

## Control Metal Ions with Chelating Agents

Because trace metal ions can be found literally anywhere in our environment, chelating agents are needed almost everywhere in industry. Chelating agents are specific materials that are added to an aqueous system to "tie-up" metal ions so they are no longer troublesome. The chelating agent complexes with the metal ion, forming a three-dimensional structure that blocks the ion's normal reactive sites and prevents it from reacting as it normally would.

#### Ethylenediaminetetraacetic acid (EDTA)

$$\begin{array}{c} O \\ || \\ H \dot{O} - C - C H_2 \\ \hline \\ \dot{N} - C H_2 C H_2 - \dot{N} \\ \hline \\ H \dot{O} - C - C H_2 \\ \hline \\ O \\ \end{array}$$

#### Diethylenetriaminepentaacetic acid (DTPA)

$$\begin{array}{c} O \\ H \dot{O} - C - C H_2 \\ \hline \\ H \dot{O} - C - C H_2 \\ \hline \\ \dot{N} - C H_2 C H_2 \\ \hline \\ \dot{N} - C H_2 C H_2 \\ \hline \\ \dot{N} - C H_2 C H_2 \\ \hline \\ \dot{N} - C H_2 C H_2 - \dot{N} \\ \hline \\ \dot{C} H_2 \\ \dot{C} H_2 \\ \hline \\ \dot{C} H_2 \\ \dot{C} \\ \dot{C} H_2 \\ \dot{C} \\ \dot{C}$$

#### N (Hydroxyethyl) ethylenediaminetriacetic acid (HEDTA)

$$\dot{N}$$
 –  $\dot{C}$   $\dot{H}$  –  $\dot{C}$   $\dot{H}$  –  $\dot{C}$   $\dot{H}$  –  $\dot{C}$  –

#### Nitrilotriacetic acid (NTA)

O 
$$CH_2 - \dot{C} - \dot{O}H$$
H $\dot{O} - \dot{C} - CH_2 - \dot{N}$ 

$$CH_2 - \dot{C} - \dot{O}H$$

$$CH_2 - \dot{C} - \dot{O}H$$

Chelating agents are used in a wide variety of industries where control of metal ions is essential to product performance. For example:

**Agriculture** — provides micronutrients in fertilizers and stabilizes herbicidal formulations

Cleaning Products — boosts cleaning performance by loosening soils and dissolving scale; prevents degradation of color, fragrances, ingredients and clarity

Cosmetic and Toiletry — increases effectiveness and improves stability of creams, oils, ointments and hair preparations

**Food and Beverage** — preserves color, flavor, texture; prevents rancidity

**Metalworking** — minimizes surface oxidation on cleaned metal

Oilfield Applications — removes and prevents scale in drilling, production, and recovery

**Pharmaceutical** — preserves color and flavor; stabilizes vitamins

**Photography** — improves final image quality; important component in silver recovery

Figure 1: In personal care products, Dow chelating agents can improve hard water performance, rinsability, and shelf life.

**Polymerization** — improves multiphase stability and polymerization characteristics; prevents polymer breakdown, discoloration, poor heat and light stability

**Pulp and Paper** — improves bleachability of pulp; reduces brightness reversion

Scale Removal and Prevention — removes and prevents scale in boilers, evaporators, heat exchangers, filter cloths, and glass lined kettles

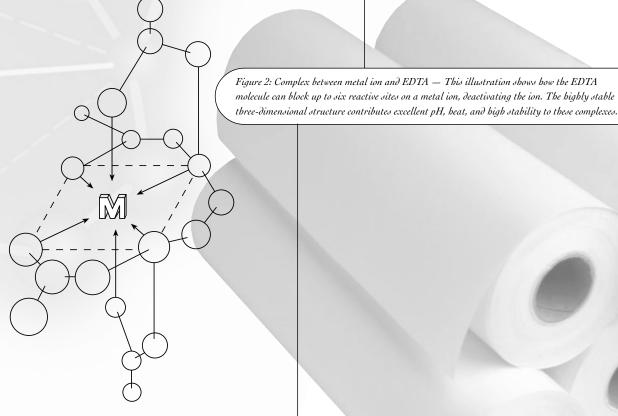
**Soap** — improves hard water performance, rinsability, and shelf-life

**Textiles** — increases cleaning stage effectiveness; stabilizes bleach baths; reduces fiber degradation; promotes brightness and more uniform colors

Water Treatment - controls water hardness

## **Dow Chelating Agents Handle Most Jobs**

Dow's chelating agents, including VERSENE\*, VERSENOL\* and VERSENEX\* products, make up the most complete and versatile group of commercial chelating agents available. The various products are designed to handle specific application requirements, so you can choose the chelating agent best suited to your needs.



**EDTA/Metal Ion Complex** 

\*Trademark of The Dow Chemical Company

Table 1: Typical Properties<sup>1</sup> of EDTA (ethylenediaminetetraacetic acid)-Based Chelating Agents

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENE 100 chelating agent	NLP	Tetrasodium ethylene- diaminetetraacetate	Amber, light	102 (mg as CaCO <sub>3</sub> per g)
VERSENE 100E chelating agent	EIMA	Tetrasodium ethylene- diaminetetraacetate	Amber, light	1g has the equivalent chelation capacity of 1.0 mmoles of EDTA
VERSENE 100E LC chelating agent	EIMA	Tetrasodium ethylene- diaminetetraacetate	Amber, light	1g has the equivalent chelation capacity of 1.0 mmoles of EDTA
VERSENE 100 XL chelating agent	NLPEIMA	Tetrasodium ethylene- diaminetetraacetate	Amber, light	102 (mg as CaCO <sub>3</sub> per g)
VERSENE 100 EP chelating agent	NLPEIMA	Tetrasodium ethylene- diaminetetraacetate	Amber, light	102 (mg as CaCO <sub>3</sub> per g)
VERSENE Diammonium EDTA chelating agent	NLPEIMA	Diammonium ethylene- diaminetetraacetate	Light, straw-colored liquid	137 (mg as CaCO <sub>3</sub> per g)
VERSENE Tetraammonium EDTA chelating agent	NLPEIMA	Tetraammonium ethylene- diaminetetraacetate	Light, straw-colored liquid	130 (mg as CaCO <sub>3</sub> per g)
VERSENE Powder chelating agent	NLPEIMA	Tetrasodium ethylene- diaminetetraacetate	White to cream powder	215 (mg as CaCO <sub>3</sub> per g)
VERSENE 220 Crystals chelating agent	NLPEIMA	Tetrasodium ethylene- diaminetetraacetate tetrahydrate	White crystaline powder	219 (mg as CaCO <sub>3</sub> per g)
VERSENE 220E chelating agent	LPEIMA	Tetrasodium ethylene- diaminetetraacetate tetrahydrate	White crystalline powder	215 (mg as CaCO <sub>3</sub> per g)
VERSENE Na <sub>2</sub> Crystals chelating agent	NLPEIMA	Disodium ethylene- diaminetetraacetate dihydrate	White to off-white powder	$267~(\mathrm{mg~as~CaCO_{3}per~g})$
VERSENE Acid chelating agent	NLPEIMA	Ethylenediaminetetraacetic acid	White powder	339 (mg as CaCO <sub>3</sub> per g)
VERSENE NA Disodium EDTA chelating agent	NLPEIMA	Disodium ethylene- diaminetetraacetate dihydrate	White to off-white powder	267 (mg as CaCO <sub>3</sub> per g)
VERSENE CA chelating agent	NLPEIMA	Calcium disodium ethylene- diaminetetraacetate dihydrate	White to off-white powder	Already a calcium chelate of EDTA

<sup>&</sup>lt;sup>1</sup>The data provided for these properties are typical values, intended only as guides, and should not be construed as sales specifications.

<sup>&</sup>lt;sup>2</sup> N = North America; L = Latin America; P = Pacific; E = Europe; I = India; M = Middle East; A = Africa

## EDTA (ethylenediaminetetraacetic acid)-Based Chelating Agents

Our EDTA (ethylenediaminetetraacetic acid)-based chelating agents are the workhorses of our chelating agent product line. The leading product in this lineup is VERSENE 100 chelating agent, a general purpose product that is widely used to control common multivalent

metal ions to pH 12, iron to pH 8, and water hardness ions above pH 4. Other products in this series make the basic EDTA chemistry available in diammonium, tetra-ammonium, disodium, and acid forms. Physical forms include liquids, powder, and crystal forms. VERSENE NA Disodium EDTA and VERSENE CA chelating agents are food and pharmaceutical grade EDTA products.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% aqueous solution)
39 wt% as Na <sub>4</sub> EDTA	380.2	1.3	10.6 lb/U.S. gal 1270 kg/m <sup>3</sup>	11 – 12
39 wt% as Na₄EDTA	380.2	1.3	10.6 lb/U.S. gal 1270 kg/m <sup>3</sup>	11– 12
39 wt% as Na₄EDTA	380.2	1.3	10.6 lb/U.S. gal 1270 kg/m³	11 – 12
38 wt% as Na₄EDTA	380.2	1.27	10.5 lb/U.S. gal 1260 kg/m <sup>3</sup>	11 – 12
38 wt% as Na <sub>4</sub> EDTA	380.2	1.26	10.5 lb/U.S. gal 1260 kg/m³	10 – 12
40 wt% as (NH <sub>4</sub> ) <sub>2</sub> EDTA	328.2	1,2	10 lb/U.S. gal 1200 kg/m³	4.6 – 5.3
38 wt% as $(NH_4)_4$ EDTA	362.2	1.17	9.8 lb/U.S. gal 1170 kg/m <sup>3</sup>	9.0 – 9.5
92 wt% as Na <sub>4</sub> EDTA·1.5H <sub>2</sub> O 86 wt% as Na <sub>4</sub> EDTA 66 wt% as H <sub>4</sub> EDTA	380.2		45 lb/cu ft 720 kg/m <sup>3</sup>	10.5 – 12.5
$99.0~\rm wt\%$ as $\rm Na_4EDTA.4H_2O$ $83.2~\rm wt\%$ as $\rm Na_4EDTA$ $64.0~\rm wt\%$ as $\rm H_4EDTA$	452.2	-	45 lb/cu ft 720 kg/m <sup>3</sup>	10.5 – 11.5
$96.9~{ m wt}\%$ as ${ m Na_4EDTA.4H_2O}$ $81.4~{ m wt}\%$ as ${ m Na_4EDTA}$ $62.6~{ m wt}\%$ as ${ m H_4EDTA}$	452.2		45 lb/cu ft 720 kg/m <sup>3</sup>	11
99.0 wt% as $Na_2H_2EDTA\cdot 2H_2O$ 89.4 wt% as $Na_2H_2EDTA$ 77.7 wt% as $H_4EDTA$	372.2	-	61 lb/cu ft 977 kg/m <sup>3</sup>	4.3 – 4.7 4.0 – 6.0 (5 wt% solution)
99 wt% as H₄EDTA	292.24	3 -	54 lb/cu ft 870 kg/m <sup>3</sup>	2.5 – 3.0 (saturated solution)
99.0 wt% as $Na_2H_2EDTA\cdot 2H_2O$ 89.4 wt% as $Na_2H_2EDTA$ 77.7 wt% as $H_4EDTA$	372.24	-	61 lb/cu ft 980 kg/m <sup>3</sup>	4.3 – 4.7 4.0 – 6.0 (5 wt% solution)
97.0 – 102.0 wt% as CaNa <sub>2</sub> EDTA·2H <sub>2</sub> O 91.2 wt% as CaNa <sub>2</sub> EDTA	410.26		40 lb/cu ft 640 kg/m <sup>3</sup>	6.5 – 7.5

Table 2: Typical Properties1 of DTPA (diethylenetriaminepentaacetic acid)-Based Chelating Agents

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENEX 80 chelating agent	NLP	Pentasodium diethylene- triaminepentaacetate	Light straw-colored liquid	80 (mg as CaCO <sub>3</sub> per g)
VERSENEX 80E chelating agent	EIMA	Pentasodium diethylene- triaminepentaacetate	Light straw-colored liquid	1g has the equivalent chelation capacity of 0.8 mmoles of DTPA
VERSENEX 105 chelating agent	LPEIMA	Pentasodium diethylene- triaminepentaacetate	Light straw-colored liquid	1g has the equivalent chelation capacity of 1.05 mmoles of DTPA
XUS-40864.00L dev mental chelating		Pentasodium diethylene- triaminepentaacetate	Light straw-colored liquid	106 (mg as CaCO <sub>3</sub> per g)
VERSENEX DTF Acid chelating a		Diethylenetriaminepentaacetic acid	White powder	1g has the equivalent chelation capacity of 2.5 mmoles of DTPA

Table 3: Typical Properties<sup>1</sup> of HEDTA (N-(hydroxyethyl)-ethylenediaminetriacetic acid)-Based Chelating

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENOL 120 chelating agent	NLP	Trisodium N-(hydroxyethyl)- ethylenediaminetriacetate	Light straw-colored liquid	120 (mg as $CaCO_3$ per g)
VERSENOL 120E chelating agent	EIMA	Trisodium N-(hydroxyethyl)- ethylenediaminetriacetate	Light straw-colored liquid	1g has the equivalent chelation capacity of 1.20 mmoles of HEDTA

Table 4: Typical Properties<sup>1</sup> of NTA (nitrilotriacetic acid)-Based Chelating Agents

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENE NTA 14 chelating agent	48 LPEIMA	Trisodium nitrilotriacetate	Clear, straw- colored liquid	1g has the equivalent chelation capacity of 1.48 mmoles of NTA
VERSENE NTA 18 chelating agent	52 LPEIMA	Trisodium nitrilotriacetate	Clear, straw- colored liquid	1g has the equivalent chelation capacity of 1.52 mmoles of NTA
VERSENE NTA Lochelating agent	C LPEIMA	Trisodium nitrilotriacetate	Clear, straw- colored liquid	1g has the equivalent chelation capacity of 1.48 mmoles of NTA
VERSENE NTA Crystal chelating a	LPEIMA agent	Trisodium nitrilotriacetate monohydrate	White crystals	1g has the equivalent chelation capacity of 3.58 mmoles of NTA
VERSENE NTA A	cid LPEIMA	Nitrilotriacetic acid	White to off-white crystalline powder	1g has the equivalent chelation capacity of 5.2 mmoles of NTA

<sup>&</sup>lt;sup>1</sup>The data provided for these properties are typical values, intended only as guides, and should not be construed as sales specifications.

<sup>&</sup>lt;sup>2</sup> N = North America; L = Latin America; P = Pacific; E = Europe; I = India; M = Middle East; A = Africa

# DTPA (diethylenetriaminepentaacetic acid)-Based Chelating Agents

We offer DTPA (diethylenetriaminepentaacetic acid)based chelating agents under the trademark VERSENEX. These products should be considered for use when: 1) the chelant will be used in the presence of oxidizers such as peroxide; 2) when metal chelates of greater stability or solubility are sought; or 3) when VERSENE 100 chelating agent has shown limited utility.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% aqueous solution)
$40.2 \text{ wt}\%$ as $\text{Na}_{\scriptscriptstyle 5}\text{DTPA}$	503.1	1.3	10.9 lb/U.S. gal 1310 kg/m³	11.0 – 11.8
$40~\mathrm{wt}\%$ as $\mathrm{Na_5DTPA}$	503.1	1.3	10.9 lb/U.S. gal 1310 kg/m³	11 – 12
$52~\rm{wt}\%$ as $\rm{Na}_5\rm{DTPA}$	503.1	1.4 (nominal)	10.9 lb/U.S. gal 1310 kg/m³	11.0 – 12.0
54 wt% as Na <sub>5</sub> DTPA	503.1	1.4	11.7 lb/U.S. gal 1400 kg/m³	11.0 – 12.0
99 wt% as $\rm H_5DTPA$	393.2	_	_	2.1 – 2.5 (saturated solution)

# HEDTA (N-(hydroxyethyl)-ethylenediaminetriacetic acid)-Based Chelating Agents

VERSENOL 120 and VERSENOL 120E chelating agents are the trisodium salts of N-(hydroxyethyl)-

ethylenediaminetriacetic acid. They have some unique properties that make them worth considering for use: 1) to control iron at pH 8–10; and 2) under more acidic conditions (i.e. low pH) where other chelants are less soluble.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% aqueous solution)
41 wt% as Na <sub>3</sub> HEDTA	344.2	1.28	10.7 lb/U.S. gal 1280 kg/m³	11.0 – 11.8
$40.5 \text{ wt}\%$ as $\text{Na}_3\text{HEDTA}$	344.2	1.28	10.7 lb/U.S. gal 1280 kg/m <sup>3</sup>	11.5 – 12.0 (typical)

## NTA (nitrilotriacetic acid)-Based Chelating Agents

Agents

This series of products offers the formulator a number of readily biodegradable, low molecular weight, general purpose chelating agents. VERSENE NTA 148, VERSENE

NTA 152, and VERSENE NTA LC chelating agents are trisodium salts of NTA and are liquid products. VERSENE NTA Crystal chelating agent offers the trisodium salt of NTA in crystal form, while VERSENE NTA Acid chelating agent provides nitrilotriacetic acid in powder form.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% aqueous solution)
$38 \text{ wt}\%$ as $\text{Na}_3\text{NTA}$	257.1	1.3	11 lb/U.S. gal 1320 kg/m³	10 – 12
39 wt% as Na <sub>3</sub> NTA	257.1	1.3	11 lb/U.S. gal 1320 kg/m³	10 – 12
38 wt% as Na <sub>3</sub> NTA	257.1	1.3	11 lb/U.S. gal 1320 kg/m³	10 – 12
92.1 wt% as Na <sub>3</sub> NTA 98.5 wt% as Na <sub>3</sub> NTA•H <sub>2</sub> O	257.1	-	-	10.5 – 11.5
99 wt% as $\rm H_3NTA$	191.2	~	55 lb/cu ft 881 kg/m <sup>3</sup>	1.7 – 2.7

# Selecting The Correct

# DOW Chelating Agent

### Other Specialty Chelants

These products are based on glycine and are readily biodegradable. They're particularly useful for chelating iron in moderately or mildly alkaline solutions.

### Table 5: Typical Properties<sup>1</sup> of Other Specialty Chelants

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value	
VERSENE DEG chelating agent	EIMA	Sodium diethanolglycine	Clear liquid	-	

Table 6: Typical Properties<sup>1</sup> of Agricultural Micronutrients

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENOL AG Fe Chelate fully chelated micronutrient	NLPEIMA	Iron disodium N-(hydroxyethyl)- ethylenediaminetriacetate	Dark red-brown liquid	-
VERSENE AG 7.7% Fe chelated micronutrient	EIMA	Ferric ammonium ethylene- diaminetetraacetate	Dark reddish-brown liquid	_

<sup>&</sup>lt;sup>1</sup>The data provided for these properties are typical values, intended only as guides, and should not be construed as sales specifications.

<sup>&</sup>lt;sup>2</sup> N = North America; L = Latin America; P = Pacific; E = Europe; I = India; M = Middle East; A = Africa





% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% solution)
41 wt% as NaDEG	185.2	1.2	-	-

## Agricultural Micronutrients

VERSENE AG and VERSENOL AG micronutrients are chelated micronutrients that are more readily utilized by plants than are inorganic forms of metals; therefore, less metal is required in the chelate form. These chelating agents are designed to provide trace amounts of iron.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% solution)
4.5 wt% as Iron	334.0	1.4	11.6 lb/U.S. gal 1390 kg/m³	6
64-65 w/v as FeNH <sub>4</sub> EDTA 48-50 wt% as FeNH <sub>4</sub> EDTA 51-52 wt% as Fe(NH <sub>4</sub> ) <sub>2</sub> EDTA 53-55 wt% as FeNH <sub>4</sub> EDTA·NH <sub>4</sub> OH 98-102 g Fe/L 7.5-7.7 wt% Fe	362.1	1.32 (@ 20°C/68°F)	10.7 lb/U.S. gal 1280 kg/m³	7.4 – 7.9 (10% w/v solution)



# Selecting The Correct

# DOW Chelating Agent

Table 7: Typical Properties<sup>1</sup> of Photo Chelates

Product	$\begin{array}{ccc} \text{Product} & \text{Composition} & \text{Appearance} \\ \text{Availability}^2 & & \end{array}$		Chelation Value	
VERSENE photo chelate LI	NLPEIMA	Ferric ammonium ethylene- diaminetetraacetate	Dark, reddish-brown liquid	-
VERSENE photo chelate H	EIMA	Ferric ammonium ethylene- diaminetetraacetate	Dark, reddish-brown liquid	_
VERSENE DAPTA Acid chelating agent	EIMA	Diaminopropanoltetraacetic acid	White powder 1g ha	as the equivalent chelation acity of 2.6 mmoles of DAPTA

Table 8: Typical Properties<sup>1</sup> of Phosphonates

Product	Product Availability <sup>2</sup>	Composition	Appearance	Chelation Value
VERSENEX CSI corrosion and scale inhibitor	N	Proprietary formulated organophosphonates	Clear orange-brown	~
VERSENATE PS peroxide stabilizer	NLPEIMA	Proprietary organo phosphonic acid/partially neutralized and polyalkylene polycarboxylic acid	Orange-brown liquid	~
VERSENATE SI scale inhibitor	NLPEIMA	Diethylenetriamine penta methylene phosphonic acid	Orange-brown liquid	~

 $<sup>^{1}</sup>$ The data provided for these properties are typical values, intended only as guides, and should not be construed as sales specifications.



<sup>&</sup>lt;sup>2</sup> N = North America; L = Latin America; P = Pacific; E = Europe; I = India; M = Middle East; A = Africa

<sup>\*</sup> Trademark of The Dow Chemical Company

#### **Photo Chelates**

VERSENE photo chelate LI and VERSENE photo chelate H are ferric ammonium EDTA, which is used as a silver bleaching agent in photoprocessing solutions. These two products are used primarily in color negative bleach-fixes for the processing of photographic paper.

VERSENE DAPTA Acid chelating agent is diaminopropanoltetraacetic acid; this product is used as a specialty photobleach chelant.

% Assay	Molecular Weight	Specific Gravity (@25/25°C)	Bulk Density	pH (1 wt% solution)
42 - 46 wt% as FeNH <sub>4</sub> EDTA 44 - 49 wt% as Fe(NH <sub>4</sub> ) <sub>2</sub> EDTA 46 - 51 wt% as FeNH <sub>4</sub> EDTA·NH <sub>4</sub> OH 83 - 92 g Fe/L 6.5 - 7.1 wt% Fe	362 as FeNH <sub>4</sub> EDTA (15.5 wt% Fe) 380 as Fe(NH <sub>4</sub> ) <sub>2</sub> EDTA (14.7 wt% Fe) 397 as FeNH <sub>4</sub> EDTA·NH <sub>4</sub> OH (14.1 wt% Fe)	1.28	10.7 lb/U.S. gal 1282 kg/m <sup>3</sup>	7
49 - 51 wt% as FeNH <sub>4</sub> EDTA 52 - 54 wt% as Fe(NH <sub>4</sub> ) <sub>2</sub> EDTA 54 - 56 wt% as FeNH <sub>4</sub> EDTA·NH <sub>4</sub> OH 100 - 105 g Fe/L 7.7 - 7.9 wt% Fe	362 as FeNH <sub>4</sub> EDTA (15.5 wt% Fe) 380 as Fe(NH <sub>4</sub> ) <sub>2</sub> EDTA (14.7 wt% Fe) 397 as FeNH <sub>4</sub> EDTA·NH <sub>4</sub> OH (14.1 wt% Fe)	1.3	10.7 lb/U.S. gal 1280 kg/m <sup>3</sup>	7.5 – 8.0
85 wt% as DAPTA acid	322.3	-	_	2.0 (2 wt% slurry)

#### **Phosphonates**

These products are used extensively to control or remove scale-forming calcium and magnesium salts, often with results superior to stabilized phosphate and other organic programs. VERSENEX CSI corrosion and scale inhibitor and VERSENATE\* SI scale inhibitor are used in many types of industrial water systems, while VERSENATE PS peroxide stabilizer has additional uses in pulp and paper production.

% Assay	Molecular Weight	Specific Gravity (@ 25/25°C)	Bulk Density	pH (1 wt% solution)
28 wt% minimum active	-	1.36	11.2 lb/U.S. gal 1350 kg/m³	3.0 – 4.2 (bulk)
28 – 32 wt% minimum active	-	1.35	11.2 lb/U.S. gal 1350 kg/m³	Titte
40 – 49 wt% minimum as DTPMP	573	1.4	11.6 lb/U.S. gal 1390 kg/m³	<2



## Selecting The Correct

# DOW Chelating Agent

When the intended application is known and the chelating agent selected, the next question is: What quantity is needed?

The three-step method discussed below should be a fast and useful technique to determine chelating agents requirements for controlling polyvalent metal ions. It should also be helpful in making quantitative estimates which can be converted into initial process economic estimates. However, unless you are experienced in making the choice of a Dow chelating agent and in determining chelating agent requirements for commercial use, consultation with Dow Technical Service and Development personnel is recommended.

### Three-Step Method

Use of the method requires first determining:

- Problem metal ion or ions
- Other metal ions present
- pH of solution
- Concentration of metal ion or ions

### Step One: Select Chelating Agent

Using the Metal Ion Control Chart (Figure 3), select the most suitable material. In most applications, VERSENE 100 chelating agent should be considered first. Note: Since calcium and magnesium (hardness metal ions) are not chelated below a pH of 4.0, no chelating agents are specified. Above pH 4.0, VERSENE 100 is usually the chelant of choice, although NTA should be considered as an alternative for chelation of hardness ions above pH 9. For ferric (Fe<sup>-5</sup>) ion control above a pH of 8.0, refer to VERSENOL 120 and/or Triethanolamine 99.

## Step Two: Determine Metal Ion(s) to Be Chelated

Using the Metal Chelate Selectivity Displacement Series (Table 9), determine the metals to be chelated. The metal ions are listed in order of chelation: Fe<sup>+3</sup> before Cu<sup>+2</sup>; Cu<sup>+2</sup> before Ni<sup>+2</sup>, etc. Note: If Ca<sup>+2</sup> is the problem metal ion and Cu<sup>+2</sup> is present, Cu<sup>+2</sup> must be inactivated first.

Figure 3: Metal Ion Control Chart

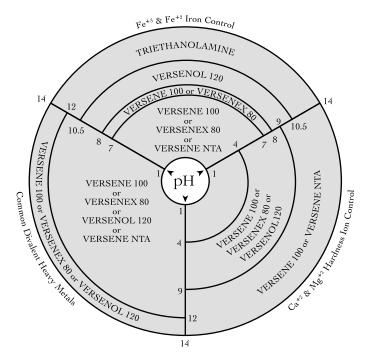
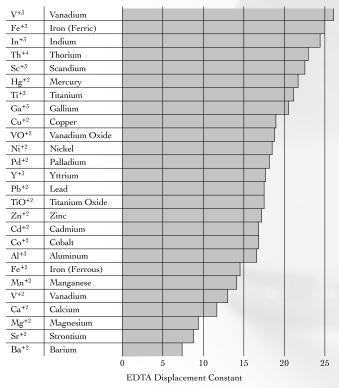


Table 9: Metal Chelate Selectivity (Displacement) Series



# Step Three: Determine Quantity Required From Table 10 (Parts of Chelating Agent Required to

Chelate One Part of Metal), determine the amount of chelating agent needed to control a unit weight of metal [4.7 grams VERSENE 100 for 1 gram Pb<sup>+2</sup>].

Table 11 (Conversion Factors, Chelating Agent Equivalents, page 14), will then be useful to estimate the amount of Dow chelating agent required.

Answers obtained by the three steps should be checked on a limited or laboratory basis. Final adjustments can then be made so the optimum quantity of chelating agent will be used in commercial processes.

Table 10: Parts of Chelating Agent Required to Chelate One Part of Metal

Metal	Name	VERSENE 100	VERSENEX 80	VERSENOL 120	Diam- monium EDTA	Tetra- ammonium EDTA	VERSENE NTA 152
Al <sup>+3</sup>	Aluminum	36.1	46.4	30.9	27.1	28.5	24.4
$\mathrm{Ba}^{\scriptscriptstyle{+2}}$	Barium	7.1	9.1	6.1	5.3	5.6	4.8
$\mathrm{Cd}^{+2}$	Cadmium	8.7	11.1	7.4	6.5	6.8	5.9
$Ca^{+2}$	Calcium	24.3	31.2	20.8	18.2	19.2	16.5
Co+2	Cobalt	16.5	21.2	14.1	12.4	13.1	11.2
Cu <sup>+2</sup>	Copper	15.3	19.7	13.1	11.5	12.1	10.4
Fe <sup>+3</sup>	Iron (Ferric)	17.5	22.4	14.9	13.1	13.8	11.8
$Fe^{+2}$	Iron (Ferrous)	17.5	22.4	14.9	13.1	13.8	11.8
Ga+3	Gallium	14.0	18.0	12.0	10.5	11.0	9.5
In+3	Indium	8.5	10.9	7.3	6.4	6.7	5.7
$Pb^{+2}$	Lead	4.7	6.0	4.0	3.5	3.7	3.2
$Mg^{+2}$	Magnesium	40.1	51.5	34.3	30.1	31.6	27.1
Mn <sup>+2</sup>	Manganese	17.7	22.8	15.2	13.3	14.0	12.0
$Hg^{+2}$	Mercury	4.9	6.2	4.2	3.6	3.8	3.3
$Ni^{+2}$	Nickel	12.2	21.3	14.2	12.4	13.1	11.2
$Pd^{\scriptscriptstyle{+2}}$	Palladium	9.2	11.8	7.8	6.9	7.2	6.2
$Sc^{+3}$	Scandium	21.7	27.8	18.5	16.3	1 <i>7</i> .1	14.7
Sr <sup>+2</sup>	Strontium	11.1	14.3	9.5	8.3	8.8	7.5
Th⁺⁴	Thorium	4.2	5.4	3.6	3.2	3.3	2.8
Ti <sup>+3</sup>	Titanium	20.4	26.1	17.4	15.3	16.1	13.8
TiO+2	Titanium Oxide	15.3	19.6	13.0	11.4	12.0	10.3
$V^{+3}$	Vanadium	19.1	24.6	16.4	14.3	15.1	12.9
$V^{+2}$	Vanadium	19.1	24.6	16.4	14.3	15.1	12.9
VO+3	Vanadium Oxide	14.6	18.7	12.5	10.9	11.5	9.8
Y+3	Yttrium	11.0	14.1	9.4	8.2	8.7	7.4
$Zn^{+2}$	Zinc	14.9	19.1	12.8	11.2	11.8	10.1

### Typical Use of Three-Step Method

#### **Problem**

Both calcium and copper ions have been identified to be problems in a textile processing step. There are 3 ppm of copper and 20 ppm of calcium in the system. The questions: Which Dow chelating agent should be used... and how much?

#### Solution

Because Ca and Cu ions must be controlled and system pH in the textile plant is 8, use of the Metal Ion Control Chart (Figure 3, page 12) suggests VERSENE 100 chelating agent as the product of choice.

Because Ca and Cu ions must be chelated, use of Table 9 (page 12) indicates that the Cu ion must be inactivated first, and then the Ca ion.

By use of Table 10 (page 13), it is apparent that 15.3 parts of VERSENE 100 product are required to chelate one part of the Cu ion, and 24.3 parts of VERSENE 100 are required to chelate one part of the Ca ion. Therefore, 15.3 times 3 ppm of copper = 45.9 ppm VERSENE 100 required to chelate the copper, and 24.3 times 20 ppm of calcium = 486 ppm of VERSENE 100 required to chelate the calcium: a total of 531.9 ppm of VERSENE 100. Often a 10% excess is used to account for fluctuations in the system.

Judgement on volume requirement for a process is dependent on volume throughput of the system to be treated. Assistance in determining specific amounts of chelating agent required for a particular system is available from Dow. For further information, please contact The Dow Chemical Company.

Use of Table 11 suggests that 248 ppm of VERSENE 220 Crystals could be utilized in replacement of the 532 ppm of VERSENE 100 product, if that were desirable.

Table 11: Conversion Factors, Chelating Agent Equivalents

To Replace One Pound Of:	VERSENE 100	VERSENE 220 Crystals	VERSENE Acid	VERSENEX 80	VERSENOL 120	VERSENE Na <sub>2</sub> Crystals	VERSENE NTA 152
VERSENE 100	-	0.466	0.301	1.28	0.880	0.395	0.671
VERSENE 220 Crystals	2.15	-	0.646	2.73	1.83	0.849	1.44
VERSENE Acid	3.32	1.55	_	4.24	2.83	1.31	2.23
VERSENEX 80	0.784	0.365	0.236	_	0.667	0.310	0.526
VERSENOL 120	1.18	0.548	0.354	1.50	_	0.465	0.789
VERSENE Na <sub>2</sub> Crystals	2.53	1.18	0.761	3.23	2.15	-	1.70
VERSENE NTA 152	1.49	0.69	0.45	1.90	1.27	0.59	_

#### Safety Considerations

The Dow chelating agents—marketed under the trademarks of VERSENE, VERSENOL, and VERSENEX—are widely used in industry. When using these products, always follow proper handling methods. Before working with any of these products, request and study Material Safety Data Sheets (MSDS), available from your nearest Dow sales office.

### For More Information

If you would like additional information, call The Dow Chemical Company at the phone number listed on the back of this brochure.

#### **Customer Notice**

Dow encourages its customers and potential users of Dow products to review their applications of such products from the standpoint of human health and environmental quality. To help ensure that Dow products are not used in ways for which they are not intended or tested, Dow personnel will assist customers in dealing with ecological and product safety considerations. Dow product literature, including Material Safety Data Sheets, should be consulted prior to use of Dow products. For information and assistance, call The Dow Chemical Company at the phone number listed on the back cover of this brochure.





## Why Dow Chelating Agents Should Be Your First Choice for Metal Ion Control

Dow chelating agents...

- Provide reliable protection for the quality, shelf-life, and value of your products
- Improve processing efficiency
- Reduce scale formation
- Effectively dissolve inorganic scales
- Improve bleach performance
- Prevent metals from reacting with your process or product
- Improve product performance in hard water
- Soften process water
- Keep metal ions in solution
- Form more stable complexes than other metal ion control agents
- Offer unique thermal, light, and pH stability
- Effective at low concentrations, helping you reduce ingredient costs
- Offer a long history of success in a broad range of applications

# Why Dow Is Your Best Source for Metal Ion Control Solutions

- Unsurpassed quality and consistency in every Dow chelating agent
- A wide range of Dow chelating agents for formulating versatility
- The exclusive METAL SIGNATURE† analytical service
- The sophisticated PIMIC† computer modeling service
- Expert technical support
- Comprehensive technical and application literature
- Complete metal ion control systems tailored to your needs
- Global production facilities and our excellent worldwide distributor network

Why not find out more about how Dow chelating agents can help you protect the value of your products and/or the efficiency of your processing? We'll be happy to answer your question, provide addition literature, and send samples of Dow chelating agents for your evaluation. Call today. The sooner you get started formulating with Dow chelating agents, the sooner you'll start getting more reliable, cost-effective protection against detrimental metal ion reactions.

# THE DOW CHEMICAL COMPANY Midland, Michigan 48674

For more information, complete literature, and product samples you can reach a Dow representative at the following numbers:

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