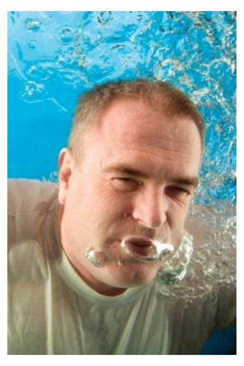

Production, use and reuse of Dutch calcite in drinking water pellet softening

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INTRODUCTION

In The Netherlands, 50% of the drinking water is treated with pellet softening for various reasons: i) public health (heavy metal solubility), ii) costs (warm water device maintenance, energy and soap requirement), iii) environmental benefits (energy and soap requirement) and iv) customer comfort (scaling) [2]. Calcium carbonate crystallizes on a seeding grain of garnet or sand and calcium carbonate pellets are produced as a by-product. These pellets are applied as a (secondary) raw material in industries such as the construction, agricultural and mineral-resource sector. The sand grain inside the pellet inhibits reuse as seeding material and application in high potential market segments such as glass, paper, food and feed. Pellet quality significantly improves by replacing the sand grain with a grain of calcite (calcium carbonate) since in such way the pellet exists of one component only and the iron content is reduced.

Earlier work showed that it is technologically possible and in some cases economically feasible to replace sand grains with commercially available calcite grains [3], obtained from limestone quarries (e.g. Italy or Germany). In order to further increase sustainability by reducing transportation, the drying, grinding and sieving of pellets and the reuse of this calcite as seeding material for softening was investigated on pilot scale at Waternet. Currently, the calcite reuse concept is tested at full scale at the Weesperkarspel facility of Waternet in a TKI project[1]. The objective is to investigate the feasibility of this reuse concept. An important aspect is the risk of contamination of the drinking water due to the reuse of calcite material which is processed externally.

METHODS

PILOT TESTS Pilot scale tests conducted at Weesperkarspel, Waternet under the following circumstances:

- Test period of 2.5 months (2013), during winter at low water temperatures (< 4 ^{O}C, most critical period for softening).
- Produced calcite pellets (1 mm) were dried, grinded and sieved in order to obtain the proof of principle and to attain indication of calcite processing efficiency (seeding material diameter spec: 0.5 mm).
- Softening pilot reactor set-up: ∅ = 30 cm; height = 6 m; velocity = 60-80 m/h
- Reference and calcite grain softening performance was compared in parallel set-up.
- Reference and calcite scenarios evaluation for water quality, costs, sustainability (LCA, Simapro) and operations & maintenance.

FULL SCALE TESTS Full scale duration test conducted at Weesperkarspel, Waternet:

- Test period of one year (February 2014 – February 2015):
- Seeding material transition from garnet to Italian calcite, and two transitions to Dutch calcite (summer run and winter run);
- Pellet and calcite monitoring program comprising:
  - Microbiological parameters (*E. coli*, *Enterococci, Clostridium perfringens*, SSRC)
  - Chemical parameters (e.g. calcium, iron, manganese, organic carbon and heavy metals)
  - Physical parameters (particle size distribution)
- Modeling of risk of heavy metal accumulation in calcite pellets and transfer to water phase
- Economic and sustainability evaluation and marketing study for novel calcite applications in Dutch industries.

Calcite reuse concept scheme :

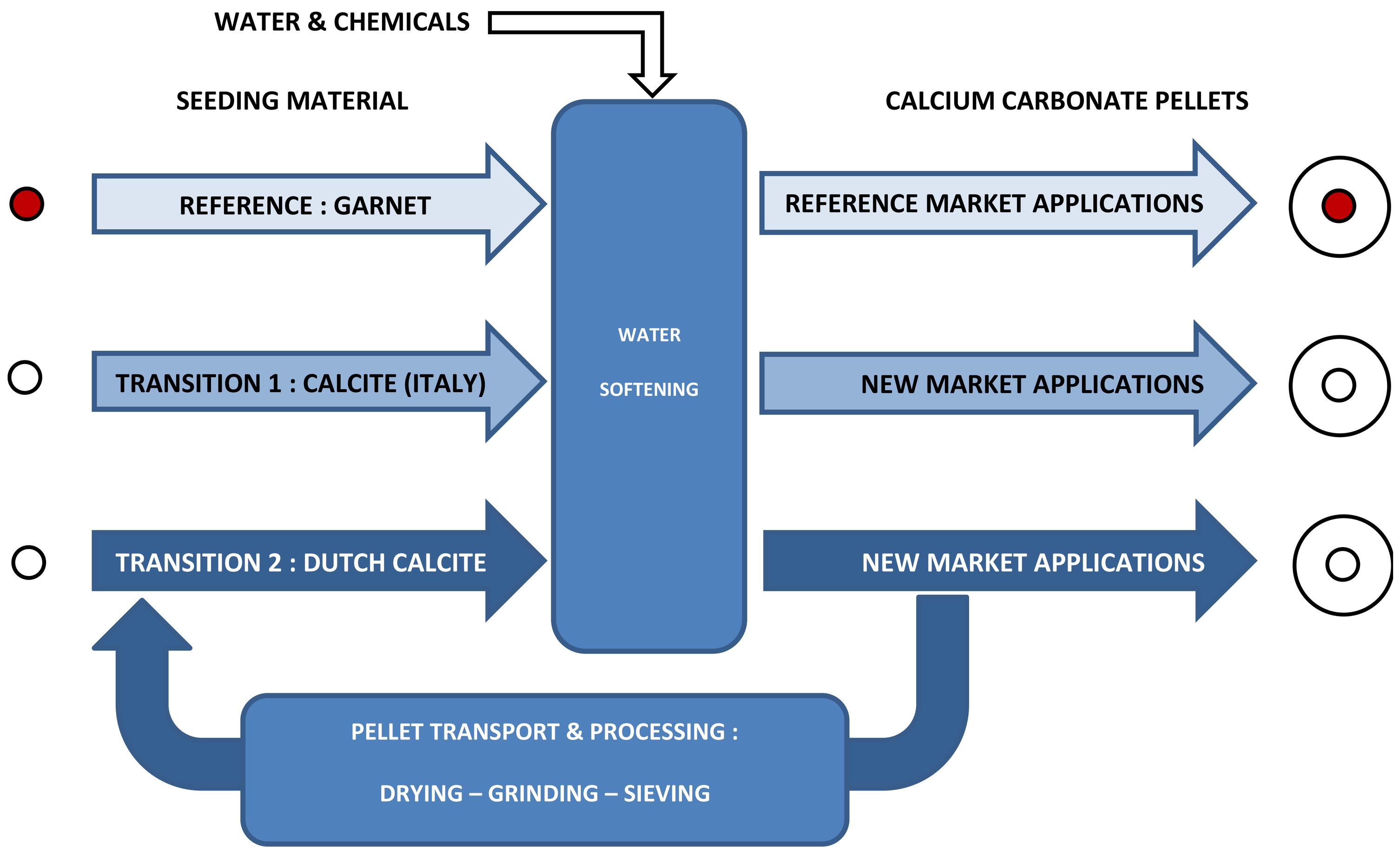

Figure 1 – Pellet softening by-product (calcium carbonate pellets) reuse concepts: reference case (garnet sand, Australia), 1st transition to high quality pellets (Italian calcite), and 2nd transition to Dutch calcite due to reuse of pellets as seeding material.

RESULTS

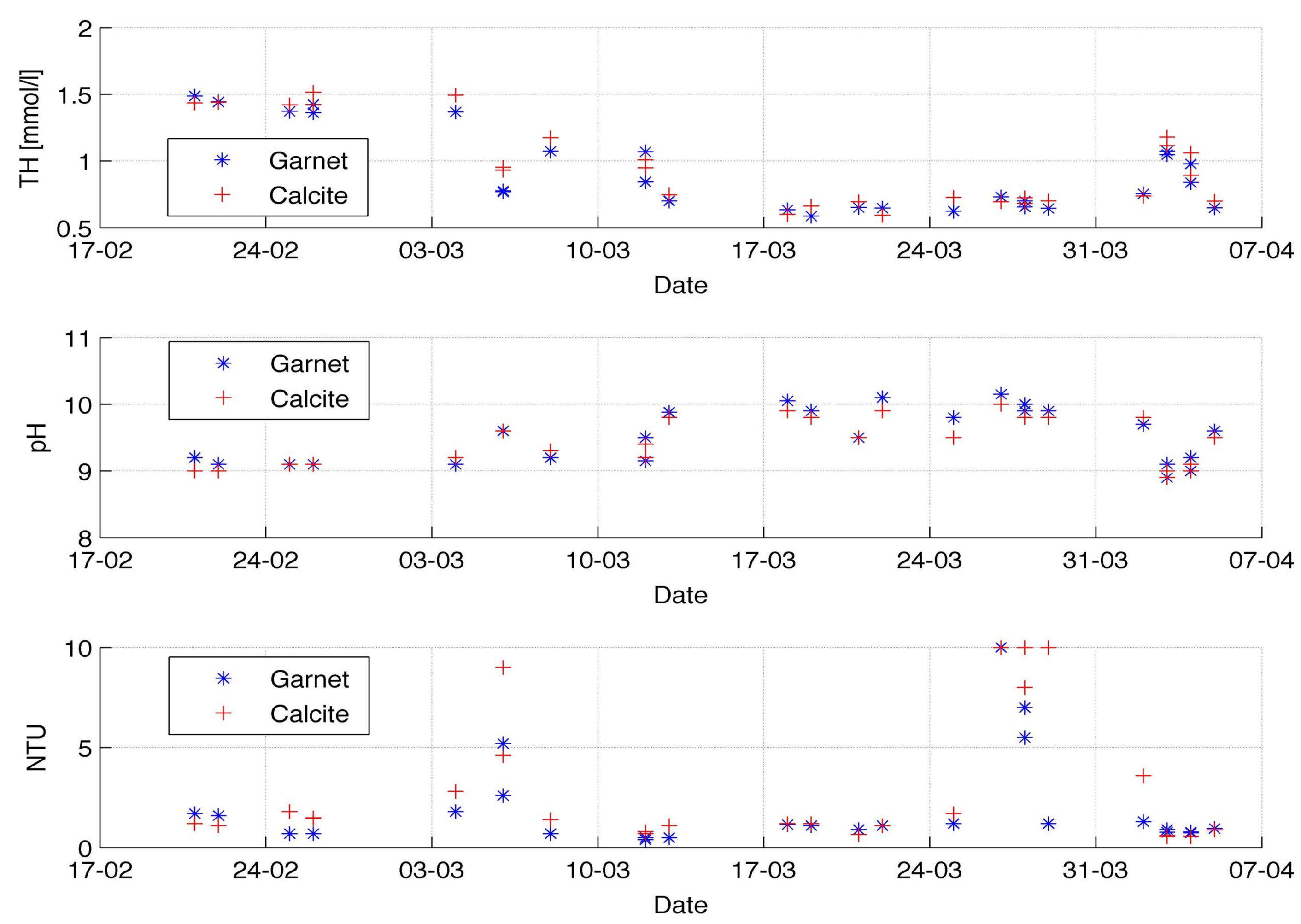

Figure 2 – Pilot plant research results: reactor effluent water quality for reference case (garnet) and reused calcite as seeding material

Table 1 – Economic business case for Weesperkarspel facility based on pilot plant research results

	Garnet case (reference)	Commercially purchased calcite	Calcite case (grind & reuse)
Grain density [kg/L]	4.1	2.7	
Grain size, d50 [mm]	0.25	0.5	
Annual grain usage [ton/y]	150	750	
Annual grain costs [k€/y]	55	113	38
Annual pellet production [ton/y]	1900	2200	1400
Annual turnover pellets [k€/y]	0	33	21
Net [k€/y]	- 55	- 80	- 17
Overall difference [k€/y]	**Reference**	**- 25**	**+ 38**

- Calcite processing efficiency at pilot scale: ~ 40%.
- Based on preliminary summer period results, the transition from garnet to Italian calcite seeding material at full scale seems technologically successful.

DISCUSSION

- Comparison of reactor effluent water quality at pilot scale for reference (garnet) and reused calcite case shows equal performance (Figure 2).
- It is expected that microbiological or chemical contamination throughout transport, processing and reuse of calcite in the softening process is meeting the risk standards.
- The economic business case shows that the transition from garnet to calcite is feasible in some cases. The calcite processing efficiency is an important input parameter which needs further research.
- The LCA concerning the Weesperkarspel plant showed a score of 225,000 ecopoints [1]. The scenario of grinded calcite seeding material results in an ecopoint decrease of 1.8 % due to reduced transportation of garnet. Usage of grinded pellets in Dutch industries (compared to imported calcite) results in an additional ecopoint decrease of 5% due to reduced transportation.

CONCLUSIONS

- Based on the pilot plant results, fluidized bed softening with reused ground calcite pellets is technologically possible, without compromising water quality, and is economically feasible for some cases
- Local production of softening seeding calcite material and local reuse of calcite is more sustainable: reduction of transportation of seeding material and calcite used by Dutch industries leads to a 7% decrease of the environmental impact of the Weesperkarspel plant.
- Modeling of heavy metal accumulation risk shows that heavy metals which are present in the source water, the softening chemicals and the seeding material show that accumulation in the pellets or subsequent transfer from seeding material to water phase does not occur.

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