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**Influence of electromagnetic fields on  
Crystallization processes: Practical applications in  
sludge treatment of wastewater treatment plants and in  
Drinking water systems**

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## Summary

This work addresses questions related to the influence of electromagnetic fields on a possible reduction of deposits.

in pipes. The investigations were carried out with a device that uses coils wound around the pipes to generate specific electromagnetic fields.

generated. Case studies were conducted in the slurry treatment systems of two wastewater treatment plants and in a drinking water supply system .

Specifically, it concerned three aspects:

1. Do electromagnetic fields lead to phenomenological differences in Crystallization processes?
2. Is it possible to control electromagnetic fields even in complex technical systems such as Successfully using wastewater treatment plants?
3. Which mechanisms of action need to be examined more closely with regard to their role? become?

ad 1.:

The investigations within the drinking water case study yielded interesting observations thanks to the relatively clean conditions:

Under the influence of the field, the thickness of the built-up layer decreased (6 times less).

Material). Crystal modification and crystal habit also showed clear differences. Similar observations can be found in the literature of other authors.

confirmed.

Furthermore, the quantitative proportion of a ferrimagnetic iron phase decreased under the influence of the field . This finding has so far been considered a hypothesis. proposed, but never experimentally proven.

ad 2.:

The application area in sludge treatment of wastewater treatment plants was specified as the central research topic.

A first case study took place at the ARA Werdhölzli (Zurich), where calcification problems which led to the addition of phosphoric acid to the sewage water. For the

In subsequent tests, the acid dosage was reduced to 50%. The layer buildup remained low, but no difference could be detected between the treated sections and the reference sections. Only a further test phase under highly calcifying conditions led to a difference in the rate of layer buildup.

The effectiveness of the devices used here was insufficient for a worthwhile application.

In another wastewater treatment plant in Worblental (Canton of Bern), mineral deposits on the heat exchangers threatened the maintenance of the operating temperature required for anaerobic digestion. The deposits consisted of vivianite, a

Divalent iron phosphate. It was demonstrated here that with a device allowing the adjustment of field parameters, the formation of new deposits can be completely prevented.  
can be prevented.

In practical applications, the (old) experience has thus been repeated that the

The successful use of electromagnetic devices depends heavily on the fields and the

This depends on physicochemical boundary conditions. The case studies illustrate that this technique is indeed practically applicable in complex systems. In terms of a sustainable solution, it can save energy and costs and reduce the salt load of drinking water and waterways.

ad 3.:

The present observations as well as theoretical considerations from physics and

Chemistry leads to the idea that forces are exerted on the body by electromagnetic fields.

Charge carriers are exerted that influence the crystallization behavior in aqueous solution. To understand the relationships between electromagnetic fields and the

To understand the chemical processes of crystallization at the molecular level,

Laboratory experiments are conducted in defined systems.

## Summary

This work deals with questions concerning the application of electromagnetic fields to prevent scale formation in pipes. Case studies included the sludge treatment of two wastewater treatment plants and a drinking water supply with very hard water.

The three main questions were:

1. Do electromagnetic fields lead to differences in crystallization processes?
2. Can electromagnetic fields be successfully used in complex technical systems like wastewater treatment plants?
3. What are the possible mechanisms and what are the relevant topics for further investigations?

First Question:

In the experimental work a device was used which produces electromagnetic fields. Through coils, the fields are induced in water pipes. The case study involving very hard drinking water yielded interesting findings:

First, under the influence of electromagnetic fields, the scale thickness, crystal structure and shape of crystals changed. These observations are supported in the literature.

It was also observed that under the influence of electromagnetic fields the amount of a ferrimagnetic iron phase changed. This effect has been suggested as a hypothesis but never been experimentally verified.

Question 2:

The application of this technique in the anaerobic fermentation of activated sludge in a Wastewater treatment plant was the central focus of this project.

A first case study took place in the wastewater treatment plant Werdhölzli (Zurich, Switzerland), where scaling is controlled by the addition of phosphoric acid to the fouling water. As an experiment, electromagnetic devices were installed and at the same time amount of the acid was reduced by half. There was little scaling but also no difference between treated sections and the reference sections could be found. A further

experimental phase under strongly precipitating conditions led to a noticeable effect in respect to the time required for scaling. Though for a successful use of the devices, a further optimization was needed.

A second case study took place in the wastewater treatment plant in Worblental (near Bern, Switzerland), where mineral deposits in heat exchangers reduced the temperature of the fouling process drastically. These deposits consist of vivianite, an iron(II) phosphate.

By using an adjustable electromagnetic device the formation of mineral deposits was prevented completely.

The case studies confirmed the old experience that a successful application of electromagnetic fields depends strongly on the kind of fields and the physical-chemical boundary conditions.

The case studies showed that this technique can indeed be of good use in complex systems. It can contribute to a sustainable prevention of scaling, thereby saving energy, costs and, in respect to the use of ion exchangers, reduce the consequent salt load of drinking water and freshwater bodies.

#### Question

3: This work, combined with theoretical physical and chemical principles, provides some clues to the mechanism of possible anti-scaling effects of electromagnetic water treatment: Electromagnetic fields exert forces on charges. As a consequence the crystallization behavior in the electrolyte solution changes. For a better understanding of the interactions of electromagnetic fields and chemical processes at the molecular level, laboratory experiments in clean, defined systems are required.