

Importance of sequestering agent in textile processing

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Background of sequestering agent

The present invention relates to a novel composition of matter having utility in the sequestering or complexing of metal ions particularly calcium and / or magnesium ions. More particularly, the present invention is unique combination of water – soluble aminopolycarboxylate demonstrating improved chelating properties. Sequestering agent are employed in a number of applications such as builders in detergent formation to eliminate interfering effects caused by dissolved metal salts, particularly calcium or magnesium salts. Sequestering agents are also employed in other applications requiring control of metal ion content in aqueous solution such as waste water treatment, potable water conditions, micro-nutrient solubilization, gas conditioning, photographic development processing catalysis of chemical processes, finishing and conditioning of textile, etc.

Invention

The present invention is an improved sequestering agent comprising of a mixture of from about 2% to 20% by weight of iminodiacetic acid or water soluble salt thereof (IDA) and from about 80% to 98% by weight of nitrilotriacetic acid or water soluble salt thereof (NTA). Iminodiacetic acid, $\text{HN}(\text{CH}_2\text{CO}_2\text{H})_2$, often abbreviated to IDA, is an polyamino carboxylic acid.

It is discovered that the sequestering agent corresponding to the above defined range of composition provides improved sequestration or chelation, particularly of calcium and magnesium ions in aqueous solution, over the performance of each component of the composition individually, thereby resulting in a synergistic addition of chelating properties. Equally surprising is the fact that addition to a composition of large amounts of IDA than called for by the present invention deleteriously affects the performance of the sequestering agent.

A preferred application of the present sequestering agent is as a detergent builder in combination with additional components such as surfactants, thereby providing an improved detergent, particularly suited for use in water containing dissolved calcium and/ or magnesium ions.⁽¹⁾ Chelating and sequestering agents have had considerable applications for many years. These materials usually form complexes or coordination compounds by reaction of their negatively charged donor groups with polyvalent metal ions such as iron, calcium, copper and magnesium. There are several classes of chelating agents including the EDTA (ethylenediamine tetra acetic acid) type and the aldonic (sugar) acid group. An aldonic acid is any of a family of sugar acids obtained by oxidation of the aldehyde functional group of an aldose to form a carboxylic acid functional group. Gluconic and citric acid are examples of the latter. The choice of chelating agent depends to a great extent upon the conditions under which it is applied for example, the EDTA family is effective in acid, neutral, or alkaline media whereas the sugar acids function best with which this note concerned⁽²⁾.

One of the most important sugar based chelating agent is sodium gluconate, which has found an extensive use as a chelating agent in the dairy, detergent, brewing, leather and textile industries. Medicinally it is used as a carrier for calcium and iron in treatment of deficiencies of these elements. Gluconates are prepared commercially by enzymatic transformation of D – glucose with glucose oxidase (EC 1.1.3.4 - D – glucose: oxygen oxidoreductase) or by catalytic air oxidation of glucose.

Higher members of the series such as sodium glucohaptonate can be prepared by addition of sodium cyanide to glucose followed by hydrolysis. Lactobionic acid and its amides were less effective as chelater for iron then were corresponding gluconic acid compounds.

The EDTA and Lactosyl urea were ineffective under this condition. The presence of an additional carboxyl groups, as in saccharic acid or sodium mucate, afforded no benefits over gluconic acid in the amount of ferric chloride complexes. Amides formed by reaction of glucono or Lactobiono – Lactone with 2 – methyl – 2 aminopropanol were slightly superior in chelating power to their parent acids⁽³⁻⁴⁾.

Main classes of sequestrant

The five main classes of sequestrant used in the textile industry are:

- ❖ Polyphosphonic acid.
- ❖ Amino polycarboxylic acid.
- ❖ Polyphosphates.
- ❖ Hydro carboxylic acid.
- ❖ Polymeric carboxylic acid.

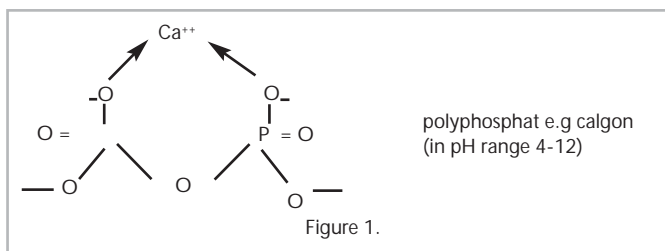
While comparing a cross range of commercially available sequestrants it is possible to see the following features:

- ❖ Different sequestering power. (i.e, the strength of the sequester - metal complex)
- ❖ Different specific sequestering power for individual metal.
- ❖ Sequestering power not only depends on the specific sequestrant / metal pairing, but also on pH and temperature.
- ❖ Different sequestering capacities.
- ❖ Sequestering capacities which are metal ion specific.
- ❖ Difference in the spread of pH over which a particular sequestrant will combine with a particular metal ion.
- ❖ That not all sequestrants are stable to high temperatures.
- ❖ That not all sequestrants are stable to oxidation or hydrolysis.
- ❖ That some sequestrants will de-metallise/pre-metallise dyes.
- ❖ That some sequestrants can affect the shade reproducibility of some dyestuffs (the effects can be very dye-sequestrant specific).
- ❖ That some sequestrant does not satisfy the environmental and toxicological requirements of every market.

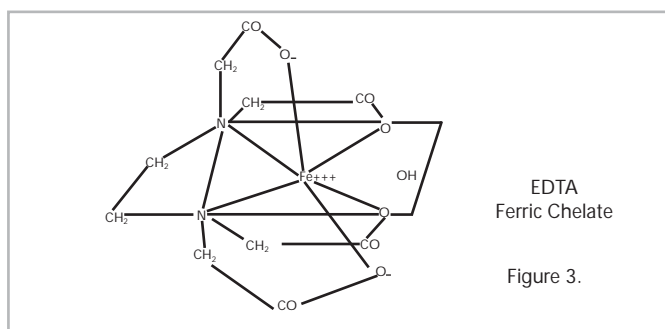
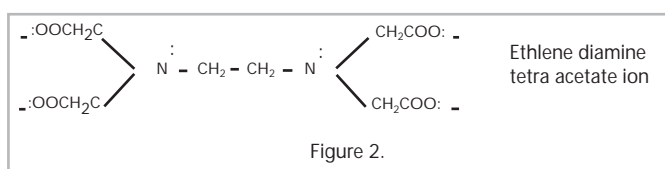
If calcium and magnesium are not sequestered

- ❖ If calcium and magnesium are not sequestered, there is the strong possibility of their combining with natural “soaps” which have been generated during the alkaline scouring process, to form waxy substance. These have been referred to as “Lime soap deposits” they can deposit not only on the substrate it self but also on the surface of machinery.
- ❖ Calcium and magnesium ions reduce the solubility of anionic dyes causing them to aggregate or even precipitate on the fiber.
- ❖ Aggregated and precipitated dyes cannot migrate or diffuse they remain on the fiber surface as particular deposits.

A chemical compound which possesses two (or more) chemical groups, which can surround a metal ion, resulting into a complex is called chelate. These chelates are more stable than the simple salts formed with acid (i.e acetic or formic acid) such simple salts formed with acids are usually highly soluble and useful way of demineralising cotton before dyeing.



Features of Polyphosphonate sequestrants:	
Feature	Comments
Very high sequestering capacity for Ca and Mg from pH 5 – 13; And for Cu / Fe from pH 1 – 13.	The resultant sequestrant – metal complexes are generally highly soluble, and not easily precipitated (even in the presence of Rock salts and Sea salts which are known to contain very high levels of alkaline earth metal impurities). By contrast, aminopolycarboxylic acids are more easily precipitated; and have higher limits of effectiveness over a narrower pH range.
Improve dyestuff solubility, by deflocculating and disaggregating effects.	Avoid dye spotting problem.
Polyphosphonic acids (rather like aminopolycarboxylic acid) do not readily biodegrade in a laboratory activated sludge test.	However, in more realistic die – away river tests, these substances are rapidly degraded in the presence of sunlight and ferric ions. These are also degraded in the soil. They do not bio-accumulate on aquatic species and are readily eliminated by fish.
Polyphosphonates can be eliminated from water by classical treatment with aluminum sulphate or lye treatment. Due to their low concentration and strong adsorption on sewage sludge and on sediments, mobilization of heavy metals into the aquatic environment is low.	



However, they are not always resistant to precipitating condition and also often easily stripped of the metal ion by a dyestuff molecule, obviously, this is the opposite of the effect required⁽⁵⁾ One of the main class of sequestrant is polyphosphate.

Another most commonly used sequestrant of textile industry is EDTA, which is considered as most stable complex, because the metal atom is enclosed in a 5 or 6 member ring. (see the Figure)

Features of EDTA	
Features	Comments
One of the oldest known, and most widely used "textile sequestrant "	EDTA is cheap and forms strong complexes with a broad spectrum of metal ions. Weight for weight comparison shows significantly inferior sequestering capacity to that of polyphosphonic acid.
Good sequestering agent for Ca / Mg at high pH values(but only in the absence of oxidizing agents). But for the ferric ion (Fe+++). The sequestering action is excellent at low pH values but begins to decrease at pH 6. At higher pH values, EDTA becomes completely ineffective at controlling Fe+++	Never likely to provide protection for localized "pinhole damage" in peroxide bleaching. The failure of EDTA to sequester iron above pH 8 renders it useless as a peroxide bath sequestrant / stabilizer – unless it is used in combination with a second sequestrant which can bind iron in the pH range 11 – 13.
EDTA can demetalise many metal containing dyes, usually resulting in a drastic shade change.	EDTA is not suitable as a dye-bath sequestrant. Beware of red, Bordeaux and burgundy shades turning a very dull blue (almost purple)
EDTA is hardly soluble in acidic pH, and is often used, therefore, in the form of a sodium or ammonium salt.	

Advantages of sequestering agent

- ❖ Prevention of pinhole formation due to catalytic oxidation caused by iron during bleaching (chelates iron / heavy metals).
- ❖ During dyeing, it prevents spots, shade change and unevenness by chelating heavy metals and dispersing impurities.
- ❖ Improved rinsing due to the scale inhibition (effective at low concentration such as its presence in rinse bath).
- ❖ During fabric preparation sequester also provides iron chelating to prevents fabric / yarn damage and provides additional stabilizing effect on the hydrogen peroxide.

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