Galvanotechnik

Älteste Fachzeitschrift für die Praxis der Oberflächenbehandlung

Technical paper
Färber & Schmid
Cooper Precipitating
Agent for Effluent Treatment

- Heavy Metal Precipitating
- Diplexin AM-566

ISSN 0016-4232 | B 20696

3 März 2015
Seiten 568 - 569
106. Band

LEUZE VERLAG seit 1902

Eco-friendly Copper Precipitation Using Diplexin AM-566

Färber & Schmid, a company based in Dietikon, Switzerland and Stuttgart, Germany, presents a new product to replace sodium sulphide (Na2S) and dimethyldithiocarbamate (DMDTC)

One of the leading printed circuit board manufacturers in Germany recently analysed all their production processes in terms of their environmental management policy. From this, they were able to determine those processes with the greatest environmental impact. It became apparent that in terms of their effluent treatment, heavy-metal ion precipitation was the most critical stage, requiring as it did large amounts of organosulphides (dimethyldithiocarbamate – DMDTC) as well as sodium sulphide, used for precipitation of copper.

Set out below is a summary of the main properties of chemicals currently used for heavy metal ion precipitation.

Sodium sulphide (Na_2S): Is mainly used for first-stage precipitation of copper. The product is usually sold in solid form and converted by the user to a 10 % aqueous solution. This chemical is attractive partly because of its relatively low price and also in terms of its very effective metal precipitation properties.

Against this, sodium sulphide suffers from major drawbacks, both in terms of environmental impact and its use in the workplace. Classified as an environmentally hazardous species, toxic hydrogen sulphide gas (H_2S) can be released during its use, as well as extremely noxious odours, for example during disposal of spent solution. Release of hydrogen sulphide during the use of this chemical can also cause tarnishing or blackening of the surface of silver-plated components in the vicinity as well as other problems, not all of these being negligible.

Organosulphides (DMDTC): are noteworthy for their superb metal precipitation properties and their attractive pricing. Even in the case of strongly-bound copper complexes, such as those with amine or EDTA ligands, the metal can usually be precipitated to meet currently enforced discharge concentration limits.

The main drawback of this class of chemical is their extremely damaging environmental impact which is reflected in their hazard classification. In some parts of the world, their eco-toxicity makes their use prohibited. A further drawback in terms of their use, is their extremely unpleasant odour. Another problem, depending on the mix of species in the effluent, is a tendency to form very turbid supernatant liquor. In many such cases, effluent can fall short of the legal requirements and may thus not be legally discharged.

Problem solving using Diplexin AM-566

After a detailed analysis of the existing situation and recognizing the problems associated with use of standard sulphide precipitating solutions, Färber & Schmid set themselves the task of developing a better solution to the problem of effective but problem-free precipitation of heavy metals. Their primary goal was to completely eliminate the use of the ecologically damaging sulphide compounds by offering a superior alternative. Following an intensive R & D programme carried out both at customers' sites and the company's own in-house customer-service laboratories, Diplexin AM-566 was developed, proving itself in every way superior to existing products. The main advantages of Diplexin AM-566 can be summarised as:

- Not designated as an environmentally hazardous compound
- Ready-to-use solution, thus no handling problems, no H_2S gas release
- Substantially odour-free in use (dosing or recirculation)
- Replaces Na_2S and DMDTC in a single stage
- Lower quantities required as compared with standard sulphide solutions
- Does not cause damage to selective ion exchange resins
- Superb eco-toxicity properties (see *Table 1*)

The values shown in *Table 1* emphasise how important it is to avoid excess dosing with DMDTC or Na_2S or to remove such excesses should they arise. Unless the concentrations of these eco-toxic species in efflu-

Table 1: Aquatic Toxicity Concentrations

	Sodium sulphide	*DMDTC*	*Diplexin AM 566*
EC50 Water flea Daphnia magna	7.1 mg/L	0.67 mg/L	400mg/L = 60 to 600 times less toxic
LC50 Fish trout/perch	25 mg/L	0.76 mg/L	2000 mg/L = 80 to 2600 times less toxic

Thanks to its excellent eco-toxicity values, Diplexin AM-566 is thus classified as Water Hazard Rating 1 (WGK 1 = weakly water hazardous)

ent discharged to sewer is tightly controlled, there is a danger, especially for smaller sewage treatment plants, that the activity and functionality of nitrification bacteria will be crippled. In consequence, the sewage plant operators will themselves no longer be able to meet their own discharge concentration levels, for example, of ammonium ions. Given the pressures to which sewage plant operators are subject, in terms of adhering to legal discharge limits, they understandably bear down on upstream industrial effluent dischargers. In some cases this has resulted in a ban on the use of DMDTC for effluent treatment.

Having noted the drawbacks of at-present widely used, but eco-toxic sulphide compounds, it should be noted here that harmful excess concentrations of such compounds can be limited or even totally avoided by treatment with ferrous salts.

Using Diplexin AM-566: Functioning and Operation

The main chemically-active component of Diplexin AM-566 is a cross-linked sulphur polymer based on neutralised polythionic ionic acid. Using a carefully selected manufacturing process, a polymer structure is created which protects the molecule from attack (hydrolysis) by weak and strong acids. The product can thus be used at pH values of 2.5 and above, without formation of hydrogen sulphide in significant amounts. Copper, which is known to be one of the hydrogen sulphide group, is most effectively precipitated at slightly acid pH values. Thanks to its features as described above, Diplexin AM-566 can be used without problems in acid media, resulting in increased efficiency and minimal use of the product itself. Furthermore, for example, amine-copper complexes are destabilised in acid solutions with their higher H^+ ion concentration. This in turn results in more efficient

Copper tetraammine complex	+ Diplexin AM-566	= copper sulphide
$Cu(NH_3)_4\ SO_4$	$H_2S_{2+n}O_6$ (Empirical formula)	CuS (Insoluble precipitate)

Fig. 1: Simplified representation of the precipitation reaction for a tetraammine copper complex

precipitation and decomplexation of copper ions (see *Fig. 1*).

Organosulphides and also sodium sulphide can only be used in neutral to weakly alkaline pH solutions in order to avoid formation of toxic H_2S gas. Should process conditions require this, metal precipitation using Diplexin AM-566 can equally well be carried out in neutral pH solutions.

In theory, all sulphide-based heavy-metal precipitating agents are ideal for precipitation of monovalent or divalent metals (Me^+/Me^{++}). They are however only sometimes usable with trivalent or quadrivalent metals $(Me^{(+++)})^n$. Extremely good precipitation results are found using Diplexin AM-566 for copper, zinc, tin, silver, mercury and cobalt. In the event other metals are present, for example nickel or chromium which may cause difficulties, modified precipitation variants are recommended.

Practical Experiences

The printed circuit board manufacturer mentioned above, has been successfully using Diplexin AM-566 for several months. Their experience can be summarised by noting that all those involved have been delighted with the outcome. Not only was the introduction of Diplexin AM-566 completely problem-free but also the local Water Board was more than satisfied with the environmentally superior results, using the new reagent.

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