inspiration booklet

REUSING WATER SECTOR RESIDUALS

A circular water chain is one that produces a minimum amount of waste, while the residuals find high-value applications in biological and technical loops. Whenever possible, this involves reprocessing the residual into the original feedstock material. Several great circular applications for residuals have already been developed within the water sector. These are presented in **part A** of this booklet. There are also a variety of current and new applications in which residuals and resources recovered from the water chain are used in other sectors. These applications are presented in **part B**.

AquaMinerals, May 2019

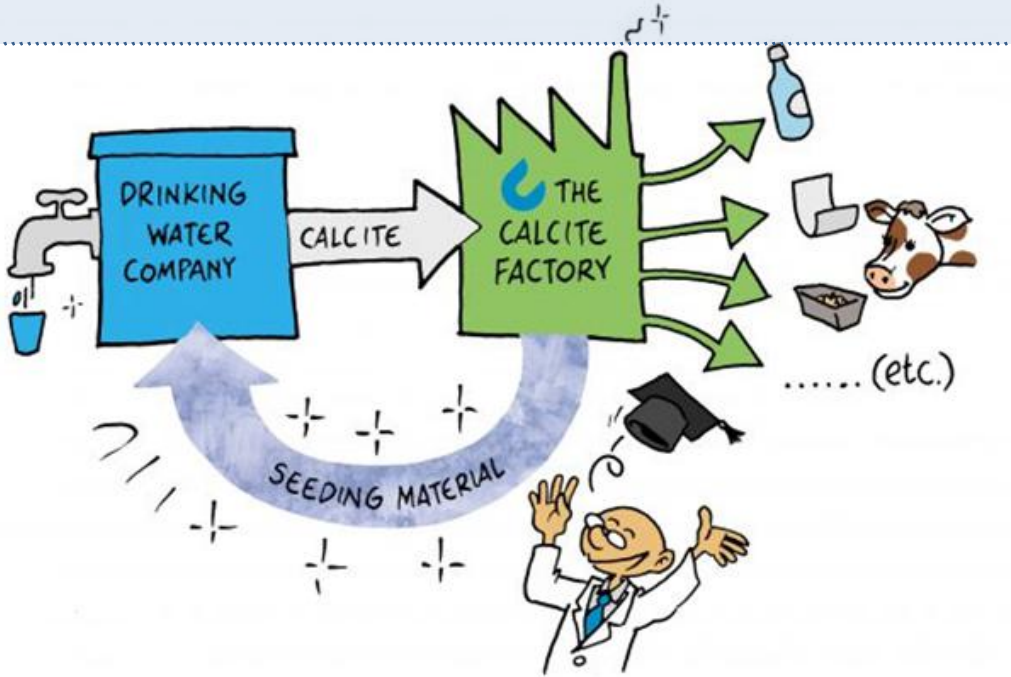
part A

8 examples

of circular reuse of residuals
within the water sector

Water softening with own calcite

Water softening processes that use calcite generate a sand-free calcite pellet which, after being ground, can be used in numerous high-value applications. The Calcite Factory in Amsterdam uses calcite pellets to produce seeding material that can be reused in the softening process, thereby closing the loop. Water softening using one's own calcite is not only circular, but the associated CO_2 footprint is much smaller, given that the seeding material comes from The Calcite Factory and not, as in the case of dolomite or garnet sand, from Italy, or of river sand from the Netherlands.



Remineralisation with broken sand-free calcite pellets

Membrane treatment, such as reverse osmosis (RO), is being increasingly used in water purification. A drawback of the current techniques is that all minerals, such as calcium, are removed from the water and then have to be returned to it. Calcium is reincorporated into the water by having it flow over a lime filter. In 2016, the Evides water company carried out pilot tests aimed at remineralising the water at low temperatures using broken and unbroken, sand-free calcite pellets. The results were positive.

Arsenic removal with iron pellets from aquafer

The Dutch drinking water sector has undertaken to cut arsenic concentrations in drinking water from the initial objective of 10 µg per litre to 1 µg per litre. Among the ways this can be achieved is to use sustainable iron pellets made from aquafer. Following lab research, the pellets were applied in practice at Dunea and Brabant Water production sites. The pellets performed superbly: arsenic concentrations remained below the targeted standard (TKI project).

Circular coagulant for the water sector

Drinking water companies and wastewater treatment processes use lots of iron salts as coagulants and flocculants. Working with Feralco and KWR, the drinking water companies are developing a coagulant made from aquafer that can be reused in the water sector (TKI project). In the first instance, this concerns coagulant from pure aquafer from groundwater abstraction, but there are prospects for creating a complete chain. The coagulant from groundwater sludge can be used for coagulating surface water. From the resulting coagulation sludge, one could again make a coagulant for application in a WWTP.

Adsorption pellets from aquafer

Aquafer, or ferric (hydr)oxide, is an excellent binding agent for phosphorus, sulphur and various heavy metals, such as arsenic. It is no surprise that aquafer has been used for decades in bio-digesters and WWTPs as a phosphorus- and sulphur-binding agent. There are also various commercial iron adsorption pellets available on the market. Together with KWR and Agravic, we are working on a similar iron pellet from aquafer for use in the removal of sulphur from (bio)gas, phosphorus from surface water and arsenic from groundwater (TKI project).

Ceramic with aquafer glazing

Terrazzo is Italian for terrace. The floors are made of mineral materials; small stones, marble pellets or pellets made from other materials, are bound by cement, dried and then polished. This flooring technique is hundreds of years old but remains very popular today. It is used in both indoor and outdoor floors, but also for wall cladding.
In the Groningen Water Company's 'industrial building of the future', Castellanos installed a terrazzo floor containing the company's own calcite pellets. Thanks to its impact- and scratch-resistance, this kind of floor is an excellent choice for the distribution centre.

Phosphorus-binding and odour control in wastewater treatment

Wastewater treatment processes use large amounts of iron salts to remove phosphorus from the wastewater and prevent the formation of hydrogen sulphide (H_2S). Rather than using iron salts, a number of WWTPs are applying doses of aquafer to precipitate the phosphorus and/or sulphur. The advantage is that there is less corrosive chlorine in the installations and the plant's CO_2 footprint is significantly reduced.

Algal control with ferrous sand

Many surface water bodies, such as ponds, lakes and ditches, have a blue-green algal problem in the summer. If the water contains enough nutrient (phosphorus), and if the temperature goes up, then algae can grow exponentially and present a hazard. ‘Zwemlust Nieuwersluis – the most attractive natural bathing pool in the Netherlands’ removes the phosphorus in its pool using ferrous sand. Similarly, ferrous sand is used in the ditches around De Blaricummermeent, a new residential area in Blaricum. The ferrous sand binds the phosphorus in a kind of filter, so that it is no longer available to the algae. We don’t yet have a technique to subsequently recover the phosphorus and regenerate the sand; only then would the application become truly circular.

part B

25 applications

with residuals and recovered materials
from drinking-water and wastewater treatment

Cradle-to-cradle carpet with sand-free calcite pellets

Every year, carpet manufacturer Desso uses 20 million kg of ground calcium carbonate made from pure calcite pellets in its EcoBase carpet tiles. This carpet backing earned a Cradle to Cradle Silver certificate and is 100% recyclable within Desso's own production process.

Only sand-free calcite pellets are suitable for use in Desso's carpet tiles, since the presence of sand would quickly cause the carpet cutters to become blunt.

Photo: Desso

Diamond glass with sand-free calcite pellets

Saint-Cobain produces a unique, colourless ('extra white') façade glass with a very low iron oxide content. The result is a glass with greater light transparency and considerably less green, when compared to normal window glass. The production of this glass requires a very pure lime. The white, 100% calcite pellets from the Limburg Water Distribution Company (WML) are perfectly suited for this purpose. The Apple Spaceship Campus is among the places where the SSG DIAMANT® glass is installed.

Applications with ground sand-free calcite pellets

The number of applications for ground limestone is virtually without limit. With ground sand-free calcite pellets we can supply all kinds of – and sometimes new – markets. Take, for instance, cattle fodder, fertilisers, **plastics (PVC)**, coatings, paints, gluing and abrasive agents, gas treatment, glass production, carpet backings, cement-binding agents, drilling fluids and ceramic products. All of these products are also used in the water sector, and therefore present ample new circular application opportunities.

Container glass with calcite pellets

The basic components of glass are sand, soda and lime. Ardagh's glass factory in Dongen uses large volumes of calcite pellets in producing its container glass, such as Coca-Cola bottles and HAK jars.
One important precondition is that the calcite pellets have to be delivered dry. This is why Van Lijssel Transport built an innovative truck, in which the calcite pellets are dried en route using the heat from the vehicle's engine.

Sulphur-binding in digesters with aquafer

The digestion of protein-rich biomass releases the stinking, poisonous gas hydrogen sulphide (H_2S). Two-thirds of the co-digesters in the Netherlands use aquafer to bind the sulphur and thus prevent the formation of H_2S. One great advantage of aquafer compared to ferric chloride, which is also used, is that it is not corrosive to the installation.
In addition, household-waste digesters, KGW digesters, sludge digesters and biodigesters in Germany, Belgium and France also use aquafer from the Dutch drinking water companies. The iron is incorporated into the natural loop via the digestate.

Miscellaneous

Research phase

Pulverised carbon in a sea-salt battery

In 2013 Dr Ten, a company specialised in product and process innovation, won the Jan Terlous Innovation Award for its development of a sea-salt battery. A battery of this kind offers an extremely clean and cheap means of storing energy. As a society, we have a great need for this storage capacity in our transition from fossil to sustainable energy. The battery is made of minerals, salts and carbon. A research project was launched at the end of 2016 to find out whether pulverised carbon from the drinking water sector could be made into a suitable source of carbon for these batteries.

Miscellaneous

(research)

Cellulose from screenings

Wastewater contains lots of toilet paper. Thanks to new techniques, the toilet paper can be screened out of the water before it flows into the treatment plant. These extracted materials are known as ‘screenings’.
About half of the screenings consist of cellulose fibres, a material with a number of interesting properties and a variety of applications. For example, as a raw material in panelling, paper and cardboard, bioplastics, insulation material, activated carbon, asphalt spill containers, or for the production of biogas via digestion.
The Water Authorities are working on the development of these applications within the framework of the Energy and Raw Materials Factory (EFGF).

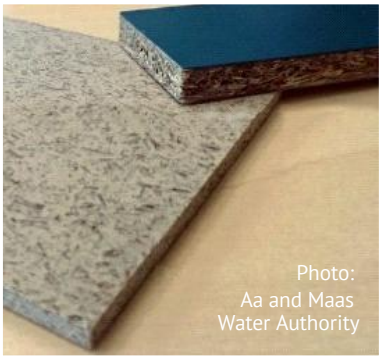


Photo:
Aa and Maas
Water Authority

Manure processing with coagulant from aquafer

Coagulant is used at the manure processing company, Mestverwerking de Kempen, to separate the thick and thin manure fractions. Previously, ferrous chloride was used for the task but, working with Feralco and AquaMinerals, a coagulant is now made on-site by acidifying the aquafer. This delivers a big environmental benefit because, in addition to using aquafer as a secondary raw material, it also involves the use of a secondary acid raw material.

Phosphorus control in flower bulb fields with ferrous sand

In the past, a great deal of phosphorus was used in flower bulb cultivation; today, lots of phosphorus still ends up, via the drainage systems, in surface water.
This is not desirable, since it leads to the eutrophication of the surface water, with blue-green algal formation as one of the consequences. By using ferrous sand rather than ordinary sand around the drainage pipes, at least 90% of the phosphorus can be trapped.
The concept was researched as early as 2010 at Wageningen University & Research (WUR). In 2018 it was applied for the first time in the field.

Nature development with iron-lime sludge

As a result of years of crop fertilisation, former agricultural lands contain lots of phosphorus, which hinders the development of highly biodiverse nature. In response, nature development measures often involve excavating such phosphorus-rich soil. But this approach is not only costly, it is also not always possible for cultural-historical or archaeological reasons, or because of its negative impact on water management. The addition of iron sludge or iron-lime sludge can offer an alternative, depending on the soils. The iron binds the phosphorus, making it unavailable to plants. Field trials have been successfully conducted with KWR, WUR, nature managers and drinking water companies.

Phosphorus fertiliser from struvite

Phosphorus is recovered from treatment sludge or wastewater in the form of struvite (magnesium ammonium phosphate). Struvite can be directly used as a fertiliser, or as a raw material in artificial phosphorus fertilisers and in various compound fertilisers. ICL Fertilisers uses struvite in its Amsterdam plant to replace part of the phosphorus it takes from phosphate ores. ICL's phosphorus fertilisers are sold all over the world. A growing number of Water Authorities are producing struvite within the framework of the Energy and Raw Materials Factory (EGFG).

Calcite pellets as slow-release fertiliser

Most lime fertilisers release quickly into the soil. But some applications actually require a lime fertiliser that releases slowly. Calcite pellets are perfectly suited for this. ECOstyle has for years sold calcite pellets to consumers and landscaping companies. In 2018, the agricultural cooperative company, Agrifirm, introduced calcite pellets to the market as a slow-release lime fertiliser for the agricultural sector.

Humic and fulvic acids as biostimulants

Humic and fulvic acids can be recovered from the brine produced by the regeneration of ion exchangers. These acids are excellent biostimulants, ensuring an efficient nutrient uptake by plants. This application is attracting growing interest as a means of producing more and safer food per surface area. Vitens has made a humic acid product, HumVi, at its Spannenburg location since 2015. The recovery of the acids is under development at other drinking water companies and Water Authorities.

Lime sludge as fertiliser

Farmers in the vicinity of drinking water production sites have long used lime sludge from drinking water as a fertiliser. The sludge can be applied dust-free, and works as quickly as commonly available lime fertilisers.

Poultry feed with calcite pellets

Poultry farmers like to see strong egg shells and a good egg mass. This is why lime is an important ingredient in our laying-bird feed. Following extensive tests, animal feed producer Agrifirm replaced the small lime stones in its poultry feed with calcite pellets from Vitens. To guarantee the safety of animal feed, the suppliers must obtain a GMP+ certificate for the product. Vitens has already succeeded in obtaining this certification for a variety of residual streams.

Pecking stones from calcite pellets

As a result of changes in the law aimed at improving animal welfare, the beaks of laying hens may no longer be trimmed or cut. Providing them with pecking stones prevents them from injuring each other with their natural beaks. Working with Ca Minerals, we developed a stone using lime pellets and ground pellets as a filler. Ca Minerals develops high-value calcium products from sustainable sources for feed, food, pharma and technical applications. We selected pellets from a variety of sites to achieve a good mineral mix; high magnesium content, for instance, has a calming effect on the hens.

Very pure lime in cattle fodder

Besides the pecking stones, we have developed another high-value calcite application with Ca Minerals for the feed industry. Since 2019, very pure and finely-ground calcite from the Limburg Water Distribution Company (WML) is being supplied as a carrier in pre-mixes for the production of milk replacers.
The product is being used by a global market leader in animal and fish feed. Sustainability and innovation are priorities here. The use of calcite from drinking water also contributes to reducing the CO_2 footprint.

Ceramics with aquafer glazing

The Lithuanian designer Agne Kucerenkaite uses aquafer in her glass and ceramic work. Her beautiful collection of glazed porcelain won the 'Good Design Award' in her native country, and was exhibited at the Dutch Design Week 2016. The designer recently expanded her collection with ceramic tiles. Each tile is handmade and unique, and the composition works with light and colours to produce a most attractive effect. This can be seen for instance at Jordy's Bakery in Rotterdam.

Bricks with coagulation sludge

Clay is the principal ingredient in bricks. Depending on the recipe, bricks can be made in all sorts of colours. One substance that affects a brick's colour is iron: it makes it red. Brick manufacturer Wienerberger uses iron-rich coagulation sludge from surface water abstraction processes to produce street bricks. The iron sludge serves not only as a colouring for the bricks, but also as a filler instead of clay.

Concrete with calcite pellets

The concrete industry is using more and more waste and recycled material in its products. Two producers use calcite pellets in their concrete to replace some of the sand. Struyk Verwo Infra uses the calcite pellets as an additive in concrete paving products, such as concrete street bricks and tiles. Heembeton (De Ruw Bouw Groep) employs calcite pellets in structural concrete, such as façades, walls and top elements.

Soil sealer from calcite pellets

Many crawl-spaces are affected by subsidence and humidity. De Schotgroep has for many years used calcite pellets to tackle these problems. The pellets are very suited for this, because they don't absorb moisture, have no capillary effect (i.e., do not draw water from below), and provide insulation. Moreover, because of the pellets' high pH level, both mould and odour nuisance are significantly reduced.

foto: Schot groep

Composite with calcite pellets

Ceramic products, such toilet bowls, washbasins and baths contain all kind of fillers. Calcite pellets are perfectly suited for this, because their round shape improves the flow behaviour. This is why the English company, Advanced Minerals, processes calcite pellets into its filler mixes for ceramic products.

Coloured lime pellets for aquaria and terraria

Creative owners like to add a little colour to the bottom of their aquaria. Traditionally, dyed sand or gravel has been used, but lime pellets can also be beautifully coloured. VDL Siergrind has long had decorative gravel made from calcite pellets in its product assortment – in all colours of the rainbow.

ECOstyle lime

ECOstyle markets calcite pellets – enriched with microorganisms – as a soil improvement product under the well-known 'AZ-Kalk' brand. Gardening enthusiasts use the calcite pellets to neutralise soil acidity. The advantage for the user is the product's easy, dust-free and year-round use. Landscaping companies also use this AZ lime.

Naïf circular scrub with drinking water lime

Working with the cosmetics brand Naïf, Waternet and The Calcite Factory, we succeeded in producing an ingredient that meets the strict requirements of the cosmetics industry. In making its scrubs, this industry still uses lots of microplastics, which are hazardous for the environment and drinking water. Scrub particles from the lime (calcite) that is extracted from drinking water offer an excellent alternative. After use, they are returned to the water, without any harmful side effects!

The examples in this booklet were developed by AquaMinerals with many of its partners, including the drinking water companies, Water Authorities, research institutes and market players, who could not always be mentioned.

For additional attractive examples from the wastewater chain, we gladly refer you to the Energy and Raw Materials website: www.efgf.nl.

Further information

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