and R₃ independently of each other denote hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl or unsubstituted or substituted heteroaryl; or

- 10 R₂ and R₃, together with the alkylidene carbon atom linking them, form an unsubstituted or substituted 5-, 6-, 7-, 8- or 9-membered ring which may contain further hetero atoms.

- 15 Under electron withdrawing substituents there are understood such substituents which have a -I and/or -M effect in aromatic ring systems.

Me represents a metal selected from manganese, titanium, iron, cobalt, nickel or copper, preferably from Mn(II)-(III)-(IV)-(V), Cu(I)-(II)-(III), Fe(I)-(II)-(III)-(IV), Co(I)-(II)-(III), Ni(I)-(II)-(III), Ti(II)-(III)-(IV) and more preferably selected from Mn(II)-(III)-(IV)-(V), Cu(I)-(II)-(III), Fe(I)-(II)-(III)-(IV) and Co(I)-(II)-(III).

- 20

L represents a ligand as herein defined, or its protonated or deprotonated analogue.

- 25 Where applicable the acyl hydrazone derivatives can be in their E- or Z-configuration.
When R₄ is hydrogen the ligand of formula (2) may be in one of its tautomeric forms or as a mixture of its different tautomeric forms.

- 30 Suitable substituents for the alkyl, heteroalkyl, cycloalkyl, alkenyl, cycloalkenyl, alkynyl, phenyl, naphthyl, aralkyl, heteroaralkyl and cycloheteroalkyl groups are especially C₁-C₄alkyl; C₁-C₄alkoxy; hydroxy; sulfo; sulfato; halogen; cyano; nitro; carboxy; amino; N-mono- or N,N-di-C₁-C₄alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety; N-phenylamino; N-naphthylamino wherein the amino groups may be quaternised; phenyl; phenoxy or naphthyloxy; preferably hydroxyl, halogen and C₁-C₄alkoxy.

In general unsubstituted alkyl, heteroalkyl, cycloalkyl, alkenyl, cycloalkenyl, alkynyl, phenyl, naphthyl, aralkyl, heteroaralkyl and cycloheteroalkyl are preferred.

- 5 Cyclic compounds are preferably 5-, 6- or 7-membered rings, 6-membered rings are preferred.

Aryl is phenyl or naphthyl.

- 10 The C₁-C₁₈alkyl radicals mentioned for the compounds of formula (2) are, for example, straight-chain or branched alkyl radicals, such as methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, isobutyl, tert-butyl or straight-chain or branched pentyl, hexyl, heptyl or octyl. Preference is given to C₁-C₁₂alkyl radicals, especially C₁-C₈alkyl radicals and preferably C₁-C₄alkyl radicals. The mentioned alkyl radicals may be unsubstituted or substituted e.g. by hydroxy, C₁-C₄alkoxy, sulfo or by sulfato, especially by hydroxy. The corresponding
15 unsubstituted alkyl radicals are preferred. Very special preference is given to methyl and ethyl, especially methyl.

- 20 Examples of aryl radicals that come into consideration for the compounds of formula (2) are phenyl or naphthyl each unsubstituted or substituted by C₁-C₄alkyl, C₁-C₄alkoxy, halogen, cyano, nitro, carboxy, sulfo, hydroxy, amino, N-mono- or N,N-di-C₁-C₄alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety, N-phenylamino, N-naphthylamino, wherein the amino groups may be quaternised, phenyl, phenoxy or by naphthyloxy. Preferred substituents are C₁-C₄alkyl, C₁-C₄alkoxy, phenyl and hydroxy.

- 25 Special preference is given to the corresponding phenyl radicals.

- 30 The C₁-C₆alkylene groups mentioned for the compounds of formula (2) are, for example, straight-chain or branched alkylene radicals, such as methylene, ethylene, n-propylene or n-butylene. C₁-C₄alkylene groups are preferred. The alkylene radicals mentioned may be unsubstituted or substituted, for example by hydroxy or C₁-C₄alkoxy.

In the compounds of formulae (1) and (2), halogen is preferably chlorine, bromine or fluorine, with special preference being given to chlorine.

C₃-C₁₂cycloalkyl refers to saturated cyclic hydrocarbons. C₃-C₁₂Cycloalkyl is for example cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, trimethylcyclohexyl, menthyl, thujyl, bornyl, 1-adamantyl oder 2-adamantyl.

- 5 C₂-C₁₈alkenyl is for example vinyl, allyl, 2-propen-2-yl, 2-buten-1-yl, 3-buten-1-yl, 1,3-butadien-2-yl, 2-penten-1-yl, 3-penten-2-yl, 2-methyl-1-buten-3-yl, 2-methyl-3-buten-2-yl, 3-methyl-2-buten-1-yl, 1,4-pentadien-3-yl, or signifies different isomers of hexenyl, octenyl, nonenyl, decenyl or dodecenyl.
- 10 C₃-C₁₂ cycloalkenyl refers to unsaturated hydrocarbon residues containing one or multiple double bonds such, 2-cyclobuten-1-yl, 2-cyclopenten-1-yl, 2-cyclohexen-1-yl, 3-cyclohexen-1-yl, 2,4-cyclohexadien-1-yl, 1-*p*-menthen-8-yl, 4(10)-thujen-10-yl, 2-norbornen-1-yl, 2,5-norbornadien-1-yl or 7,7-dimethyl-2,4-norcaradien-3-yl.
- 15 C₇-C₉ aralkyl is for example benzyl, β -phenyl-ethyl, α,α -dimethylbenzyl.
C₅-C₁₆heteroaralkyl signifies for example a C₁-C₈ alkyl moiety which is substituted with a C₄-C₈heteroaryl group, preferably with a C₅-C₆heteroaryl group.

C₅-C₆heteroaryl is for example pyridine or pyrimidine.

20

- X represents any coordinating or bridging species, preferably selected from any mono-, bi- or tri-charged anions and any neutral molecules able to coordinate the metal in a mono-, bi- or tri-dentate manner, preferably selected from O₂²⁻, O²⁻, RBO₂²⁻, RCOO⁻, RCONR⁻, HOO⁻, OH⁻, RO⁻, NO₃⁻, NO₂⁻, NO, CO, S²⁻, RS⁻, PO₃⁴⁻, STP-derived anions, PO₃OR³⁻, H₂O, CO₃²⁻, HCO₃⁻,
 25 ROH, NRR'R'', CH₃CN, RCN, Cl⁻, Br⁻, OCN⁻, SCN⁻, CN⁻, N₃⁻, F⁻, I⁻, RO⁻, ClO₄⁻, SO₄²⁻, HSO₄⁻, SO₃²⁻, RSO₃⁻, LMeO⁻ and LMeOO⁻, and more preferably selected from O₂²⁻, O²⁻, RBO₂²⁻, RCOO⁻ (preferably CH₃COO⁻), HOO⁻, OH⁻, RO⁻, NO₃⁻, NO₂⁻, NO, CO, S²⁻, RS⁻, PO₃⁴⁻, PO₃OR³⁻, H₂O, CO₃²⁻, HCO₃⁻, ROH, NRR'R'', CH₃CN, RCN, Cl⁻, Br⁻, OCN⁻, SCN⁻, CN⁻, N₃⁻, F⁻, I⁻, RO⁻, ClO₄⁻, SO₄²⁻, HSO₄⁻, SO₃²⁻, RSO₃⁻ (preferably CF₃SO₃⁻), wherein R is as defined
 30 below, L and Me have the definitions and preferred meanings given herein above and herein below. R is especially preferably hydrogen, C₁-C₄alkyl or phenyl, especially hydrogen.

Y represents any non-coordinated counter ion, preferably selected from RCOO⁻, ClO₄⁻, BF₄⁻, PF₆⁻, RSO₃⁻, RSO₄⁻, SO₄²⁻, S₂O₆⁻, OCN⁻, SCN⁻, NO₃⁻, NO₂⁻, F⁻, Cl⁻, Br⁻, I⁻, RO⁻, ClO₄⁻, BR₄⁻,

FeCl₄⁻, RBO₂⁻, SO₃²⁻, HSO₄²⁻, N⁺RR'R''R''', SbCl₆⁻, CuCl₄⁻, CN⁻, PO₄³⁻, HPO₄²⁻, H₂PO₄²⁻, STP-derived anions, CO₃²⁻, HCO₃⁻, Li⁺, Ba²⁺, Na⁺, Mg²⁺, K⁺, Ca²⁺, Cs⁺ and PR₄⁺ and more preferably selected from RCOO⁻, ClO₄⁻, BF₄⁻, PF₆⁻, RSO₃⁻, RSO₄⁻ (preferably CF₃SO₃⁻), SO₄²⁻, S₂O₆²⁻, OCN⁻, SCN⁻, NO₃⁻, NO₂⁻, F⁻, Cl⁻, Br⁻, I⁻, RO⁻, ClO₄⁻, BR₄⁻, FeCl₄⁻, RBO₂⁻, SO₃²⁻, HSO₄²⁻,
 5 N⁺RR'R''R''', SbCl₆⁻, CuCl₄⁻, PO₄³⁻, HPO₄²⁻, H₂PO₄²⁻, CO₃²⁻, HCO₃⁻, Li⁺, Ba²⁺, Na⁺, Mg²⁺, K⁺, Ca²⁺ and Cs⁺.

R, R', R'', R''' independently represent a group selected from hydrogen, hydroxyl, -OR₁₀ wherein R₁₀ is alkyl, alkenyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl or a carbonyl
 10 derivative group. Preferably R, R', R'', R''' represent hydrogen, optionally substituted alkyl or optionally substituted aryl, more preferably hydrogen or optionally substituted phenyl, naphthyl or C₁₋₄-alkyl;

Y can also be a customary organic counter-ion, for example citrate, oxalate or tartrate.

15 The counter ions Y in formula (1) balance the charge z on the complex formed by the ligand L, metal Me and coordinating or bridging species X. Thus, if the charge z is positive, Y may be an anion such as RCOO⁻, ClO₄⁻, BF₄⁻, PF₆⁻, RSO₃⁻, RSO₄⁻ (preferably CF₃SO₃⁻), SO₄²⁻, OCN⁻, SCN⁻, NO₃⁻, F⁻, Cl⁻, Br⁻, I⁻, RO⁻, ClO₄⁻, HSO₄²⁻, PO₄³⁻, HPO₄²⁻, H₂PO₄²⁻, CO₃²⁻ or HCO₃⁻, with R being hydrogen, optionally substituted alkyl or optionally substituted aryl. If z is
 20 negative, Y may be a common cation such as an alkali metal, alkaline earth metal or (alkyl)ammonium cation.

The charge of the counter-ion Y is accordingly preferably 1+, 2+, 1- or 2-, especially 1+ or 1-. Particularly 1-.

25 For the compounds of formula (1), n is preferably an integer having a value of from 1 to 4, preferably 1 or 2 and especially 1.

For the compounds of formula (1), m is preferably an integer having a value of 1 or 2,
 30 especially 1.

For the compounds of formula (1), p is preferably an integer having a value of from 0 to 4, especially 2.

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For the compounds of formula (1), z is preferably an integer having a value of from 8- to 8+, especially from 4- to 4+ and especially preferably from 0 to 4+. z is more especially the number 0.

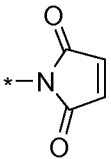
- 5 For the compounds of formula (1), q is preferably an integer from 0 to 8, especially from 0 to 4, and is especially preferably the number 0.

Preferably X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- , LMeO^- and LMeOO^- ; Y is $\text{R}_{28}\text{COO}^-$, ClO_4^- , BF_4^- , PF_6^- , $\text{R}_{28}\text{SO}_3^-$, $\text{R}_{28}\text{SO}_4^-$, SO_4^{2-} , NO_3^- , F^- , Cl^- , Br^- and I^- ;

- 10 R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl.

Preferably R_1 is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3 \text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

- 15 $-\text{O}-\text{C}(\text{O})\text{OR}_{100}$, $-\text{COOR}_{100}$, $-\text{C}(\text{O})\text{N}(\text{R}_{100}\text{R}'_{100})$, $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{CN}$, $-\text{NO}_2$, $-\text{SO}_3\text{R}_{100}$, $-\text{CF}_3$, F , Cl , Br ,

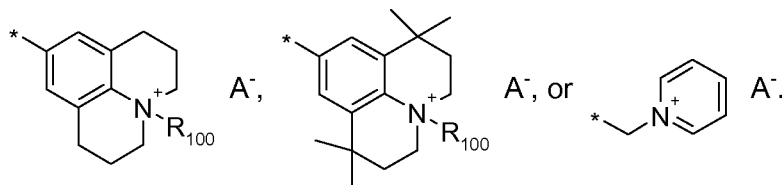
I , $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$, $-\text{N}(\text{R}_{101}\text{R}'_{101})$ and  wherein

R_{100} , R'_{100} , R''_{100} independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; * is the point of attachment and A^- is an anion,

- 20 R_{101} , R'_{101} independently are $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{C}(\text{O})\text{N}(\text{R}_{100}\text{R}'_{100})$ or $-\text{C}(\text{O})\text{OR}_{100}$;

or

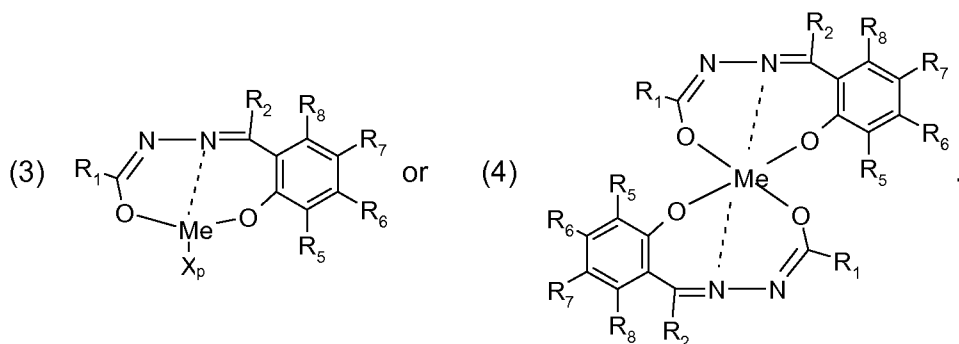
R_1 together with the electron withdrawing substituent is a group



- The anion A^- is preferably RCOO^- , ClO_4^- , BF_4^- , PF_6^- , RSO_3^- , RSO_4^- (preferably CF_3SO_3^-), SO_4^{2-} , OCN^- , SCN^- , NO_3^- , F^- , Cl^- , Br^- , I^- , RO^- , ClO_4^- , HSO_4^{2-} , PO_4^{3-} , HPO_4^{2-} , $\text{H}_2\text{PO}_4^{2-}$, CO_3^{2-} or HCO_3^- , with R being hydrogen, unsubstituted or optionally substituted C_1 - C_{18} alkyl

More preferably A^- is RSO_3^- , OCN^- , SCN^- , NO_3^- , F^- , I^- and Cl^- . Most preferably A^- is Cl^- .

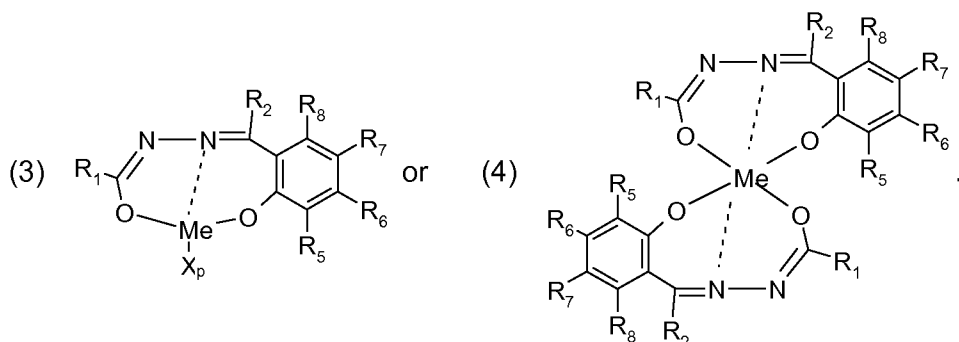
For example the catalyst is of formula (3) or (4)



wherein

- 5 Me is manganese in oxidation states II-V or iron in oxidation states I to IV;
X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- ;
 R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;
p is an integer from 1 to 4;
 R_1 is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3\text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or
- 10 phenyl substituted with 1 to 5 electron withdrawing substituents;
 R_2 denotes hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;
- 15 R_5 , R_6 , R_7 and R_8 independently from each other are hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; $-\text{OR}_{100}$, $-\text{NR}_{100}\text{R}'_{100}$, halogen; or independently have the meaning as defined for R_1 ; or
- 20 R_5 and R_6 , R_6 and R_7 and/or R_7 and R_8 , may be linked together to form 1, 2 or 3 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more $-\text{O}-$, $-\text{S}-$ or $-\text{NR}_9-$ and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C_1 - C_6 alkyl groups.
- 25 In a specific embodiment of the invention the catalyst is of formula (3) or (4)

- 9 -



wherein

Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

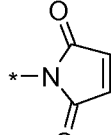
X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $R_{28}COO^-$, $R_{28}O^-$;

5 R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;

p is an integer from 1 to 4;

R_1 is $-(CH_2)_k-N^+(R_{100}R'_{100}R''_{100})_3 A^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

10 $-OC(O)OR_{100}$, $-COOR_{100}$, $-C(O)-R_{100}$, $-CN$, $-NO_2$, $-SO_3R_{100}$, $-CF_3$, F, Cl, Br, I,

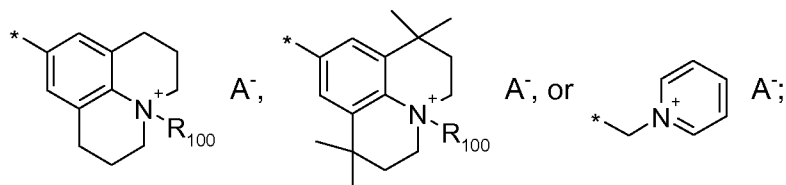
$-N(R_{100}R'_{100}R''_{100})_3^+ A^-$, $-N(R_{101}R'_{101})$ and  wherein R_{100} , R'_{100} , R''_{100} are

independently hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; * is the point of attachment and A^- is an anion,

15 R_{101} , R'_{101} independently are $-C(O)-R_{100}$, $-C(O)N(R_{100}R'_{100})$ or $-C(O)OR_{100}$;

or

R_1 together with the electron withdrawing substituent is a group



R_2 denotes hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

20

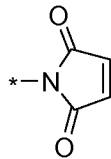
R₅, R₆, R₇ and R₈ independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkynyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen; or independently have the meaning as defined for R₁; or

R₅ and R₆, R₆ and R₇ and/or R₇ and R₈, may be linked together to form 1, 2 or 3 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more -O-, -S- or -NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

Examples of suitable anions A⁻ have already been given above. Most preferred is Cl⁻.

Particularly preferred is R₁ in the meaning of phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

-OC(O)OR₁₀₀, -COOR₁₀₀, -C(O)-R₁₀₀, -CN, -NO₂, -SO₃R₁₀₀, -CF₃, F, Cl, Br, I,

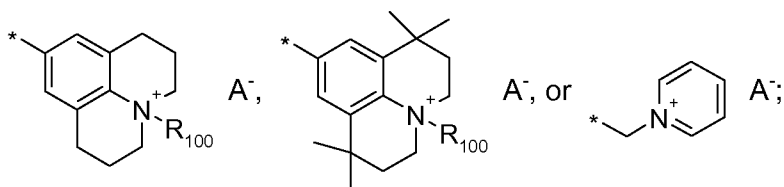
-N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺A⁻, -N(R₁₀₁R'₁₀₁) and  wherein R₁₀₀, R'₁₀₀, R''₁₀₀ are

independently hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀, R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; * is the point of attachment and A⁻ is an anion,

R₁₀₁, R'₁₀₁ independently are -C(O)-R₁₀₀, -C(O)N(R₁₀₀R'₁₀₀) or -C(O)OR₁₀₀;

or

R₁ together with the electron withdrawing substituent is a group



In another preferred embodiment R₁ has the meaning of -(CH₂)_k-N⁺(CH₃)₃ A⁻. Definitions for the substituents have already been given above.

- 11 -

The $R_5 - R_8$ in both phenyl rings can be selected independently from the definitions given above and, for example, R_5 in one ring can have a different meaning from the R_5 in the other ring. This applies equally to the R_6 to R_8 .

5 Preferably Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

X is H_2O , F^- , Cl^- , Br^- , HOO^- , $R_{28}COO^-$ or $R_{28}O^-$;

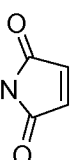
R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl;

p is an integer 1 or 2;

R_1 is phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group

10 consisting of

$-OR_{100}$, $-COOR_{100}$, $-C(O)-R_{100}$, $-CN$, $-NO_2$, $-SO_3R_{100}$, $-CF_3$, F , Cl , Br , I , $-N(R_{100}R'_{100}R''_{100})_3^+ A^-$,

$-N(R_{101}R'_{101})$ or  wherein R_{100} , R'_{100} , R''_{100} are independently hydrogen, C_1 - C_{18} alkyl

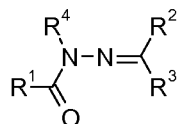
or phenyl, * is the point of attachment and A^- is an anion;

R_{101} , R'_{101} independently are $-C(O)-R_{100}$, $-C(O)N(R_{100}R'_{100})$ or $-C(O)OR_{100}$;

15 R_2 , R_5 , R_6 , R_7 and R_8 independently from each other are hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkynyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; $-OR_{100}$, $-NR_{100}R'_{100}$, halogen; or independently have the meaning as defined for R_1 .

20

In a specific embodiment of the invention the integers m and p in formula (I) are 0 and the ligand L of formula (2) is used as a catalyst for oxidation reactions;



(2)

wherein the substituents are as defined above including their

preferences.

25

Surprisingly it has been found that the ligands alone can also be used as catalysts for oxidation reactions for example in a washing process.

The complex compounds of formula (1) or the pure ligands of formula (2) are used as

30

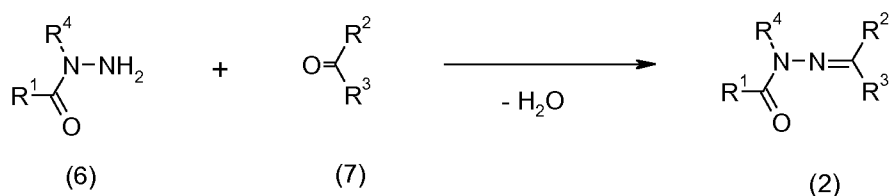
catalysts together with peroxide or a peroxide-forming substance, O_2 and/or air for the

bleaching of stains or of soiling on textile material in the context of a washing process or by the direct application of a stain remover; for the cleaning of hard surfaces, especially kitchen surfaces, wall tiles or floor tiles; for the use in automatic dishwashing compositions; for the bleaching of stains or of soiling on textile material by atmospheric oxygen, whereby the bleaching is catalysed during and/or after the treatment of the textile in the washing liquor; for the prevention of redeposition of migrating dyes during the washing of textile material; for the use in washing and cleaning solutions having an antibacterial action; as pretreatment agents for bleaching textiles; as catalysts in selective oxidation reactions in the context of organic synthesis; for the waste water treatment; for bleaching in the context of paper-making; for sterilization; and for contact lens disinfection.

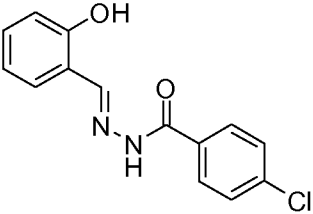
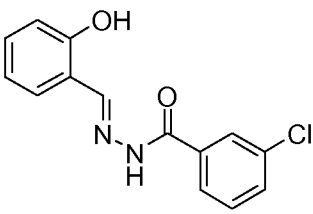
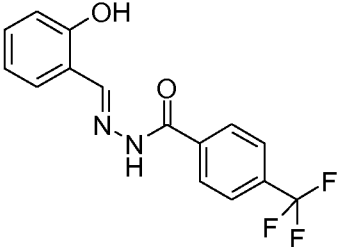
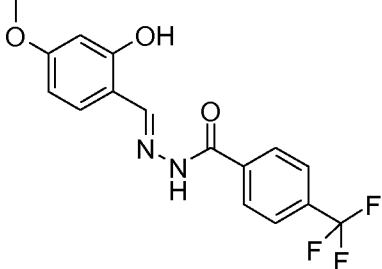
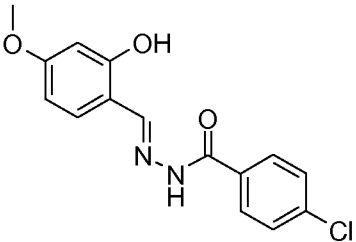
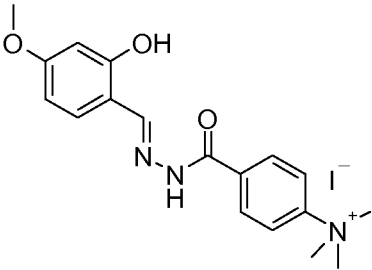
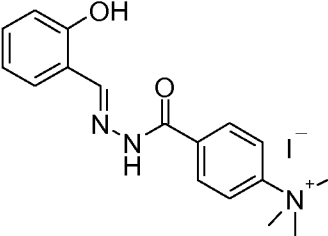
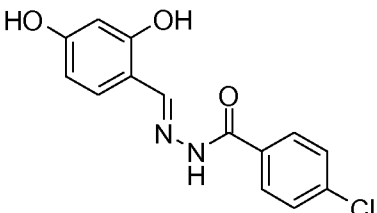
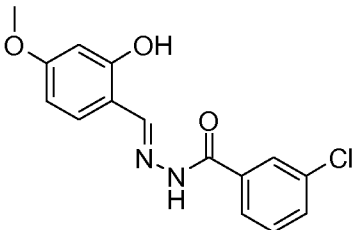
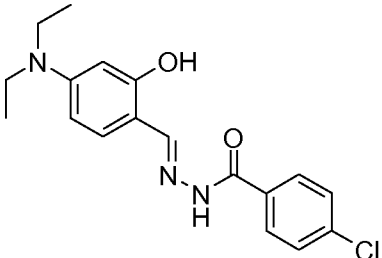
Another aspect of the invention is a process for the bleaching of stains or of soiling on textile materials in the context of a washing process or by the direct application of a stain remover and for the cleaning of hard surfaces comprising

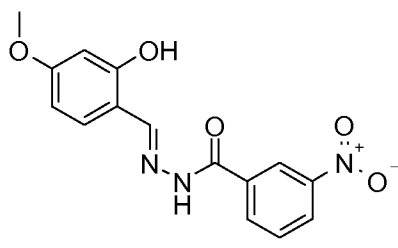
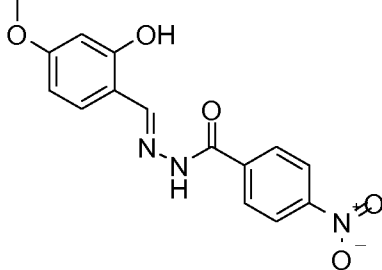
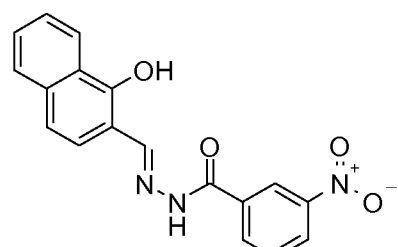
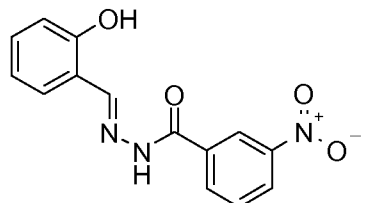
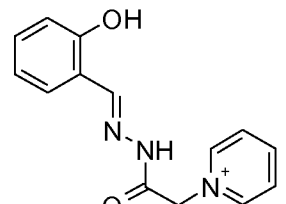
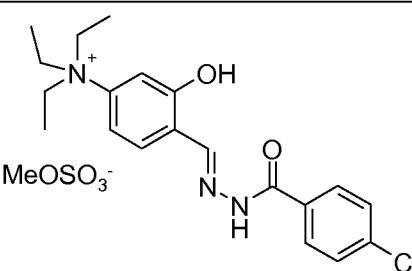
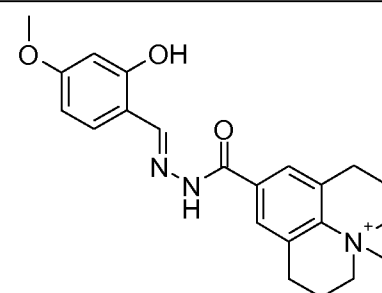
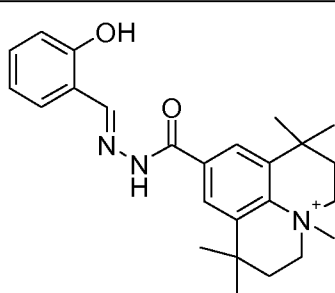
bringing into contact a textile material or hard surface material in an aqueous medium, a complex compound of formula (1) or a ligand of formula (2) as described above and a peroxide or a peroxide-forming substance or O₂ and/or air.

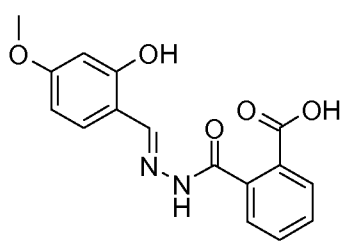
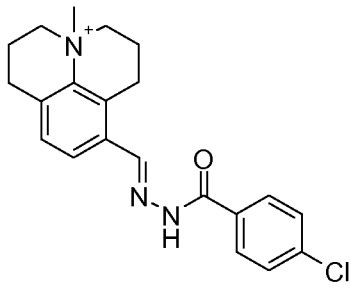
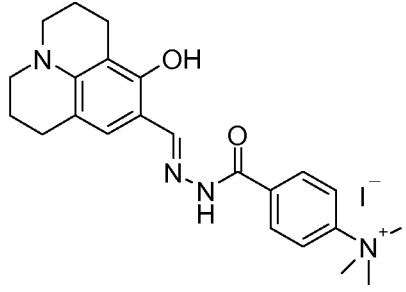
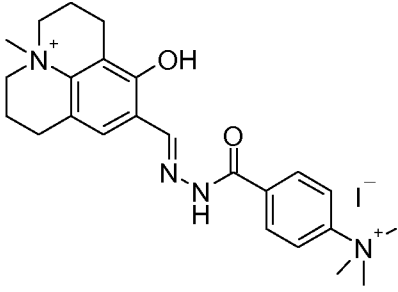
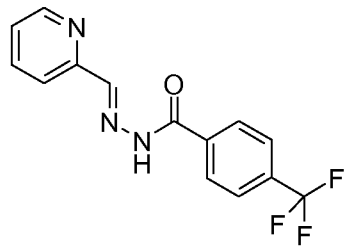
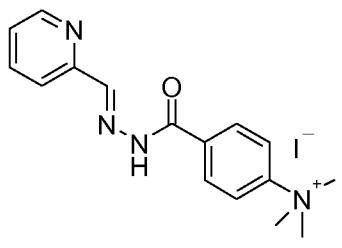
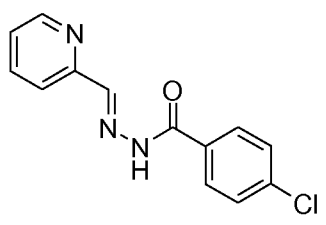
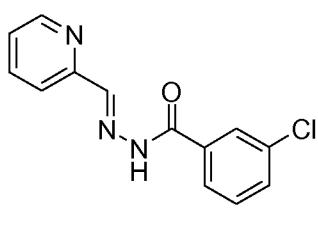
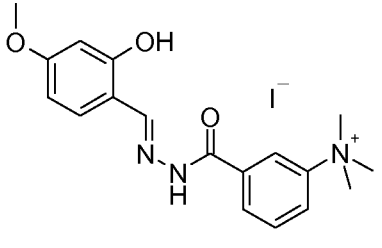
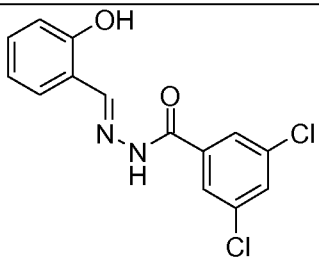
The ligands can be prepared according to standard procedures by reacting a carbonyl compound, such as an aldehyde with a primary amine to form the corresponding Schiff base, in particular with a hydrazide of formula (6) with a carbonyl compound of formula (7) wherein the substituents are as defined above.

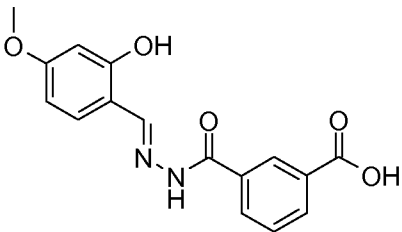
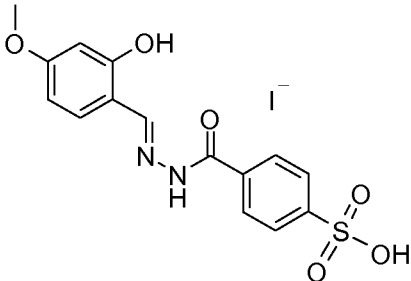
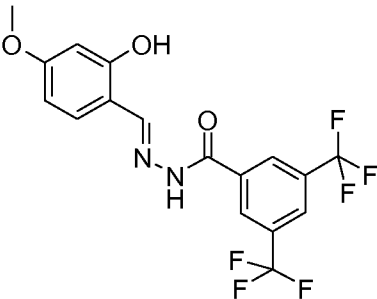
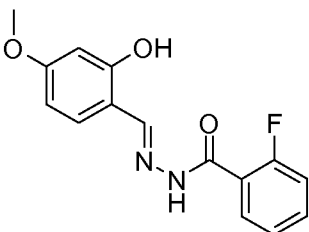
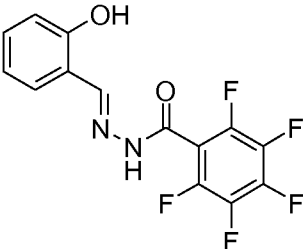
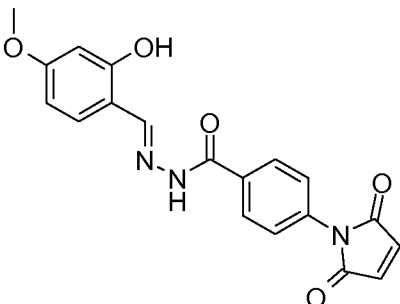
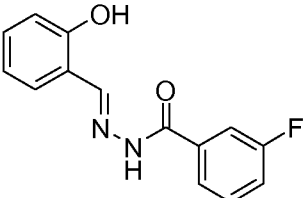
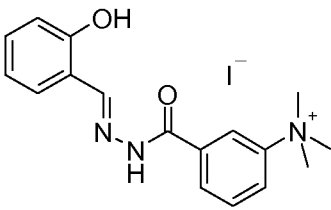


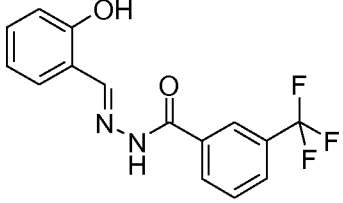
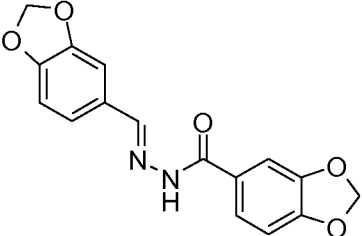
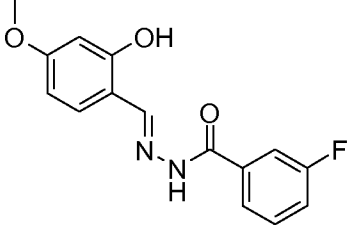
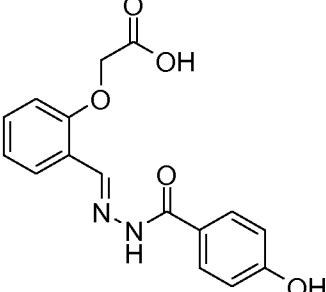
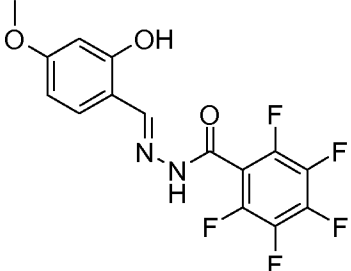
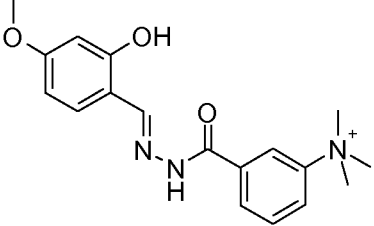
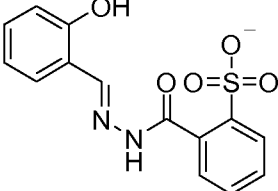
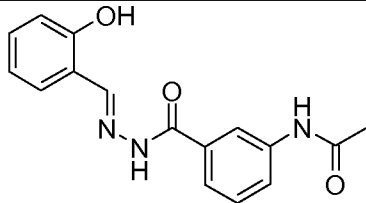
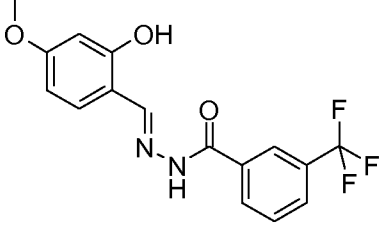
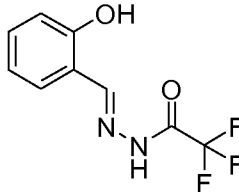
Individual ligands are summarized in the following table.

 E/Z-isomers and tautomeric forms L1	 E/Z-isomers and tautomeric forms L2
 E/Z-isomers and tautomeric forms L7	 E/Z-isomers and tautomeric forms L8
 E/Z-isomers and tautomeric forms L3	 E/Z-isomers and tautomeric forms L9
 E/Z-isomers and tautomeric forms L10	 E/Z-isomers and tautomeric forms L4
 E/Z-isomers and tautomeric forms L6	 E/Z-isomers and tautomeric forms L5

 E/Z-isomers and tautomeric forms L11	 E/Z-isomers and tautomeric forms L13
 E/Z-isomers and tautomers L44	 E/Z-isomers and tautomeric forms L12
 E/Z-isomers and tautomers L57	 E/Z-isomers and tautomeric forms L20
 E/Z-isomers and tautomeric forms L23	 E/Z-isomers and tautomeric forms L24

 E/Z-isomers and tautomers L60	 E/Z-isomers and tautomeric forms L26
 E/Z-isomers and tautomeric forms L27	 E/Z-isomers and tautomeric forms L28
 E/Z-isomers and tautomeric forms L29	 E/Z-isomers and tautomeric forms L30
 E/Z-isomers and tautomeric forms L31	 E/Z-isomers and tautomeric forms L32
 E/Z-isomers and tautomeric forms L33	 E/Z-isomers and tautomeric forms L34

 E/Z-isomers and tautomeric forms L35	 E/Z-isomers and tautomeric forms L36
 E/Z-isomers and tautomers L37	 E/Z-isomers and tautomers L38
 E/Z-isomers and tautomeric forms L39	 E/Z-isomers and tautomers L40
 E/Z-isomers and tautomeric forms L63	 E/Z-isomers and tautomeric forms L56

 E/Z-isomers and tautomeric forms L64	 E/Z-isomers and tautomers L46
 E/Z-isomers and tautomeric forms L65	 E/Z-isomers and tautomers L50
 E/Z-isomers and tautomeric forms L51	 E/Z-isomers and tautomeric forms L52
 E/Z-isomers and tautomers L53	 E/Z-isomers and tautomers L54
 E/Z-isomers and tautomeric forms L66	 E/Z-isomers and tautomers L16

It will be appreciated that the complex (1) can be formed by any appropriate means, including *in situ* formation whereby precursors of the complex are transformed into the active complex of general formula (1) under conditions of storage or use. Preferably, the complex is formed as a well-defined complex or in a solvent mixture comprising a salt of the metal Me and the ligand L or ligand L-generating species. Alternatively, the catalyst may be formed *in situ* from suitable precursors for the complex, for example in a solution or dispersion containing the precursor materials. In one such example, the active catalyst may be formed *in situ* in a mixture comprising a salt of the metal Me and the ligand L, or a ligand L-generating species, in a suitable solvent. Thus, for example, if Me is manganese, an manganese salt such as MnCl_2 or $\text{Mn}(\text{OOCCH}_3)_2$ can be mixed in solution with the ligand L, or a ligand L-generating species, to form the active complex. Such synthesis procedures are for example described in *Inorganica Chimica Acta* (1974), 9(2), 137-42; *Monatshefte fuer Chemie* (1976), 107(6), 1455-62; *Transition Metal Chemistry* (Dordrecht, Netherlands) (1977), 2(1), 29-30; *Inorganica Chimica Acta* (2007), 360(5), 1599-1608; *Malaysian Journal of Science*, 25(1), 107-114; 2006; *Pestycydy* (Warsaw), (1-2), 21-31; 2004 or in *Journal of the Indian Chemical Society*, 81(11), 950-953; 2004.

In another such example, the ligand L, or a ligand L-generating species, can be mixed with metal Me ions present in the substrate or wash liquor to form the active catalyst *in situ*. Suitable ligand L-generating species include metal-free compounds or metal coordination complexes that comprise the ligand L and can be substituted by metal Me ions to form the active complex according to formula (1).

The metal complex compounds of formula (1) or the ligands of formula (2) are used together as catalysts with peroxide or a peroxide-forming substance, O_2 and/or air. Examples that may be mentioned in that regard include the following uses:

- a) the bleaching of stains or of soiling on textile material in the context of a washing process or by the direct application of a stain remover;
- b) the cleaning of hard surfaces, especially kitchen surfaces, wall tiles or floor tiles, for example to remove stains that have formed as a result of the action of moulds ("mould stains"); the use in automatic dishwashing compositions is also a preferred use;

- c) the bleaching of stains or of soiling on textile material by atmospheric oxygen, whereby the bleaching is catalysed during and/or after the treatment of the textile in the washing liquor;
- d) the prevention of redeposition of migrating dyes during the washing of textile material;
- 5 e) use in washing and cleaning solutions having an antibacterial action;
- f) as pretreatment agents for bleaching textiles;
- g) as catalysts in selective oxidation reactions in the context of organic synthesis;
- h) waste water treatment;
- i) use as a catalyst for reactions with peroxy compounds for bleaching in the context of
10 paper-making. This relates especially to the delignification of cellulose and bleaching of the pulp, which can be carried out in accordance with customary procedures. Also of interest is the use as a catalyst for reactions with peroxy compounds for the bleaching of waste printed paper;
- j) sterilisation and
- 15 k) contact lens disinfection.

Preference is given to the bleaching of stains or soiling on textile material; to the cleaning of hard surfaces, especially kitchen surfaces, wall tiles, floor tiles as well as the use in automatic dishwasher formulations; to the bleaching of stains or of soiling on textile material
20 by atmospheric oxygen, whereby the bleaching is catalysed during and/or after the treatment of the textile in the washing liquor; or to the prevention of redeposition of migrating dyes in the context of a washing process.

The preferred metals for these uses are manganese and/or iron, in particular manganese.
25

It should be emphasised that the use of metal complex compounds, for example, in the bleaching of textile or hard surface material, does not cause any appreciable damage to fibres and dyeings as well as to the hard surface materials, such as table- and kitchen-ware, as well as tiles.
30

Processes for bleaching stains in any washing liquor are usually carried out by adding to the washing liquor (with H_2O_2 or a precursor of H_2O_2) one or more metal complex compounds of formula (1). Alternatively, it is possible to add a detergent that already comprises one or two metal complex compounds. It will be understood that in such an application, as well as in the

other applications, the metal complex compounds of formula (1) can alternatively be formed *in situ*, the metal salt (e.g. manganese(II) salt, such as manganese(II) chloride, and/or iron(II) salt, such as iron(II) chloride) and the ligand being added in the desired molar ratios.

- 5 Consequently a further aspect of the invention is a detergent, cleaning, disinfecting or bleaching composition comprising
- I) from 0 to 50 wt-%, based on the total weight of the composition, A) of at least one anionic surfactant and/or B) of a non-ionic surfactant,
 - II) from 0 to 70 wt-%, based on the total weight of the composition, C) of at least one
10 builder substance,
 - III) from 1 – 99 wt-%, based on the total weight of the composition, D) of at least one peroxide and/or one peroxide-forming substance, O₂ and/or air,
 - IV) E) at least one metal complex compound of formula (1) or a ligand of formula (2) as defined above in an amount that, in the liquor, gives a concentration of from 0.5 to 100
15 mg/litre of liquor, when from 0.5 to 50 g/litre of the detergent, cleaning, disinfecting or bleaching agent are added to the liquor,
 - V) from 0 – 20 wt-%, based on the total weight of the composition, of at least one further additive, and
 - VI) water ad 100 wt-%, based on the total weight of the composition.

20

Preferably such a composition is used for a textile material or a hardsurface material.

All wt-% are based on the total weight of the detergent, cleaning, disinfecting or bleaching composition.

25

The detergent, cleaning, disinfecting or bleaching composition can be any kind of industrial or domestic cleaning, disinfecting or bleaching formulation.

30

It can be used for example in compositions used for textile material as well as in composition used for hardsurfaces, such as hard surface materials, such as table- and kitchen-ware, as well as tiles.

Preferred hard surface cleaning compositions are dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations.

The above percentages are in each case percentage by weight, based on the total weight of the composition. The compositions preferably contain from 0.005 to 2 wt-% of at least one metal complex compound of formula (1), more preferably from 0.01 to 1 wt-% and most preferably from 0.05 to 1 wt-%.

When the compositions according to the invention comprise a component A) and/or B), the amount thereof is preferably from 1 to 50 wt-%, especially from 1 to 30 wt-%.

When the compositions according to the invention comprise a component C), the amount thereof is preferably from 1 to 70 wt-%, especially from 1 to 50 wt-%. Special preference is given to an amount of from 5 to 50 wt-% and especially an amount of from 10 to 50 wt-%.

Corresponding washing, cleaning, disinfecting or bleaching processes are usually carried out by using an aqueous liquor containing from 0.1 to 200 mg of one or more compounds of formula (1) per litre of liquor. The liquor preferably contains from 1 to 50 mg of at least one compound of formula (1) per litre of liquor.

The composition according to the invention can be, for example, a peroxide-containing heavy-duty detergent or a separate bleaching additive, or a stain remover that is to be applied directly. A bleaching additive is used for removing coloured stains on textiles in a separate liquor before the clothes are washed with a bleach-free detergent. A bleaching additive can also be used in a liquor together with a bleach-free detergent.

Stain removers can be applied directly to the textile in question and are used especially for pretreatment in the event of heavy local soiling.

The stain remover can be applied in liquid form, by a spraying method or in the form of a solid substance, such as a powder especially as a granule.

Granules can be prepared, for example, by first preparing an initial powder by spray-drying an aqueous suspension comprising all the components listed above except for component E), and then adding the dry component E) and mixing everything together. It is also possible

to add component E) to an aqueous suspension containing components A), B), C) and D) and then to carry out spray-drying.

It is also possible to start with an aqueous suspension that contains components A) and C),
5 but none or only some of component B). The suspension is spray-dried, then component E) is mixed with component B) and added, and then component D) is mixed in the dry state. It is also possible to mix all the components together in the dry state.

The anionic surfactant A) can be, for example, a sulfate, sulfonate or carboxylate surfactant
10 or a mixture thereof. Preference is given to alkylbenzenesulfonates, alkyl sulfates, alkyl ether sulfates, olefin sulfonates, fatty acid salts, alkyl and alkenyl ether carboxylates or to an α -sulfonic fatty acid salt or an ester thereof.

Preferred sulfonates are, for example, alkylbenzenesulfonates having from 10 to 20 carbon
15 atoms in the alkyl radical, alkyl sulfates having from 8 to 18 carbon atoms in the alkyl radical, alkyl ether sulfates having from 8 to 18 carbon atoms in the alkyl radical, and fatty acid salts derived from palm oil or tallow and having from 8 to 18 carbon atoms in the alkyl moiety. The average molar number of ethylene oxide units added to the alkyl ether sulfates is from 1 to 20, preferably from 1 to 10. The cation in the anionic surfactants is preferably an alkaline
20 metal cation, especially sodium or potassium, more especially sodium. Preferred carboxylates are alkali metal sarcosinates of formula $R_{19}-CON(R_{20})CH_2COOM_1$ wherein R_{19} is C_9-C_{17} alkyl or C_9-C_{17} alkenyl, R_{20} is C_1-C_4 alkyl and M_1 is an alkali metal, especially sodium.

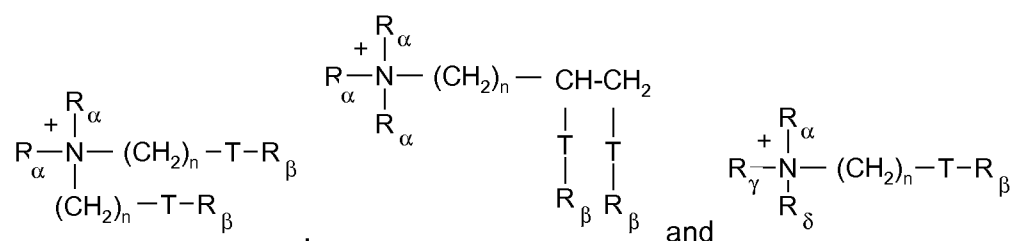
The non-ionic surfactant B) may be, for example, a primary or secondary alcohol ethoxylate,
25 especially a C_8-C_{20} aliphatic alcohol ethoxylated with an average of from 1 to 20 mol of ethylene oxide per alcohol group. Preference is given to primary and secondary $C_{10}-C_{15}$ aliphatic alcohols ethoxylated with an average of from 1 to 10 mol of ethylene oxide per alcohol group. Non-ethoxylated non-ionic surfactants, for example alkylpolyglycosides, glycerol monoethers and polyhydroxyamides (glucamide), may likewise be used.

30 The total amount of anionic and non-ionic surfactants is preferably from 5 to 50 wt-%, especially from 5 to 40 wt-% and more especially from 5 to 30 wt-%. The lower limit of those surfactants to which even greater preference is given is 10 wt-%.

In addition to anionic and/or non-ionic surfactants the composition may contain cationic surfactants. Possible cationic surfactants include all common cationic surface-active compounds, especially surfactants having a textile softening effect.

Non-limited examples of cationic surfactants are given in the formulas below:

5



wherein

each radical R_{α} is independent of the others C_{1-6} -alkyl-, -alkenyl- or -hydroxyalkyl; each

10 radical R_{β} is independent of the others C_{8-28} -alkyl- or alkenyl;

R_{γ} is R_{α} or $(\text{CH}_2)_n - \text{T} - \text{R}_{\beta}$;

R_{δ} is R_{α} or R_{β} or $(\text{CH}_2)_n - \text{T} - \text{R}_{\beta}$; $\text{T} = -\text{CH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$ and

n is between 0 and 5.

15 Preferred cationic surfactants present in the composition according to the invention include hydroxyalkyl-trialkyl-ammonium-compounds, especially C_{12-18} -alkyl(hydroxyethyl)dimethyl-ammonium compounds, and especially preferred the corresponding chloride salts. Compositions of the present invention can contain between 0.5 wt-% and 15 wt-% of the cationic surfactant, based on the total weight of the composition.

20

As builder substance C) there come into consideration, for example, alkali metal phosphates, especially tripolyphosphates, carbonates and hydrogen carbonates, especially their sodium salts, silicates, aluminum silicates, polycarboxylates, polycarboxylic acids, organic phosphonates, aminoalkylenepoly(alkylenephosphonates) and mixtures of such compounds.

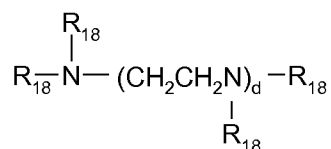
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Silicates that are especially suitable are sodium salts of crystalline layered silicates of the formula $\text{NaHSi}_t\text{O}_{2t+1} \cdot p\text{H}_2\text{O}$ or $\text{Na}_2\text{Si}_t\text{O}_{2t+1} \cdot p\text{H}_2\text{O}$ wherein t is a number from 1.9 to 4 and p is a number from 0 to 20.

Among the aluminum silicates, preference is given to those commercially available under the names zeolite A, B, X and HS, and also to mixtures comprising two or more of such components. Special preference is given to zeolite A.

Among the polycarboxylates, preference is given to polyhydroxycarboxylates, especially citrates, and acrylates, and also to copolymers thereof with maleic anhydride. Preferred polycarboxylic acids are nitrilotriacetic acid, ethylenediaminetetraacetic acid and ethylenediamine disuccinate either in racemic form or in the enantiomerically pure (S,S) form.

Phosphonates or aminoalkylenepoly(alkylenephosphonates) that are especially suitable are alkali metal salts of 1-hydroxyethane-1,1-diphosphonic acid, nitrilotris(methylenephosphonic acid), ethylenediaminetetramethylenephosphonic acid and diethylenetriaminepenta-methylenephosphonic acid, and also salts thereof. Also preferred polyphosphonates have the following formula



wherein

R_{18} is $\text{CH}_2\text{PO}_3\text{H}_2$ or a water soluble salt thereof and

d is an integer of the value 0, 1, 2 or 3.

Especially preferred are the polyphosphonates wherein b is an integer of the value of 1.

The amount of the peroxide or the peroxide-forming substance is preferably 0.5 – 30 wt-%, more preferably 1 – 20 wt-% and especially preferably 1 – 15 wt-%.

As the peroxide component D) there come into consideration every compound which is capable of yielding hydrogen peroxide in aqueous solutions, for example, the organic and inorganic peroxides known in the literature and available commercially that bleach textile materials at conventional washing temperatures, for example at from 10 to 95°C.

Preferably, however, inorganic peroxides are used, for example persulfates, perborates, percarbonates and/or persilicates.

Example of suitable inorganic peroxides are sodium perborate tetrahydrate or sodium perborated monohydrate, sodium percarbonate, inorganic peroxyacid compounds, such as

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for example potassium monopersulphate (MPS). If organic or inorganic peroxyacids are used as the peroxygen compound, the amount thereof will normally be within the range of about 2-80 wt-%, preferably from 4-30 wt-%.

5 The organic peroxides are, for example, mono- or poly-peroxides, urea peroxides, a combination of a C₁-C₄alkanol oxidase and C₁-C₄alkanol (Such as methanol oxidase and ethanol as described in WO95/07972), alkylhydroxy peroxides, such as cumene hydroperoxide and t-butyl hydroperoxide.

10 The peroxides may be in a variety of crystalline forms and have different water contents, and they may also be used together with other inorganic or organic compounds in order to improve their storage stability.

15 All these peroxy compounds may be utilized alone or in conjunction with a peroxyacid bleach precursor and/or an organic bleach catalyst not containing a transition metal. Generally, the bleaching composition of the invention can be suitably formulated to contain from 2 to 80 wt-%, preferably from 4 to 30 wt-%, of the peroxy bleaching agent.

As oxidants, peroxo acids can also be used. One example are organic mono peracids of formula
$$R_{19}-\overset{\overset{O}{\parallel}}{C}-O-OM$$
,

20 wherein

M signifies hydrogen or a cation,

R₁₉ signifies unsubstituted C₁-C₁₈alkyl; substituted C₁-C₁₈alkyl; unsubstituted aryl; substituted aryl; -(C₁-C₆alkylene)-aryl, wherein the alkylene and/or the alkyl group may be substituted; and phthalimidoC₁-C₈alkylene, wherein the phthalimido and/or the alkylene group may be
25 substituted.

Preferred mono organic peroxy acids and their salts are those of formula
$$R'_{19}-\overset{\overset{O}{\parallel}}{C}-O-OM$$
,
wherein

M signifies hydrogen or an alkali metal, and

R'₁₉ signifies unsubstituted C₁-C₄alkyl; phenyl;-C₁-C₂alkylene-phenyl or
30 phthalimidoC₁-C₈alkylene.

Especially preferred is CH₃COOOH and its alkali salts.

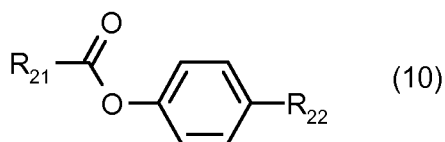
Especially preferred is also ϵ -phthalimido peroxy hexanoic acid and its alkali salts.

Also suitable are diperoxyacids, for example, 1,12-diperoxydodecanedioic acid (DPDA), 1,9-diperoxyazelaic acid, diperoxybrassicic acid, diperoxysebasic acid, diperoxyisophthalic acid, 2-decyldiperoxybutane-1,4-dioic acid and 4,4'-sulphonylbisperoxybenzoic acid.

Instead of the peroxy acid it is also possible to use organic peroxy acid precursors and H_2O_2 . Such precursors are the corresponding carboxylic acid or the corresponding carboxyanhydride or the corresponding carbonylchloride, or amides, or esters, which can form the peroxy acids on perhydrolysis. Such reactions are commonly known.

Peroxyacid bleach precursors are known and amply described in literature, such as in the British Patents 836988; 864,798; 907,356; 1,003,310 and 1,519,351; German Patent 3,337,921; EP-A-0185522; EP-A-0174132; EP-A-0120591; and U.S. Pat. Nos. 1,246,339; 3,332,882; 4,128,494; 4,412,934 and 4,675,393.

Peroxy acids precursors are often referred to as bleach activators. Suitable bleach activators include the bleach activators, that carry O- and/or N-acyl groups and/or unsubstituted or substituted benzoyl groups. Preference is given to polyacylated alkylenediamines, especially tetraacetylenediamine (TAED); acylated glycolurils, especially tetraacetyl glycol urea (TAGU), N,N-diacetyl-N,N-dimethylurea (DDU); sodium-4-benzoyloxy benzene sulphonate (SBOBS); sodium-1-methyl-2-benzoyloxy benzene-4-sulphonate; sodium-4-methyl-3-benzoyloxy benzoate; trimethyl ammonium toluoyloxy-benzene sulphonate; acylated triazine derivatives, especially 1,5-diacetyl-2,4-dioxohexahydro-1,3,5-triazine (DADHT); compounds of formula (6):



wherein R_{22} is a sulfonate group, a carboxylic acid group or a carboxylate group, and wherein R_{21} is linear or branched (C_7 - C_{15})alkyl, especially activators known under the names SNOBS, SLOBS and DOBA; acylated polyhydric alcohols, especially triacetin, ethylene glycol diacetate and 2,5-diacetoxy-2,5-dihydrofuran; and also acetylated sorbitol and mannitol and

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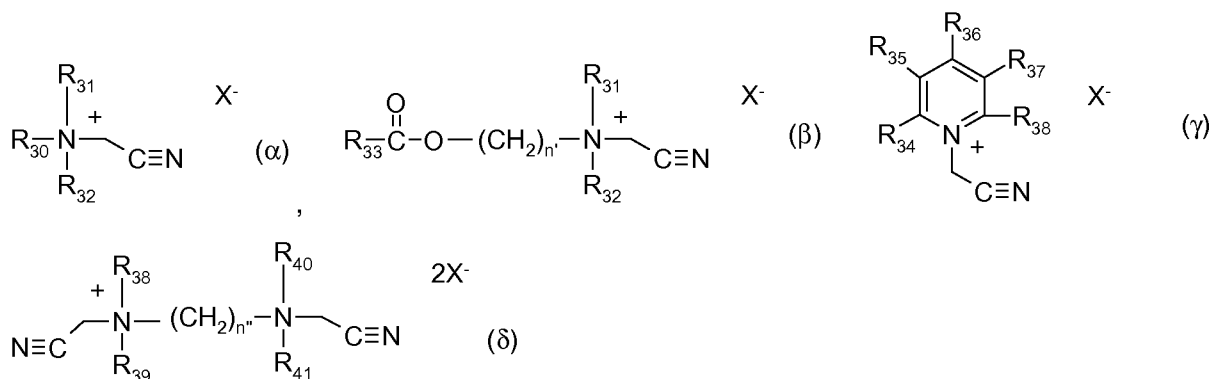
acylated sugar derivatives, especially pentaacetylglucose (PAG), sucrose polyacetate (SUPA), pentaacetylfructose, tetraacetylxylose and octaacetyllactose as well as acetylated, optionally N-alkylated glucamine and gluconolactone. It is also possible to use the combinations of conventional bleach activators known from German Patent Application

5 DE-A-44 43 177. Nitrile compounds that form perimine acids with peroxides also come into consideration as bleach activators.

Another useful class of peroxyacid bleach precursors is that of the cationic i.e. quaternary ammonium substituted peroxyacid precursors as disclosed in US Pat. Nos. 4,751,015 and
10 4,397,757, in EP-A0284292 and EP-A-331,229. Examples of peroxyacid bleach precursors of this class are: 2-(N,N,N-trimethyl ammonium) ethyl sodium-4-sulphonphenyl carbonate chloride - (SPCC), N-octyl,N,N-dimehyl-N10 -carbophenoxy decyl ammonium chloride - (ODC), 3-(N,N,N-trimethyl ammonium) propyl sodium-4-sulphophenyl carboxylate and N,N,N-trimethyl ammonium toluoyloxy benzene sulphonate.

15

A further special class of bleach precursors is formed by the cationic nitriles as disclosed in EP-A-303,520, WO 96/40661 and in European Patent Specification No.'s 458,396, 790244 and 464,880. These cationic nitriles also known as nitril quats have the formula



20

wherein

R₃₀ is a C₁-C₂₄alkyl; a C₁-C₂₄alkenyl; an alkaryl having a C₁-C₂₄alkyl; a substituted C₁-C₂₄alkyl; a substituted C₁-C₂₄alkenyl; a substituted aryl,

25 R₃₁ and R₃₂ are each independently a C₁-C₃alkyl; hydroxyalkyl having 1 to 3 carbon atoms, - (C₂H₄O)_nH, n being 1 to 6; -CH₂-CN

R₃₃ is a C₁-C₂₀alkyl; a C₁-C₂₀alkenyl; a substituted C₁-C₂₀alkyl; a substituted C₁-C₂₀alkenyl; an alkaryl having a C₁-C₂₄alkyl and at least one other substituent,

R₃₄, R₃₅, R₃₆, R₃₇ and R₃₈ are each independently hydrogen, a C₁-C₁₀alkyl, a C₁-C₁₀alkenyl, a substituted C₁-C₁₀alkyl, a substituted C₁-C₁₀alkenyl, carboxyl, sulfonyl or cyano

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R_{38} , R_{39} , R_{40} and R_{41} are each independently a C_1 - C_6 alkyl,

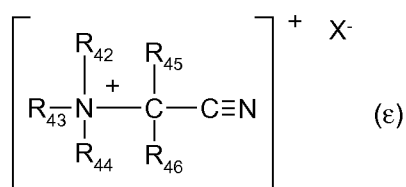
n' is an integer from 1 to 3,

n'' is an integer from 1 to 16, and

X is an anion.

5

Other nitril quats have the following formula



wherein

R_{42} and R_{43} form, together with the nitrogen atom to which they are bonded, a ring
10 comprising 4 to 6 carbon atoms, this ring may also be substituted by C_1 - C_5 -alkyl,

C_1 - C_5 -alkoxy, C_1 - C_5 -alkanoyl, phenyl, amino, ammonium, cyano, cyanamino or chloro
and 1 or 2 carbon atom(s) of this ring may also be substituted by a nitrogen atom, by a
oxygen atom, by a N - R_{47} -group and/or by a R_{44} - N - R_{47} -group, wherein R_{47} is hydrogen,

C_1 - C_5 -alkyl, C_2 - C_5 -alkenyl, C_2 - C_5 -alkinyl, phenyl, C_7 - C_9 -aralkyl,

15 C_5 - C_7 -cycloalkyl, C_1 - C_5 -alkanoyl, cyanomethyl or cyano,

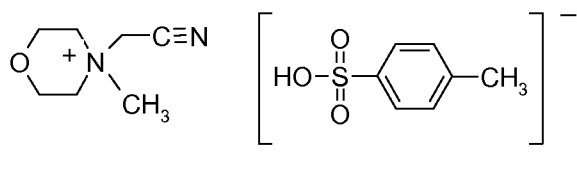
R_{44} is C_1 - C_{24} -, preferably C_1 - C_4 -alkyl; C_2 - C_{24} - alkenyl, preferably C_2 - C_4 -alkenyl, cyanomethyl
or C_1 - C_4 -alkoxy- C_1 - C_4 -alkyl,

R_{45} and R_{46} are independently from each other hydrogen; C_1 - C_4 -alkyl; C_1 - C_4 -alkenyl;

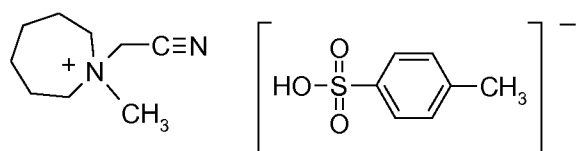
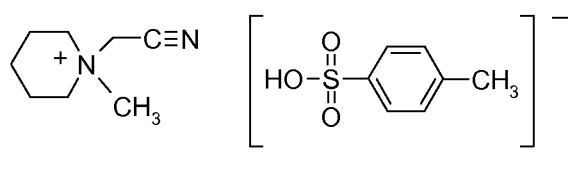
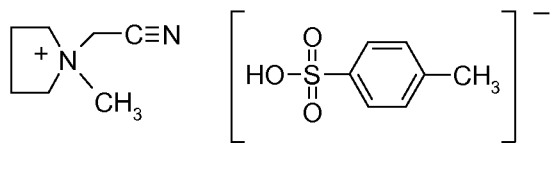
C_1 - C_4 -alkoxy- C_1 - C_4 -alkyl; phenyl or C_1 - C_3 -alkylphenyl, preferably hydrogen, methyl or
20 phenyl, whereby preferably the moiety R_{45} signifies hydrogen, if R_{46} is not hydrogen,
and

X^- is an anion.

Suitable examples of nitril quats of formula (ϵ) are

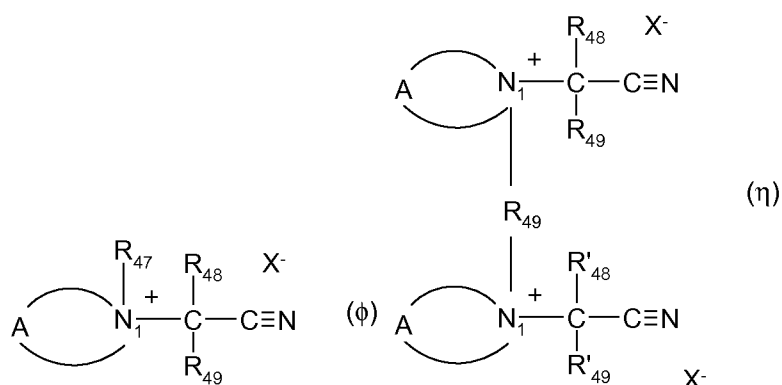


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and

5 Other nitrile quats have the formula



wherein

- A is a saturated ring formed by a plurality of atoms in addition to the N_1 atom, the saturated ring atoms to include at least one carbon atom and at least one heteroatom in addition to the N_1 atom, the said one heteroatom selected from the group consisting of O, S and N atoms,
- 10 the substituent R_{47} bound to the N_1 atom of the Formula (ϕ) structure is (a) a $\text{C}_1\text{-C}_8$ -alkyl or alkoxyalkyl where the alkoxy is C_{2-4} , (b) a $\text{C}_4\text{-C}_{24}$ cycloalkyl, (c) a $\text{C}_7\text{-C}_{24}$ alkaryl, (d) a repeating or nonrepeating alkoxy or alkoxyalkyl alcohol, where the alkoxy unit is C_{2-4} , or (e) $\text{-CR}_{50}\text{R}_{51}\text{-C}\equiv\text{N}$ where R_{50} and R_{51} are each H, a $\text{C}_1\text{-C}_{24}$ alkyl, cycloalkyl, or alkaryl, or a
- 15 repeating or nonrepeating alkoxy or alkoxyalkyl alcohol where the alkoxy unit is C_{2-4} , in Formula (ϕ) at least one of the R_{48} and R_{49} substituents is H and the other of R_{48} and R_{49} is H, a $\text{C}_1\text{-C}_{24}$ alkyl, cycloalkyl, or alkaryl, or a repeating or nonrepeating alkoxy or alkoxyalkyl alcohol where the alkoxy unit is C_{2-4} , and Y is at least one counterion.

In a preferred embodiment of the invention the catalyst of formula (1) is used together with a peroxide or peroxide precursor and a bleach activator which is selected from the group consisting of tetraacetylenediamine, pentaacetylglucose, sodium octanoyloxybenzenesulfonate, sodium nonanoyloxybenzenesulfonate, sodium decanoyloxybenzenesulfonate, sodium undecanoyloxybenzenesulfonate, sodium dodecanoyloxybenzenesulfonate, octanoyloxybenzoic acid, nonanoyloxybenzoic acid, decanoyloxybenzoic acid, undecanoyloxybenzoic acid, dodecanoyloxybenzoic acid, octanoyloxybenzene, nonanoyloxybenzene, decanoyloxybenzene, undecanoyloxybenzene and dodecanoyloxybenzene.

The precursors may be used in an amount of up to 12 wt-%, preferably from 2-10 wt-% based on the total weight of the composition.

It is also possible to use further bleach catalysts, which are commonly known, for example transition metal complexes as disclosed in EP 1194514, EP 1383857 or WO04/007657.

Further bleach catalysts are disclosed in: US2001044401, EP0458397, WO9606154, EP1038946, EP0900264, EP0909809, EP1001009, WO9965905, WO0248301, WO0060045, WO02077145, WO0185717, WO0164826, EP0923635, DE 19639603, DE102007017654, DE102007017657, DE102007017656, US20030060388, EP0918840B1, EP1174491A2, EP0805794B1, WO9707192A1, US6235695B1, EP0912690B1, EP832969B1, US6479450B1, WO9933947A1, WO0032731A1, WO03054128A1, DE102004003710, EP1083730, EP1148117, EP1445305, US6476996, EP0877078, EP0869171, EP0783035, EP0761809 and EP1520910.

It is possible to use H₂O₂, O₂, air, the peroxy-containing compounds, the peroxy-acids as well as their precursors, further bleach catalyst and bleach activists in any combination with the inventive metal complexes.

The compositions may comprise, in addition to the combination according to the invention, one or more optical brighteners, for example from the classes bis-triazinylamino-stilbenedisulfonic acid, bis-triazolyl-stilbenedisulfonic acid, bis-styryl-biphenyl or bis-benzofuranyl-biphenyl, α bis-benzoxalyl derivative, bis-benzimidazolyl derivative or coumarin derivative or a pyrazoline derivative.

The compositions may furthermore comprise one or more further additives. Such additives are, for example, dirt-suspending agents, for example sodium carboxymethylcellulose; pH regulators, for example alkali metal or alkaline earth metal silicates; foam regulators, for example soap; salts for adjusting the spray drying and the granulating properties, for example sodium sulfate; perfumes; and also, if appropriate, antistatics and softening agents such as, for example, smectite; bleaching agents; pigments; and/or toning agents. These constituents should especially be stable to any bleaching agent employed.

If the detergent composition is used in an automatic dishwasher it is also common to use silver-corrosion inhibitors.

Such auxiliaries are added in a total amount of from 0.1 - 20 wt-%, preferably from 0.5 - 10 wt-%, especially from 0.5 - 5 wt-%, based on the total weight of the detergent formulation.

Furthermore, the detergent may optionally also comprise enzymes. Enzymes can be added for the purpose of stain removal. The enzymes usually improve the action on stains caused by protein or starch, such as, for example, blood, milk, grass or fruit juices. Preferred enzymes are cellulases and proteases, especially proteases. Cellulases are enzymes that react with cellulose and its derivatives and hydrolyse them to form glucose, cellobiose and celooligosaccharides. Cellulases remove dirt and, in addition, have the effect of enhancing the soft handle of the fabric.

Examples of customary enzymes include, but are by no means limited to, the following: proteases as described in US-B-6 242 405, column 14, lines 21 to 32; lipases as described in US-B-6 242 405, column 14, lines 33 to 46; amylases as described in US-B-6 242 405, column 14, lines 47 to 56; and cellulases as described in US-B-6 242 405, column 14, lines 57 to 64.

Commercially available detergent proteases, such as Alcalase[®], Esperase[®], Everlase[®], Savinase[®], Kannase[®] and Durazym[®], are sold e.g. by NOVOZYMES A/S.

Commercially available detergent amylases, such as Termamyl[®], Duramyl[®], Stainzyme[®], Natalase[®], Ban[®] and Fungamyl[®], are sold e.g. by NOVOZYMES A/S.

Commercially available detergent cellulases, such as Celluzyme[®], Carezyme[®] and Endolase[®], are sold e.g. by NOVOZYMES A/S.

Commercially available detergent lipases, such as Lipolase[®], Lipolase Ultra[®] and Lipoprime[®], are sold e.g. by NOVOZYMES A/S.

Suitable mannanases, such as Mannanaway[®], are sold by NOVOZYMES A/S.

Beside in laundry care products, in a hard surface cleaner, especially in a composition used in automatic dishwashers the following enzymes are also commonly used: proteases, amylases, pullulanases, cutinases and lipases, for example proteases such as BLAP[®], Optimase[®], Opticlean[®], Maxacal[®], Maxapem[®], Esperase[®] and/or Savinase[®], amylases such as Termamyl[®], Amylase-LT[®], Maxamyl[®] and/or Duramyl[®], lipases such as Lipolase[®], Lipomax[®], Lumafast[®] and/or Lipozym[®]. The enzymes which may be used can, as described e.g. in International Patent Applications WO 92/11347 and WO 94/23005, be adsorbed on carriers and/or embedded in encapsulating substances in order to safeguard them against premature inactivation. They are present in the cleaning formulations according to the invention preferably in amounts not exceeding 5 wt-%, especially in amounts of from 0.1 wt-% to 1.2 wt-%.

Amylases: The present invention preferably makes use of amylases having improved stability in detergents, especially improved oxidative stability. Such amylases are non-limitingly illustrated by the following: (a) An amylase according to WO 94/02597, Novo Nordisk A/S, published Feb. 3, 1994, as further illustrated by a mutant in which substitution is made, using alanine or threonine (preferably threonine), of the methionine residue located in position 197 of the *B.licheniformis* alpha-amylase, known as TERMAMYL[®], or the homologous position variation of a similar parent amylase, such as *B. amyloliquefaciens*, *B.subtilis*, or *B.stearothermophilus*; (b) Stability-enhanced amylases as described by Genencor International in a paper entitled "Oxidatively Resistant alpha-Amylases" presented at the 207th American Chemical Society National Meeting, March 13-17 1994, by C. Mitchinson. Therein it was noted that bleaches in automatic dishwashing detergents inactivate alpha-amylases but that improved oxidative stability amylases have been made by Genencor from *B. licheniformis* NCIB8061. Any other oxidative stability-enhanced amylase can be used.

Proteases: Protease enzymes are usually present in preferred embodiments of the invention at levels between 0.001 wt-% and 5 wt-%. The proteolytic enzyme can be of animal, vegetable or microorganism (preferred) origin. More preferred is serine proteolytic enzyme of bacterial origin. Purified or nonpurified forms of enzyme may be used. Proteolytic enzymes produced by chemically or genetically modified mutants are included by definition, as are close structural enzyme variants. Suitable commercial proteolytic enzymes include Alcalase[®], Esperase[®], Durazyme[®], Savinase[®], Maxatase[®], Maxacal[®], and Maxapem[®] (protein engineered Maxacal). Purafect[®] and subtilisin BPN and BPN' are also commercially available.

When present, lipases comprise from about 0.001 wt-% to about 0.01 wt-% of the instant compositions and are optionally combined with from about 1 wt-% to about 5 wt-% of a surfactant having limesoap-dispersing properties, such as an alkyldimethylamine N-oxide or a sulfobetaine. Suitable lipases for use herein include those of bacterial, animal and fungal origin, including those from chemically or genetically modified mutants.

When incorporating lipases into the instant compositions, their stability and effectiveness may in certain instances be enhanced by combining them with small amounts (e.g., less than 0.5 wt-% of the composition) of oily but non-hydrolyzing materials.

The enzymes, when used, may be present in a total amount of from 0.01 to 5 wt-%, especially from 0.05 to 5 wt-% and more especially from 0.1 to 4 wt-%, based on the total weight of the detergent formulation.

If the detergent formulation is a hard surface cleaning composition, preferably a dishwashing detergent formulation, more preferably an automatic dishwashing detergent formulation, then it can optionally also comprises from about 0.001 wt-% to about 10 wt-%, preferably from about 0.005 wt-% to about 8 wt-%, most preferably from about 0.01 wt-% to about 6 wt-% of an enzyme stabilizing system. The enzyme stabilizing system can be any stabilizing system which is compatible with the deterative enzyme. Such a system may be inherently provided by other formulation actives, or be added separately, e.g., by the formulator or by a manufacturer of detergent-ready enzymes. Such stabilizing systems can, for example, comprise calcium ion, boric acid, propylene glycol, short chain carboxylic acids, boronic acids, and mixtures thereof, and are designed to address different stabilization problems depending on the type and physical form of the detergent composition.

In order to enhance the bleaching action, the compositions may, in addition to comprising the catalysts described herein, also comprise photocatalysts the action of which is based on the generation of singlet oxygen.

Further preferred additives to the compositions according to the invention are dye-fixing agents and/or polymers which, during the washing of textiles, prevent staining caused by dyes in the washing liquor that have been released from the textiles under the washing conditions. Such polymers are preferably polyvinylpyrrolidones, polyvinylimidazoles or polyvinylpyridine-N-oxides, which may have been modified by the incorporation of anionic or

cationic substituents, especially those having a molecular weight in the range of from 5000 to 60 000, more especially from 10 000 to 50 000. Such polymers are usually used in a total amount of from 0.01 to 5 wt-%, especially from 0.05 to 5 wt-%, more especially from 0.1 to 2 wt-%, based on the total weight of the detergent formulation. Preferred polymers are those mentioned in WO-A-02/02865 (see especially page 1, last paragraph and page 2, first paragraph) and those in WO-A-04/05688.

When the inventive detergent composition is used as hardsurface cleaner, especially when the composition is used in automatic dishwasher formulation then, it has been found out, that it is preferable to avoid the use of simple calcium-precipitating soaps as antifoams in the present compositions as they tend to deposit on the dishware. Indeed, phosphate esters are not entirely free of such problems and the formulator will generally choose to minimize the content of potentially depositing antifoams in the instant compositions.

Other examples for foam suppressors are paraffin, paraffin/alcohol combinations, or bisfatty acid amides.

The hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations herein may also optionally contain one or more heavy metal chelating agents, such as hydroxyethyldiphosphonate (HEDP). More generally, chelating agents suitable for use herein can be selected from the group consisting of amino carboxylates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures thereof. Other suitable chelating agents for use herein are the commercial DEQUEST series, and chelants from Nalco, Inc.

Aminocarboxylates useful as optional chelating agents include ethylenediaminetetracetates, N-hydroxyethylethylenediaminetriacetates, nitrilotriacetates, ethylenediamine tetrapropionates, triethylenetetraaminehexacetates, diethylenetriamine-pentaacetates, and ethanoldiglycines, alkali metal, ammonium, and substituted ammonium salts thereof and mixtures thereof.

Aminophosphonates are also suitable for use as chelating agents in the compositions of the invention when at least low levels of total phosphorus are permitted in detergent compositions, and include ethylenediaminetetrakis (methylenephosphonates).

Further biodegradable sequestrants are, for example, aminoacid acetates, such as Trilon M (BASF) and Dissolvine GL (AKZO), as well as asparaginic acid derivatives, such as Baypure CX.

- 5 Preferably, the aminophosphonates do not contain alkyl or alkenyl groups with more than about 6 carbon atoms.

A highly preferred biodegradable chelator for use herein is ethylenediamine disuccinate ("EDDS").

10

If utilized, these chelating agents or transition-metal selective sequestrants will generally comprise from about 0.001 wt-% to about 10 wt-%, more preferably from about 0.05 wt-% to about 1wt-% of the hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations herein.

15

Preferred hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations herein may additionally contain a dispersant polymer. When present, a dispersant polymer is typically at levels in the range from 0 wt-% to about 25 wt-%, preferably from about 0.5 wt-% to about 20 wt-%, more preferably from about 1 wt-% to about 8 wt-% of the detergent composition. Dispersant polymers are useful for improved filming performance of the present dishwasher detergent compositions, especially in higher pH embodiments, such as those in which wash pH exceeds about 9.5. Particularly preferred are polymers, which inhibit the deposition of calcium carbonate or magnesium silicate on dishware.

25

Suitable polymers are preferably at least partially neutralized or alkali metal, ammonium or substituted ammonium (e.g., mono-, di- or triethanolammonium) salts of polycarboxylic acids. The alkali metal, especially sodium salts are most preferred. While the molecular weight of the polymer can vary over a wide range, it preferably is from about 1,000 to about 500,000, more preferably is from about 1,000 to about 250,000.

30

Unsaturated monomeric acids that can be polymerized to form suitable dispersant polymers include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. The presence of

monomeric segments containing no carboxylate radicals such as methyl vinyl ether, styrene, ethylene, etc. is suitable provided that such segments do not constitute more than about 50 wt-% of the dispersant polymer.

- 5 Copolymers of acrylamide and acrylate having a molecular weight of from about 3,000 to about 100,000, preferably from about 4,000 to about 20,000, and an acrylamide content of less than about 50 wt-%, preferably less than about 20 wt-% of the dispersant polymer can also be used. Most preferably, such dispersant polymer has a molecular weight of from about 4,000 to about 20,000 and an acrylamide content of from about 0 wt-% to about 15 wt-%,
10 based on the total weight of the polymer.

Particularly preferred dispersant polymers are low molecular weight modified polyacrylate copolymers. Such copolymers contain as monomer units: a) from about 90 wt-% to about 10 wt-%, preferably from about 80 wt-% to about 20 wt-% acrylic acid or its salts and b) from
15 about 10 wt-% to about 90 wt-%, preferably from about 20 wt-% to about 80 wt-% of a substituted acrylic monomer or its salt and have the general formula:

$-\text{[C(R}_a\text{)C(R}_b\text{)(C(O)OR}_c\text{)]}$ wherein the apparently unfilled valencies are in fact occupied by hydrogen and at least one of the substituents R_a , R_b , or R_c , preferably R_a or R_b , is a 1 to 4 carbon alkyl or hydroxyalkyl group; R_a or R_b can be a hydrogen and R_c can be a hydrogen or
20 alkali metal salt. Most preferred is a substituted acrylic monomer wherein R_a is methyl, R_b is hydrogen, and R_c is sodium.

A suitable low molecular weight polyacrylate dispersant polymer preferably has a molecular weight of less than about 15,000, preferably from about 500 to about 10,000, most preferably
25 from about 1,000 to about 5,000. The most preferred polyacrylate copolymer for use herein has a molecular weight of about 3,500 and is the fully neutralized form of the polymer comprising about 70 wt-% acrylic acid and about 30 wt-% methacrylic acid.

Other dispersant polymers useful herein include the polyethylene glycols and polypropylene glycols having a molecular weight of from about 950 to about 30,000.

30

Yet other dispersant polymers useful herein include the cellulose sulfate esters such as cellulose acetate sulfate, cellulose sulfate, hydroxyethyl cellulose sulfate, methylcellulose sulfate, and hydroxypropylcellulose sulfate. Sodium cellulose sulfate is the most preferred polymer of this group.

Other suitable dispersant polymers are the carboxylated polysaccharides, particularly starches, celluloses and alginates.

Yet another group of acceptable dispersants are the organic dispersant polymers, such as polyaspartate.

5

Depending on whether a greater or lesser degree of compactness is required, filler materials can also be present in the instant hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations. These include sucrose, sucrose esters, sodium sulfate, potassium sulfate, etc.,
10 in amounts up to about 70 wt-%, preferably from 0 wt-% to about 40 wt-% of the hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations. Preferred filler is sodium sulfate, especially in good grades having at most low levels of trace impurities.

15 Sodium sulfate used herein preferably has a purity sufficient to ensure it is non-reactive with bleach; it may also be treated with low levels of sequestrants, such as phosphonates or EDDS in magnesium-salt form. Note that preferences, in terms of purity sufficient to avoid decomposing bleach, applies also to pH-adjusting component ingredients, specifically including any silicates used herein.

20

Organic solvents that can be used in the cleaning formulations according to the invention, especially when the latter are in liquid or paste form, include alcohols having from 1 to 4 carbon atoms, especially methanol, ethanol, isopropanol and tert-butanol, diols having from 2 to 4 carbon atoms, especially ethylene glycol and propylene glycol, and mixtures thereof, and
25 the ethers derivable from the mentioned classes of compound. Such water-miscible solvents are present in the cleaning formulations according to the invention preferably in amounts not exceeding 20 wt-%, especially in amounts of from 1 wt-% to 15 wt-%.

30 Many hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations herein will be buffered, i.e., they are relatively resistant to pH drop in the presence of acidic soils. However, other compositions herein may have exceptionally low buffering capacity, or may be substantially unbuffered. Techniques for controlling or varying pH at recommended usage levels more

generally include the use of not only buffers, but also additional alkalis, acids, pH-jump systems, dual compartment containers, etc., and are well known to those skilled in the art.

Certain hard surface cleaning compositions, preferably dishwashing detergent formulations, more preferably automatic dishwashing detergent formulations, comprise a pH-adjusting component selected from water-soluble alkaline inorganic salts and water-soluble organic or inorganic builders. The pH-adjusting components are selected so that when the hard surface cleaning composition, preferably dishwashing detergent formulation, more preferably automatic dishwashing detergent formulation is dissolved in water at a concentration of 1,000-5,000 ppm, the pH remains in the range of above about 8, preferably from about 9.5 to about 11. The preferred nonphosphate pH-adjusting component can be selected from the group consisting of:

(i) sodium carbonate or sesquicarbonate;

(ii) sodium silicate, preferably hydrous sodium silicate having $\text{SiO}_2:\text{Na}_2\text{O}$ ratio of from about 1:1 to about 2:1, and mixtures thereof with limited quantities of sodium metasilicate;

(iii) sodium citrate;

(iv) citric acid;

(v) sodium bicarbonate;

(vi) sodium borate, preferably borax;

(vii) sodium hydroxide; and

(viii) mixtures of (i)-(vii).

Preferred embodiments contain low levels of silicate (i.e. from about 3 wt-% to about 10 wt-% SiO_2).

Illustrative of highly preferred pH-adjusting component systems of this specialized type are binary mixtures of granular sodium citrate with anhydrous sodium carbonate, and three-component mixtures of granular sodium citrate trihydrate, citric acid monohydrate and anhydrous sodium carbonate.

The amount of the pH adjusting component in compositions used for automatic dishwashing is preferably from about 1 wt-% to about 50 wt-% of the composition. In a preferred embodiment, the pH-adjusting component is present in the composition in an amount from about 5 wt-% to about 40 wt-%, preferably from about 10 wt-% to about 30 wt-%.

For compositions herein having a pH between about 9.5 and about 11 of the initial wash solution, particularly preferred automatic dishwashing detergent formulations embodiments comprise, by weight of the automatic dishwashing detergent formulations, from about 5 wt-%

to about 40 wt-%, preferably from about 10 wt-% to about 30 wt-%, most preferably from about 15 wt-% to about 20 wt-%, of sodium citrate with from about 5 wt-% to about 30 wt-%, preferably from about 7 wt-% to 25 wt-%, most preferably from about 8 wt-% to about 20 wt-% sodium carbonate.

- 5 The essential pH-adjusting system can be complemented (i.e. for improved sequestration in hard water) by other optional detergency builder salts selected from nonphosphate detergency builders known in the art, which include the various water-soluble, alkali metal, ammonium or substituted ammonium borates, hydroxysulfonates, polyacetates, and polycarboxylates. Preferred are the alkali metals, especially sodium, salts of such materials.
- 10 Alternate water-soluble, non-phosphorus organic builders can be used for their sequestering properties. Examples of polyacetate and polycarboxylate builders are the sodium, potassium, lithium, ammonium and substituted ammonium salts of ethylenediamine tetraacetic acid; nitrilotriacetic acid, tartrate monosuccinic acid, tartrate disuccinic acid, oxydisuccinic acid, carboxymethoxysuccinic acid, mellitic acid, and sodium benzene polycarboxylate salts.

- 15 The detergent formulations can take a variety of physical forms such as, for example, powder granules, tablets (tabs), gel and liquid. Examples thereof include, *inter alia*, conventional high-performance detergent powders, supercompact high-performance detergent powders and tabs. One important physical form is the so-called concentrated granular form, which is
- 20 added to a washing machine.

- Also of importance are so-called compact or supercompact detergents. In the field of detergent manufacture, there is a trend towards the production of such detergents that contain an increased amount of active substances. In order to minimize energy consumption
- 25 during the washing procedure, compact or supercompact detergents need to act effectively at low washing temperatures, for example below 40°C, or even at room temperature (25°C). Such detergents usually contain only small amounts of fillers or of substances, such as sodium sulfate or sodium chloride, required for detergent manufacture. The total amount of such substances is usually from 0 to 10 wt-%, especially from 0 to 5 wt-%, more especially
- 30 from 0 to 1 wt-%, based on the total weight of the detergent formulation. Such (super)compact detergents usually have a bulk density of from 650 to 1000 g/l, especially from 700 to 1000 g/l and more especially from 750 to 1000 g/l.

The detergent formulations can also be in the form of tablets (tabs). The advantages of tabs reside in the ease of dispensing and convenience in handling. Tabs are the most compact form of solid detergent formulation and usually have a volumetric density of, for example, from 0.9 to 1.3 kg/litre. To achieve rapid dissolution, such tabs generally contain special
5 dissolution aids:

- carbonate/hydrogen carbonate/citric acid as effervescent;
- disintegrators, such as cellulose, carboxymethyl cellulose or cross-linked poly(N-vinylpyrrolidone);
- rapidly dissolving materials, such as sodium (potassium) acetates, or sodium (potassium)
10 citrates;
- rapidly dissolving, water-soluble, rigid coating agents, such as dicarboxylic acids.

The tabs may also comprise combinations of such dissolution aids.

The detergent formulation may also be in the form of an aqueous liquid containing from 5 wt-
15 % to 50 wt-%, preferably from 10 wt-% to 35 wt-%, of water or in the form of a non-aqueous liquid containing no more than 5 wt-%, preferably from 0 wt-% to 1 wt-% of water. Non-aqueous liquid detergent formulations may comprise other solvents as carriers. Low molecular weight primary or secondary alcohols, for example methanol, ethanol, propanol and isopropanol, are suitable for that purpose. The solubilising surfactant used is preferably
20 a monohydroxy alcohol but polyols, such as those containing from 2 to 6 carbon atoms and from 2 to 6 hydroxy groups (e.g., 1,3-propanediol, ethylene glycol, glycerol and 1,2-propanediol) can also be used. Such carriers are usually used in a total amount of from 5 wt-% to 90 wt-%, preferably from 10 wt-% to 50 wt-%, based on the total weight of the detergent formulation. The detergent formulations can also be used in so-called "unit liquid dose" form.

25 Also an aspect of the invention is a granule comprising

- a) from 1 - 99 wt-%, based on the total weight of the granule, of at least one metal complex compound of formula (1) or a ligand of formula (2) as defined above and of at least one peroxide,
- 30 b) from 1 - 99 wt-%, based on the total weight of the granule, of at least one binder,
- c) from 0 - 20 wt-%, based on the total weight of the granule, of at least one encapsulating material,
- d) from 0 - 20 wt-%, based on the total weight of the granule, of at least one further additive and

e) from 0 - 20 wt-% based on the total weight of the granule, of water.

All wt-% are based on the total weight of the granule.

- 5 As binder (b) there come into consideration water-soluble, dispersible or water-emulsifiable anionic dispersants, non-ionic dispersants, polymers and waxes.

The anionic dispersants used are, for example, commercially available water-soluble anionic dispersants for dyes, pigments etc..

- 10 The following products, especially, come into consideration: condensation products of aromatic sulfonic acids and formaldehyde, condensation products of aromatic sulfonic acids with unsubstituted or chlorinated diphenyls or diphenyl oxides and optionally formaldehyde, (mono-/di-)alkylnaphthalenesulfonates, sodium salts of polymerised organic sulfonic acids, sodium salts of polymerised alkylnaphthalenesulfonic acids, sodium salts of polymerised
15 alkylbenzenesulfonic acids, alkylarylsulfonates, sodium salts of alkyl polyglycol ether sulfates, polyalkylated polynuclear arylsulfonates, methylene-linked condensation products of arylsulfonic acids and hydroxyarylsulfonic acids, sodium salts of dialkylsulfosuccinic acid, sodium salts of alkyl diglycol ether sulfates, sodium salts of polynaphthalenemethanesulfonates, lignosulfonates or oxylignosulfonates and heterocyclic
20 polysulfonic acids.

- Especially suitable anionic dispersants are condensation products of naphthalenesulfonic acids with formaldehyde, sodium salts of polymerised organic sulfonic acids, (mono-/di-)alkylnaphthalenesulfonates, polyalkylated polynuclear arylsulfonates, sodium salts of
25 polymerised alkylbenzenesulfonic acid, lignosulfonates, oxylignosulfonates and condensation products of naphthalenesulfonic acid with a polychloromethyldiphenyl.

- Suitable non-ionic dispersants are especially compounds having a melting point of, preferably, at least 35°C that are emulsifiable, dispersible or soluble in water, for example the
30 following compounds:

1. fatty alcohols having from 8 to 22 carbon atoms, especially cetyl alcohol;
2. addition products of, preferably, from 2 to 80 mol of alkylene oxide, especially ethylene oxide, wherein some of the ethylene oxide units may have been replaced by substituted epoxides, such as styrene oxide and/or propylene oxide, with higher unsaturated or

saturated monoalcohols, fatty acids, fatty amines or fatty amides having from 8 to 22 carbon atoms or with benzyl alcohols, phenyl phenols, benzyl phenols or alkyl phenols, the alkyl radicals of which have at least 4 carbon atoms;

3. alkylene oxide, especially propylene oxide, condensation products (block polymers);
- 5 4. ethylene oxide/propylene oxide adducts with diamines, especially ethylenediamine;
5. reaction products of a fatty acid having from 8 to 22 carbon atoms and a primary or secondary amine having at least one hydroxy-lower alkyl or lower alkoxy-lower alkyl group, or alkylene oxide addition products of such hydroxyalkyl-group-containing reaction products;
- 10 6. sorbitan esters, preferably having long-chain ester groups, or ethoxylated sorbitan esters, such as polyoxyethylene sorbitan monolaurate having from 4 to 10 ethylene oxide units or polyoxyethylene sorbitan trioleate having from 4 to 20 ethylene oxide units;
7. addition products of propylene oxide with a tri- to hexa-hydric aliphatic alcohol having from 3 to 6 carbon atoms, e.g. glycerol or pentaerythritol; and
- 15 8. fatty alcohol polyglycol mixed ethers, especially addition products of from 3 to 30 mol of ethylene oxide and from 3 to 30 mol of propylene oxide with aliphatic monoalcohols having from 8 to 22 carbon atoms.

Especially suitable non-ionic dispersants are surfactants of formula



wherein

R_{23} is C_8-C_{22} alkyl or C_8-C_{18} alkenyl;

R_{24} is hydrogen; C_1-C_4 alkyl; a cycloaliphatic radical having at least 6 carbon atoms; or
25 benzyl;

"alkylene" is an alkylene radical having from 2 to 4 carbon atoms and

n is a number from 1 to 60.

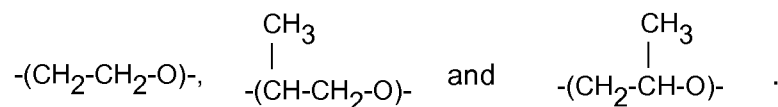
The substituents R_{23} and R_{24} in formula (11) are advantageously each the hydrocarbon
30 radical of an unsaturated or, preferably, saturated aliphatic monoalcohol having from 8 to 22 carbon atoms. The hydrocarbon radical may be straight-chain or branched. R_{23} and R_{24} are preferably each independently of the other an alkyl radical having from 9 to 14 carbon atoms.

Aliphatic saturated monoalcohols that come into consideration include natural alcohols, e.g. lauryl alcohol, myristyl alcohol, cetyl alcohol or stearyl alcohol, and also synthetic alcohols, e.g. 2-ethylhexanol, 1,1,3,3-tetramethylbutanol, octan-2-ol, isononyl alcohol, trimethylhexanol, trimethylnonyl alcohol, decanol, C₉-C₁₁oxo-alcohol, tridecyl alcohol, isotridecyl alcohol and linear primary alcohols (Alfols) having from 8 to 22 carbon atoms. Some examples of such Alfols are Alfol (8-10), Alfol (9-11), Alfol (10-14), Alfol (12-13) and Alfol (16-18). ("Alfol" is a registered trade mark of the company Sasol Limited).

Unsaturated aliphatic monoalcohols are, for example, dodecenyl alcohol, hexadecenyl alcohol and oleyl alcohol.

The alcohol radicals may be present singly or in the form of mixtures of two or more components, e.g. mixtures of alkyl and/or alkenyl groups that are derived from soybean fatty acids, palm kernel fatty acids or tallow oils.

(Alkylene-O) chains are preferably bivalent radicals of the formulae



Examples of a cycloaliphatic radical include cycloheptyl, cyclooctyl and preferably cyclohexyl.

As non-ionic dispersants there come into consideration preferably surfactants of formula



wherein

R₂₅ is C₈-C₂₂alkyl;

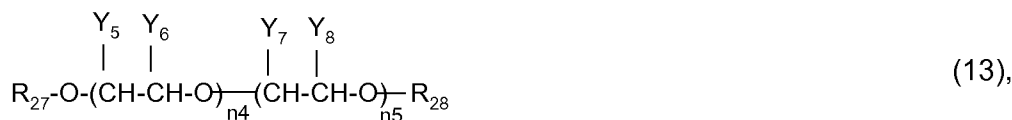
R₂₆ is hydrogen or C₁-C₄alkyl;

Y₁, Y₂, Y₃ and Y₄ are each independently of the others hydrogen, methyl or ethyl;

n₂ is a number from 0 to 8; and

n₃ is a number from 2 to 40.

Further important non-ionic dispersants correspond to formula



wherein

R₂₇ is C₉-C₁₄alkyl;

R₂₈ is C₁-C₄alkyl;

Y₅, Y₆, Y₇ and Y₈ are each independently of the others hydrogen, methyl or ethyl, one of the radicals Y₅, Y₆ and one of the radicals Y₇, Y₈ always being hydrogen; and n₄ and n₅ are each independently of the other an integer from 4 to 8.

The non-ionic dispersants of formulae (11) to (13) can be used in the form of mixtures. For example, as surfactant mixtures there come into consideration non-end-group-terminated fatty alcohol ethoxylates of formula (7), e.g. compounds of formula (11) wherein

R₂₃ is C₈-C₂₂alkyl,

R₂₄ is hydrogen and

the alkylene-O chain is the radical -(CH₂-CH₂-O)-

and also end-group-terminated fatty alcohol ethoxylates of formula (9).

Examples of non-ionic dispersants of formulae (11), (12) and (13) include reaction products of a C₁₀-C₁₃fatty alcohol, e.g. a C₁₃oxo-alcohol, with from 3 to 10 mol of ethylene oxide, propylene oxide and/or butylene oxide and the reaction product of one mol of a C₁₃fatty alcohol with 6 mol of ethylene oxide and 1 mol of butylene oxide, it being possible for the addition products each to be end-group-terminated with C₁-C₄alkyl, preferably methyl or butyl.

Such dispersants can be used singly or in the form of mixtures of two or more dispersants.

Instead of, or in addition to, the anionic or non-ionic dispersant, the granules according to the invention may comprise a water-soluble organic polymer as binder. Such polymers may be used singly or in the form of mixtures of two or more polymers.

Water-soluble polymers that come into consideration are, for example, polyethylene glycols, copolymers of ethylene oxide with propylene oxide, gelatin, polyacrylates, polymethacrylates, polyvinylpyrrolidones, vinylpyrrolidones, vinyl acetates, polyvinylimidazoles, polyvinylpyridine-N-oxides, copolymers of vinylpyrrolidone with long-chain α-olefins, copolymers of vinylpyrrolidone with vinylimidazole, poly(vinylpyrrolidone/dimethylaminoethyl methacrylates),

copolymers of vinylpyrrolidone/dimethylaminopropyl methacrylamides, copolymers of vinylpyrrolidone/dimethylaminopropyl acrylamides, quaternised copolymers of vinylpyrrolidones and dimethylaminoethyl methacrylates, terpolymers of vinylcaprolactam/ vinylpyrrolidone/dimethylaminoethyl methacrylates, copolymers of vinylpyrrolidone and methacrylamidopropyltrimethylammonium chloride, terpolymers of caprolactam/vinylpyrrolidone/dimethylaminoethyl methacrylates, copolymers of styrene and acrylic acid, polycarboxylic acids, polyacrylamides, carboxymethyl cellulose, hydroxymethyl cellulose, polyvinyl alcohols, polyvinyl acetate, hydrolysed polyvinyl acetate, copolymers of ethyl acrylate with methacrylate and methacrylic acid, copolymers of maleic acid with unsaturated hydrocarbons, and also mixed polymerisation products of the mentioned polymers.

Of those organic polymers, special preference is given to polyethylene glycols, carboxymethyl cellulose, polyacrylamides, polyvinyl alcohols, polyvinylpyrrolidones, gelatin, hydrolysed polyvinyl acetates, copolymers of vinylpyrrolidone and vinyl acetate, and also polyacrylates, copolymers of ethyl acrylate with methacrylate and methacrylic acid, and polymethacrylates.

Suitable water-emulsifiable or water-dispersible binders also include paraffin waxes.

Encapsulating materials (c) include especially water-soluble and water-dispersible polymers and waxes. Of those materials, preference is given to polyethylene glycols, polyamides, polyacrylamides, polyvinyl alcohols, polyvinylpyrrolidones, gelatin, hydrolysed polyvinyl acetates, copolymers of vinylpyrrolidone and vinyl acetate, and also polyacrylates, paraffins, fatty acids, copolymers of ethyl acrylate with methacrylate and methacrylic acid, and polymethacrylates.

Further additives (d) that come into consideration are, for example, wetting agents, dust removers, water-insoluble or water-soluble dyes or pigments, and also dissolution accelerators, optical brighteners and sequestering agents.

The preparation of the granules according to the invention is carried out, for example, starting from:

a) a solution or suspension with a subsequent drying/shaping step or

b) a suspension of the active ingredient in a melt with subsequent shaping and solidification.

a) First of all the anionic or non-ionic dispersant and/or the polymer and, optionally, the further additives are dissolved in water and stirred, if desired with heating, until a homogeneous solution is obtained. The catalyst according to the invention is then dissolved or
5 suspended in the resulting aqueous solution. The solids content of the solution should preferably be at least 30 wt-%, especially from 40 wt-% to 50 wt-%, based on the total weight of the solution. The viscosity of the solution is preferably less than 200 mPas.

The aqueous solution so prepared, comprising the catalyst according to the invention, is then
10 subjected to a drying step in which all water, with the exception of a residual amount, is removed, solid particles (granules) being formed at the same time. Known methods are suitable for producing the granules from the aqueous solution. In principle, both continuous methods and discontinuous methods are suitable. Continuous methods are preferred, especially spray-drying and fluidised bed granulation processes.

Especially suitable are spray-drying processes in which the active ingredient solution is
15 sprayed into a chamber with circulating hot air. The atomisation of the solution is effected e.g. using unitary or binary nozzles or is brought about by the spinning effect of a rapidly rotating disc. In order to increase the particle size, the spray-drying process may be
20 combined with an additional agglomeration of the liquid particles with solid nuclei in a fluidised bed that forms an integral part of the chamber (so-called fluid spray). The fine particles (<100 µm) obtained by a conventional spray-drying process may, if necessary after being separated from the exhaust gas flow, be fed as nuclei, without further treatment,
25 directly into the atomizing cone of the atomiser of the spray-dryer for the purpose of agglomeration with the liquid droplets of the active ingredient.

During the granulation step, the water can rapidly be removed from the solutions comprising
the catalyst according to the invention, binder and further additives. It is expressly intended
that agglomeration of the droplets forming in the atomising cone, or agglomeration of
30 droplets with solid particles, will take place.

b) The catalyst according to the invention is dried in a separate step prior to the melt-
granulation and, if necessary, dry-ground in a mill so that all the solids particles are < 50 µm

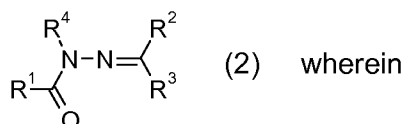
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in size. The drying is carried out in an apparatus customary for the purpose, for example, in a paddle dryer, vacuum cabinet or freeze-dryer.

Other product forms of the present invention include product forms specifically developed for industrial and institutional cleaning, for example liquid solutions of the catalyst in water or organic solvents or solid forms such as powders or granules which can be dosed in a separate bleaching step of the cleaning application.

Some of the ligands defined above are novel and are also a subject of the present invention.

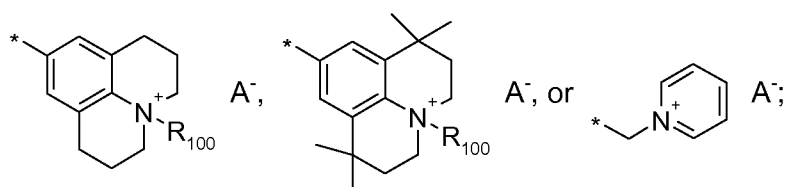
A compound of formula (2)



R_1 is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3 \text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$ wherein the

R_{100} , R'_{100} , R''_{100} independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; and A^- is an anion, or

R_1 together with the electron withdrawing substituent is a group



* is the point of attachment;

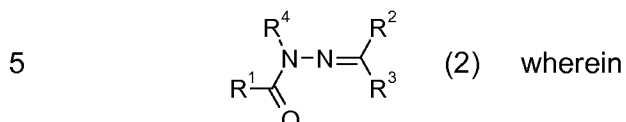
R_4 denotes hydrogen, C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkynyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

R_2 and R_3 independently of each other denote hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkynyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl; or

- 48 -

R₂ and R₃, together with the alkylidene carbon atom linking them, form an unsubstituted or substituted ring 5-, 6-, 7-, 8- or 9-membered ring which may contain further hetero atoms.

Preferred is a compound of formula (2)

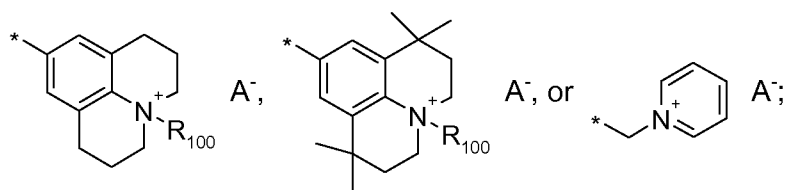


R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻ wherein the

R₁₀₀, R'₁₀₀, R''₁₀₀ independently are hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀, R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which

may contain a further nitrogen atom; and A⁻ is an anion, or

R₁ together with the electron withdrawing substituent is a group



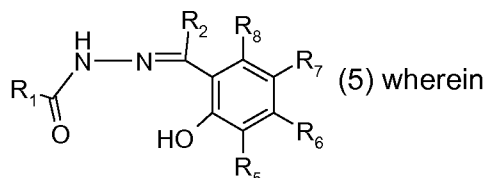
* is the point of attachment;

R₄ denotes hydrogen, C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

R₂ and R₃ independently of each other denote hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl; or

R₂ and R₃, together with the alkylidene carbon atom linking them, form an unsubstituted or substituted ring 5-, 6-, 7-, 8- or 9-membered ring which may contain further hetero atoms.

For example a compound which is of formula (5)

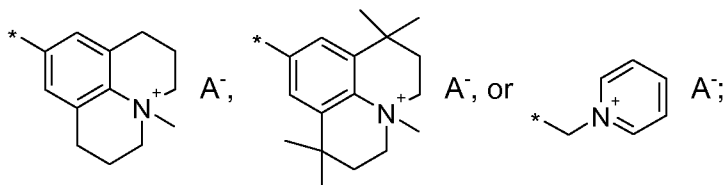


R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻ wherein the

R₁₀₀, R'₁₀₀, R''₁₀₀ independently are hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀, R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which

5 may contain a further nitrogen atom; and A⁻ is an anion, or

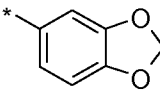
R₁ together with the electron withdrawing substituent is a group



* is the point of attachment;

R₂ denotes hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

R₅, R₆, R₇ and R₈ independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl,

15 C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen or a group ; or independently

have the meaning as defined for R₁;

or

R₅ and R₆, R₆ and R₇ or R₇ and R₈, are linked together to form 1, 2, 3 or 4 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more -O-, -S- or -NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

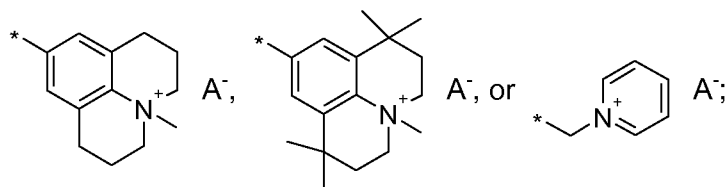
Preferred is a compound wherein

25 R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻ wherein the

R₁₀₀, R'₁₀₀, R''₁₀₀ independently are hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀, R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; and A⁻ is F⁻, Cl⁻, Br⁻ or I⁻, or

30 R₁ together with the electron withdrawing substituent is a group

- 50 -



* is the point of attachment;

R₂ denotes hydrogen, unsubstituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉phenylalkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl
 5 halogen;

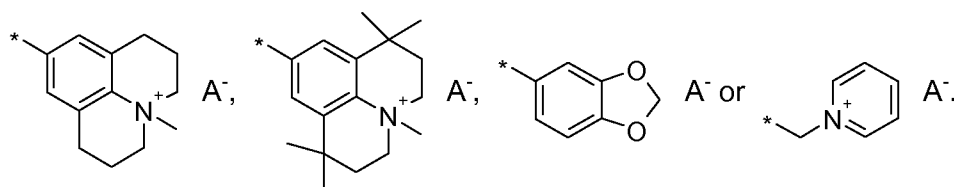
R₅, R₆, R₇ and R₈ independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl;
 or -OR₁₀₀, -NHR₁₀₀, -NR₁₀₀R'₁₀₀, halogen;

10 or phenyl substituted with 1 to 5 electron withdrawing groups selected from the group consisting of -OC(O)OR₁₀₀, -COOR₁₀₀, -C(O)-R₁₀₀, -CN, -NO₂, -SO₃R₁₀₀, -CF₃, F, Cl, Br, I,

-OR₁₀₀, -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻ and wherein R₁₀₀, R'₁₀₀, R''₁₀₀ independently are

hydrogen, C₁-C₁₈alkyl or phenyl, * is the point of attachment and A⁻ is as defined above; or

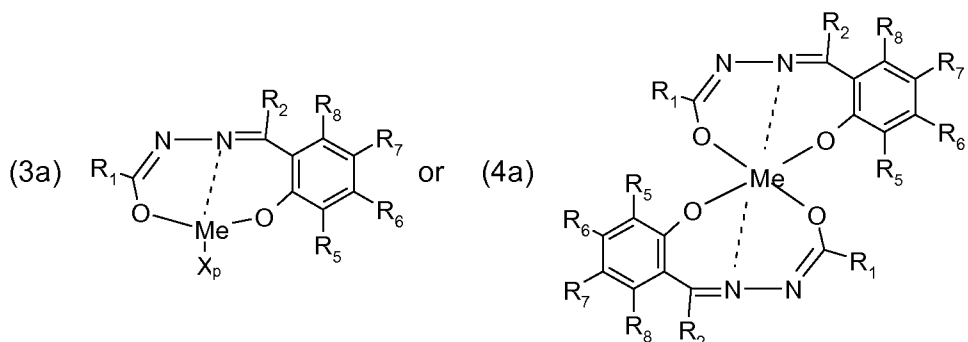
R₅, R₆, R₇ and R₈ together with the electron withdrawing substituent are independently a
 15 group



Preferably R₁ is phenyl substituted with 1 to 3 electron withdrawing substituents -N(R₁₀₀)₃⁺ A⁻, more preferably with 1 or 2 and most preferably with 1.

20

Yet a further aspect of the invention is a complex compound of formula (3a) or (4a)



wherein

Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

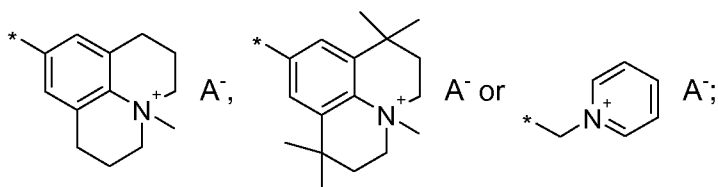
X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- ;

5 R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;

p is an integer from 1 to 4;

R_1 is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3 \text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$ wherein the

10 R_{100} , R'_{100} , R''_{100} independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; and A^- is F^- , Cl^- , Br^- or I, or R_1 together with the electron withdrawing substituent is a group

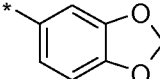


15 * is the point of attachment;

R_2 denotes hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

20 R_5 , R_6 , R_7 and R_8 independently from each other are hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted

- 52 -

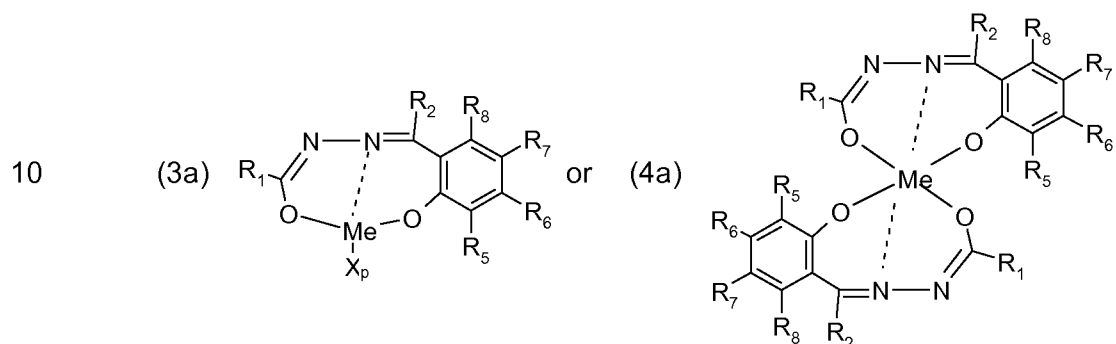
phenyl or naphthyl; $-\text{OR}_{100}$, $-\text{NR}_{100}\text{R}'_{100}$, halogen or a group ; or independently

have the meaning as defined for R_1 ;

or

R_5 and R_6 , R_6 and R_7 or R_7 and R_8 , are linked together to form 1, 2, 3 or 4 carbocyclic or
 5 heterocyclic rings, which may be uninterrupted or interrupted by one or more $-\text{O}-$, $-\text{S}-$ or $-\text{NR}_9-$ and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C_1 - C_6 alkyl groups.

Yet a further aspect of the invention is a complex compound of formula (3a) or (4a)



wherein

Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- ;

R_{28} is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;

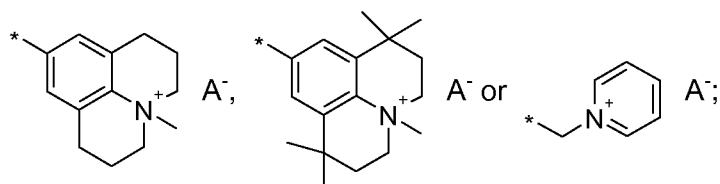
15 p is an integer from 1 to 4;

R_1 is phenyl substituted with 1 to 5 electron withdrawing substituents $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$ wherein the

R_{100} , R'_{100} , R''_{100} independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which

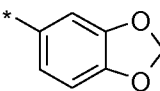
20 may contain a further nitrogen atom; and A^- is F^- , Cl^- , Br^- or I, or

R_1 together with the electron withdrawing substituent is a group



* is the point of attachment;

R₂ denotes hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

- 5 R₅, R₆, R₇ and R₈ independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen or a group ; or independently

have the meaning as defined for R₁;

- 10 or

R₅ and R₆, R₆ and R₇ or R₇ and R₈, are linked together to form 1, 2, 3 or 4 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more -O-, -S- or -NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

- 15

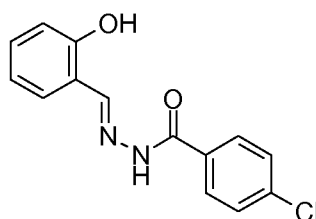
All definitions and preferences given above apply where applicable equally to all aspects of the invention.

The following examples illustrate the invention.

- 20

Parts and percentages relate to weight, unless otherwise indicated. Temperatures are in degrees Celsius, unless otherwise indicated.

Synthesis Example 1: Preparation of:



L1

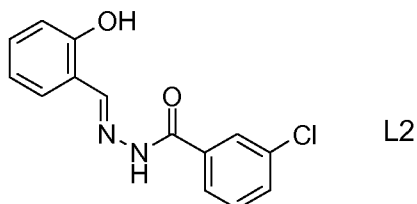
E/Z isomers and tautomeric forms

- 25 A mixture of 3.48 g of 4-chlorobenzhydrazide and 2.47 g of salicylaldehyde in 80 mL of ethanol is heated to 50°C. After stirring for 30 minutes at this temperature 1 mL of concentrated hydrochloric acid is added. The resulting pale yellow suspension is stirred for 16 hours, then filtrated and the residue washed with minor amounts of ethanol. After drying

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at 60°C in the vacuum 4.18 g of the desired product as a pale beige powder is obtained. Melting point: 223°C.

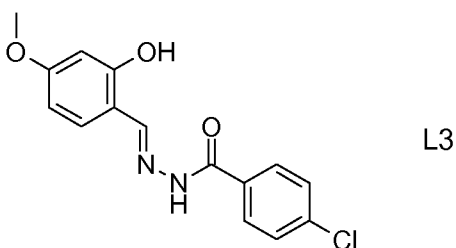
Synthesis Example 2: Preparation of:



E/Z isomers and tautomeric forms

- 5 1.15 g of 3-chlorobenzhydrazide are suspended in 35 mL of ethanol and stirred at room temperature for 10 minutes. After addition of 0.93 g of salicylaldehyde and 1 mL of concentrated hydrochloric acid the resulting yellow solution is stirred for 16 hours at room temperature. A colorless precipitate is filtrated off, washed with 10 mL of water and dried at 100°C in the vacuum yielding 1.39 g of the desired product as a colorless powder. Melting point: 201.8°C.
- 10

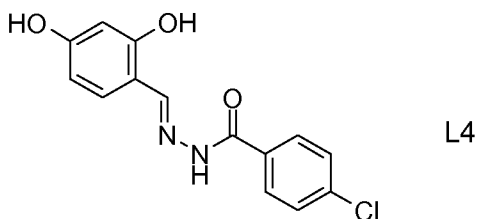
Synthesis Example 3: Preparation of:



E/Z isomers and tautomeric forms

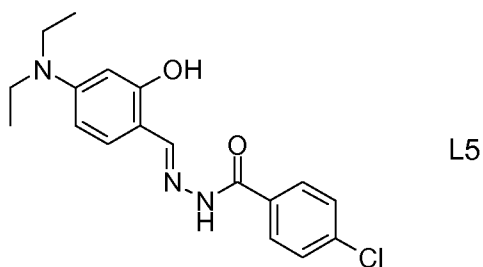
- To a mixture of 0.44 g of 4-chlorobenzhydrazide and 0.39 g of 2-hydroxy-4-methoxy-benzaldehyde in 35 mL of ethanol is added 0.5 mL of concentrated hydrochloric acid. Immediately a yellow suspension is formed which is stirred at room temperature for 16 hours. After filtrating off a pale yellow powder which is washed with 5 mL of ethanol and dried at 70°C in vacuum 0.60 g of the desired product are obtained. Melting point: 196.9°C.
- 15

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Synthesis Example 4: Preparation of:

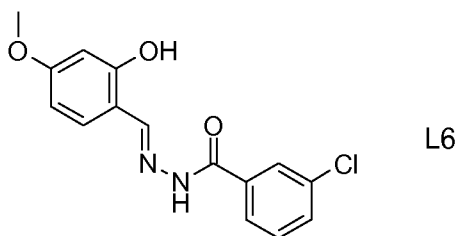
E/Z isomers and tautomeric forms

To a mixture of 0.44 g of 4-chlorobenzhydrazide and 0.39 g of 2,4-dihydroxy-benzaldehyde in 35 mL of ethanol is added 0.5 mL of concentrated hydrochloric acid. Immediately a reddish brown solution is formed which is stirred at room temperature for 16 hours. After filtrating off a beige powder which is washed with 5 mL of water and dried at 70°C in vacuum 0.17 g of the desired product are obtained. Melting point: 280°C.

Synthesis Example 5: Preparation of:

E/Z isomers and tautomeric forms

To a mixture of 0.44 g of 4-chlorobenzhydrazide in 35 mL of ethanol 0.49 g of 4-diethylamino-2-hydroxy-benzaldehyde is added dropwise. After the addition of 0.5 mL of concentrated hydrochloric acid a brown solution is formed which is stirred at room temperature for 16 hours. A brownish precipitate is filtered off, washed with 5 mL of water and dried at 70°C in vacuum yielding 0.70 g of the desired product are obtained. Melting point: 210°C.

Synthesis Example 6: Preparation of:

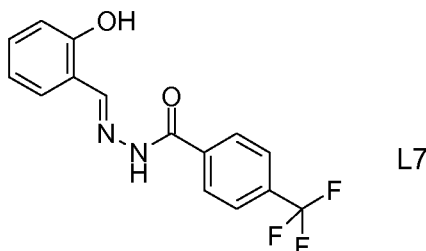
E/Z isomers and tautomeric forms

To a mixture of 0.44 g of 3-chlorobenzhydrazide in 35 mL of ethanol 0.39 g of 2-hydroxy-4-methoxy-benzaldehyde is added dropwise. After addition of 0.5 mL of concentrated hydrochloric acid a yellow solution is formed which is stirred at room temperature for 16

- 56 -

hours. A pale yellow precipitate is then filtered off, which is washed with 5 mL of water and dried at 70°C in vacuum yielding 0.38 g of the desired product. Melting point: 181.3°C.

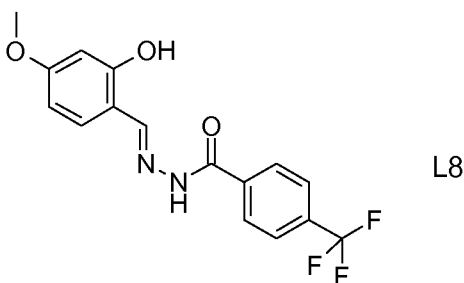
Synthesis Example 7: Preparation of:



E/Z isomers and tautomeric forms

- 5 To a mixture of 0.52 g of 4-trifluoromethyl-benzhydrazide in 15 mL ethanol 0.31 g of salicyl aldehyde is added dropwise at room temperature. Immediately a colorless suspension is formed. After addition of 0.5 mL of concentrated hydrochloric acid the suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 5 mL of ethanol and dried in the vacuum at 50°C yielding 0.20 g of the desired product as a colorless
- 10 powder. Melting point: 230.6°C.

Synthesis Example 8: Preparation of:

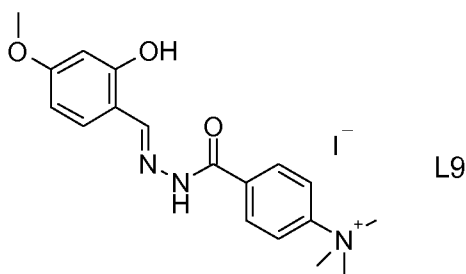


E/Z isomers and tautomeric forms

- To a mixture of 0.52 g of 4-trifluoromethyl-benzhydrazide in 15 mL ethanol 0.39 g of 2-hydroxy-4-methoxy-benzaldehyde is added dropwise at room temperature. After addition of
- 15 0.5 mL of concentrated hydrochloric acid a yellow suspension is formed which is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 5 mL of ethanol and dried in the vacuum at 50°C yielding 0.51 g of the desired product as a yellow powder. Melting point: 200°C (under decomposition).

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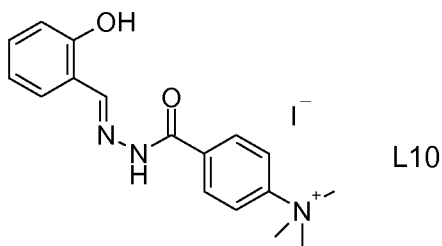
Synthesis Example 9: Preparation of:



E/Z isomers and tautomeric forms

To a mixture of 0.39 g of (4-hydrazinocarbonyl-phenyl)-trimethyl-ammonium iodide in 35 mL of ethanol 0.19 g of 2-hydroxy-4-methoxy-benzaldehyde is added dropwise at room temperature under formation of a colorless suspension. After addition of 0.5 mL of concentrated hydrochloric acid a yellow suspension is formed which is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 5 mL of water and dried in the vacuum at 70°C yielding 0.17 g of the desired product as a colorless powder. Melting point: 176.8°C.

Synthesis Example 10: Preparation of:

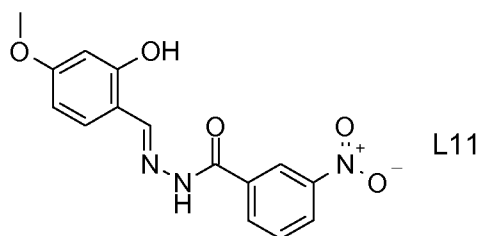


E/Z isomers and tautomeric forms

To a mixture of 0.39 g of (4-hydrazinocarbonyl-phenyl)-trimethyl-ammonium iodide in 35 mL of ethanol 0.15 g of salicylaldehyde is added dropwise at room temperature under formation of a colorless suspension. After addition of 0.5 mL of concentrated hydrochloric acid stirring is continued for 16 hours at room temperature. A colorless precipitate is then filtrated off and dried in the vacuum at 70°C yielding 0.21 g of the desired product as a colorless powder. Melting point: 170.4°C.

- 58 -

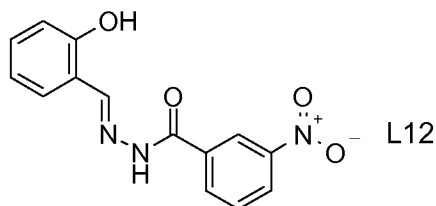
Synthesis Example 11: Preparation of:



E/Z isomers and tautomeric forms

0.46 g of 3-nitrobenzhydrazide are stirred for 10 min. in 35 mL of ethanol. Then 0.39 g of 2-hydroxy-4-methoxy-benzaldehyde are added dropwise at room temperature. After addition of 0.5 mL of concentrated hydrochloric acid immediately a precipitate is formed. The yellow suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 5 mL of water and dried in the vacuum at 100°C yielding 0.68 g of the desired product as a yellow solid. Melting point: 253.7°C.

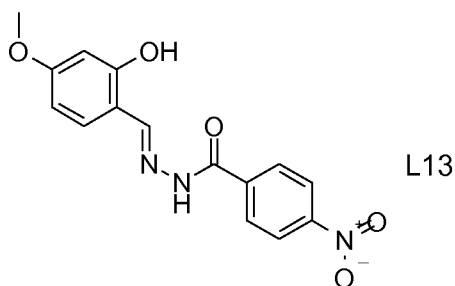
Synthesis Example 12: Preparation of:



E/Z isomers and tautomeric forms

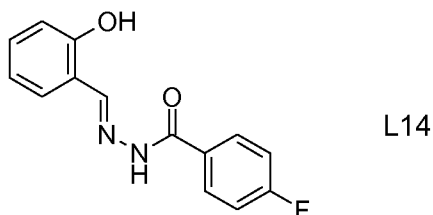
1.39 g of 3-nitrobenzhydrazide are stirred for 30 min. in 35 mL of ethanol. Then 0.93 g of salicyl aldehyde are added dropwise at room temperature. After addition of 1 mL of concentrated hydrochloric acid a yellow suspension is formed. The yellow suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 10 mL of water and dried in the vacuum at 100°C yielding 2.00 g of the desired product as a yellowish powder. Melting point: 243.7°C.

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Synthesis Example 13: Preparation of:

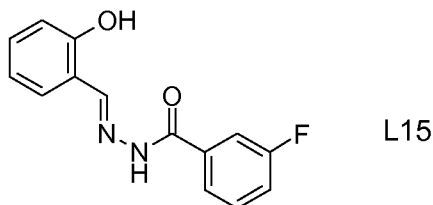
E/Z isomers and tautomeric forms

- 0.46 g of 4-nitrobenzhydrazide are stirred for 10 minutes in 35 mL of ethanol resulting in a yellowish suspension. Then 0.39 g of 2-hydroxy-4-methoxy-benzaldehyde are added dropwise at room temperature. After addition of 0.5 mL of concentrated hydrochloric acid the yellow suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off, washed with 5 mL of water and dried in the vacuum at 100°C yielding 0.70 g of the desired product as a dark yellow powder. Melting point: 214.8°C.

Synthesis Example 14: Preparation of:

E/Z isomers and tautomeric forms

- A mixture of 1.21 g of 4-fluorobenzhydrazide and 0.95 g of salicylaldehyde in 40 mL of ethanol is heated to 60°C. After addition of 5 drops of concentrated acetic acid the mixture is stirred for 1 hour at refluxing temperature. After cooling down to room temperature a colorless precipitate is filtered off and dried at 60°C in the vacuum yielding 0.97 g of the desired product as a colorless powder.

Synthesis Example 15: Preparation of:

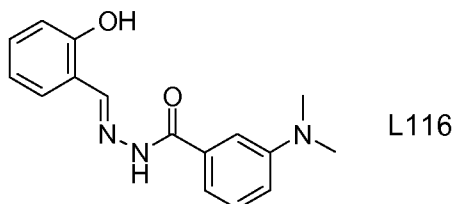
E/Z isomers and tautomeric forms

0.99 g of 3-fluorobenzhydrazide are dissolved in 30 mL of ethanol by stirring and heating. After addition of 0.78 g of salicylaldehyde and 5 drops of concentrated acetic acid the resulting yellowish solution is stirred for 1 hour at refluxing temperature. A colorless

- 60 -

precipitate is filtrated off, washed with water and dried at 60°C in the vacuum yielding 1.01 g of the desired product as a colorless powder.

Synthesis Example 16: Preparation of:

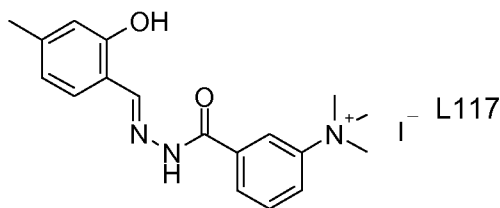


E/Z isomers and tautomeric forms

- 5 330 mg of 3-dimethylbenzhydrazide are dissolved in 6 mL of ethanol by stirring. After addition of 225 mg of salicylaldehyde and 0.5 mL of concentrated hydrochloric acid the resulting yellowish suspension is stirred for 4 hours at room temperature. The precipitate is then filtrated off and recrystallised from methanol. After drying in the vacuum at 25°C, 98 mg of the desired product are isolated as a yellow powder. Melting point: 192.6°C.

10

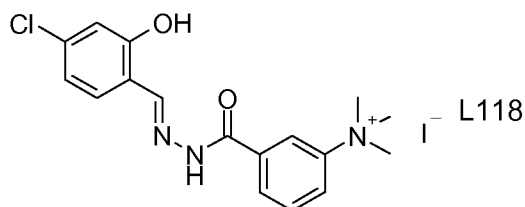
Synthesis Example 17: Preparation of:



E/Z isomers and tautomeric forms

- 15 134 mg of (3-hydrazinocarbonyl-phenyl)-trimethyl-ammonium iodide are stirred for 10 minutes in 8 mL of ethanol. Then 315 mg of 2-hydroxy-4-methyl-benzaldehyde are added at room temperature. After addition of 0.5 mL of concentrated hydrochloric acid the resulting yellowish suspension is stirred for 0.5 hours at room temperature. The precipitate is then filtrated off and dried in the vacuum at 25°C, yielding 285 mg of the desired product as a yellow powder. Melting point: 185.7°C.

Synthesis Example 18: Preparation of:



E/Z isomers and tautomeric forms

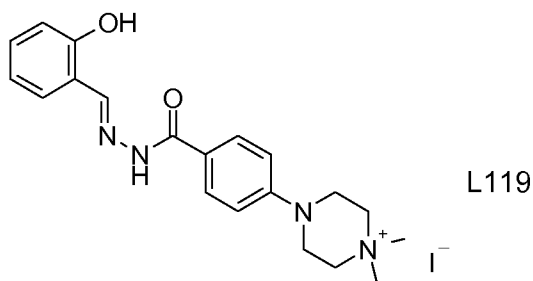
- 20 To a mixture of 248 mg of (3-hydrazinocarbonyl-phenyl)-trimethyl-ammonium iodide in 7.5 mL of ethanol 121 mg of 4-chloro-2-hydroxybenzaldehyde are added at room temperature

- 61 -

under formation of a colorless suspension. After addition of 0.5 mL of concentrated hydrochloric acid stirring is continued for 16 hours at room temperature. A yellow precipitate is then filtrated off and recrystallised from ethanol. After drying in the vacuum at 25°C, 90 mg of the desired product are isolated as a yellow powder.

5

Synthesis Example 19: Preparation of:

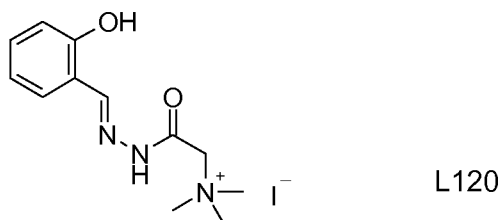


E/Z isomers and tautomeric forms

61 mg of 4-(4-hydrazinocarbonyl-phenyl)-1,1-dimethyl-piperazin-1-ium iodide are stirred for 10 minutes in 5 mL of ethanol. Then 20 mg of salicylaldehyde are added at room temperature. After addition of 0.5 mL concentrated hydrochloric acid the resulting orange suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off and dried in the vacuum at 25°C, yielding 26 mg of the desired product as an orange powder.

10

Synthesis Example 20: Preparation of:



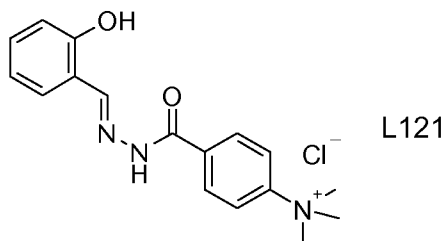
E/Z isomers and tautomeric forms

250 mg of hydrazinocarbonylmethyl-trimethyl-ammonium iodide are suspended in 2.5 mL of ethanol by stirring. After addition of 118 mg of salicylaldehyde and 0.25 mL of concentrated hydrochloric acid the resulting yellowish suspension is stirred for 16 hours at room temperature. The precipitate is then filtrated off and washed with ethanol. After drying in the vacuum at 25°C, 270 mg of the desired product are isolated as a yellow powder.

20

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Synthesis Example 21: Preparation of:



E/Z isomers and tautomeric forms

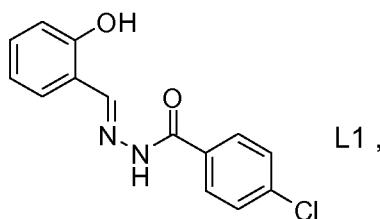
To a solution of 0.755 g of (4-hydrazinocarbonyl-phenyl)-trimethyl-ammonium iodide in 9 mL of ethanol 0.245 mL of salicylaldehyde is added dropwise at room temperature. After addition of 0.5 mL of concentrated hydrochloric acid stirring is continued for 16 hours at room temperature. A colorless precipitate is then filtrated off and dried in the vacuum at 30°C. This iodide salt was solved in water and passed over a DOWEX 1x8 packed column. The combined water eluates were evaporated in vaccum to obtain a beige solid in 20% yield.

APPLICATION EXAMPLES

Application Example 1: (Peroxide Bleaching of morin in solution)

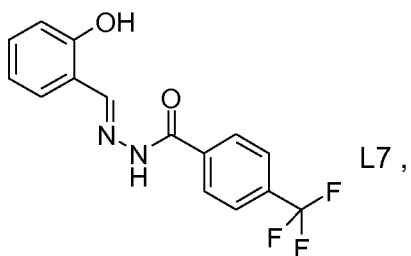
2.5 μ M catalyst solution (1:1 complex of Mn(II) chloride tetrahydrate with the ligand in question in water or methanol) are added at time t=0 to a solution of 160 μ M morin in 10 mM carbonate buffer, pH 10 containing 10mmol/l hydrogen peroxide. The solution is located in a thermostatically controllable vessel, equipped with a magnetic stirrer, at 23°C. The extinction of the solution is measured at 410 nm over a period of 10 min. The values for the decoloration after 3 min. are indicated as percentages.

The following ligands were used:

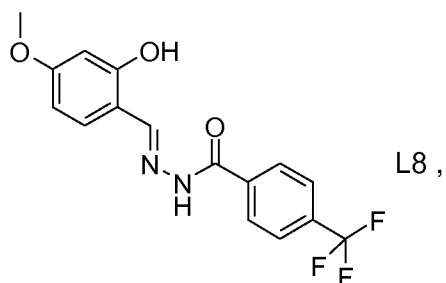


E/Z-isomers and tautomeric forms

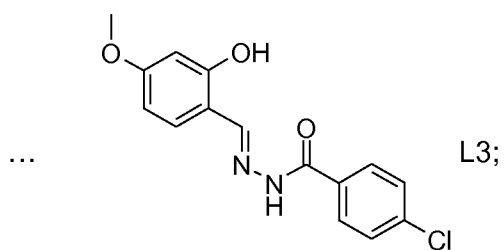
- 63 -



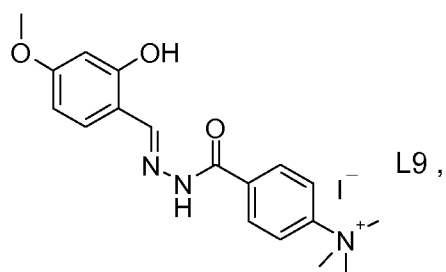
E/Z-isomers and tautomeric forms



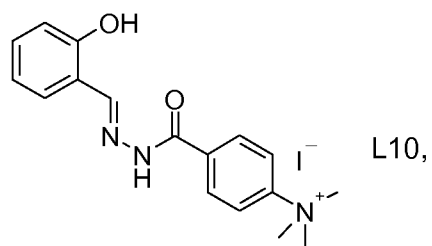
E/Z-isomers and tautomeric forms



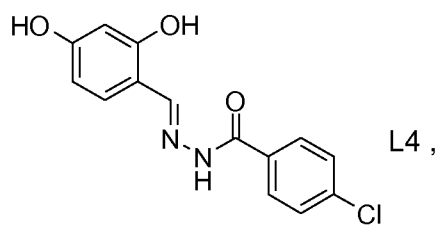
E/Z-isomers and tautomeric forms



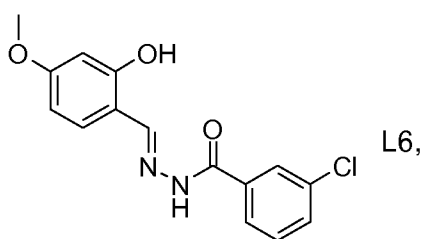
E/Z-isomers and tautomeric forms



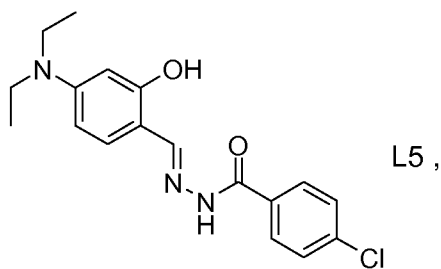
E/Z-isomers and tautomeric forms



E/Z-isomers and tautomeric forms

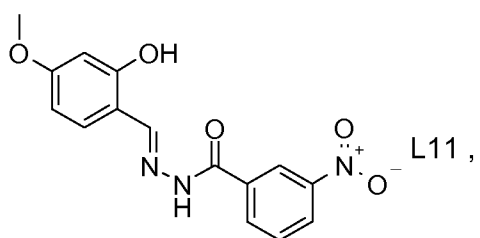


E/Z-isomers and tautomeric forms

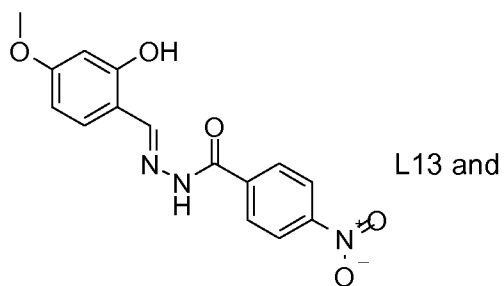


E/Z-isomers and tautomeric forms

- 64 -

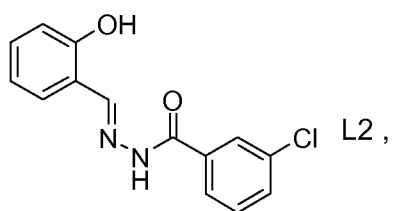


E/Z-isomers and tautomeric forms

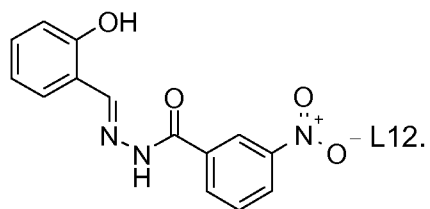


L13 and

E/Z-isomers and tautomeric forms



E/Z-isomers and tautomeric forms .



E/Z-isomers and tautomeric forms

Table 1

Ligand	Extent of the decoloration after 3 min (%)
L10	80
L9	85
L8	77
L1	81
L7	85
L3	80
L4	46
L6	84
L5	29
L11	82
L13	83
L2	84
Reference without catalyst	3

The bleaching action of the compounds according to the invention is by far superior to the reference of 10 mM hydrogen peroxide alone.

5

Application Example 2: (Peroxide Bleaching action in washing agents)

7.5 g of white cotton fabric and 2.5 g of tea-stained cotton fabric are treated in 80 ml of washing liquor. The liquor contains a standard washing agent (ECE, 456 IEC) in a concentration of 7.5 g/l. The hydrogen peroxide concentration is 8.6 mmol/l. The catalyst concentration (1:1 complex of manganese(II) chloride tetrahydrate with the ligand in question, prepared in methanolic solution with the addition of a small amount of lithium hydroxide) is 50 μ mol/l. The washing process is carried out in a steel beaker in a LINITEST apparatus for 30 minutes at 40°C. For evaluating the bleaching results, the increase in the lightness DY (difference in lightness according to CIE) of the stains brought about by the treatment is determined spectrophotometrically in difference to values obtained without the addition of a catalyst. A value >0 indicates catalytic activity.

10

15

Table 2

1:1 Mn complex with ligand	DY increase on top of peroxide
L10	5.6
L9	6.0
L8	5.9
L1	5,2
L7	2,3
L3	3,9
L4	3,2
L13	4
L6	5,9
L5	3,8
L11	3,6
L1	3,7
L12	3

As can be seen from Table 2 above, the manganese complexes exhibit a very good bleaching action.

5

The results of Table 2 show, that those manganese complexes with ligands bearing an electron attracting group exhibit enhanced bleaching performance.

Application Example 3 with un-complexed ligands: (peroxide bleaching action in washing

10 agents)

22.4 g of white cotton fabric and 0.8 g of BC01 tea-stained or EMPA114 red wine-stained cotton fabric are treated in 150 ml of washing liquor. The liquor contains a commercial color care washing powder in a concentration of 4.5 g/l, and 0.83g/l sodium percarbonate (SPC).

The catalyst concentration ligand L10 in an un-complexed form is 20 $\mu\text{mol/l}$. The washing process is carried out in a steel beaker in a LINITEST apparatus for 40 minutes at 30°C. For evaluating the bleaching results, the increase in the lightness DY (difference in lightness according to CIE) of the stains brought about by the treatment is determined spectrophotometrically. The higher the ΔY value, the better the bleach performance

Table 3 ΔY of Acylhydrazone Ligand with SPC containing detergent

	BC01	EMPA114
Percarbonate alone	6.2	21.0
Percarbonate + L10	10.4	26.8

As can be seen from Table 3 above, the Ligand L10 alone exhibits a very good bleaching action.

5

Application Example 4 with un-complexed ligands: (bleach activity on top of TAED action in washing agents)

22.4 g of white cotton fabric and 0.8 g of BC01 tea-stained or EMPA114 red wine-stained cotton fabric are treated in 150 ml of washing liquor. The liquor contains a commercial color care washing powder in a concentration of 4.5 g/l, 0.83g/l sodium percarbonate (SPC) and 0.166g Tetraacetyethylenediamin (TAED). The catalyst concentration Ligand L10 in a un-complexed form is 20 μ mol/l. The washing process is carried out in a steel beaker in a LINITEST apparatus for 40 minutes at 30°C. For evaluating the bleaching results, the increase in the lightness DY (difference in lightness according to CIE) of the stains brought about by the treatment is determined spectrophotometrically. The higher the ΔY value, the better the bleach performance

10

15

Table 4 ΔY of Acylhydrazone Ligand with SPC/TAED containing detergent

	BC01	EMPA114
SPC/TAED	9.1	24.9
SPC/TAED + L10	15.1	30.0

As can be seen from Table 4 above, the Ligand L10 exhibits a very good bleaching action, even on top of a SPC/TAED bleach system.

20

Application Example 5 un-complexed ligand: (bleach activity with AATCC Standard detergent)

22.4 g of white cotton fabric and 0.8 g of BC01 tea-stained cotton fabric are treated in 150 ml of washing liquor. The liquor contains AATCC standard powder detergent in a concentration of 7.5g/l, 0.68g/l sodium percarbonate (SPC) and 0.151g Tetraacetyethylenediamin (TAED).

25

The catalyst concentration Ligand L9 in a un-complexed form is 20 μ mol/l. The washing process is carried out in a steel beaker in a LINITEST apparatus for 40 minutes at 40°C. For evaluating the bleaching results, the increase in the lightness DY (difference in lightness according to CIE) of the stains brought about by the treatment is determined

5 spectrophotometrically. The higher the ΔY value, the better the bleach performance

Table 5 ΔY of Acylhydrazone Ligand with AATCC detergent

	BC01
SPC/TAED	12.7
SPC + L9	14.8

As can be seen from Table 5 above, the ligand L9 exhibits a very good bleaching action,
10 which exceeds the performance of the standard bleach system SPC/TAED.

Application Example 6 un-complexed ligand: (bleach activity with liquid bleach additive)

48 g of white cotton fabric and 0.8 g of BC01 tea-stained and 0.8g EMPA114 red wine or
0.8g BC03 tea and BC06 strawberry-stained cotton fabric are treated in 250 ml of washing

15 liquor. The liquor contains a commercial color care washing powder in a concentration of 4.5g/l, 2.4g/l of a commercial liquid bleach additive (Vanish). The catalyst concentration

Ligand L10 in a un-complexed form is 10 μ mol/l and 20 μ mol/l. The washing process is carried out in a steel beaker in a LINITEST apparatus for 40 minutes at 40°C. For evaluating the bleaching results, the increase in the lightness DY (difference in lightness according to CIE)

20 of the stains brought about by the treatment is determined spectrophotometrically. The higher the ΔY value, the better the bleach performance.

Table 6 Acylhydrazone ligand with detergent and bleach additive

	BC01	EMPA114	BC03	BC06
Detergent	2.7	16.3	1.9	0.1
Detergent + Bleach additive	6.2	22.4	5.1	4.9
Detergent + Bleach additive + 10 μ mol/l L10	8.1	23.2	8.4	5.9
Detergent + Bleach additive + 20 μ mol/l L10	10.4	26.7	12.8	8.7

As can be seen from Table 6 above, the ligand L10 exhibits a very good bleaching action also with liquid bleach additives.

- 5 Application Example 7 un-complexed ligand (incorporation of L10 into liquid bleach additive)
3.02mmol/l of L10 (counter ion Cl^-) are incorporated into a commercial liquid bleach additive. This additive is applied in a bleach experiment immediately, 1 day, one week and one month after preparation, storage of the bleach additive at ambient temperature.

The washing process is as follows:

- 10 24.2 g of white cotton fabric and 0.8 g of BC01 tea-stained cotton fabric are treated in 150 ml of washing liquor. The liquor contains a commercial color care washing powder in a concentration of 4.5g/l, 3.7g/l of the commercial liquid bleach additive containing the catalyst concentration Ligand L10 (counter ion Cl^-) in a un-complexed form. The washing process is carried out in a steel beaker in a LINITEST apparatus for 40 minutes at 40°C. For evaluating
15 the bleaching results, the increase in the lightness DY (difference in lightness according to CIE) of the stains brought about by the treatment is determined spectrophotometrically. The higher the ΔY value, the better the bleach performance.

Table 7 L10 containing liq. bleach additive, performance after storage (ΔY BC01)

	immediately	1 day	1 week	1 month
L10-Bleach additive	10.4	10.4	10.8	10.1

- 20 The application of the bleach additive without L10 leads to a ΔY of 6.5

The results in Table 7 indicate no loss in bleach activity after a storage time of one month.

Additionally the content of hydrogen peroxide in the bleach additive is determined iodometrically

- 25 Table 8 concentration of hydrogen peroxide (mol/l) in L10 containing bleach additive after storage

	immediately	1 day	1 week	1 month
L10 Bleach additive	1.93	1.93	1.92	1.92

Table 8 indicates that no peroxide is decomposed in the presence of L10.

Application Example 8 un-complexed ligand: (dishwashing)

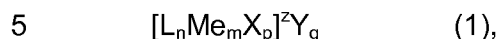
Tee-stained cups are prepared according to the IKW method („IKW-Arbeitskreis Maschinenspülmittel, Methoden zur Bestimmung der Reinigungsleistung von maschinellen Geschirrspülmitteln (Part A and B)", SÖFW, 11+14, 1998). Tea-stained cups are filled with a carbonate buffer solution (pH 9.6) containing 44 mM hydrogen peroxide and 30 µM catalyst. After 15 minutes the solution is removed, and the cups are rinsed with water. The removal of the tea deposit is evaluated visually on a scale from 0 (i.e. unchanged, very strong deposit) to 10 (i.e. no deposit). A rating of 4.5 is observed in experiments without catalyst.

10 Table 9

Catalyst (Ligand)	Rating
Reference	4.5
Ligand 10	8
Ligand 121 of Synthesis Example 21	7

Claims

1. Use, as a catalyst for oxidation reactions, of at least one complex of formula (1)



wherein

Me is manganese, titanium, iron, cobalt, nickel or copper;

X is a coordinating or bridging radical;

10 **n** is an integer from 1 to 4;

m is an integer from 0 to 2;

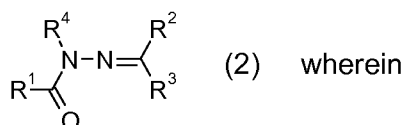
p is an integer having a value of from 0 to 10;

z is the charge of the metal complex,

Y is a counter-ion,

15 **q** = z/(charge of Y), and

L is a ligand of formula (2)



20 **R₁** denotes CF₃ or C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl which are substituted by one or more electron withdrawing substituents; or

phenyl or naphthyl which are substituted by one or more electron withdrawing substituents;

25 **R₄** denotes hydrogen, C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroalkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

R₂ and **R₃** independently of each other denote hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroalkyl, unsubstituted or substituted phenyl or naphthyl or unsubstituted or substituted heteroaryl; or

30 **R₂** and **R₃**, together with the alkylidene carbon atom linking them, form an unsubstituted or substituted 5-, 6-, 7-, 8- or 9-membered ring which may contain further hetero atoms.

2. Use according to claim 1 wherein

X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- , LMeO^- and LMeOO^- ;

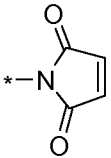
Y is $\text{R}_{28}\text{COO}^-$, ClO_4^- , BF_4^- , PF_6^- , $\text{R}_{28}\text{SO}_3^-$, $\text{R}_{28}\text{SO}_4^-$, SO_4^{2-} , NO_3^- , F^- , Cl^- , Br^- and I^- ;

R₂₈ is hydrogen, unsubstituted or substituted $\text{C}_1\text{-C}_{18}$ alkyl or phenyl; and the other definitions are as given in claim 1.

5

3. Use according to claim 1 or 2 wherein **R₁** is $-(\text{CH}_2)_k\text{-N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3\text{A}^-$, wherein **A⁻** is an anion and *k* is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

$-\text{O}-\text{C}(\text{O})\text{OR}_{100}$, $-\text{COOR}_{100}$, $-\text{C}(\text{O})\text{N}(\text{R}_{100}\text{R}'_{100})$, $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{CN}$, $-\text{NO}_2$, $-\text{SO}_3\text{R}_{100}$, $-\text{CF}_3$, F , Cl , Br ,

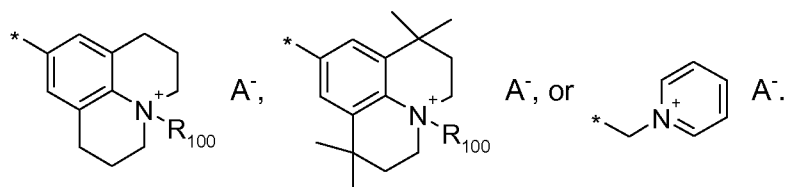
10 I , $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+\text{A}^-$, $-\text{N}(\text{R}_{101}\text{R}'_{101})$ and  wherein

R₁₀₀, **R'₁₀₀**, **R''₁₀₀** independently are hydrogen, unsubstituted or substituted $\text{C}_1\text{-C}_{18}$ alkyl or phenyl; or two of **R₁₀₀**, **R'₁₀₀**, **R''₁₀₀** together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; * is the point of attachment and **A⁻** is an anion,

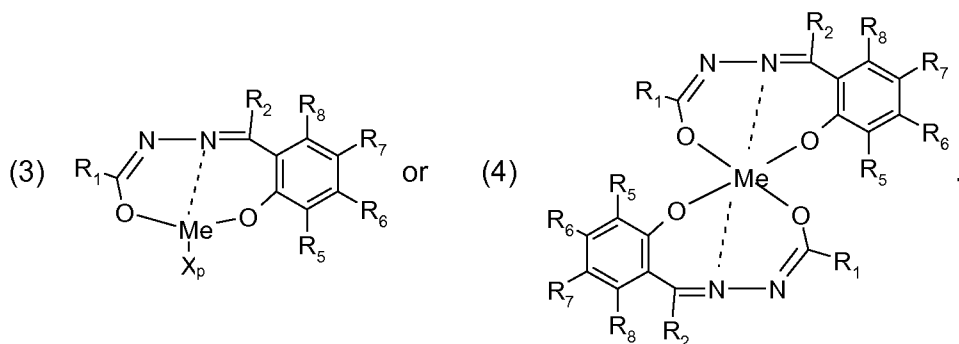
15 **R₁₀₁**, **R'₁₀₁** independently are $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{C}(\text{O})\text{N}(\text{R}_{100}\text{R}'_{100})$ or $-\text{C}(\text{O})\text{OR}_{100}$;

or

R₁ together with the electron withdrawing substituent is a group



20 4. Use according to claim 1, 2 or 3 wherein the catalyst is of formula (3) or (4)



- 73 -

wherein

Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

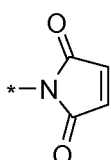
X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- ;

R₂₈ is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;

5 **p** is an integer from 1 to 4;

R₁ is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3\text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

$-\text{OC}(\text{O})\text{OR}_{100}$, $-\text{COOR}_{100}$, $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{CN}$, $-\text{NO}_2$, $-\text{SO}_3\text{R}_{100}$, $-\text{CF}_3$, F , Cl , Br , I ,

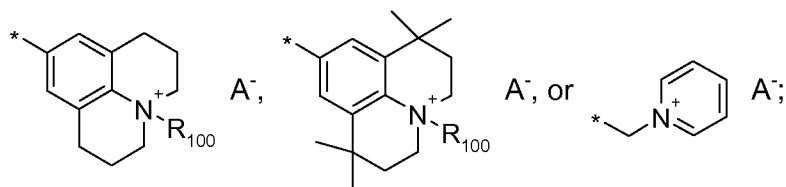
10 $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+\text{A}^-$, $-\text{N}(\text{R}_{101}\text{R}'_{101})$ and  wherein **R₁₀₀**, **R'₁₀₀**, **R''₁₀₀** are

independently hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom, * is the point of attachment and A^- is an anion,

R₁₀₁, **R'₁₀₁** independently are $-\text{C}(\text{O})-\text{R}_{100}$, $-\text{C}(\text{O})\text{N}(\text{R}_{100}\text{R}'_{100})$ or $-\text{C}(\text{O})\text{OR}_{100}$;

15 or

R₁ together with the electron withdrawing substituent is a group



R₂ denotes hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkynyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, 20 C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

R₅, **R₆**, **R₇** and **R₈** independently from each other are hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkynyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted 25 phenyl or naphthyl; $-\text{OR}_{100}$, $-\text{NR}_{100}\text{R}'_{100}$, halogen; or independently have the meaning as defined for **R₁**; or

R₅ and **R₆**, **R₆** and **R₇** and/or **R₇** and **R₈**, may be linked together to form 1, 2 or 3 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more $-\text{O}-$, $-\text{S}-$ or $-\text{N}-$

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NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

5. Use according to any of the preceding claims wherein

5 **Me** is manganese in oxidation states II-V or iron in oxidation states I to IV;

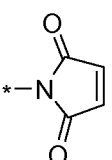
X is H₂O, F⁻, Cl⁻, Br⁻, HOO⁻, R₂₈COO⁻ or R₂₈O⁻;

R₂₈ is hydrogen, unsubstituted or substituted C₁-C₁₈alkyl;

p is an integer 1 or 2;

R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents selected from the group consisting of

-OR₁₀₀, -COOR₁₀₀, -C(O)-R₁₀₀, -CN, -NO₂, -SO₃R₁₀₀, -CF₃, F, Cl, Br, I, -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻,

-N(R₁₀₁R'₁₀₁) or  wherein **R₁₀₀**, **R'₁₀₀**, **R''₁₀₀** are independently hydrogen, C₁-C₁₈alkyl

or phenyl, * is the point of attachment and A⁻ is an anion;

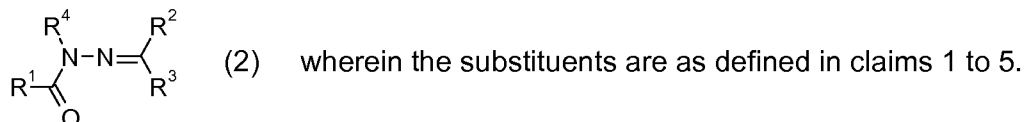
R₁₀₁, **R'₁₀₁** independently are -C(O)-R₁₀₀, -C(O)N(R₁₀₀R'₁₀₀) or -C(O)OR₁₀₀;

15 **R₂**, **R₅**, **R₆**, **R₇** and **R₈** independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen; or independently have the meaning as defined for R₁.

20

6. Use according to any of the preceding claims wherein

m and **p** are 0 and the ligand L of formula (2) is used as a catalyst for oxidation reactions;



25 7. Use according to any preceding claim wherein the metal complex compounds of formula (1) or the pure ligands of formula (2) are used as catalysts together with peroxide or a peroxide-forming substance, O₂ and/or air for the bleaching of stains or of soiling on textile material in the context of a washing process or by the direct application of a stain remover; for the cleaning of hard surfaces, especially kitchen surfaces, wall tiles or floor tiles; for the

30 use in automatic dishwashing compositions; for the bleaching of stains or of soiling on textile

material by atmospheric oxygen, whereby the bleaching is catalysed during and/or after the treatment of the textile in the washing liquor; for the prevention of redeposition of migrating dyes during the washing of textile material; for the use in washing and cleaning solutions having an antibacterial action; as pretreatment agents for bleaching textiles; as catalysts in selective oxidation reactions in the context of organic synthesis; for the waste water treatment; for bleaching in the context of paper-making; for sterilization; and for contact lens disinfection.

8. A process for the bleaching of stains or of soiling on textile materials in the context of a washing process or by the direct application of a stain remover and for the cleaning of hard surfaces comprising

bringing into contact a textile material or hard surface material in an aqueous medium, a complex compound of formula (1) or a ligand of formula (2) according to claim 1 and a peroxide or a peroxide-forming substance or O_2 and/or air.

9. A detergent, cleaning, disinfecting or bleaching composition comprising

I) from 0 to 50 wt-%, based on the total weight of the composition, A) of at least one anionic surfactant and/or B) of a non-ionic surfactant,

II) from 0 to 70 wt-%, based on the total weight of the composition, C) of at least one builder substance,

III) from 1 – 99 wt-%, based on the total weight of the composition, D) of at least one peroxide and/or one peroxide-forming substance, O_2 and/or air,

IV) E) at least one metal complex compound of formula (1) or a ligand of formula (2) as defined above in an amount that, in the liquor, gives a concentration of from 0.5 to 100 mg/litre of liquor, when from 0.5 to 50 g/litre of the detergent, cleaning, disinfecting or bleaching agent are added to the liquor,

V) from 0 – 20 wt-%, based on the total weight of the composition, of at least one further additive, and

VI) water ad 100 wt-%, based on the total weight of the composition.

10. A composition according to claim 9, which is used for a textile material or a hardsurface material.

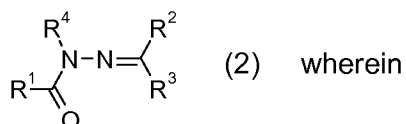
11. A granule comprising

- 76 -

- f) from 1 - 99 wt-%, based on the total weight of the granule, of at least one metal complex compound of formula (1) or a ligand of formula (2) as defined in claim 1 and of at least one peroxide,
- g) from 1 - 99 wt-%, based on the total weight of the granule, of at least one binder,
- 5 h) from 0 - 20 wt-%, based on the total weight of the granule, of at least one encapsulating material,
- i) from 0 - 20 wt-%, based on the total weight of the granule, of at least one further additive and
- j) from 0 - 20 wt-% based on the total weight of the granule, of water.

10

12. A compound of formula (2)

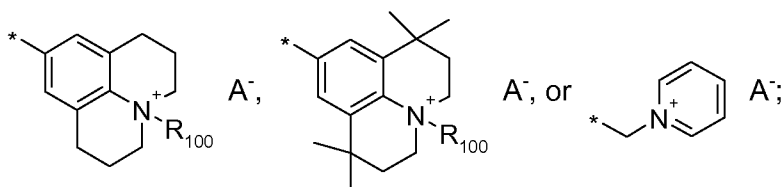


R_1 is $-(\text{CH}_2)_k-\text{N}^+(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3 \text{A}^-$, wherein A^- is an anion and k is a number from 1 to 4; or phenyl substituted with 1 to 5 electron withdrawing substituents $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$

15 wherein the

R_{100} , R'_{100} , R''_{100} independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; and A^- is an anion, or R_1 together with the electron withdrawing substituent is a group

20



* is the point of attachment;

R_4 denotes hydrogen, C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl;

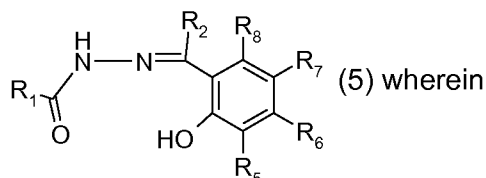
25 R_2 and R_3 independently of each other denote hydrogen, unsubstituted or substituted C_1 - C_{28} alkyl, C_2 - C_{28} alkenyl, C_2 - C_{22} alkinyl, C_3 - C_{12} cycloalkyl, C_3 - C_{12} cycloalkenyl, C_7 - C_9 aralkyl, C_3 - C_{20} heteroalkyl, C_3 - C_{12} cycloheteroalkyl, C_5 - C_{16} heteroaralkyl, unsubstituted or substituted phenyl or naphthyl, or unsubstituted or substituted heteroaryl; or

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R₂ and R₃, together with the alkylidene carbon atom linking them, form an unsubstituted or substituted ring 5-, 6-, 7-, 8- or 9-membered ring which may contain further hetero atoms.

13. A compound according to claim 12 which is of formula (5)

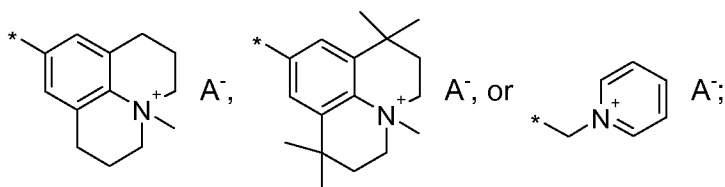
5



R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents $-N(R_{100}R'_{100}R''_{100})_3^+ A^-$ wherein the

R₁₀₀, R'₁₀₀, R''₁₀₀ independently are hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀, R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring which may contain a further nitrogen atom; and A⁻ is an anion, or

R₁ together with the electron withdrawing substituent is a group



* is the point of attachment;

R₂ denotes hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

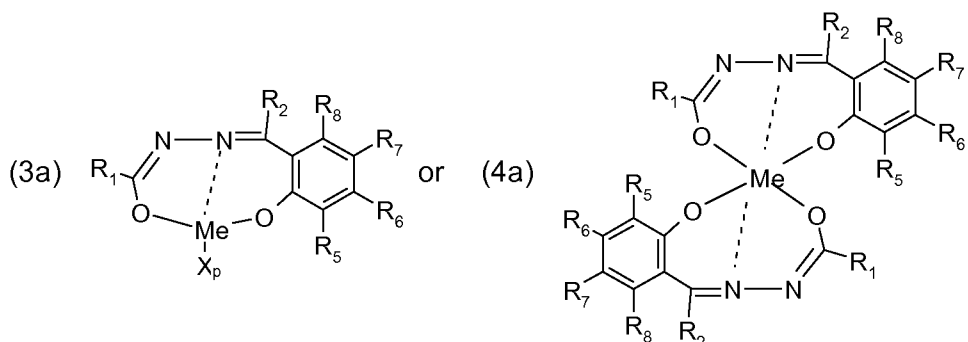
R₅, R₆, R₇ and R₈ independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen or a group ; or independently

have the meaning as defined for R₁;

or

R₅ and R₆, R₆ and R₇ or R₇ and R₈, are linked together to form 1, 2, 3 or 4 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more -O-, -S- or -NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

14. A complex compound of formula (3a) or (4a)



wherein

5 **Me** is manganese in oxidation states II-V or iron in oxidation states I to IV;

X is CH₃CN, H₂O, F⁻, Cl⁻, Br⁻, HOO⁻, O₂²⁻, O²⁻, R₂₈COO⁻, R₂₈O⁻;

R₂₈ is hydrogen, unsubstituted or substituted C₁-C₁₈alkyl or phenyl;

p is an integer from 1 to 4;

R₁ is -(CH₂)_k-N⁺(R₁₀₀R'₁₀₀R''₁₀₀)₃ A⁻, wherein A⁻ is an anion and k is a number from 1 to 4; or

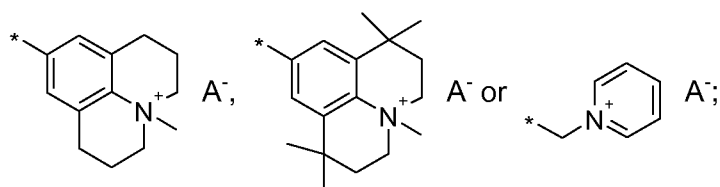
10 phenyl substituted with 1 to 5 electron withdrawing substituents -N(R₁₀₀R'₁₀₀R''₁₀₀)₃⁺ A⁻ wherein the

R₁₀₀, **R'₁₀₀**, **R''₁₀₀** independently are hydrogen, C₁-C₁₈alkyl or phenyl, or two of R₁₀₀, R'₁₀₀,

R''₁₀₀ together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring

which may contain a further nitrogen atom; and A⁻ is F⁻, Cl⁻, Br⁻ or I⁻, or

15 **R₁** together with the electron withdrawing substituent is a group



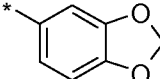
* is the point of attachment;

R₂ denotes hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl,

20 C₅-C₁₆heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

R₅, **R₆**, **R₇** and **R₈** independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted

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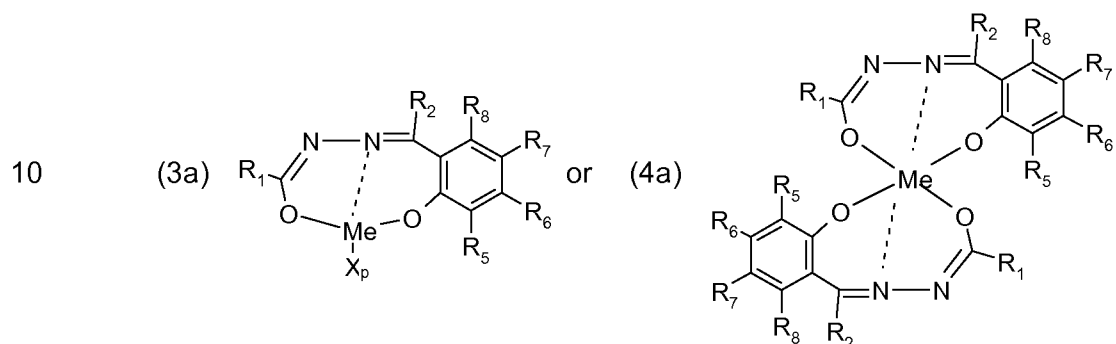
phenyl or naphthyl; $-\text{OR}_{100}$, $-\text{NR}_{100}\text{R}'_{100}$, halogen or a group ; or independently

have the meaning as defined for R_1 ;

or

R_5 and R_6 , R_6 and R_7 or R_7 and R_8 , are linked together to form 1, 2, 3 or 4 carbocyclic or
5 heterocyclic rings, which may be uninterrupted or interrupted by one or more $-\text{O}-$, $-\text{S}-$ or $-\text{NR}_9-$ and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C_1 - C_6 alkyl groups.

15. A complex compound of formula (3a) or (4a)



wherein

Me is manganese in oxidation states II-V or iron in oxidation states I to IV;

X is CH_3CN , H_2O , F^- , Cl^- , Br^- , HOO^- , O_2^{2-} , O^{2-} , $\text{R}_{28}\text{COO}^-$, R_{28}O^- ;

R₂₈ is hydrogen, unsubstituted or substituted C_1 - C_{18} alkyl or phenyl;

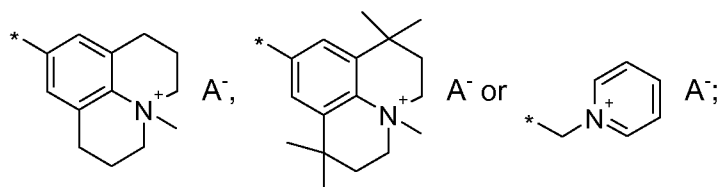
15 **p** is an integer from 1 to 4;

R₁ is phenyl substituted with 1 to 5 electron withdrawing substituents $-\text{N}(\text{R}_{100}\text{R}'_{100}\text{R}''_{100})_3^+ \text{A}^-$ wherein the

R₁₀₀, **R'₁₀₀**, **R''₁₀₀** independently are hydrogen, C_1 - C_{18} alkyl or phenyl, or two of R_{100} , R'_{100} , R''_{100} together with the nitrogen atom to which they are bonded form a 5 or 6 membered-ring

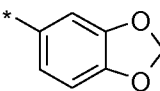
20 which may contain a further nitrogen atom; and **A⁻** is F^- , Cl^- , Br^- or I^- , or

R₁ together with the electron withdrawing substituent is a group



* is the point of attachment;

R₂ denotes hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted aryl, or unsubstituted or substituted heteroaryl;

- 5 **R₅, R₆, R₇ and R₈** independently from each other are hydrogen, unsubstituted or substituted C₁-C₂₈alkyl, C₂-C₂₈alkenyl, C₂-C₂₂alkinyl, C₃-C₁₂cycloalkyl, C₃-C₁₂cycloalkenyl, C₇-C₉aralkyl, C₃-C₂₀heteroalkyl, C₃-C₁₂cycloheteroalkyl, C₅-C₁₆heteroaralkyl, unsubstituted or substituted phenyl or naphthyl; -OR₁₀₀, -NR₁₀₀R'₁₀₀, halogen or a group ; or independently

have the meaning as defined for R₁;

- 10 or

R₅ and R₆, R₆ and R₇ or R₇ and R₈, are linked together to form 1, 2, 3 or 4 carbocyclic or heterocyclic rings, which may be uninterrupted or interrupted by one or more -O-, -S- or -NR₉- and/or which may be further fused with other aromatic rings and/or which may be substituted with one or more C₁-C₆alkyl groups.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/053722

A. CLASSIFICATION OF SUBJECT MATTER

INV. B01J31/18 B01J31/22 A61L12/12 C11D11/02 D06L3/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B01J A61L C11D D06L

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

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

EPO-Internal, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 196 39 603 A1 (HENKEL KGAA [DE]) 2 April 1998 (1998-04-02) cited in the application the whole document	1-5,7-15
X	GASPARINI, GIULIO ET AL: "Limitations of the "tethering" strategy for the detection of a weak noncovalent interaction" CHEMICAL COMMUNICATIONS (CAMBRIDGE, UNITED KINGDOM) (2007), (13), 1340-1342 CODEN: CHCOFS; ISSN: 1359-7345, 19 January 2007 (2007-01-19), XP002533529 compound 1A ----- -/--	12

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * & * document member of the same patent family

Date of the actual completion of the international search

24 June 2009

Date of mailing of the international search report

07/07/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Bork, Ana-Maria

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/053722

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEOVAC, V. M. ET AL: "Metal complexes with Girard reagents-based ligands: Part II. Copper(II) and zinc(II) complexes with pyridoxilene and salicylidene Girard-T hydrazone" JOURNAL OF THERMAL ANALYSIS AND CALORIMETRY (2006), 86(2), 379-384 CODEN: JTACF7; ISSN: 1388-6150, 2006, XP019436338 Fig.1, compound [H2SalGT]+ and Fig. 2	12,14
X	SHALLABY, A. M. ET AL: "Complexes of copper(II), cobalt(II), nickel(II), cadmium(II), and mercury(II) halides with hydrazones derived from Girard T and chromone" JOURNAL OF INORGANIC AND NUCLEAR CHEMISTRY (1979), 41(2), 267-9 CODEN: JINCAO; ISSN: 0022-1902, 1979, XP002533530 page 267, left-hand column; compound I	12
X	US 4 436 736 A (HODAKOWSKI LEONARD E [US] ET AL) 13 March 1984 (1984-03-13) Columns 17,18 - Table 1, first compound	12
X	US 2 670 348 A (GREGORY WALTER A ET AL) 23 February 1954 (1954-02-23) examples 1,3	12
A	MOHAN M ET AL: "SYNTHESIS, CHARACTERIZATION AND ANTITUMOR ACTIVITY OF SOME METAL COMPLEXES OF 3- AND 5-SUBSTITUTED SALICYLALDEHYDE O-HYDROXYBENZOYLHYDRAZONES" INORGANICA CHIMICA ACTA, X, XX, vol. 152, no. 1, 1 January 1988 (1988-01-01), pages 25-36, XP008038629 ISSN: 0020-1693 the whole document	1-15
A	POURALIMARDAN ET AL: "Hydrazone Schiff base-manganese(II) complexes: Synthesis, crystal structure and catalytic reactivity" INORGANICA CHIMICA ACTA, X, XX, vol. 360, no. 5, 8 March 2007 (2007-03-08), pages 1599-1608, XP005918398 ISSN: 0020-1693 cited in the application the whole document	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2009/053722

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 19639603	A1	02-04-1998	NONE	
US 4436736	A	13-03-1984	NONE	
US 2670348	A	23-02-1954	NONE	