

#### 40.- FACT, Filtration Assisted Crystallization Technology

<b>Title and name of product or technology</b>
FACT, Filtration Assisted Crystallization Technology
<b>Abstract</b>
<p>FACT, which stands for Filtration Assisted Crystallization Technology, is a hybrid process based on heterogeneous crystallization and filtration. During the process development heterogeneous seeds are selected, which enable a combination of fast crystallization and easy filtration. In the FACT-concept a small amount of an ion/molecule to be removed on the surface of a small amount of heterogeneous (i.e. of another chemical composition than the material to be removed) seeds in a crystallizer. Next, a filter separates the seeds with the layer of crystallized material from the solvent (often but not exclusively water). The grown seeds are then recycled to the crystallizer as a concentrated suspension. Consequently, the heterogeneous seeds grow during the FACT process until the moment that they are bled off when they reached the required size. FACT is compact due to the fast crystallization and easy filtration and it has been shown for water softening – one of the many possible applications of FACT – that it can compete technically and economically with alternative softening technologies like the pellet reactor and ion exchange.</p>
<b>Description including main features/advantages</b>
<p>FACT, a new generic process developed by TNO, can amongst others be applied for the removal of hardness by means of the precipitation of calcium carbonate (<math>\text{CaCO}_3</math>) on heterogeneous seeds. During the development heterogeneous seeds are selected by Medium Throughput Screening techniques, which accelerate the crystallization and which can easily be separated from the treated liquid. The acceleration of the crystallization is caused by stimulation of the heterogeneous nucleation. Examples of interactions between the seed and the material to be crystallized that can stimulate heterogeneous nucleation are preferential adsorption of the reacting ions and/or a good lattice matching between the seed and the crystal. The size of the seeds, which determines the surface area available for crystallization, is not only important for the crystallization kinetics, but also for the solid-liquid separation. In FACT the heterogeneous seeds are typically in the range between 5 and 50 <math>\mu\text{m}</math>. This seed size is large enough to enable an easy and cheap S-L separation by standard filters and small enough to small enough to accelerate crystallization by providing a sufficiently large active surface area for crystallization.</p>
<b>Innovative aspects</b>
<p>The innovation in FACT-concept is the use of a relatively small amount (about 1 g/l) of heterogeneous seeds which create process advantages like a significant increase of the crystallization kinetics, while at the other hand a compact and cheap filter can be utilized for the S-L separation. The heterogeneous seeds are recycled to the crystallizer after filtration. TNO has applied for a patent on the FACT process. An important advantage of FACT is that it is a generic applicable hybrid process. For the application of FACT in the softening of water the following advantages were demonstrated:</p> <ul style="list-style-type: none"><li>• <math>\text{Ca}^{2+}</math>-ions could be removed very efficiently with FACT. The removal could be tuned at levels between 50 and 98%, thus also creating the possibility of split stream treatment.</li><li>• FACT has the potential to be cheaper than competing – state of the art – softening techniques like the Pellet Reactor</li><li>• FACT is much more flexible in the choice of the process conditions/-concepts and the type of seed material than the Pellet Reactor</li><li>• The combination of a fast crystallization kinetics (5-10 times faster) and the low height of the unit operations ensure that FACT-installations can be much more compact than the Pellet Reactor.</li></ul>

- Both the softened water and the removed  $\text{CaCO}_3$  can be (re)used easily, so it is a potential water free process.

**Current and potential industrial users/domains of application**

Until now the development of FACT has been focused on the softening of ground-/drinking-/process-water. The FACT-concept is generic and can for instance also be applied for the removal of  $\text{F}^-$ , heavy metals or  $\text{PO}_4^{3-}$  from process- or wastewater. A further promising application of FACT is to use the concept for a controlled change of the shape and/or size and/or polymorph of solid products like fine chemicals and/or pharmaceuticals.

**Current state of development**

On site pilot plant experiments have been carried out for the FACT concept for two industrial ground- and process water streams at a scale of up to 5-10  $\text{m}^3/\text{hour}$  using calcium silicate as heterogeneous seed and a Pulse Tube Filter for the solid-liquid separation. In these tests the water streams were softened successfully with FACT: the  $\text{Ca}^{2+}$ -concentrations could be decreased by 80-85%, the solids content in the filtrate was below specification and high filtration fluxes between 2.5 and 4  $\text{m}^3/\text{m}^2.\text{hr}$  could be realized with the Pulse Tube Filter at relatively low pressures between 0.2 and 2.5 bar. The experimentally measured crystallization and filtration data were used in a rough economic evaluation of the costs for the softening of groundwater with FACT. This evaluation showed that FACT could be about 30% cheaper than the costs for softening with the pellet reactor, the state-of-the-art technique for the production of Dutch drinking water.

FACT has reached the status of proof of concept and is close to implementation. Main points of attention during the further development are solving unwanted scaling on some components in the installation – potential technical solutions have been identified but not yet tested – and to demonstrate long term stability and robustness of the FACT process.

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