Technical Information

November 2016

WF-No. 9890

Trilon® M Granules SG

® = Registered trademark of BASF in many countries.

Organic chelating agent for controlling the metal ion concentration in aqueous systems.

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We create chemistry

Introduction

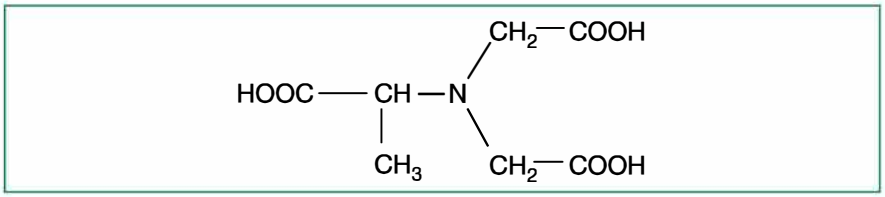
In addition to the strong, sustainable and readily biodegradable chelating agents of the Trilon® M product line (MGDA, methylglycinediacetic acid), BASF offers an assortment of traditional products such as the Trilon® A brands (NTA, nitrilotriacetic acid), Trilon® B brands (EDTA, ethylenediaminetetraacetic acid), Trilon® C brands (DTPA, diethylenetriaminepentaacetic acid), and Trilon® D Liquid (HEDTA, hydroxy ethyl ethylenediaminetriacetic acid).

Due to their higher performance, Trilon® M brands offer the customer better value than weak chelating agents such as citrates, for example. The excellent ecological and toxicological profile of the active ingredient of Trilon® M Granules SG (MGDA, methylglycinediacetic acid) has been verified in studies. BASF thus recommends Trilon® M Granules SG as a substitute for other, less ecologically compatible chelating agents. Phosphonates, for example, contribute to the eutrophication of aquatic environments. Our team of application experts will be happy to help customize formulations.

Chemical nature

Trilon® M Granules SG is a Trisodium salt of methyl glycinediacetic acid (MGDA-Na_3). Methylglycinediacetic acid is also referred to as alpha-alanine diacetic acid.

Methylglycinediacetic acid, $C_7H_{11}NO_6$, is an aminocarboxylic acid containing four functional groups.



PRD-No.*

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* BASF commercial product numbers.

Appearance

Trilon® M Granules SG is a slightly yellow granulate.

Handling and Storage

Handling

a) Trilon® M Granules SG should be stored in a dry place at temperatures below approx. 50 °C.

b) The product must be stored moisture-free since it is hygroscopic. Opened containers should be resealed tightly after each removal of product to prevent absorption of moisture.

c) Please refer to the latest Safety Data Sheet for detailed information on product safety.

Storage material

Containers made of the following materials are appropriate for the storage of Trilon® M Granules SG:

a) Stainless steel 1.4541 – AISI 321 stainless steel (X6 CrNiTi 1810)
b) Stainless steel 1.4571 – AISI 316 Ti stainless steel (X6 CrNiMoTi 17122)
c) Stainless steel 1.4306 – AISI 321 L stainless steel (X2 CrNi 1911)
d) Polyethylene (HDPE/LDPE)

Storage stability

Trilon® M Granules SG may be stored for at least 36 months in its original packaging if stored properly.

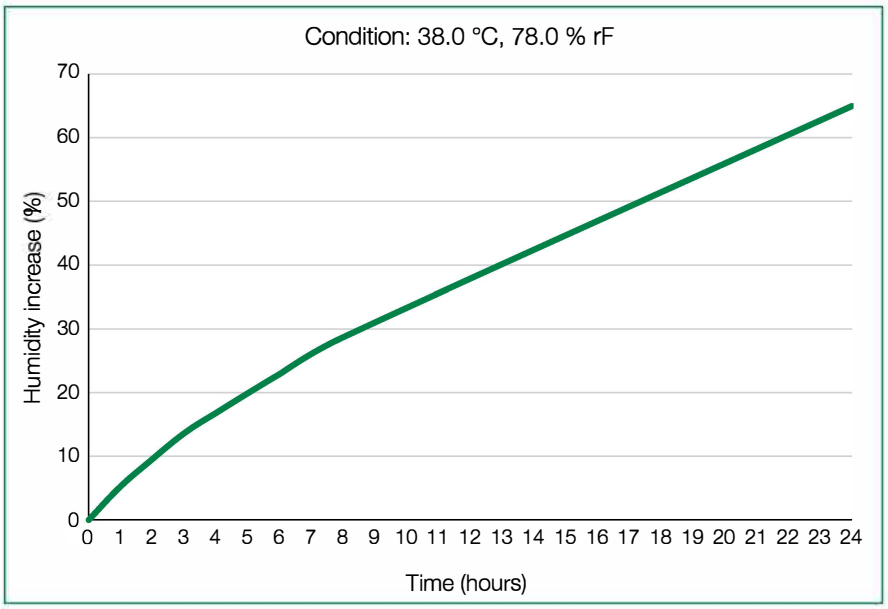
Properties

Some physical properties are listed in the table below. These are typical values only and not all of them are monitored on a regular basis. They are correct at the time of publication and do not necessarily form part of the product specification. A detailed product specification is available on request or via BASF's WorldAccount: https://worldaccount.basf.com (registered access).

Trilon® M Granules SG	Unit	Value
Supply form (25 °C)		solid
Molecular Weight (M.W.)	g/mol	271
Concentration (pot. titration with $FeCl_3$ solution)		
calculated as trisodium salt (MGDA Na_3)	%	approx. 76
calculated as free acid (MGDA H_3)	%	approx. 58
pH value (DIN 19268, 23 °C, 1% in water)		approx. 11.5
Bulk density (DIN ISO 697, dia. 40 mm)	g/l	approx. 775
Calcium binding capacity (BASF method, pH 11)	mg $CaCO_3$/g t.q.	approx. 310
Water content (DIN EN 13267)	%	approx. 13
Melting point (DIN EN ISO 3146)	°C	> 300 (decomposition)
Solubility in water (BASF method, 25 °C)	g in 1 litre	approx. 950

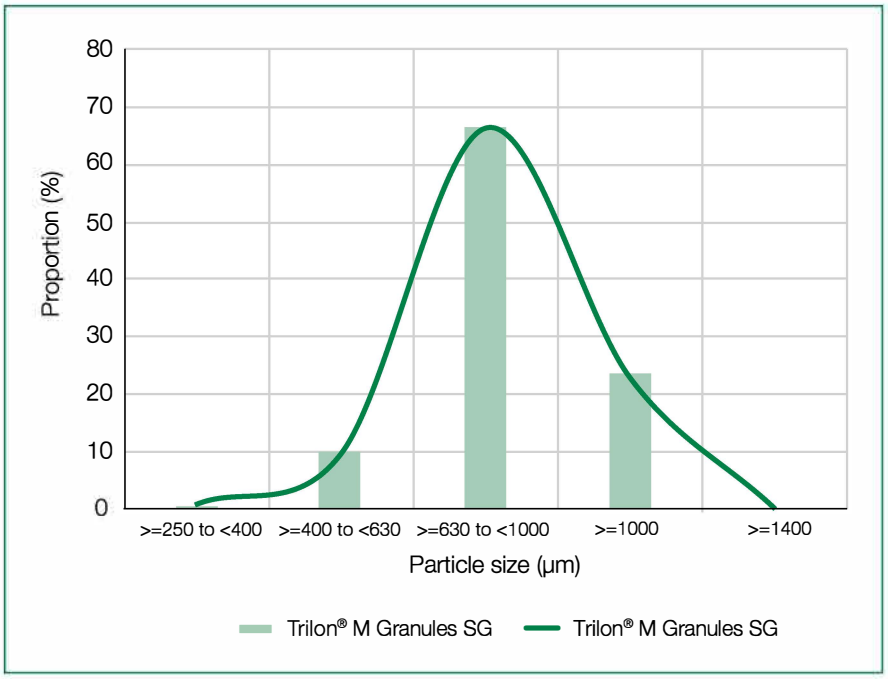
Hygroscopicity

For storage and processing of Trilon® M Granules SG it is important to know how the product behaves at elevated temperatures and humidity. The following graph shows this dependency (the specifications represent approximate values):



Particle distribution

The following graph shows the particle distribution (curve) and component ratio (bars) of Trilon® M Granules SG (the specifications represent approximate values):



Complex formation

The most important property of Trilon® M Granules SG is its ability to form water-soluble complexes with polyvalent ions (e.g., calcium, magnesium, lead, copper, zinc, cadmium, mercury, manganese, iron) over a wide pH range from 2 to 13.5. MGDA usually forms 1 : 1 complexes, i. e. 1 mol of MGDA chelates binds 1 mol of metal ions. The complexes remain stable, especially in alkaline media and, even at temperatures of up to 100 °C.

From the law of mass action, the equation for the stability constant K for 1 : 1 complexes can be written as follows:

$$K = \frac{[MeZ^{(m-n)-}]}{[Me^{n+}]\,[Z^{m-}]}$$

Where

$[MeZ^{(m-n)-}]$ is the concentration of the formed metal complex,

$[Me^{n+}]$ is the concentration of the free metal ion, with Me^{n+} being a positively charged metal ion,

$[Z^{m-}]$ is the concentration of the chelating agent anion (MGDA), and

K is the chelate formation constant of the metal complex.

Logarithms of the chelate formation constant (log K) of a number of MGDA/ metal ion complexes:

Metal ion	log K
Fe^{3+}	16.5
Cu^{2+}	13.9
Pb^{2+}	12.1
Ni^{2+}	12.0
Co^{2+}	11.1
Zn^{2+}	10.9
Cd^{2+}	10.6
Mn^{2+}	8.4
Fe^{2+}	8.1
Ca^{2+}	7.0
Mg^{2+}	5.8
Sr^{2+}	5.2
Ba^{2+}	4.9

A high value for log K indicates that the chelating agent has a high affinity for that particular metal ion, and it provides a preliminary indication of whether the chelating agent is suitable for the specific application.

MGDA-H_3 is a tribasic acid that dissociates in three steps.

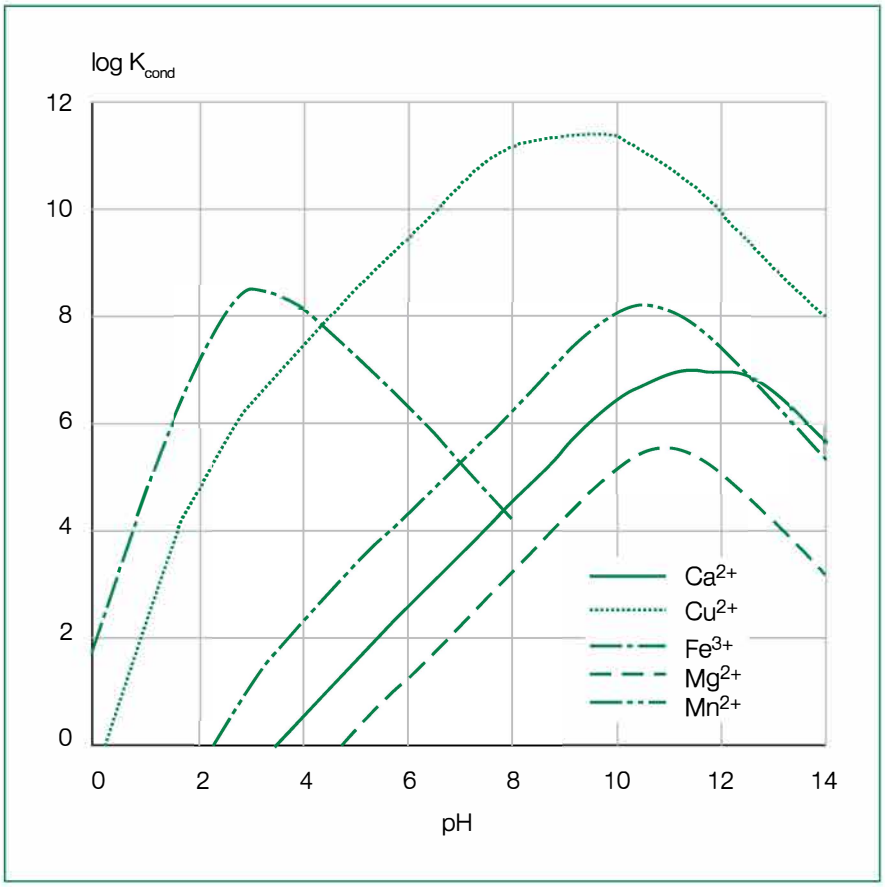
The pK_a values are as follows:

MGDA-H_3	pK_a1	1.6
MGDA-H_2^-	pK_a2	2.5
MGDA-H^{2-}	pK_a3	10.5

In aqueous solutions, MGDA competes for metal ions with other anions such as hydroxide, sulphate, sulphide, carbonate and oxalate that form sparingly soluble metal salts. The formation of chelates reduces the concentration of free metal ions $[Me^{n+}]$ to such an extent that the solubility products of many sparingly soluble metal salts are no longer exceeded. The result is that the salts no longer precipitate or may even redissolve.

The high stability of the complexes prevents the typical reactions of the metal ion. This leads to the suppression of the manganese-, iron- or copper-catalyzed decomposition of peroxidic bleaches, for instance.

Besides the log K value, the conditional stability constants [log K_{cond}] might also help in choosing the proper chelating agent for an application. In addition, these take into consideration the acid-base dissociation equilibria of chelating agent and complex in water and therefore the effect of the pH value on the complex.



Conditional stability constants for the most important MGDA metal complexes.

Chemical stability

Trilon® M Granules SG has superior chemical stability.

Trilon® M Granules SG is highly stable compared with other organic chelating agents (e.g., citric acid, tartaric acid, gluconate), especially at high temperatures.

Unlike inorganic chelating agents (e.g., triphosphate), hydrolysis does not occur for longer periods of time, even when applying pressure at 200 °C. The water, however, evaporates at higher temperatures.

Trilon® M Granules SG starts to decompose at temperatures > 300 °C.

Trilon® M Granules SG is neither decomposed by strong acids nor by strong bases. Strong oxidizing agents such as chromic acid and potassium permanganate lead to decomposition. Trilon® M Granules SG is sufficiently stable to hydrogen peroxide, percarbonate, and perborate in most applications.

Hypochlorite and chlorine-cleaving chemicals lead to the decomposition of Trilon® M Granules SG. Previously formed alkaline earth and heavy metal complexes are partially destroyed.

Corrosion

Trilon® M Granules SG generally stabilizes multivalent metal ions and might accelerate the dissolving behavior of metals through chelate formation. However, corrosion (with the exception of aluminum) always requires the presence of an oxidant such as air.

In ventilated media, nonalloyed steels are attacked by erosion. The corrosion is significantly reduced by alkaline pH values and more or less completely prevented by the elimination of oxygen and other oxidants. Cleaning procedures under weak alkaline conditions that are optimal for Trilon® M Granules SG therefore damage steels (with the exception of aluminum) to a much lesser degree than cleaning procedures with acidic agents.

The corrosion observed with Trilon® M Granules SG is surface abrasion. Pitting or stress corrosion is usually not observed in low-chloride media. This is why it is particularly advantageous that Trilon® M Granules SG is supplied with minimal chloride level.

Since corrosion is characterized by many additional influences such as exposure to air, galvanic elements between different materials, or flow conditions, the following general information may only be applied to the use of Trilon® M Granules SG after a case-by-case review: Austenitic stainless steels (e.g., material no. AISI 321 L, AISI 321 or AISI 316 Ti) are very well suited for the storage and transport of Trilon® M Granules SG. Ferritic steels (e.g., boiler plate HII, material no. 1.0425) have only limited resistance to solutions of Trilon® M Granules SG.

At 50 °C, the corrosion rate in the absence of air was below 0.01 mm/a. Crevice corrosion of welded joints has been observed sporadically, however, so that long-term storage in appliances made of nonalloyed carbon steel is not recommended. The corrosion rate can be slowed down by eliminating air from the system.

Aluminum is quickly corroded by strong bases. Aluminum and aluminum-based alloys (e.g., material 3.4365) are therefore not resistant to the alkaline Trilon® M Granules SG. Preparations containing Trilon® M Granules SG whose pH is set to 5 – 7 are significantly less corrosive to aluminum.

Ecology and toxicology

Trilon® M Granules SG has outstanding ecological (ecotoxicological) and toxicological properties. Trilon® M Granules SG can therefore be used in various applications without limitation. The active ingredient in Trilon® M Granules SG, MGDA, is classified as “slightly biodegradable” based on OECD standards. This means that MGDA, in such a test, for example, is degraded into water and its mineral components by the microorganisms present in wastewater treatment plants.

The products supplied by BASF conform to stringent standards with respect to their toxicological and ecotoxicological properties in order to provide protection of human and the environment. BASF has thoroughly tested the active ingredient MGDA and therefore also possesses extensive data on Trilon® M Granules SG.

Safety

We are not aware of any ill effect that can result from using Trilon® M Granules SG for the purpose for which it is intended and from processing it in accordance with current practices.

According to the experience that we have gained over many years and other information at our disposal, Trilon® M Granules SG does not exert harmful effects on health, provided it is used properly, due attention is given to the precautions necessary for handling chemicals, and the information and advice given in our Safety Data Sheets are observed.

Labeling

Please consult the current Safety Data Sheets for information on the classification and labelling of our products and other information relevant to safety.

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