TMT 15® - Toxicology / Ecology / Properties of Precipitates

Application information / Info 15 E

TMT 15® is a ready-to-use 15% aqueous solution of trimercapto-s-triazine, trisodiumsalt, an organosulfide that represents the active agent. The following are our comments on the data contained in the material safety data sheet.

1. Toxicology

Acute toxicity

The LD_{50} (rat, oral) of TMT 15® is relatively high, so that the product is not categorised as toxic or harmful according to the chemicals regulations. It only need to be labelled as Xi “irritant” because of the irritative effect to the eyes. TMT 15® is not regulated for transport i. e. it is not classified as dangerous good.

Mutagenicity

TMT 15® was tested for mutagenic activity in vitro using the AMES Test at Inveresk Research International. No mutagenic activity was registered in any of the 6 strains of bacteria used (Salmon. typhim. E. coli) up to the highest concentration tested - 113.3 mg per plate. The Micronucleus Test on mice also showed that TMT 15® is not mutagenic under these conditions.

2. Ecology

Fish toxicity

The LC_0-value indicated on the material safety data sheet (fish test) of 13,720 mg TMT 15®/l (calculated for the commercial product TMT 15®) means in practice that even an overdose of 12,000 ml of TMT 15® per cubic meter of waste water did not kill any of the fish tested and that this concentration is still non-toxic. In purifying flue-gas wash water from waste incinerators and power plants, for example, only 50 -100 ml of TMT 15® per cubic meter are used for heavy metal precipitation; such an overdose would be very unlikely in practice.

Bacterial toxicity

TMT 15® is not biodegradable but is also not acutely toxic for the bacterial coenobium. TMT 15®'s resistance to biodegradation indicates that metal-TMT sludge will be very stable and that bacterial attacks will not cause the release of metallic ions.

TMT 15® will be adsorbed on activated sludge.

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Water hazard class

The commercial product TMT 15® was classified in the German water hazard class 1 and thus does not toxically inhibit bacteria used for wastewater purification. Thus TMT 15® will not endanger the degradation process in biological sewage-treatment plants. In practice, the opposite will more likely be the case - that, by precipitating bacteriotoxic heavy metal traces, TMT 15® will have a certain "protective" value for bacteria.

TMT 15®-excess dosage

It was determined in tests that, on the basis of the amount of TMT 15® normally used in practice - 50-100 ml of TMT 15®/cubic meter of flue gas wash water, TMT 15® added in excess of this amount - in relation to the metallic ions dissolved in the waste water - does not remain in free (= dissolved form). Rather it reacts with the metal hydroxide already formed by pre-neutralisation and converts them into sparingly soluble metal-TMT compounds. Thus any TMT 15® excess is used up, and does not remain in solution.

TMT 15®-detection and identification

The combined use of lime and TMT 15® results in a sludge that consists mainly of hydroxides and contains only small - although varying - amounts of metal-TMT compounds. Following separation of this sludge no TMT 15® is detected in the clarified water. Our Info 5 contains a micro-assay method for TMT 15®.

3. Properties of precipitates (Heavy Metal-TMT-Compounds)

Composition

Defined metal-TMT compounds are produced by precipitation out of aqueous solution. The composition of these compounds was established by way of elementary analysis, whereby it was demonstrated that each TMT molecule can bind three equivalent heavy metals. This results in the following formal compounds:

Monovalent metals

$3\ Me^{+} + TMT^{3-} \rightarrow Me_3TMT$ (low solubility)

Bivalent metals

$3\ Me^{2+} + 2\ TMT^{3-} \rightarrow Me_3(TMT)_2$ (low solubility)

Me^{+}, Me^{2+} = heavy metal
TMT^{3-} = $C_3N_3S_3^{3-}$

TMT thus reacts as a complete molecule. No hydrogen sulphide is split off and true metal-organic compounds - no metallic sulphides - are formed! In the case of the bivalent metals three-dimensional networks - in effect macromolecules - seem to be present.

Solubility products and solubility in water

Conditions: 24 °C, pH 7, 72 h of agitation to achieve equilibrium, determination of metal concentrations in water by means of AAS. Metal concentrations of, in some cases, far under 1 mg/l (0.0001 to 1 mg/l) were detected. The solubility products of metal-TMT compounds are within the same order of magnitude as the metal sulphides; they are, however, considerably lower then the corresponding metal hydroxides.

Elutability

Experiments with copper-TMT sludge (mass = 100 g DS per mixture) were carried out in accordance with DIN 38414, Part 4 "Determination of Elutability with water" (S 4). The eluate was found by means of AAS to contain < 0,05 mg Cu/l after 24 h of eluation.
An German waste-to-energy plant, in cooperation with various Bavarian authorities, carried out large-scale elution trials with original sludge stemming from flue-gas scrubber water treatment. The results show that here also, as far as we are currently capable of detecting, only minimal traces of resolubilised metal compounds could be found in the eluates.
Additionally we have carried out our own laboratory-scale elution trials with various sludges containing heavy metals from waste incinerators according to the German (DIN 38 414) as well as the Swiss (TVA Switzerland) guidelines. The results we achieved were also very good. We will be happy to provide a detailed report on request.

Leachability tests

Weather exposure tests were carried out for 125 days with copper-TMT sludge (filter-moist, approx. 20 % DS). Rain water that had seeped through the sample was caught in an open bottle and thus became more and more concentrated through evaporation. In spite of these especially stringent conditions - as compared to a landfill where seepage does not evaporate - the concentration of copper in the collected water was well under 1 mg of Cu/l (pH 5.7 - 6.5).

Reactions with acids and oxidising agents

Metal-TMT compounds show practically no reaction with diluted acids, nor is any hydrogen sulphide released. Concentrated acids do, however, dissolve considerable amounts of metals out of the precipitates. Strong oxidising agents (conc. HNO_3, H_2O_2, NaClO etc.) destroy the metal-TMT compounds.

Thermal stability

$Hg_3(TMT)_2$ does not decompose until temperatures above 210 °C are reached. Decomposition occurs in several stages, being faster in an air atmosphere than in a nitrogen atmosphere (test method: thermogravimetry, 5 °C/Min., 30 - 300 °C). No amount of mercury worth mentioning is lost during decomposition. A 2.4 % loss of Hg is first registered in a 1-hour holding test at 300 °C with exposure to the air. The decomposition products were not analysed. Mercury sulphide may be formed (sublimation point 580 °C).

Bacterial decomposition

TMT is not biodegradable. The bacterial decomposition that may take place in a landfill was not investigated due to a lack if reproducible test methods. Under certain conditions, metallic sulphides are possible as final products.

Hindrance of TMT 15® precipitation

The presence of high concentrations of strong complexing agents (EDTA, etc.) may reduce the effectiveness of TMT 15® precipitation. TMT 15® is destroyed by strong oxidising agents.

Hazard warning
TMT 15® is classified ”Irritant”. For information on labelling, transport classifications, first aid and toxicology, please see the current safety data sheet.