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(54) Title: 6-AZO-5,5'-DIHYDROXY-7,7'-DISULFO-2,2'-DINAPHTHYLAMINE DERIVATIVES

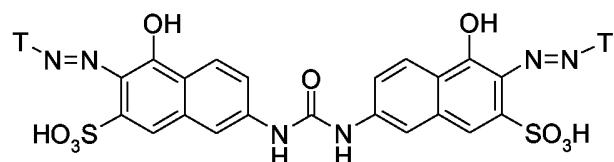
(57) Abstract: The present invention provides 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives, their use as dyes, dyed paper and formulations comprising them.

6-Azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives

The present invention refers to 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives, to their use as dyes, to dyed paper and to formulations comprising them.

5 Compounds having two 7-amino-3-azo-4-hydroxy-2-naphthalenesulfonic acid units are common dyes.

DE 196 15 260 A1, for example, describes dyes of the formula

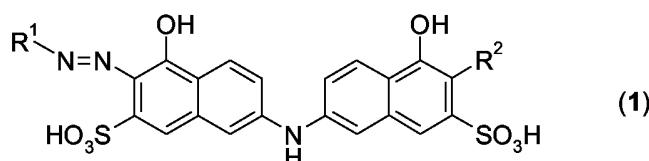


10 in which two 7-amino-3-azo-4-hydroxy-2-naphthalenesulfonic acid units are linked via a urea group.

It is an object of the present invention to provide novel dyes having two 7-amino-3-azo-4-hydroxy-2-naphthalenesulfonic acid units, which can be used for dyeing natural or 15 synthetic materials, especially paper, and which show excellent colour strength, brilliance and substantivity.

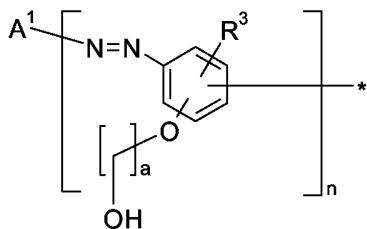
This object is solved by the 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives according to claims 1-3 by aqueous and solid formulations thereof according to claims 7 and 20 and by paper according to claim 6.

The 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives of the present invention have formula



25 in which
 R¹ represents

- 2 -



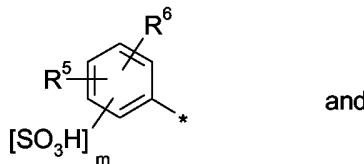
in which

a is 1-4

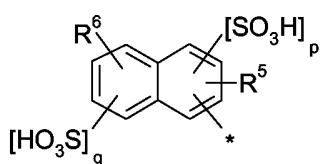
n is 0 or 1,

5 R^3 represents hydrogen, C_{1-4} -alkyl, C_{3-6} -cycloalkyl, aralkyl, phenyl, C_{1-4} -alkoxy, sulfo, hydroxy, nitro, halogen, C_{1-4} -alkylcarbonyl, carboxy, carbamoyl, C_{1-4} -alkoxycarbonyl, C_{1-4} -alkylaminocarbonyl, cyano, amino, ureido or $NHCOC_{1-4}$ -alkyl, whereby C_{1-4} -alkyl and C_{1-4} -alkoxy may be substituted with hydroxy or C_{1-4} -alkoxy, and phenyl may be substituted with C_{1-4} -alkyl, C_{1-4} -alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

10 A^1 if n is 1 is selected from the group consisting of



and

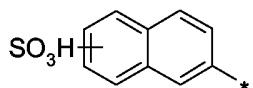


in which

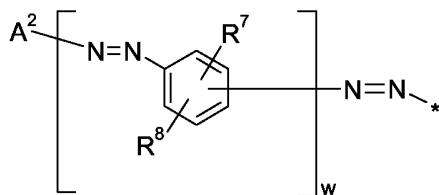
m, p and q are identical or different, and are 0, 1 or 2,

15 R^5 and R^6 are identical or different and represent hydrogen, C_{1-4} -alkyl, C_{3-6} -cycloalkyl, aralkyl, phenyl, C_{1-4} -alkoxy, sulfo, hydroxy, nitro, halogen, C_{1-4} -alkylcarbonyl, carboxy, carbamoyl, C_{1-4} -alkoxycarbonyl, C_{1-4} -alkylaminocarbonyl, cyano, amino, ureido or $NHCOC_{1-4}$ -alkyl, whereby C_{1-4} -alkyl and C_{1-4} -alkoxy may be substituted with hydroxy or C_{1-4} -alkoxy, and phenyl may be substituted with C_{1-4} -alkyl, C_{1-4} -alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

20

 A^1 if n is 0 is R^2 represents H or

- 3 -



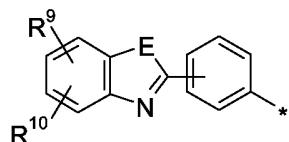
in which

w is 0 or 1,

R⁷ and R⁸ are identical or different and represent hydrogen, C₁₋₄-alkyl, C₃₋₆-cycloalkyl, aralkyl, phenyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen, C₁₋₄-alkylcarbonyl, carboxy, carbamoyl, C₁₋₄-alkoxycarbonyl, C₁₋₄-alkylaminocarbonyl, cyano, amino, ureido or NHCOC₁₋₄-alkyl, whereby C₁₋₄-alkyl and C₁₋₄-alkoxy may be substituted with hydroxy or C₁₋₄-alkoxy, and phenyl may be substituted with C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

10

A² represents either A¹, whereby A¹ has the meaning as indicated for the 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** of the present invention, or A² represents



15

in which
R⁹ and R¹⁰ are identical or different and represent hydrogen, C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro or carboxy,

E represents sulfur or NH.

20 C₁₋₄-Alkyl is methyl, ethyl, propyl, isopropyl, butyl, sec-butyl, *tert*-butyl or isobutyl. C₁₋₄-Alkoxy is methoxy, ethoxy, propoxy, isopropoxy, butoxy, sec-butoxy, *tert*-butoxy or isobutoxy. C₃₋₆-Cycloalkyl is cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl. Aralkyl can be benzyl or 2-phenylethyl. C₁₋₄-Alkoxy is methoxy, ethoxy, propoxy, isopropoxy, butoxy, sec-butoxy, *tert*-butoxy or isobutoxy. Halogen can be fluorine, bromine, chlorine or iodine.

25

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Preferences:

R^3 preferably represent hydrogen, C_{1-4} -alkyl, C_{1-4} -alkoxy, sulfo, hydroxy, nitro or carboxy, whereby C_{1-4} -alkyl and C_{1-4} -alkoxy may be substituted with hydroxy.

More preferably R^3 represents C_{1-4} -alkyl, e.g. methyl.

5

R^5 and R^6 are identical or different and represent hydrogen, C_{1-4} -alkyl, C_{1-4} -alkoxy, hydroxy, nitro or carboxy, whereby C_{1-4} -alkyl and C_{1-4} -alkoxy may be substituted with hydroxy.

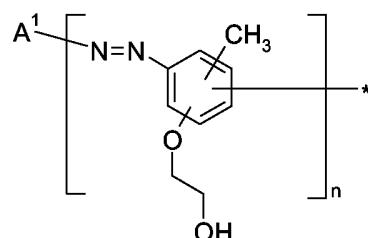
10 More preferably R^5 and R^6 are identical or different and represent hydrogen, C_{1-4} -alkyl, nitro or hydroxy.

R^7 and R^8 are identical or different and represent hydrogen, C_{1-4} -alkyl, C_{1-4} -alkoxy, hydroxy, nitro or carboxy, whereby C_{1-4} -alkyl and C_{1-4} -alkoxy may be substituted with hydroxy.

15 More preferably R^7 is C_{1-4} -alkyl, which may be substituted with hydroxy and R^8 is C_{1-4} -alkyl.

Even more preferred are 6-azo-7-amino-4-hydroxy-2-naphthalenesulfonic acid derivatives of formula 1 wherein

R^1 represents

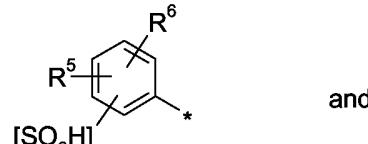


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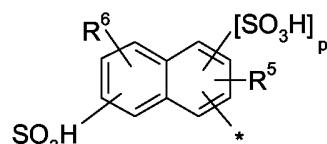
in which

n is 0 or 1,

A^1 if n is 1 is selected from the group consisting of



and



25 in which

m is 1 or 2,

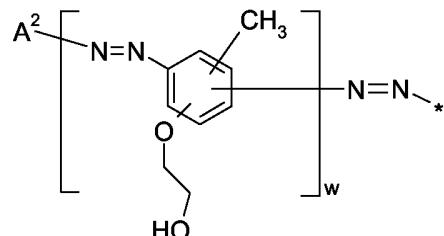
p is 0 or 1,

- 5 -

R^5 is hydrogen, methyl or nitro,

R^6 is hydrogen or hydroxy, and

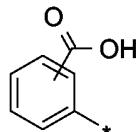
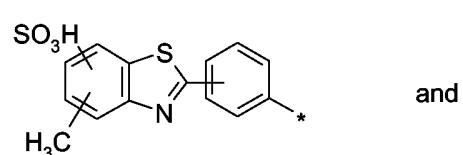
R^2 represents H or



5 in which

w is 0 or 1,

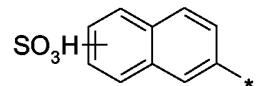
A^2 represents either A^1 as defined above or is selected from the group consisting of



10

Most preferred are 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives of formula 1 wherein

n is 0 and R^1 and R^2 are both



15

Also part of the invention, is the use of the 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives 1 of the present invention as a dye for dyeing natural or synthetic materials such as paper, cellulose, polyamide, leather or glass fibres. Preferably the 6-azo-

20 5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives 1 are used for dyeing paper.

Paper dyed with 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives 1 is also part of the invention.

The 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** can be applied to the materials, preferably to paper, in the form of aqueous or solid formulations.

The aqueous and solid formulations comprising 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-di-

5 naphthylamine derivatives **1** are also part of the invention.

The solid formulations comprising 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** can be powders or granulate materials, and may include auxiliaries. Examples of auxiliaries are solubilizers such as urea, extenders such as dextrin, Glauber salt or sodium 10 chloride, sequestrants such as tetrasodium phosphate, and also dispersants and dust-proofing agents.

The aqueous formulations comprising 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** may also include auxiliaries. Examples of auxiliaries used for aqueous

15 formulations are solubilizers such as ϵ -caprolactam or urea, and organic solvents such as glycols, polyethylene or polypropylene glycols, dimethyl sulphoxide, N-methylpyrrolidone, acetamide, alkanolamines or polyglycolamines. Further auxiliaries used in aqueous formulations are viscosity modifiers, antifoaming agents or dispersing agents.

20 Preferably, the aqueous formulations are aqueous solutions which comprise from 5 to 30% by weight 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** based on the weight of the solution. Preferably, these concentrated aqueous solutions also contain a low level of inorganic salts, which may be achieved by known methods, for example by reverse osmosis.

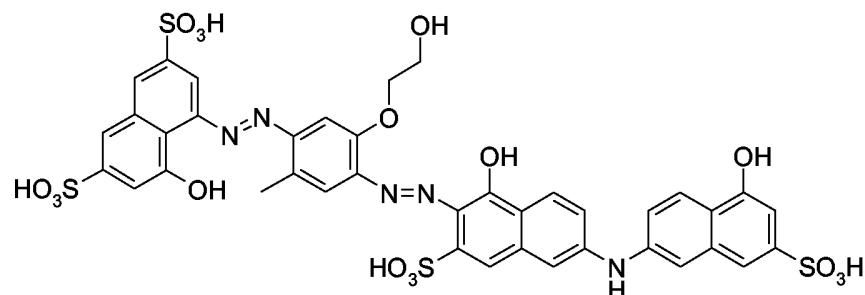
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The 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** are dyes, which show excellent colour strength, luminance and substantivity.

Due to the $-\text{O}-(\text{CH}_2)_a-\text{OH}$ group the compounds are less carcinogen.

Examples**Examples 1**

Preparation of



46% (w/v) sodium nitrite (75.8 mL) is added to a suspension of 49.7% (w/w) 4-[(4-amino-5-hydroxyethoxy-o-tolyl)azo]-5-hydroxynaphthalene-2,7-disulphonic acid (123 g) in desalinated water (600 mL) at room temperature. The obtained solution is cooled to 10 °C and added to a solution of concentrated HCl (195.5 mL) in desalinated water (200 mL) within 90 minutes.

10 The reaction mixture is stirred for further 60 minutes at room temperature. Excess nitrite is destroyed by addition of sulfamic acid.

The obtained solution is added to a suspension of 5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine (91.24% (w/w), 92 g) in desalinated water (300 mL) within 90 minutes at room temperature and at pH 9.0. The reaction mixture is stirred overnight at room temperature.

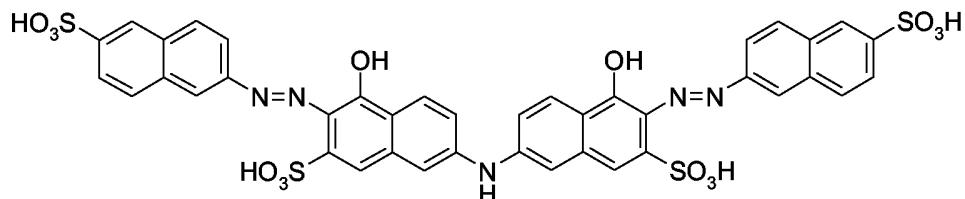
20 NaOH (50% (w/v), 167 mL) is added to the solution. The reaction mixture is warmed to 90 °C for 2 hours. Then, the reaction mixture is cooled to room temperature, and the pH is adjusted to 7.3. Isopropanol (600 mL) is added at room temperature. The obtained precipitate is filtered and dried in vacuo at 80 °C to yield 152g = 69%

The 4-[(4-amino-5-hydroxyethoxy-o-tolyl)azo]-5-hydroxynaphthalene-2,7-disulphonic acid is prepared analogous to Example 3.

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Example 2

Preparation of



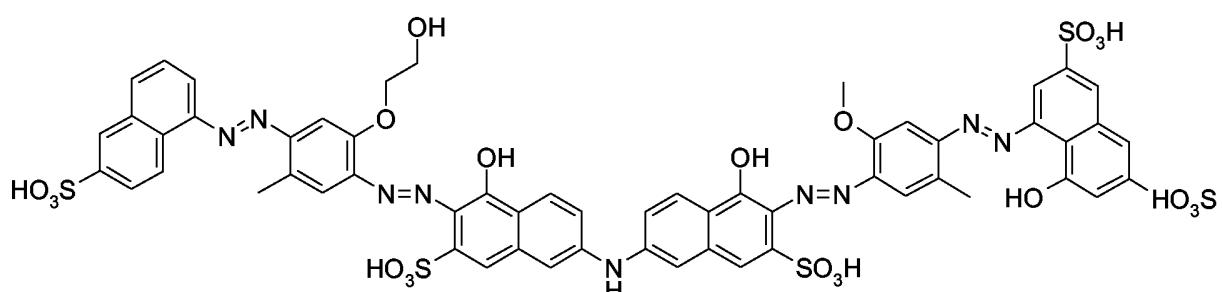
5 HCl conc (24.49 mL) is added to a suspension of 95% 6-amino-2-naphthalenesulfonic acid (23.5 g) in salinated water (140 mL). 46% (w/v) Sodium nitrite (15.16 mL) is added within 20 minutes at 10 °C. The mixtures is diluted with salinated water (50 mL) and stirred for further 30 minutes.

10 The obtained solution is added to a suspension of 91.24% (w/w) 5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine (25.29 g) in desalinated water (250 mL) within 90 minutes at 10 °C and at pH 8.2. The reaction mixture is warmed to room temperature. Isopropanol (500 mL) is added and the mixture is stirred for 15 minutes. The mixture is filtrated and the precipitate is dried to yield 37.88 g

15

Examples 3

Preparation of



(1i)

20

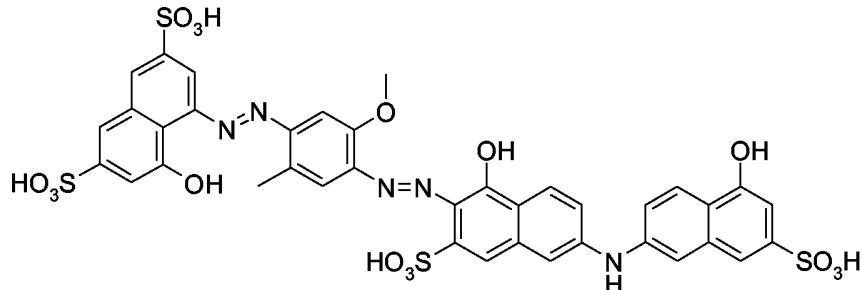
HCl conc (24.49 mL) is added to a suspension of 97.2% 1-amino-6-naphthalenesulfonic acid (11.41 g) in salinated water (60 mL) at room temperature. 46% (w/v) Sodium nitrite (7.58 mL) is added within 30 minutes at 10 °C. Excess nitrite is destroyed by addition of sulfamic acid, and the pH is adjusted to 2.1. To this solution was added within 10 minutes a solution of

25 2-(2'-hydroxyethoxy)-5-methylanilin (8,6 g) in desalinated water (50 mL) having a pH of 1.8.

The pH of the mixture is slowly raised to pH 5. The mixture is filtered and the filtrate is treated with 46% 7w/v) sodium nitrite (7.58 mL), and then added to a solution of HCl conc (24.49 mL) in desalinated water (50 mL). The mixture is stirred for 1 h and excess nitrite is destroyed by addition of sulfamic acid.

5

This solution is added within 50 minutes to a solution of the compound



in desalinated water (100 mL) at room temperature and pH 8. The mixture is stirred for 1 hour at room temperature. Isopropanol (500 mL) is added. The mixture is filtrered and the 10 precipitate is dried to yield 48.89 g

The above compound is prepared as follows:

46% (w/v) sodium nitrite (75.8 mL) is added to a suspension of 49.7% (w/w) 4-[(4-amino-5-methoxy-o-tolyl)azo]-5-hydroxynaphthalene-2,7-disulphonic acid (611.27 g) in desalinated 15 water (600 mL) at room temperature. The obtained solution is cooled to 10 °C and added to a solution of concentrated HCL (195.5 mL) in desalinated water (200 mL) within 90 minutes. The reaction mixture is stirred for further 60 minutes at room temperature. Excess nitrite is destroyed by addition of sulfamic acid.

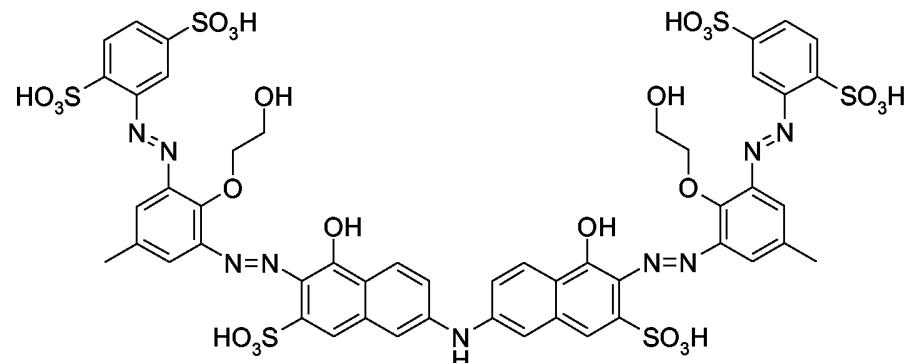
20 The obtained solution is added to a suspension of 5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthyl-amine (91.24% (w/w), 252.89 g) in desalinated water (300 mL) within 90 minutes at room temperature and at pH 9.0. The reaction mixture is stirred overnight at room temperature.

25 NaOH (50% (w/v), 167 mL) is added to the solution. The reaction mixture is warmed to 90 °C for 2 hours. Then, the reaction mixture is cooled to room temperature, and the pH is adjusted to 7.3. Isopropanol (600 mL) is added at room temperature. The obtained precipitate is filtered and dried in vacuo at 80 °C to yield 400.2 g

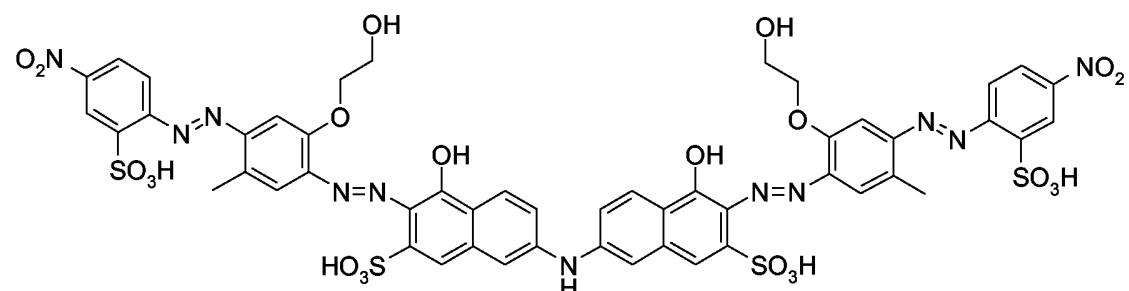
- 10 -

In an analogous manner can be prepared:

Ex.4

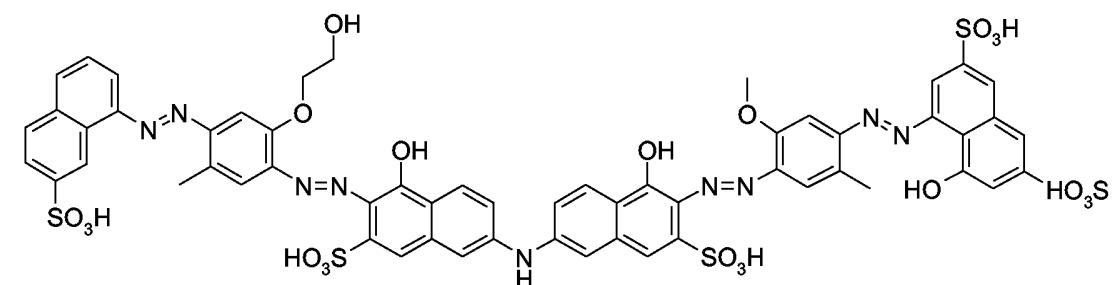


Ex.5

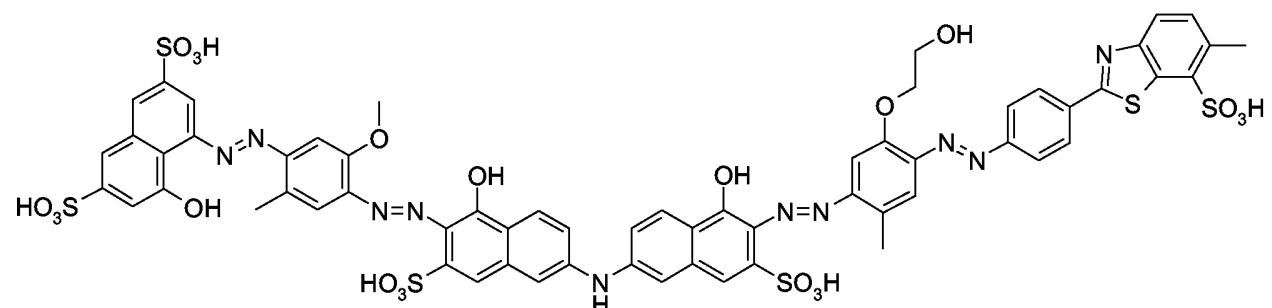


5

Ex.6



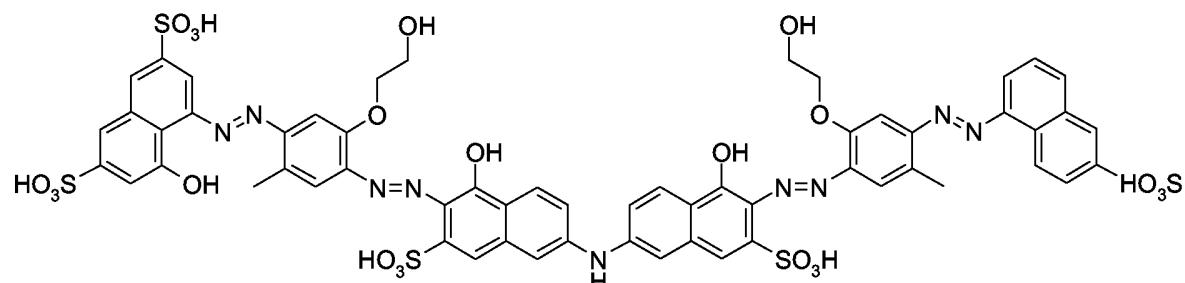
Ex. 7



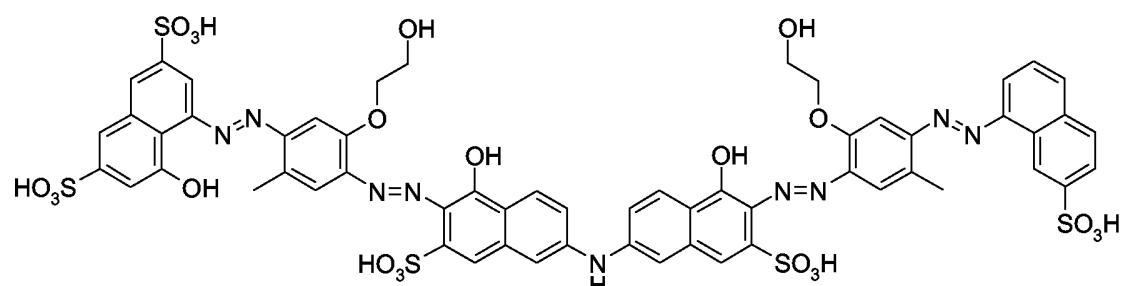
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- 11 -

Ex.8



Ex.9

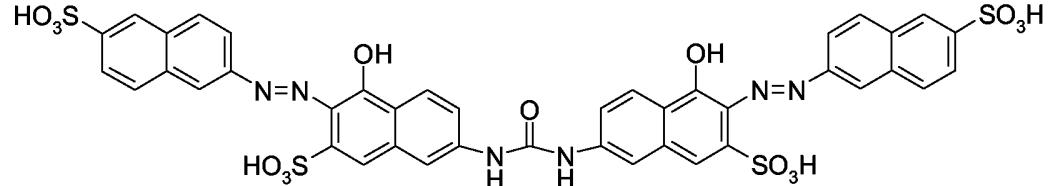


5

Application Examples:

Under standard application conditions the paper pulp is stirred with dye over a defined time period (i.e. 15min.). If necessary a fixing agent, i.e. Tinofix WSP, will be added. With this 10 pulp a hand sheet will be formed by a sheet former and then dried. The dosage of the dyestuff will be adjusted to a defined color depth, i.e. (reference depth) RD 0.2.

In case of the comparable urea bridge dye



15 0.3% of dried material was used. The di-J-acid compound needs only 0.24% to achieve the depth.

The degree of exhaustion was determined after an internal method.

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The light fastness is evaluated in a light fastness machine according to ISO 105 B02, assessed against blue scale.

The color strength was determined with Helios CFU at reverence depth (RD) 0.2.

5 The CIELab coordinates and degrees of exhaustion of the dyes are measured.

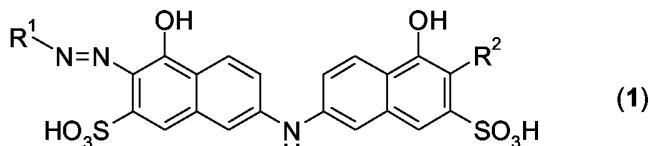
Table 1 shows the results

Example	Exhaustion %	Light fastness	C value (brilliancy)	Hue
2	96	1	41.7	342
3	92	2-3	22.6	262
4	91	1+	27	273
5	93	-2	28.8	282
6	94	-4	23.2	259
7	87	-3	19.1	271
8	96	2-3	24.6	278
9	96	-3	25.1	272

The table shows that best brilliance results are obtained using Example 2.

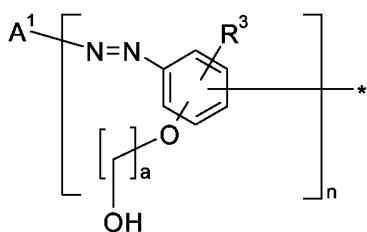
Claims

1. 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives of formula



in which

5 \mathbf{R}^1 represents



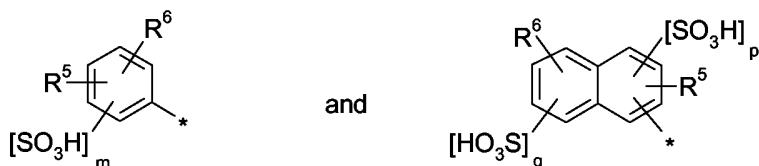
in which

a is 1-4

n is 0 or 1,

10 \mathbf{R}^3 represents hydrogen, C₁₋₄-alkyl, C₃₋₆-cycloalkyl, aralkyl, phenyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen, C₁₋₄-alkylcarbonyl, carboxy, carbamoyl, C₁₋₄-alkoxycarbonyl, C₁₋₄-alkylaminocarbonyl, cyano, amino, ureido or NHCOC₁₋₄-alkyl, whereby C₁₋₄-alkyl and C₁₋₄-alkoxy may be substituted with hydroxy or C₁₋₄-alkoxy, and phenyl may be substituted with C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

15 \mathbf{A}^1 if n is 1 is selected from the group consisting of

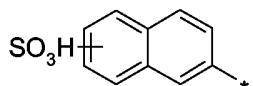
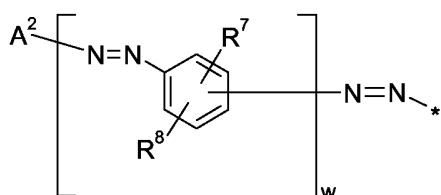


in which

m, p and q are identical or different, and are 0, 1 or 2,

20 \mathbf{R}^5 and \mathbf{R}^6 are identical or different and represent hydrogen, C₁₋₄-alkyl, C₃₋₆-cycloalkyl, aralkyl, phenyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen, C₁₋₄-alkylcarbonyl, carboxy, carbamoyl, C₁₋₄-alkoxycarbonyl, C₁₋₄-alkylaminocarbonyl, cyano, amino, ureido or NHCOC₁₋₄-alkyl, whereby C₁₋₄-alkyl and C₁₋₄-alkoxy may be substituted with hydroxy or C₁₋₄-alkoxy, and phenyl may be substituted with C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

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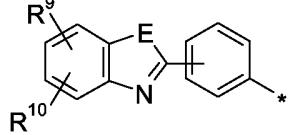
A¹ if n is 0 is**R²** represents H or

5 in which

w is 0 or 1,

R⁷ and R⁸ are identical or different and represent hydrogen, C₁₋₄-alkyl, C₃₋₆-cycloalkyl, aralkyl, phenyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen, C₁₋₄-alkylcarbonyl, carboxy, carbamoyl, C₁₋₄-alkoxycarbonyl, C₁₋₄-alkylaminocarbonyl, cyano, amino, ureido or NHCOC₁₋₄-alkyl, whereby C₁₋₄-alkyl and C₁₋₄-alkoxy may be substituted with hydroxy or C₁₋₄-alkoxy, and phenyl may be substituted with C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro, halogen or carboxy, and

A² represents either A¹, whereby A¹ has the meaning as indicated for the 6-azo-5,5'-di-hydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives **1** of the present invention, or A² represents



in which

R⁹ and R¹⁰ are identical or different and represent hydrogen, C₁₋₄-alkyl, C₁₋₄-alkoxy, sulfo, hydroxy, nitro or carboxy,

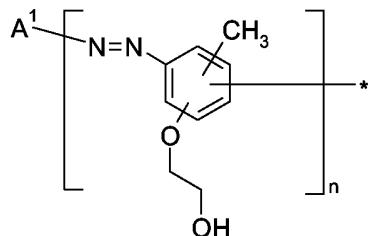
20 **E** represents sulfur or NH.

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2. 6- azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives formula **1** according to claim 1 wherein

R¹ represents



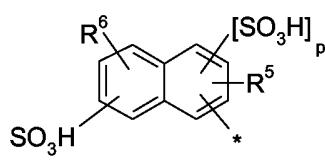
5 in which

n is 0 or 1,

A¹ if **n** is 1 is selected from the group consisting of



and



in which

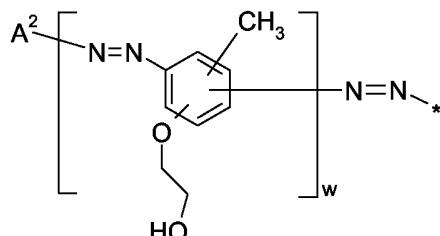
10 **m** is 1 or 2,

p is 0 or 1,

R⁵ is hydrogen, methyl or nitro,

R⁶ is hydrogen or hydroxy, and

R² represents H or

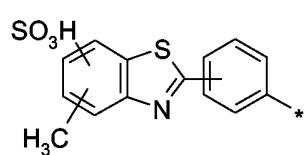


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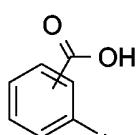
in which

w is 0 or 1,

A² represents either **A**¹, whereby **A**¹ is as defined above in claim 2, or is selected from the group consisting of



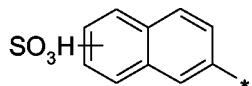
and



20

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3. 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives of formula 1 according to claim 1 wherein **n** is **0** and R¹ and R² are both



5

4. Use of the 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives according to claim 1 for dyeing natural or synthetic materials.

10 5. Use of the 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives according to claim 1 for dyeing paper.

6. Paper dyed with a 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivatives according to claim 1.

15 7. An aqueous formulation comprising a 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivative according to claim 1.

8. A solid formulation comprising a 6-azo-5,5'-dihydroxy-7,7'-disulfo-2,2'-dinaphthylamine derivative according to claim 1.

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