The future of drinking water

A pilot study is testing a new system for producing fresh drinking water from brackish groundwater

Predicted future growth in population numbers and rising sea levels mean demand for drinking water will continue to increase just as the natural availability of freshwater decreases. It is likely that brackish groundwater will be an important source of drinking water in the future, but the current methods used to produce fresh water from this source are expensive in terms of their energy use and environmental impact.

A new process for producing drinking water from brackish groundwater is about to be trialled in the Netherlands. The results, which will be available following the two-year pilot, will determine whether a cheaper and more energy-efficient alternative to conventional reverse-osmosis (RO) installations will soon be commercially available.

New system

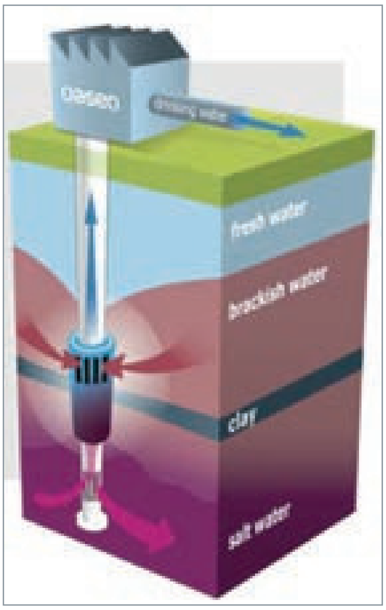
The Puro concept has been developed by the Delft University of Technology, Oasen, Logisticon, Waternet and Haitjema.

The system comprises a specially drilled 200m-deep well, with two filter sections and an RO installation inside the well between the two filter sections. The RO unit treats the water in the well at a depth of approximately 110m below surface.

The advantages of this concept are that not all of the extracted groundwater needs to be pumped to the surface, the high hydrostatic pressure is utilised to force the groundwater through the membranes, and the brine is discharged deeper underground at a level where the natural salt concentrate is equal to the discharged concentrate.

It is expected that the Puro system will achieve an energy-use reduction of 40% over conventional RO installations at surface level, and no anti-scalants are needed to keep the membranes clean.

Within the pilot scheme there is an additional advantage in using brackish groundwater for drinking-water production as it is below an existing well field that is vulnerable to salinisation. Known as the 'Freshkeeper' principle, an innovation of the Dutch KWR Watercycle Research Institute, the system will minimise the seepage of brackish water into other wells.



Left: sketch of the principle of reverse osmosis in a groundwater well

Screens and casing

An important element of the system is the drill specification of the well and the quality of the screens and casing.

The geology at the pilot location consists of a semi-impervious top layer of clay and peat to a depth of roughly 15m below surface level. Underneath this is a sandy aquifer to a depth of 26m. A major semi-impervious clay layer is found between 26m and 40m. At greater depths, down to about 200m, fine sands and poorly developed impermeable clay layers alternate. The boundary between fresh and brackish water is found at about 60m.

A 900mm-diameter borehole was drilled by Haitjema to a depth of ±125m using the airlifting/reverse-circulation drilling method. The diameter was reduced to 500mm for the final depth of 200m.

The installation of the PVC screen and casing was supported by Boode Waterwell Systems. Boode developed a customised solution for the well screens and casing as a large diameter with high-pressure resistance was needed for the system. A 630mm-diameter PVC screen and casing with a 0.5mm slot size was designed for installation to 60-75m, where the brackish water will be extracted.

At 175-200m a 200mm-diameter PVC screen was installed, where the concentrate will be injected in the aquifer. The glue connections on each length were specially designed as press-fit to enable the driller to work faster. The cylindrical precision of Boode's PVC screens and casings, achieved due to the slowest possible rate of extrusion, simplifies the drilling and installation process and avoids potential costly delays due to material stripping through poor connections associated with inferior tolerances in some PVC material.

Installation of a 630mm PVC screen and casing, supported by Boode Waterwell Systems

"It is likely that brackish groundwater will be an important source of drinking water in the future"

Special features

One of the special features of this well is that the RO unit is seated on a stainless-steel flange at a depth of approximately 120m below surface level. For this purpose, the well has been grouted beneath the stainless-steel flange. When not in operation, the resulting load of the unit will be approximately 1,500kg. When in operating mode, this load will be reduced because of the injection of ►

Right: installation of the stainless-steel riser at the pilot location

brine, causing the water pressure to rise approximately 1bar.

Consideration must also be given to the quality of seal as the brackish water in the upper section needs to be separated from the salt water in the deeper section. For this reason, a special cone has been mounted on the flange and a tapered counterpart with rubber rings is attached to the underside of the RO unit.

"In October 2010 the Puro system ended with the highest score at the Dutch InnoWATOR funding scheme"

For ease of inspections and servicing, the RO unit can be installed and removed by a 3in (8cm) stainless-steel riser. During operation the filtrated water is pumped through this riser to the surface.

Recently developed 16in (41cm) membranes are placed within the RO unit. With the bigger membrane surface, when compared with the standard membranes used over the last 30 years, the aim is to achieve an abstraction of 50m^3/hour and a recovery of 50%.

The Puro system has already attracted considerable attention, and in October 2010 the Puro system ended with the highest score at the Dutch InnoWATOR funding scheme, affording the consortium a further €500,000 (US$ 690,170) of funding.

The results of the pilot are awaited with interest.

This article was written by Bart Scheffers of Boode Waterwell Systems and Niels Robat of Haitjema, with contributions from Delft University of Technology, Oasen, Logisticon and Waternet.

In deep water

The Rockmore ROK 500DH hammer helps water-well driller in a tight spot

The ROK 500DH hammer

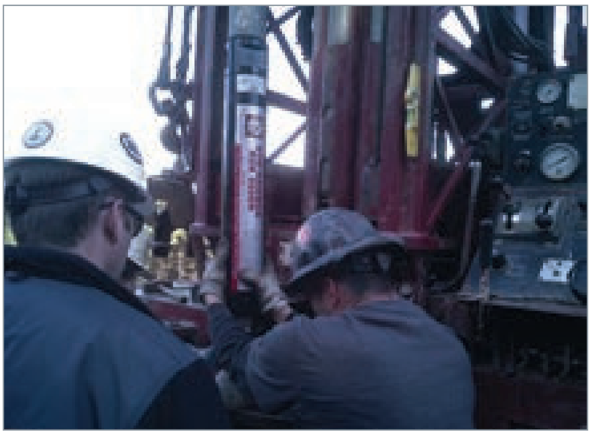
Officially released last year, Rockmore International's ROK 500DH down-the-hole (DTH) hammer is part of the company's emerging Deep Hole series.

Designed to increase drilling effectiveness in deep-hole applications, the ROK 500DH incorporates engineering advancements for DTH drilling in geothermal, exploration, water-well and other mining and construction sectors.

Rockmore has also made some recent updates to the hammer to improve its operation.

In late spring 2013, the hammer was able to get a water-well driller in Washington, US, out of a tough spot when his existing hammer quit working before it had reached the water table.

The ROK 500DH hammer mounted on a drill rig



The crew had used a competitor's hammer, which failed at about 1,300ft (396.2m). They called Rockmore International's distributor at Drillers Depot in Portland, Oregon, for help, and Rockmore was able to get the ROK 500DH-001 hammer out to the customer on the same day and finish the job for them.

"The DH hammer was the right choice for the job because the existing competitor's hammer stopped drilling before the target depth was achieved as it could not manage to flush the cuttings at that depth," explains Rockmore International's executive vice-president, Pejman Eghdami. "Our DH hammer is specifically designed to flush water and rock cuttings in very deep and difficult rock conditions and operate efficiently and effectively in such water-well and geothermal environments."

Current demand

"Most drilling customer for the Deep Hole series are in the water-well and geothermal applications," says Eghdami. "And we have sold many units to North and South America and Europe.

"Demand for our products has been steady in the second half of this year, despite a lower level earlier this year. The water-well and geothermal drilling markets are still facing challenges in a weak European economy and from a very slow US economic recovery. We expect a slow increase in demand for drilling consumables next year."

Job details

Hole diameter: 5.75in (15cm)
Rockmore bit: DH500-146CCV-3107
Rig model and compressor capacity: Atlas Copco with 950cfm (1,614m^3/h) and 350psi (24.6kgf/cm^2)
Location: East of Vancouver, Washington, US
Depth: Started at 1,300ft (396.2m) and finished at 1,400ft (426.7m)
Hammer model: ROK 500DH-001
Problem solved: Driller was using a hammer that was getting no penetration rate at 1,300ft. After installing the ROK 500DH, they were able to finish the hole to 1,400ft