Environmental enforcement

NOTICES ON
WATER PROTECTION

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Electromagnetic Water treatment

Case studies in wastewater treatment plants and drinking water applicat

Federal Office for the Environment, Forests and Landscape (BUWAL)

3.2.1 Drinking water supply with hard water

As part of the dissertation, in addition to investigations of wastewater treatment plants, a case study on the use of electromagnetic fields in a drinking water supply system was conducted. The drinking water sector and the deposits occurring within it represent a chemically far less complex system than wastewater treatment plants.

The drinking water case study examined involves a drinking water supply independent of the municipal drinking water network, which is fed by three sources of extremely hard water.

Table 3.5 : Average drinking water composition

PH	7.8 (- **8.4)**
conductivity	1000 - 1400 pS/cm 4
alkalinity	mM (-6 mM) 2.6
~a2+	mM
~g2+	1.2 mM
~0~2-	Approximately 1.8 mM (estimated)

The hard drinking water leads to significant limescale problems, requiring regular and costly maintenance work at various locations within the system that uses the drinking water. The limescale problems were most severe in the cooling system of the refrigeration compressors, in the kitchen (dish, glass, and stainless steel cleaning), and on the heating elements of three boilers. Since conventional remediation proposals (adding hardness stabilizers to the raw water, a reverse osmosis system for the humidifiers and drinking water, water softeners for the kitchen, or internal pipe coating) are expensive and potentially problematic from a bacteriological or corrosive perspective with alternating operation, an experiment using electromagnetic fields was undertaken.

Problems with air conditioning

In the cooling system of the refrigeration compressors, the cooling water is heated from approximately 10°C to 28-30°C. This leads to a 1.26-fold increase in CaCO3 supersaturation (Fig. 3.1 3.).

Experiment with electromagnetic fields

The investigation of limescale formation in the cooling pipes of the refrigeration compressors was conducted as a "before/after" comparison: At the start of the experiment, a section of pipe that had been installed in the line for two years was cut out and replaced with a corresponding new pipe (same material from the same delivery). This new pipe section was then cut out again one year later. This resulted in a comparison of identical pipes in the same location over an observation period of three years. No changes were made to the system's operation while the pipes were installed. The operating temperature at the location of the removed test pipes is between 28 and 30°C.

Results

1. Visual findings: The difference in the thickness of the formed layer is striking. Assuming that the density of the crusts is the same, six times less material has been deposited under field influence in the same time period than under reference conditions.

2. Chemical composition: In both cases, the deposit consists mainly of calcium carbonate. In contrast to the total amount of precipitated calcium, the iron content does not appear to have been affected by the fields.

3. Powder diffractometry: The investigations of the deposits formed in the cooling tubes revealed that the mineral composition is different compared to the reference: Where pure aragonite had been found before the installation of the electromagnetic devices, the X-ray analysis of the deposits formed under experimental conditions showed approximately equal proportions of calcite and aragonite.

F 35 Powder diffractogram of the deposits from the sample formed under field influence (top image), the reference sample without field influence (2nd image), and comparison images with pure calcite and pure aragonite. The reference sample consists of pure aragonite (no calcite lines). The sample from the experiment consists of approximately equal parts calcite and aragonite.

4. REM recordings :

Scanning electron microscope images of the reference sample show beautiful aragonite needles and prisms, either aggregated into bundles or occurring individually. The precipitation formed under field influence (even at 5000x magnification) shows only a porous, unstructured accumulation of microcrystalline crystals.

Fig. 3, %E.: Scanning electron microscope images from the cooling pipe of the refrigeration compressors at a magnification of 200 times: the images on the left (reference) show beautiful aragonite needles, the image on the right (deposition formed under field influence) shows no recognizable crystalline structures.

Conclusions from the drinking water case study

The case study in the drinking water sector, a relatively clean system compared to sewage treatment plants , led to more differentiated and insightful observations.

Under the conditions provided by the local drinking water, the pipe network and the fields used, the following changes could be observed:

- The amount of lime deposited was reduced by a factor of 6 by the electromagnetic field .
- The amount of iron deposited is not dependent on the field. Due to the reduction in the amount of lime deposited, the percentage of iron is significantly higher under field influence (dilution effect).
- The crystal modification of the precipitate remaining on the tube wall changed under the influence of the electromagnetic fields. While the reference consisted of aragonite, the crystalline structure from the experiment consists of a Ca 1:1 mixture of calcite and aragonite.
- The SEM clearly shows that the crystal habit is changed: The reference sample shows well-formed aragonite needles, while in the sample from the experiment no crystalline forms are visible even at high resolution.

The observations described here should not be generalized. They were made in the described situation under these experimental conditions. Similar observations have been described in the literature.