

Commercialization of the pellet method softening.

Bringing radical changes to waterworks and society.

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INTRODUCTION

Decrease in water hardness would result in a significant social and environmental benefits. Therefore, many waterworks have been interested in a solution that could be applied and bring better water quality to their clients. Basing on this need a cooperation between Dutch consulting company Royal HaskoningDHV and Danwatec was initiated to adopt pellet reactor method as the most suitable softening technology for Danish waterworks. The pellet method, vastly used in Netherlands for more than 30 years, is based on a precipitation of calcium carbonate as a consequence of dosing sodium hydroxide and pH increase occurring in a fluidized bed reactor. Store Heddinge waterworks management board seriously considered implementing a full scale softening at their plant. Although the pellet method is known to be more suitable to large size waterworks, its adopting to medium size waterworks, like Store Heddinge waterworks, was a challenge that was a main aim to overcome in this project. Moreover, to make it happen different actors had been approached to clarify any uncertainties regarding the new water processing. Those actors and their main area of interest were following:

Waterworks	Customers	Municipality
<ul style="list-style-type: none"> Process specifications Cost: investment and operation Water quality 	<ul style="list-style-type: none"> Price vs saving Health Water taste 	<ul style="list-style-type: none"> Health Safety Permission

Therefore a path to implement full scale softening plant was convoluted and involved decision makers at all levels, see Figure 1. This took time and required thoroughly preparation to give all necessary information, for example to run the pilot scale investigations.

PILOT PLANT

The pilot investigations started in summer 2015 and had following aims:

- Develop an expertise about adaptation of the pellet method to Danish requirements;
- Produce pellets and examine their quality;
- Evaluate the tools for modelling water quality (PHREEQC software and databases);
- Trials to identify main process parameters and optimize it.

During the a year of pilot plant operation it was possible to build a bridge between Dutch expertise in the field of constructing and operating the pellet reactor with Danish drinking water requirements, that were used especially for supporting full scale softening process application to the municipality. Obtained results of pellets produced in pilot plant helped in finding the end user, local farmer, for a large amount that supposed to be produced in the full-scale treatment plant.

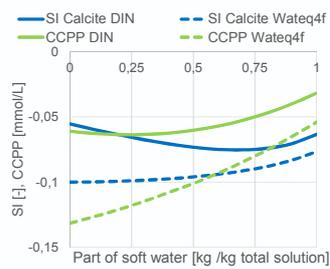


Figure 2 Results of applying different models for calculating of SI and CCPP of soft and hard water mixtures

Another useful tool, applied to evaluate data collected during pilot plant investigations, was principal component analysis (PCA). The analysis helped in extracting necessary information and get better view on correlated variables. For example, Figure 3, where some normalized data were analyzed show positive correlation between NaOH dosing rate ("Dosing-NaOH") and pH in reactor outflow ("Reactor-pH"), but negative correlation of those factors to bacteria count ("Kimalt") found in reactor outflow.

Figure 3 Example of applying principal component analysis on data collected from the pilot plant. Loading plot for PC1 and PC2.

References:
Standard: DIN 38404-10; GERMAN STANDARD METHODS FOR THE EXAMINATION OF WATER, WASTE WATER AND SLUDGE - PHYSICAL AND PHYSICO-CHEMICAL PARAMETERS (GROUP C) - PART 10: CALCULATION OF THE CALCIT SATURATION OF WATER (C 10)

To control water quality a widespread practice is to use Langelier Saturation Index but, due to its simplification, different other models were applied and evaluated to calculate CaCO₃ saturation index (SI) and calcium carbonate precipitation potential (CCPP). Application of more sophisticated models, taking into consideration dissolved species, was possible with use of PHREEQC software. On Figure 2 results from applying two databases are presented; German standard method DIN 38404-10 and Wateq4f database. The Wateq4f includes more species, like strontium and fluoride, that are not included in the German standard, which could explain differences.

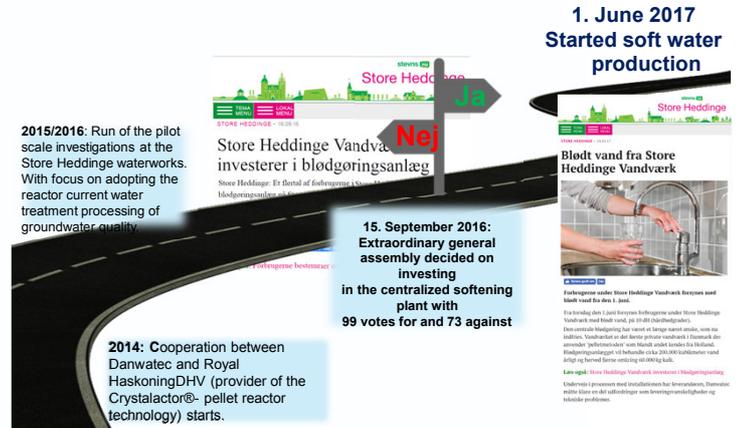
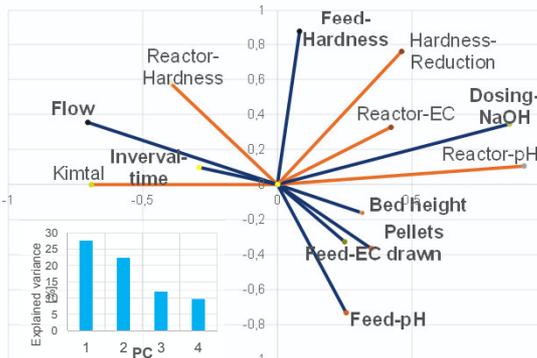


Figure 1 A path to the full pellet reactor softening plant in Store Heddinge waterworks

FULL SCALE PELLETT REACTOR

The full scale softening plant, Picture 1, started officially producing soft water since 1st June 2017, and since then a new water quality was widely commented by the customers. Among the feedback following comments could have been found:

- Generally glad for the change, even though initial concerns;
 - Noticeably reduced problem with scale on household appliances items;
 - Question why they receive medium hard water, and not the soft one;
 - Claim a change in water taste - 'flat' water.
- However, there are also customers with negative attitude toward the new water processing and complained about "natrium hydroxide in the water" or too high pH, even though none of those has been measured by them. None of this was found in analyses of samples that were collected every week for a few months after starting pumping soft water to customers.

Also waterworks could have seen direct savings with applying pellet reactor, because treating of raw water enabled to decrease iron levels before filtration, Figure 4, and therefore decrease amount of produced backwash sludge.

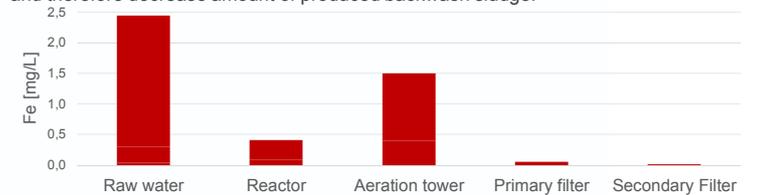


Figure 4 Iron concentration at each stage of water processing after applying pellet reactor method.

Picture 1 Full scale pellet reactor commissioned to Store Heddinge waterworks.



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