

Factsheet on:

Calcium Sulphate and its Release into Soil and Groundwater

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Gypsum is a rock like mineral commonly found in the earth's crust, extracted, processed and used by Man in construction or decoration in the form of plaster and alabaster since 9000 B.C. The facts below show that calcium sulphate is a substance with no adverse health and environmental effects.

I. Facts about calcium Sulphate

1. EINEC 231-900-3
2. CAS 7778-18-9 (CaSO₄); 10101-41-4 (CaSO₄·2H₂O); 13397-24-5 (gypsum)

a. Characteristics of Calcium Sulphate (Gypsum) (CaSO₄ · 2H₂O)

- solubility in water at 25°C :
 - 2.1 g CaSO₄/litre
 - 2.6 g CaSO₄ · 2H₂O/litre
 - K_s (CaSO₄) : 2.38 × 10⁻⁴
 - corresponding with 1.45 g SO₄²⁻/litre
- hardness : 1.5 tot 2 Mohs; 32 à 45 Knoop; 60 Vickers; 1.25 Rosiwal
- specific weight : 2.32 g/cm³
- pH : neutral
- crystal form : monoclinic
- very stable molecule
- transformation conditions: other modifications like hemihydrates (CaSO₄ x ½ H₂O or anhydrite (CaSO₄) can convert into dihydrate; the EINECS nomenclature does not make a difference between the different types of calcium sulphate with different crystal water content

b. Calcium Sulphate (CaSO₄ · 2H₂O): a non-dangerous substance

- Calcium sulphate **is not labelled** according to the hazard symbol for nature polluting substances according to Directive 67/548/EEC as amended of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances; and does not bear any warning signs.
- Calcium Sulphate **is registered** under code E 516 as a food additive.
- **There is no evidence of toxicity** caused by calcium sulphate in living organisms.¹ It has been tested as non-ecotoxic in such biological tests as *daphnia magna* (DIN 38412 Teil 30), in fish tests with *leusicus idus* (DIN 38412 Teil 31) and with *photobacterium phosphoreum*.

II. Calcium Sulphate Behaviour in the soil

Sulphur (as sulphate) is a major plant nutrient, and is essential for crop growth². Gypsum is listed as an inorganic fertilizer, with no nitrogen, phosphorus or potassium, but 18% sulphur, and a good source of calcium.

Calcium Sulphate is used to improve soil quality³. The most important applications are⁴:

- for the reclamation of sodic soils through ion exchange (calcium replacing sodium)
- to reduce run-off water and its resulting erosion in dry agricultural areas
- as an ameliorant for acidic subsoils and soils in forestry
- to improve Ca- and S-nutritional elements in agriculture (rape and cereals)
- Gypsum is also useful as an additive for soils with high levels of sodium.

III. Calcium Sulphate and Water

Calcium Sulphate is the least soluble among the family of sulphates. The ion sulphate (SO_4^{2-}) has no adverse effect on health, even at concentrations corresponding to a saturation of CaSO_4 (app. 1500mg/l). Several studies failed to find any association between exposure to high levels of sulphates (i.e. sodium and/or magnesium sulphates in concentrations mostly up to 1200 mg/l, sometimes up to 2000 and more mg/l) and diarrhoea or other adverse health issue⁵.

At 25°C a litre of water saturated with calcium sulphate contains 1.45g of sulphate (SO_4^{2-}) and 0.65g of calcium (Ca^{2+}). When the water is saturated, an addition of calcium sulphate will not change the concentration of sulphate. This concentration can only increase if another sulphate (e.g. Magnesium sulphate) is added into the water.

The concentration of sulphate in groundwater highly depends on the nature of the natural ground: in gypsum areas, groundwater may be saturated (1.45g of sulphate per litre) and in this case the addition of gypsum will not change the sulphate concentration.

¹ a. Internal test Bayer AG: $\text{LC}_{50} > 2000$ mg/l, *Poecilia reticulata*, 96h.

b. Patrick et al., *Progressive Fish-Culturist*, 30, 137-140 (1968): LC_{50} 2980 mg/l, *Lepomis macrochirus*, 96h.

c. Wallen et al., *Sewage and Industrial Wastes*, 29, 695-701 (1957): $\text{TLm} > 56000$ mg/l *Gambusia affinis*, 96h.

d. BIBRA toxicity profile calcium sulphate: $\text{NOEC} > 2000$ mg/l rainbow trout, 28d.

² Ullmann Encyclopedia of Industrial Chemistry – Vol. A25 p. 563

³ a.; Gypsum Waste as Soil amendment-Hugh Riley, *Planteforsk-2001*. Norwegian.

b. Gypsum Waste in compost (Norwegian), Erik Norgaard, *Norsk Jordforbedring*, 2002

⁴ Agricultural disposal method of Construction Site Gypsum Wallboard Waste-2001-Journal of Construction Education) *Construction Drywall As A Soil Amendment*", Edwin H. White and Mark E. Burger July 1993, pages 70-71

⁵ A. Health Effects from Exposure to High Levels of Sulfate in Drinking Water Study, U.S. Environmental Protection Agency, Office of Drinking Water and Ground Water, 21 January 1999. b. WHO, *Guidelines for Drinking-Water Quality*, 2nd edition, Vol.2, Health criteria and other supporting information, 13.30 Sulfate, p.351.

IV. The Management of Construction and Demolition Waste containing Calcium Sulphate

Gypsum is also used in other construction industries, mainly in the production of cement, in ceramics, in floor screeds, and thus needs to be treated at the end of life.

Most countries have Gypsum content limits for the use of C&D waste derived secondary aggregates.

Permitted Gypsum content in C&D waste derived secondary aggregates

Country	Mixed aggregates	Concrete aggregates
Germany	<0.5 or <1% % SO ₃ content	<1% SO ₃ content
France	<1%	Virtually 0%
UK	n/a	<1%
Belgium	<1%	<1%
The Netherlands	<1%	<1%
Italy	<1%	<1%

V. Available Test Methods for Calcium Sulphate

Risks in use and recommended test methods have been described in the following documents:

- VGB technical Scientific reports: Comparison of Natural Gypsum and FGD Gypsum: studies for a comparative assessment of the health impact of natural gypsum and FGD gypsum from coal-fired power plants with a view to their use in the manufacture of building materials, 1990
- VGB Powertech/ Instruction sheet analysis of FGD Gypsum-Second edition 2008

In case of emission scenario test, calcium and sulphate have to be dissolved by the same method. The resulting non-dangerous concentrations formula **(Calcium) conc. = 0,43 x (Sulphate) conc.** associated to calcium sulphate. Only concentrations exceeding this relationship could be evaluated to be dangerous.

VI. Recommendations on the determination of dangerous substances to be developed in CEN/TC 351

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This formula is only applicable on ER 3 hygiene health and safety and does not influence technical requirements given for calcium and/or sulphate concentrations.