

INHIBITION OF COPPER MIGRATION WITH SILICATES – PERSPECTIVES AND LIMITATIONS OF AN EXPERIMENTAL BATCH APPROACH AND FIRST RESULTS WITH NEW INHIBITOR CONCEPTS

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Summary

The central addition of corrosion inhibitors to drinking water is a state of the art measure in order to ensure its quality in case of waters with high corrosiveness. Whereas first the avoidance of red-water formation has been the focus of an anti-corrosion treatment with the new drinking water directive additionally the reduction of heavy metal migration due to the interaction of the drinking water with various kinds of metallic materials of the household installation is also the objective of the application of corrosion inhibitors.

The metal uptake is strongly influenced by the individual regime of water usage that varies considerably according to the individual habits of the consumer. Therefore, according to the German TrinkwV, the determination of the chemical parameters copper, nickel and lead has to be based on a representative value reflecting the mean weekly water consumption of the final user. A standardised method to determine this parameter, that is widely accepted, is DIN 50931-1. According to the results a substantiated recommendation can be given about the compatibility of the installation materials with the water investigated. Furthermore, the efficiency of corrosion inhibitors, i.e. based on silicate and phosphate, can be measured.

The influence of phosphate and silicates on the copper migration has been subject to numerous studies during the recent years. The results indicate that the addition of ortho phosphate generally leads to a reduction of the copper uptake, although some studies showed no effect or even an increase of the copper level. The standard silicate types, although very efficient against red-water formation, show a significant lower specific efficiency or even no effect on copper migration.

In order to comply with the demand of a phosphate free corrosion inhibitor, two new proprietary inhibitor concepts based on silicate have been developed. As polymeric silicate had shown in earlier studies a much faster adsorption to metal surfaces than monomeric one, the approach has been to provide within the tight

legal frame a silicate solution with a maximised portion of oligo- respectively polymeric units.

The “highly polymerised” silicate follows the conventional concept of long-term stable ready to use dosing solutions by optimisation the composition, whereas the “highly cross-linked” silicate overcomes the limitations of long-term stability by in-situ mixing of two concentrated solutions, allowing the mixture polymerise under controlled conditions, which can be monitored by the viscosity increase, and dosing it into the water before the reaction leads to the unwanted solidification of the liquid mixture.

In order to fine-tune the composition of the new silicate types with regard to their efficiency to reduce copper migration a new laboratory method to study the copper up-take had to be developed. The standard method according to DIN 50931-1 is too time and resources consuming that it could be used for a systematic inhibitor screening.

The method developed is a hybrid between elution trials and a special kind of batch trials specially designed for the investigation of copper migration. In a glass flask, that can be protected against the entry of air during the test, copper material and the test water including corrosion inhibitor is introduced and the flask is shaken during the test. Via a specific device water samples for analysis are taken after pre-defined test duration. The inhibitor efficiency is evaluated by the development of the copper concentration in dependence of time. The test duration was typically between one and four days.

In order to calibrate the newly developed method, selected studies were carried out, using the water and the corrosion inhibitor that had already been thoroughly studied regarding copper migration according to DIN 50931-1. The results obtained with the new short term batch method showed the same tendencies and thus can be used to pre-evaluate inhibitor systems. With the new method the higher performance of the new silicate types could be shown.

A selected corrosion inhibitor based on the new highly polymerised silicate was tested within the scope of an industrial research project carried out by the TZW Karlsruhe with the focus on copper migration. Applying 15 mg/l as SiO₂ of the highly polymerised silicate succeeded to sharply reduce the mean weekly copper concentration measured by DIN 50931-1 of a drinking water from approximately 2 mg/l below 0.2 mg/l.

This paper shows first results on the inhibition of copper migration by newly developed silicate based inhibitors. Although the studies still are in an early stage, the very promising data indicate that the new types of silicate inhibitors could have a significantly enlarged applicability than the silicate types currently on the market.