Partnership for Sustainable Textiles

Complexing agents: EDTA und DPTA

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Content

1. Identification and classification

Ethylenediaminetetraacetic acid (CAS no. 60-00-4) or EDTA and diethylenetriaminepentaacetic acid (CAS no. 67-43-6) or DTPA are aminopolycarboxylic acids consisting of carboxyl groups and one or more nitrogen-containing groups. DTPA is a white, water-soluble solid, while EDTA is a colourless solid that dissolves easily in ethanol.

It is estimated that in 2008 40 tonnes of EDTA were used in Germany across the various application areas (Groß 2012). No accurate consumption figures are available for DTPA.

Both EDTA and DPTA are strong chelating complexing agents – that is, they are able to form complexes with cations and bind them. They are therefore widely used in metal insolubilisation – for example, as cleaning agents but also as fertilisers or preservatives, as well as having many other uses.

2. Existing regulations

In 1991 Germany's Federal Environment Ministry, Federal Ministry of Research and Federal Ministry of Health, together with industry, issued a declaration on the reduction of water pollution by EDTA.

The EU Ecolabel for textiles prohibits the use of EDTA and DTPA; the Ecolabel also bans the use of EDTA in cosmetics. In 2016 there was a motion for a European Parliament resolution restricting the use of EDTA in skincare products for babies.

3. Use in wet textile production processes

EDTA and DTPA also have many uses in the textile industry, although these uses are strongly linked to specific processes and substances (Schmidt and Brauch 2003).

In the past EDTA was used as a detergent and softener in washing agents, but this is no longer recommended (Schönberger and Schäfer 2003).

In the past it was also used for desizing: for this purpose it has now been replaced by polyacrylates and phosphonates (Schönberger and Schäfer 2003).

An important use of EDTA is in stabilising bleach baths ('bleach stabiliser' in concentrations of <1%; Hauthal 2007) in order to prevent decomposition of the H2O2 bleaching agent by metal ions.

EDTA can also be used as an auxiliary with complexing properties in dyeing and printing (Friedlipartner 2005).

Complexing agents are used in the alkaline boiling of cellulose fibres to remove calcium ions. It is usual to use several complexing agents, including EDTA and DTPA (Schönberger and Schäfer 2003).

4. Hazard potential

Acute and chronic human toxicity

EDTA has low human toxicity potential. According to the European CLP Regulation, EDTA causes serious eye irritation (H319) and is harmful if swallowed (H302) or inhaled (H332).

DTPA, on the other hand, is suspected of damaging fertility or the unborn child (H361). According to the CLP Regulation, it also causes serious eye irritation (H319) and is harmful if swallowed (H302) or inhaled (*H332).*

Environmental toxicity

According to environmental toxicity tests at three trophic levels (fish, daphnia and algae), EDTA has low aquatic toxicity with a predicted no-effect concentration (PNEC) for freshwater organisms of 2.2 mg/l (REACh 2016a). The PNEC in soil is 0.72 mg/kg (dry weight) and thus significantly lower (REACh 2016a).

For DTPA the PNEC is 6.4 mg/l for surface water; no data is available for soil (REACh 2016b).
When calculating environmental toxicity values, it should be borne in mind that secondary effects may occur – for example, if the complexing agents withdraw essential metals from the medium or cause heavy metals to be released from the sediment (BAuA 2004).

5. Environmental behaviour

EDTA and DTPA enter the aquatic environment mainly via wastewater (BAuA 2004). This is principally because EDTA and its metal complexes are not biodegradable according to OECD criteria and they therefore pass through wastewater treatment either partially or completely. However, an elimination rate of up to 90% has been achieved by increasing the pH value and retention time and having a high sludge age (BAuA 2004).

EDTA is therefore classed as 'enhanced biodegradable' rather than persistent (P) (REACh 2016a). DPTA, like EDTA, is not biodegradable and is therefore classed as persistent (P) (REACh 2016a). In the environment both EDTA and DPTA undergo photodegradation (EU REACh).

Both substances, EDTA and DPTA, have little or no bioaccumulative effect (B).

It should be noted that at a neutral pH EDTA does not bind to the mineral surface of the soil or sediment and it can therefore seep into groundwater (BAuA 2004). Another environmental aspect is that EDTA can dissolve heavy metal salts in the sediment that are then released on the surface and thus become bioavailable (BAuA 2004).

6. Possible substitutes

According to the Oeko-Institut, there are many possible substitutes for EDTA (Groß 2012).
Alongside complexing agents based on aminopolycarboxylic acids, there are also complexing agents based on phosphonates and polyphosphonates (Schönberger and Schäfer 2003). The most common substitutes are other aminopolycarboxylic acids (methylglycinediacetic acid (MGDA), glutamic diacetic acid (GLDA)), nitrilotriacetic acid (NTA), polyphosphonates, phosphonates, polycarboxylates, hydroxycarboxylic acids and sugar copolymers.

When choosing a substitute, it is important to consider its effectiveness: EDTA and DTPA have greater complexing power than their substitutes (Schönberger and Schäfer 2003). Table 1 provides a concise comparison of the various substitutes.

Environmental properties	**EDTA, DTPA**	**NTA**	**Polyphosphates**	**Phosphonates**	**Poly-carboxylates**	**Hydroxy-carboxylic acids**	**Sugar copolymers**
Biodegradable	no	yes	anorganic	no	no	yes	yes
Bioelimination	no	-	-	yes [Nowack, 1997]	yes	-	-
N content	yes	yes	no	no	no	no	no
P content	no	no	yes	yes	no	no	no
Remobilisation of heavy metals	yes	possible	no	no	no	no	no

Table 1: Qualitative environmental evaluation of various complexing agents according to Bachus, 1999, from Schönberger and Schäfer 2003.

It is also important to consider the environmental parameters shown in Table 2, such as degradability, remobilisation potential and eutrophication as a result of inputs of nitrogen or phosphorus (Schönberger and Schäfer 2003).

Properties	**EDTA, DTPA**	**NTA**	**Polyphosphates**	**Phosphonates**	**Poly-carboxylates**	**Hydroxy-carboxylic acids**	**Sugar copolymers**
Softening	+	+	+	++	+	0	+
Dispersing	-	-	0	0	+	-	_

Stabilising peroxides	+	-	-	++	0	-	+ (special products)
Demineralising	++	+	0	++	0	0	0

Table 2: Efficiency of complexing agents (the efficiency increases in the sequence -, 0, +, ++) according to Bachus, 1999, from Schönberger and Schäfer 2003

7. Summary

EDTA and DTPA are complexing agents that have a wide range of uses in the textile industry. In the past both substances were used mainly as detergents and softeners in washing agents; now they more often function as stabilisers in bleach baths.

Both are toxic to humans if swallowed or inhaled. In addition, DTPA is suspected of damaging fertility or the unborn child.

Environmental hazards arise mainly from the persistence of the two substances. Elimination can be increased through adherence to certain parameters in sewage treatment plants, but the wide fluctuations in textile wastewater make this impractical. There are also hard-to-quantify risks as a result of potential secondary effects in aquatic media.

There are a number of possible alternatives, such of which have been trialled. In some specific applications, however, substitution has not yet been conclusively successful. The differences between high-volume, outdated areas of application (e.g. as water softeners) and specific applications should therefore be taken into account.

8. References

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Authors:
Dr. Harald Schönberger
Katharina Graf