Increased sustainability of softening by producing pure calcite pellets for reuse

Hofs, B; Baars, ET; Palmen, LJ; Elings, JA; Kors, L.J.; Kramer, Onno; Koppers, H; van der Hoek, Jan Peter

Publication date
2015

Document Version
Final published version

Published in
AIWW Conference

AMSTERDAM INTERNATIONAL WATER WEEK

Increased sustainability of softening by producing pure calcite pellets for reuse

B. Hofs[*], E.T. Baars[**], L.J. Palmen[*], J. Elings[***], L.J. Kors[**], O.J.I. Kramer[**], H. Koppers[***], J.P. van der Hoek[,****]**

* KWR Watercycle Research Institute, P.O. Box 1072, 3430 BB, Nieuwegein, the Netherlands
** Waternet, P.O. Box 8169, 1005 AD, Amsterdam, the Netherlands
*** Reststoffenunie Waterleidingbedrijven, P.O. Box 1072, 3430 BB, Nieuwegein, the Netherlands
**** Delft University of Technology, P.O. Box 5048, 2600 GA, Delft, the Netherlands

Abstract: About 50% of the drinking water in the Netherlands is centrally softened by the drinking water companies in a process known as pellet softening. In this process a base and seeding material are mixed in an upflow reactor, where subsequently $CaCO_3$ precipitates on a seed core as pellets. The seeding material is usually sand, but recently $CaCO_3$ was introduced as seeding material at several full scale plants. The pure calcite pellets that are produced as a by-product in these plants can be reused as seeding material, after grinding and sieving part of the produced pellets. The main advantages of this reuse are an expected significant decrease of the ecological footprint of both calcite as raw material and the drinking water treatment plants using pellet softening, and increased valorisation of the pellets. However, the handling and processing of the pellets and seeding material should be such, that microbiological and chemical contamination risks of the drinking water are negligible. This research shows that grinded and sieved $CaCO_3$ outperforms commercial $CaCO_3$ and that microbiological risks can be adequately controlled.

Keywords: calcium carbonate; precipitation; pellet softening

Introduction

In the Netherlands central softening reactors are used to treat about 50% of the drinking water, in a process known as pellet softening (Hofman et al. 2007). In pellet softening, raw water and a base are mixed in the bottom of an upflow reactor, filled with water and pellets. The base causes supersaturation of $CaCO_3$, which precipitates on the pellets and seeds.

Till recently, sand was used as seeding material. Theoretically, there is no reason why $CaCO_3$ cannot be used as a seeding material; the density is very similar to that of (normal) sand (both about 2.7 kg/dm^3), and $CaCO_3$ will readily precipitate onto it. The advantage of using $CaCO_3$ as seed is that a much purer by-product is obtained as no sand is then included in the pellets. This allows for applications of increased value, and is one of the reasons why several Dutch drinking water companies have recently switched to using $CaCO_3$ as seeding material instead of sand. Also, the ecological impact of the total drinking water treatment plant (DWTP) could be reduced significantly by locally reusing grinded and sieved $CaCO_3$ pellets as seeding material (Schetters et al. 2014).

In this research, performed around the full scale tests at DWTP Weesperkarspel (from water utility company Waternet), pellet softening with either commercially available $CaCO_3$ or grinded and sieved $CaCO_3$ pellets as seeding material was studied. The emphasis was on the comparison of the performance of these two types of seeding material, and the microbiological aspects (both during processing and complying with regulations).

Material and Methods

At DWTP Weesperkarspel the water temperature, water flow, caustic soda flow, pH, turbidity, Ca^{2+}(aq) and HCO_3^-(aq) concentration of reactor influent and effluent were

measured on a regular basis. The seeding material consumption was also monitored. These measurements provided sufficient information to assess the softening process.

Locally produced pellets with a $CaCO_3$ core were transported, processed and transported again, and samples were taken during the processing in order to investigate the presence of *E. coli*, Enterococci, spores of sulphate-reducing clostridia (SSRC) and *Clostridium perfringens*.

Results and Conclusions

Pellet softening on full scale with sand, and both commercially available, and grinded and sieved $CaCO_3$ pellets as seeding material (Fig. 1) showed that the commercially available $CaCO_3$ is outperformed with respect to turbidity by the grinded and sieved pellets, which perform as well as the sand. Differences are small, but the turbidity of the effluent of the reactors is lower when grinded and sieved pellets (or sand) are used as seeding material.

Samples from the seeding material processing chain (produced from pellets) do not give rise to alarming changes (Table 1) in microbiological activity, although hygienic transport, storage and processing is needed. The produced seeding material conforms to current regulations in the Netherlands for use of sand as seeding material in drinking water treatment.

Pure calcite pellets produced with commercial calcite seed in pellet softening by Dutch drinking water companies are already applied in industry. Locally grinded calcite pellets are used by Desso as one of the raw materials in their carpet's back (EcoBase™), which has a Cradle to cradle® certificate.

Grinded and sieved pellets outperform commercial $CaCO_3$ as seeding material in pellet softening. Microbiological risks of using grinded and sieved pellets as seeding material can be controlled by taking adequate measures.

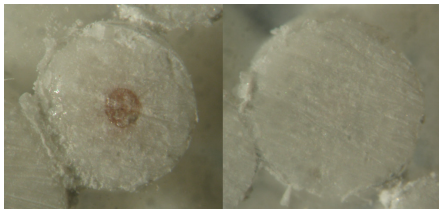

Fig. 1 Cross section of pellets produced in softening with either a core of sand (left) or commercial $CaCO_3$ (right), diameter is about 1 mm.

Table 1 Results of microbiological analysis from samples taken during and after processing of pellets.

Sample	Indicator			
	E. coli	Enterococci	SSRC	*Clostridium perfringens*
	[cfu/10 ml $CaCO_3$]			
Produced pellets in storage bunker	<1	<1	<1	<1
Before drying	<1	<1	<1	<1
After drying and cooling	<1	<1	<1	<1
After grinding	<1	<1	<1	<1
Produced seeding material	<1	<1	1	1

Required by law in the Netherlands (for use as seeding material in drinking water treatment - BRL-K240): *E. coli,* Enterococci <1 colony forming units (cfu) per ml $CaCO_3$; SSRC and *C. perfringens* < 10 cfu/10 ml $CaCO_3$.

References

Hofman, J., Van Der Hoek, J.P., Nederlof, M. and Groenendijk, M. (2007) Twenty years of experience with centralised softening in the Netherlands: Water quality, environmental benefits, and costs. Water 21 (FEB), 21-24.

Schetters, M.J.A., van der Hoek, J.P., Kramer, O.J.I., Kors, L.J., Palmen, L.J., Hofs, B. and Koppers, H. (2014) Circular economy in drinking water treatment: reuse of grinded pellets as seeding material in the pellet softening process. Water Science and Technlogy, In Press, Uncorrected Proof.