Educational Article

Corrosion Control in Drinking Water Distribution Using Simple Methods

Part 5: Properties and Corrosion of Copper and Copper Alloys

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Abstract: Due to its excellent processing properties and corrosion resistance, copper is a popular material for drinking water installations. Provided it is suitable for the specific water conditions and installed correctly, it can be used without issues for many decades—though a certain amount of copper release inevitably occurs. Furthermore, there are uncertainties regarding its suitability for use, which depends on the specific properties of the water. If used outside its recommended application limits, it may suffer from accelerated surface corrosion—resulting in elevated copper concentrations in the drinking water—or from pitting corrosion damage, either of which would necessitate the replacement of the installation. In contrast, brass and red brass—materials frequently used for faucets and fittings—exhibit greater corrosion resistance. While brass may occasionally be susceptible to dezincification, red brass demonstrates the lowest propensity for corrosion. When utilizing brass and red brass, it is essential to ensure that the alloys comply with the requirements set forth in the regulatory framework for metallic materials; this is crucial, in particular, to ensure that the permissible limit for lead in drinking water is not exceeded.

Keywords: Copper release, copper corrosion, corrosion inhibition, corrosion rate, oxygen corrosion, pitting corrosion, salt influence, stagnation test, surface corrosion.

1. Properties of copper, brass, and red brass

1.1. Introduction

Metals are a constant cause of corrosion in drinking water installations. Despite the use of copper as a material, corrosion can compromise the integrity of both the pipe itself and the quality of the drinking water.

Copper is a reddish metal that is soft, malleable and ductile. It has high thermal and electrical conductivity and is largely resistant to corrosion in air and water. These properties make it a popular choice for use in drinking water installations. However, due to its high price, its use in drinking water networks is limited. It is mostly used in the form of alloys, for example in extraction equipment, spindles in hydrants, and impellers in pumps. [1].

Although copper is classified as a noble metal, with a standard potential of +0.340 V, copper pipes exposed to saline water with dissolved gases (oxygen, carbon dioxide) are susceptible to corrosion. In oxygen-free water, however, copper is almost inert (thermodynamically stable). **In oxygenated water, it corrodes slowly, with the corrosion products adhering primarily to the surface.** These products can, to varying degrees, passivate the underlying copper. **However, a portion of the corrosion products**

dissolves into the contact water as copper(II) ions—a process referred to as metal release. In this process, the limit value for copper of 2.0 mg/L—stipulated in the EU drinking Water Ordinance for a stagnation period of 4 hours—may be exceeded [2]. Since copper release is particularly high in new installations but decreases rapidly during operation, this limit value applies only after an operating period of 16 weeks. According to the Federal Institute for Risk Assessment (BfR), **copper is an essential trace element** that fulfills the following functions:

- Component of biochemical catalysts (e.g., cytochrome C oxidase, superoxide dismutase),
- important for growth, bone stability, blood cell maturation, and iron transport.

The daily copper requirement for adults is 1.0–1.5 mg/day, and for children, it is 0.5–1.0 mg/day. These ranges are very narrow; the toxic threshold begins at just 5 mg/day for adults, and for children aged one year and older, it starts at 1 to 4 mg/day, depending on body weight [3]. Acute copper(II) toxicity manifests as digestive issues, nausea, vomiting, and diarrhea. Chronic copper toxicity, resulting from the long-term intake of elevated copper levels, can lead to liver damage, kidney problems, and other health impairments. Metallic copper is bacteriostatic—that is, it inhibits bacterial growth rather than killing bacteria directly. Dissolved copper(II) is toxic to aquatic organisms at concentrations as low as 0.01 mg/L, although sensitivity and reactions vary widely [4,5].

1.2. Copper in drinking water distribution

The materials permitted for use in drinking water distribution are specified in the German Federal Environment Agency's (UBA) assessment of metallic materials in contact with drinking water [6]. Copper materials are approved for use in material groups B through D (fittings, pipe connections, and devices), as shown in Table 1.

Table 1. Copper materials for drinking water in accordance with the UBA's criteria [6].

Material designation according to ISO	**Cu-DHP** [1]	**Cu-ETP**	**Cu-OF**	**Cu-PHC**	**Cu-HCP**	**Cu-DLP**
Material designation according to DIN EN	CW024A	CW004A	CW008A	CW020A	CW021A	CW023A
Copper content (%)	≥ 99.90	≥ 99.90	≥ 99.95	≥ 99.95	≥ 99.95	≥ 99.90
Phosphorus content (%)	0.015 - 0.040	-	≤ 0.0003	0.001- 0.006	0.002 - 0.007	0.005 - 0.013
Oxygen content (%)	-	≤ 0,040	-	-	-	-
Density (g/cm³)	8.94	8.93	8.90	8.90	8.90	8.94
Properties	Oxygen-free, phosphorus-containing copper	Electrolytically refined, oxygen-bearing copper	Oxygen-free, high-purity copper	Oxygen-free, high-purity copper with low phosphorus content	Oxygen-free, high-purity copper with low phosphorus content	Oxygen-free copper with medium phosphorus content

[1] in accordance with EN 1057 [7].

Furthermore, when using copper pipes, the following restrictions apply regarding the potable water utilized: pH ≥ 7.4. Alternatively, the applicable criteria are a pH of 7.0 to < 7.4 and a Total Organic Carbon (TOC) value of ≤ 1.5 mg/l [6].

Seamless round copper pipes intended for water and gas lines in plumbing and heating systems must comply with EN 1057 [7]. In Germany, when used in gas and potable water installations, compliance with the DVGW datasheet GW 392 [8] is additionally mandatory. This requirement also extends to sheathed and internally tinned copper pipes. When using these pipes, it is essential to verify that the standard designation " EN 1057" is printed on them, as this is the sole guarantee of trouble-free operation within

potable water installations. In such cases, the copper material meets DHP requirements (Table 1). The pipe material is available in three temper states—soft (R220), half-hard (R250), and hard (R290)—and should be used consistently throughout a given installation. The pipes differ in terms of their tensile strength and elongation at break. Prior to installation, it is crucial to ensure that the pipes are clean and smooth. Contaminants—such as oils and greases resulting from manufacturing and processing operations—can significantly accelerate corrosion by fostering the formation of local galvanic cells, which ultimately leads to pitting corrosion.

Regarding joining techniques, a distinction is made between permanent and detachable connections. Permanent connections include press-fit and push-fit joints, soft-soldered and hard-soldered joints, as well as welded joints. Detachable options include compression ring fittings, flanged joints, screw fittings, and pipe couplings [9].

1.3. Copper alloys in drinking water installations

In addition to copper, the two most important alloys, brass and red brass, are also used in drinking water installations and are classified in EN 1982 [10]. Red brass or brass adapters are frequently utilized for the purpose of connecting pipes. Fittings are typically composed of brass (e.g., meter housings, check valves, and shut-off valves).

Brass is an alloy consisting of at least 50% copper and up to 40% zinc. Up to a zinc content of 37% by mass, only the α-phase is present, in which the zinc is incorporated into the copper lattice; as a result—much like copper itself—these alloys are cold-formable. In this instance, they are referred to as wrought alloys. Until recently, lead was a significant minor constituent in copper-zinc-lead alloys specifically formulated for mechanical machining. However, due to stricter limits on lead levels in drinking water, these materials will no longer be permitted as of January 12, 2028, in accordance with the UBA's assessment criteria for metallic materials in contact with drinking water [6]. The lead concentration in brass must remain below 0.2% to ensure reliable compliance with the limit for lead in drinking water of 0.005 mg/L (effective January 12, 2028). All permissible alloys are listed in the assessment basis, which also includes a negative list. Nevertheless, lead-containing brass continues to be used for meter housings and fittings to facilitate their machining. In such cases, however, the material must be protected from contact with water by means of a watertight coating. For instance, meters are coated with epoxy resin, while fittings are first nickel-plated and subsequently chrome-plated.

Red brass is an alloy of copper, tin, and zinc, and the name refers to the reddish color of the material. It is used for valve housings and fittings. Red brass is considered corrosion-resistant and is protected against dezincification due to its higher copper content. According to the UBA's assessment criteria, red brass CuSn5Zn5Pb2-C (CC499K) with a lead content of 0.2–3.0% is only listed until January 11, 2028 [6]. The alternative red brass with the designation CuSn4Zn2PS has a lower lead content of maximum 0.2% and is suitable for product groups B to D without restriction in terms of drinking water hygiene.

2. Corrosion of copper and copper alloy

1.1 Surface corrosion of copper

According to EN 12502-2, copper and copper materials may be susceptible to various forms of corrosion, including pitting, selective corrosion, bimetallic corrosion, and erosion corrosion, in addition to uniform surface corrosion [11]. **Surface corrosion leads to the formation of surface layers. In cold water, these layers typically consist of red copper(I) oxide (cuprite) and green-blue malachite, a basic copper carbonate.**

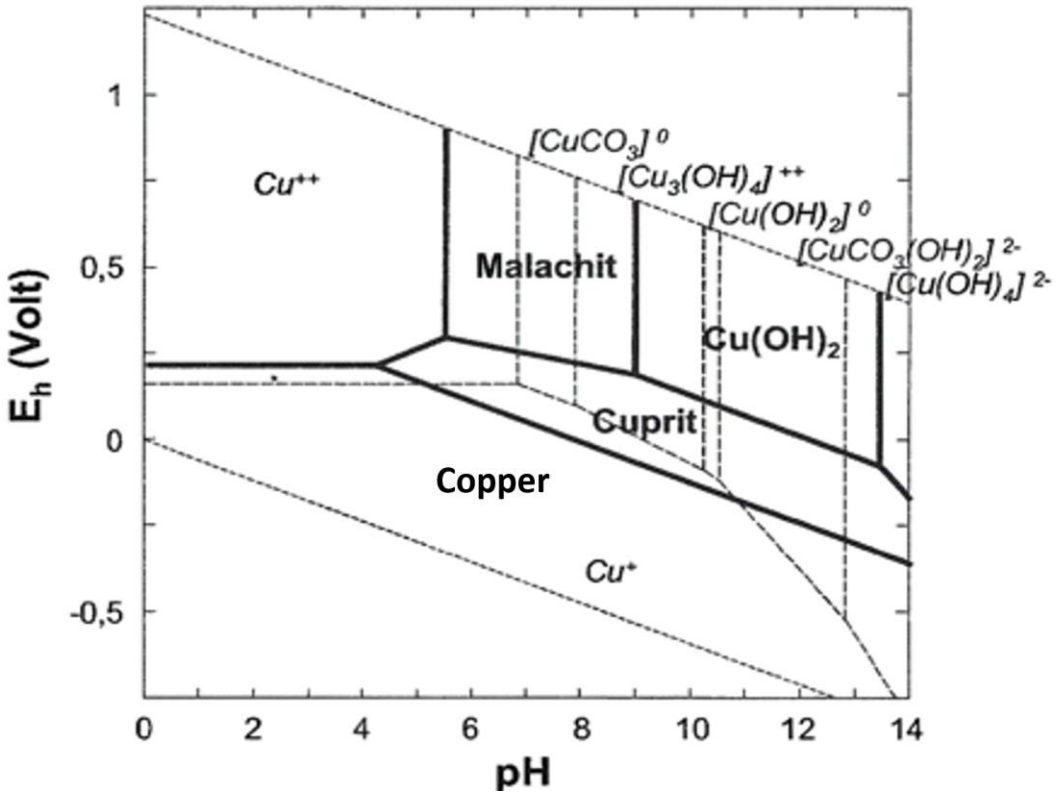

Figure 2. Pourbaix diagram of copper in equilibrium with water containing 0.1 mmol/l (6.35 mg/l) copper(II) , 30 mg/l carbon dioxide, and 7 mg/l oxygen, excluding the corrosion products copper carbonate, azurite, and tenorite [13].

In warm water, surface layers of cuprite, calcite (calcium carbonate), and black copper(II) oxide (tenorite) usually form [12]. The latter is thermodynamically the most stable solid phase above pH 8, but its formation in cold water is kinetically inhibited. Merkel calculated the Pourbaix diagram for copper in hard cold water (Figure 2) [13]. It is evident that copper exhibits stability in the presence of oxygen at 0.2 V to approximately pH 4.5, and undergoes oxidation to cuprite at higher pH values. In the pH range of drinking water (6.5 to 9.0), malachite should also form at higher potentials. Given that tenorite has been ruled out as a corrosion product, the range of malachite existence increases up to a pH value of 9. Subsequently, copper(II) hydroxide becomes the dominant phase. The Pourbaix diagram is not able to provide a definitive answer regarding the identification of the solid phase responsible for copper release in the water phase. However, it is certain that a micrometer-thick, amorphous cuprite layer forms on the copper surface first, and in rare cases, a crystalline layer is formed (see Figure 3).

Copper(I) oxide not only serves as a mechanically protective layer but is also a p-type semiconductor (positive semiconductor) characterized by a copper deficiency. During corrosion, two copper(I) ions are replaced by one copper(II) ion and one electron hole. This change in oxidation states facilitates the **migration of a positive charge through the crystal lattice**, thereby causing the copper(I) oxide at the interface with the water to be oxidized into copper(II) oxide, which is soluble. Electrochemical impedance spectroscopy (EIS) performed on copper in neutral tap water demonstrated that the overall corrosion rate is driven not by the oxide anions, but rather by the anodic oxidation and diffusion of copper ions within the copper oxide layer [14]. In these studies, the oxide layers—with the exception of the outermost layer—consisted primarily of copper(I) oxide; the surface layer, however, contained small quantities of copper(II) oxide, copper(II) hydroxide, and copper carbonate. It was established that oxygen is reduced at the cuprite

surface and—correspondingly—copper is oxidized at the metal surface. **Over time, the mineral malachite forms on the cuprite, initially appearing as pustules ranging in size from 40 to 100 µm** (see Figure 3). **Since malachite is not a semiconductor, it can develop into a continuous, passivating layer in older pipelines** [15].

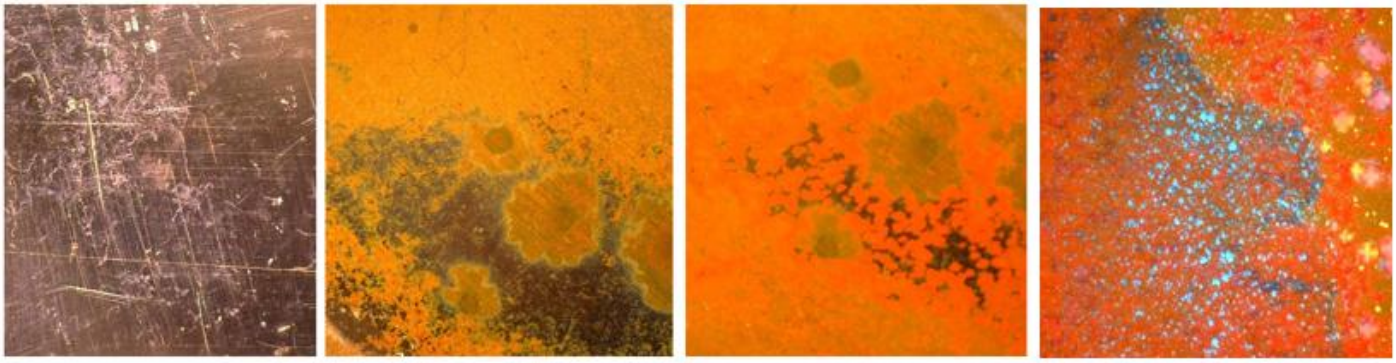

Figure 3. Surface corrosion of a copper coupon after 0, 3, 10, and 95 days in drinking water, red: cuprite, blue: malachite.

Concurrently with the metal's corrosion process, the contact water becomes enriched with copper(II) ions. As a result of these corrosion processes, the materials are—on the one hand—attacked, while—on the other hand—the drinking water becomes contaminated with corrosion products, which are predominantly present in dissolved form, but also as suspended and undissolved matter. However, the surface corrosion described here only rarely leads to actual corrosion damage in the case of copper.

The standard EN 12502-2 [11] provides guidance on the **factors that influence the likelihood of surface corrosion occurring in drinking water**:

- **the concentrations of carbonic acid species (carbon dioxide, hydrogen carbonate, and carbonate),**
- **the duration of water stagnation,**
- **the operating conditions,**
- **and the age of the installation.**

Surface corrosion is particularly high in newly installed pipes and installations that are operated irregularly; however, it decreases over the course of the service life. In isolated cases, blue-colored water has been observed in newly installed drinking water systems that were operated only sporadically. This indicates a copper concentration significantly exceeding the limit value for drinking water. Therefore, it is recommended to flush out stagnant water from new copper installations thoroughly before using the water for drinking purposes.

1.2 Pitting corrosion of copper

Copper pitting corrosion leads to corrosion damage far more frequently than general surface corrosion. **It occurs predominantly in cold water pipes after several years of operation—particularly when the water is chlorinated and exhibits a high pH value (> 8), a low bicarbonate content, moderate chloride levels (> 60 mg/l), and high sulfate levels (> 120 mg/l).** The pits are small and round; while the resulting leakage is relatively minor, it nevertheless leads to damage within the building. According to the European standard EN 12502-2 [11], corrosion in cold water corresponds to **Type 1**, with particular emphasis placed on the significant influence of proper installation. **The probability of corrosion decreases as bicarbonate and chloride concentrations increase. Sulfate and nitrate ions, conversely, increase the susceptibility to corrosion.** Pitting corrosion does not occur in oxygen-free water.

Type 2 pitting corrosion occurs exclusively in hot water systems characterized by a low pH value (pH < 7), a low bicarbonate concentration (bicarbonate < 1.5 mmol/L), and high sulfate levels [11]. **The probability of corrosion is elevated when the ratio of bicarbonate concentration to sulfate concentration falls below 1.5.** In such water types, Type 2 corrosion can be largely suppressed by increasing the pH value.

1.3 Inhibitors to minimize copper corrosion

Inhibitors reduce both copper corrosion and copper release, resulting in a kinetic effect. However, this does not render the material inert; rather, it remains protected only as long as the inhibitor is present within the corrosion system. This protection may persist even beyond the dosing period, provided the inhibitor is strongly adsorbed—as is the case, for example, with 1,2,3-benzotriazole. This substance adsorbs onto the metallic copper, thereby preventing the onset of corrosion [16]. However, the use of 1,2,3-benzotriazole in drinking water is not permitted. Two review articles provide an overview of inhibitors [17, 18]. Due to their toxic properties, these inhibitors are also excluded from use in drinking water applications.

According to the list of approved water treatment substances and disinfection methods [19], **the addition of various mono-, di-, and polyphosphates, as well as sodium silicate**—including in combination—is permitted in Germany for drinking water applications aimed at corrosion mitigation. Owing to their alkalizing effect, the addition of sodium hydroxide, sodium bicarbonate, and sodium carbonate also exerts a corrosion-inhibiting effect; however, these substances are not explicitly listed for this specific purpose.

1.4 Copper release into drinking water

The release of copper into the water can be explained by the following processes: (a) oxidation of metallic copper to copper(II) and migration into the cuprite layer; (b) diffusion of copper ions to the surface of the oxide layer and migration into the aqueous phase; (c) diffusion of oxygen through the oxide layer; and (d) reduction to oxide oxygen and incorporation into the cuprite crystal lattice. It is known that copper enters the contact water as hydrated copper(II) ions [13]. Copper(I) compounds, in contrast, exhibit very low solubility. Furthermore, dissolved copper(I) compounds disproportionate in acidic and neutral solutions—in accordance with Equation 1—into metallic copper and copper(II).

$$2\ \mathrm{Cu(I)} \leftrightarrows \mathrm{Cu} + \mathrm{Cu(II)} \qquad (1)$$

The corrosion process is governed by pH: at a low pH of 5, copper ions diffuse from the oxide layer into the solution. Corrosion proceeds, and no equilibrium concentration is reached in the water. Within the pH range of drinking water (6.5 to 9.5), a linear increase in copper concentration is initially observed up to a pH of 7.6, after which it decreases again. This process is described by Equation 1. In parallel with the oxidation of copper, dissolved oxygen is consumed. Both the pH value and the buffering capacity of the carbon dioxide–bicarbonate system are of particular significance for copper release. The primary product in carbonate-containing drinking water is the neutral contact ion pair $[CuCO_3]_0$ (see Figure 2) [22]. This complex exhibits an intense absorption band in the ultraviolet region, which can be utilized to determine the concentration of dissolved copper.

In natural waters, humic substances and other anions—particularly phosphate—also influence dissolution processes. Dartmann [21] demonstrated that orthophosphate (PO_4^{3-}) can both decrease and increase copper release. On the one hand, phosphate reduces copper corrosion as well as oxygen-induced oxidation, resulting in less copper passing into the aqueous phase. On the other hand, phosphate inhibits the formation of malachite, thereby causing a higher concentration of copper to remain in the aqueous phase. Humic substances—naturally occurring polar macromolecules formed during the

decomposition of organic matter—also influence copper release in a complex manner by adsorbing copper(II) while simultaneously inhibiting malachite formation.

The influence of chloride and sulfate on copper release was investigated within the framework of a BMFT project [22]. It was found that chloride reduces copper release, whereas sulfate increases it. The combination of sulfate and chloride resulted in the highest level of copper release. Furthermore, it was determined that sulfate exerts a long-term effect.

Since copper corrosion is not yet fully understood, it is currently not possible to reliably deduce from water properties alone whether copper pipes are suitable for a specific type of drinking water. According to the assessment basis of the UBA (German Environment Agency), the drinking water in a new installation should comply with the copper limit value of 2.0 mg/L no later than 16 weeks after installation [6]. This requirement is met if the drinking water in question has a pH value of ≥ 7.4—or a pH value within the range of 7.0 to 7.4—as well as a TOC value of ≤ 1.5 mg/L. The corresponding values should be published by the water utility. If specific test results regarding copper release are available for a particular supply area, this information must be taken into account during material selection. **This implies that an assessment of copper release by the water utility is required.** It should be noted that the validity of this application recommendation—which is based on a statistical analysis—does not take the aforementioned buffering capacity into account and lacks full scientific validation.

For this reason, laboratory-scale investigations should be conducted initially. The following chapter describes some of these tests; their application and results will be presented in the next article. Furthermore, laboratory investigations allow for the examination of the influence of various salts on copper release.

In contrast to copper, there are no restrictions regarding the use of internally tinned copper in drinking water installations, provided that the tin coating complies with DVGW Worksheet GW 392, based on the testing standard W 534 [23]. Moreover, tin is currently not a parameter subject to testing under the Drinking Water Ordinance.

3 Experiments to determine copper corrosion

3.1 Determination of the corrosion rate of copper

The corrosion rate of copper is calculated as the sum of the mass of copper incorporated into the surface layer and the mass of copper transferred into the contact water per unit of time. To this end, several weighed test coupons are exposed to water—either under static conditions or within a flow system—and the material loss of the copper samples is determined at defined time points following the selective removal of the surface layer. **Copper release is quantified through a parallel analysis of the contact water for dissolved copper.**

Assuming that copper loss is negligible compared to the amount of copper incorporated into the surface layer, and that only a single corrosion product (cuprite) is formed, the corrosion rate can also be derived from the increase in layer thickness over time using gravimetric measurements [15].

A further method is based on the fact that dissolved oxygen in drinking water acts as the dominant oxidizing agent in the surface corrosion of copper, and that the oxygen consumption corresponds to the extent of copper corrosion [13].

The corrosion rate, i.e., the amount of oxygen consumed by the corrosion system per unit area and time, can be determined from an oxygen difference measurement in a test pipe. For this purpose, a pipe section that has previously been permanently flushed with water is switched to circulation mode and the decrease in oxygen content is measured and evaluated as a function of time [22]. The corrosion rate of the metal can be determined from the (negative) slope of the oxygen concentration time curve, the specific geometric properties of the test tube, and the volume of the circulation apparatus. For

copper, the stoichiometry according to Equation 2 applies, assuming a negligible proportion of malachite and other copper(II) minerals.

$$4\ Cu + O_2 = 2\ Cu_2O \qquad (2)$$

Since corrosion rates are temperature-dependent, the temperature should be kept as constant as possible during the stagnation phase. In the laboratory, this can be achieved through temperature control; on a technical scale, it is accomplished by conducting the experiment in a temperature-controlled room. At a minimum, the temperature should be monitored and documented during the stagnation test. In addition to oxygen measurements, it is advisable to measure pH and electrical conductivity—particularly when pH levels or salt concentrations are varied to assess their influence on corrosion [23]. Furthermore, reaction rates can be determined using electrochemical methods. For instance, EIS measurements yield the initial corrosion rate constant [14]. Moreover, surface corrosion on a bare copper sheet can be quantified by measuring the corroded areas [25].

3.2 Copper release rate determination

Methods for determining time-dependent corrosion using discontinuous sampling have been described [14, 22]. Following acidification, the samples are stable, allowing the dissolved copper content to be determined in the laboratory photometrically, atomic absorption spectrometry (AAS), inductively coupled plasma optical emission spectrometry (ICP-OES), or inductively coupled plasma mass spectrometry (ICP-MS). Graphite furnace AAS and ICP-MS are particularly suitable for low copper concentrations. If the copper concentration is to be determined continuously, this can be achieved by measuring the intensity of the d^9 band of the hexaaquacopper(II) cation $[Cu(H_2O)_6]^{2+}$ at 800 nm. However, since the sensitivity is low, a colorimetric reaction must typically be performed; as a result, the measurement solution cannot be reused. A more sensitive online method utilizes the charge-transfer absorption band of the neutral copper carbonate complex $[CuCO_3]^0$ at 276.5 nm [27].

Since the Pourbaix diagram indicates the stability of the copper carbonate complex only within the pH range of 7 to 8, the concentration should be verified using an independent method—such as ICP-MS. Based on the concentration-time data, copper release under stagnation conditions can be determined. Furthermore, temporal extrapolation is possible. If the objective is merely to verify compliance with the drinking water limit of 2.0 mg/L copper after a stagnation period of 4 hours, water samples can be collected from the copper piping once this stagnation phase has elapsed, and the copper concentration determined using an analytical method [24].In addition, the initial rate constant of copper corrosion can also be determined from the concentration-time data [28].

3.3 Determination of the influence of pH on corrosion

Although it is well known that **copper corrosion increases as the pH value decreases**, it is not possible to deduce—for a specific water source—the precise magnitude of this influence or whether the copper limit value will be exceeded as a result of a defined shift in pH value. In this regard, circulation tests conducted at various pH levels can provide water suppliers with a measure of certainty. The pH value also exerts an influence on the carbonic acid equilibrium: at a pH of 6.4, bicarbonate and the sum of carbon dioxide and carbonic acid are present in approximately equal concentrations. At a pH of around 10, bicarbonate and carbonate are each present at 50%.

3.4 Determining the influence of salts on corrosion

Both raw water and drinking water can vary in their composition, with salts playing a particularly significant role. They dissociate in water and intervene in the process as ions: they either promote corrosion by facilitating the formation of soluble species or inhibit it through the deposition of solid substances on the surface. To investigate the short-term influence on copper corrosion, a copper pipe—previously equilibrated in the test water—is installed in a circulation apparatus. Either a single salt or a combination of several salts is added to the test water, and the release of copper is monitored over time to determine the salts' impact. **Salts capable of influencing copper corrosion include sulfates, nitrates, and chlorides.** Together with bicarbonate, these typically constitute the most important minor constituents found in drinking water.

3.5 Determining the influence of inhibitors on corrosion

Inhibitors are employed to reduce both copper corrosion and copper release. To evaluate the efficacy of an inhibitor, static tests or flow-through experiments of extended duration are often required, as its effect can frequently only be reliably demonstrated after several weeks. The inhibitor's impact on the metal or alloy can be determined by examining the surface using optical or spectrometric methods. Concurrently, the release of copper into the water can be quantified by analyzing the contact water. The corresponding test procedures are described in the next article.

3.6 Procedure for problems in drinking water installation

If greenish-blue deposits form on fixtures or sanitary installations, they consist primarily of limescale and often contain only a minor proportion of copper. This may be interpreted as an indication of surface corrosion of copper materials within the drinking water installation; however, it does not constitute proof of elevated copper corrosion. Conversely, water that appears blue or green indicates high copper concentrations. A water analysis can be used to determine whether elevated corrosion is present. The Federal Environment Agency has issued recommendations for sampling procedures for this purpose [29]. According to these recommendations, the pipeline under examination is flushed until the water temperature remains constant. Subsequently, a 1-liter sample (S0) is collected. The fixture is then shut off and left unused for four hours. Following this period, the first (S1) and second (S2) stagnation samples are collected in succession, with each sample having a volume of one liter. All three samples are analyzed for their copper content. None of the samples may exceed the limit value of 2.0 mg/L of copper. Sample S0 is considered representative of the domestic service connection—specifically, the mains or incoming water. Sample S1 reflects the copper concentration in the immediate vicinity of the fixture, while Sample S2 reflects the concentration within the remainder of the drinking water installation. The procedure described is also applied to determine nickel and lead levels, in accordance with the EU Drinking Water Ordinance.

4. Summary

Copper and copper alloys—such as brass and gunmetal—are popular materials for drinking water installations due to their excellent processing properties and low susceptibility to corrosion. However, through surface corrosion, copper—a heavy metal—continuously leaches into the water within the pH range typical for drinking water. Nevertheless, the limit value of 2 mg/L after 16 weeks of operation is rarely exceeded. Stagnant water should always be flushed out before use; this applies particularly to new installations. If the water supplier possesses data demonstrating that this requirement cannot be met given the specific water quality, they are obliged to inform the customer accordingly. Furthermore, in the presence of acidic, weakly buffered water, pitting corrosion may occur. This constitutes the primary cause of corrosion-related damage in drinking water installations.

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