KEEPING OUR WELLS FRESH

Gert GRAKIST (a), **Kees MAAS** (b), **Wim ROSBERGEN** (c) and **Joost KAPPELHOF** (d)

(a) Hydron Advies & Diensten, Weverstede 53,
3413 JS Nieuwegein, The Netherlands, email: ggt@hydron-ad.nl
(b) Kiwa Water Research, PO Box 1072,
3430 BB Nieuwegein, The Netherlands, email: Kees.Maas@kiwa.nl
(c) Provincial Board Zuid-Holland, department Water & Milieu,
PO Box 90602, 2509 LP 's-Gravenhage, The Netherlands, email: rosbergw@pzh.nl
(d) Kiwa Water Research, PO Box 1072,
3430 BB Nieuwegein, The Netherlands, email: Joost.Kappelhof@kiwa.nl

ABSTRACT

Lying well below sea level, the western part of the Netherlands is constantly being intruded by brackish groundwater. Even in the eastern part, which lies slightly higher, brackish groundwater occurs at shallow depths in many places. Many water wells are being seriously threatened by the upconing of fossil seawater. Over 100 pumping stations have already been closed down for that reason, and it is estimated that more than 20 % of the existing Dutch well fields will eventually experience salinization. It is usually only the lower tips of the well screens, though, that attract salt water. Instead of closing the plants, we propose to recover the fresh and the brackish parts of the discharge separately and to treat the brackish part by membranes.

THE FRESH HOLDER CONCEPT

The idea is not new, but is only now becoming feasible, due the sharply increasing efficiency of the membrane filtration technique. Figure 1a,b illustrates the concept, which we call Fresh Holder (a word that, when translated in Dutch, has the subsidiary meaning of keeping someone satisfied). The figure to the left shows the current practice. There is now way to prevent brackish groundwater - if present at some depth - to eventually reach the wells. The right hand figure shows a possible set up to recover and treat the fresh and brackish parts of the discharge separately.

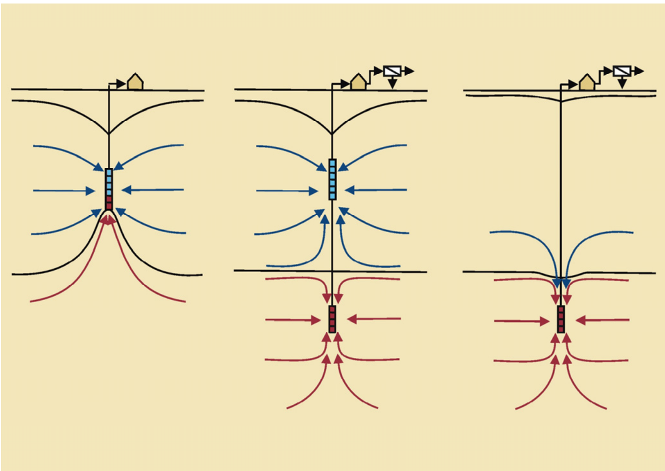

Figure 1 *a, b, c. The fresh holder concept.*

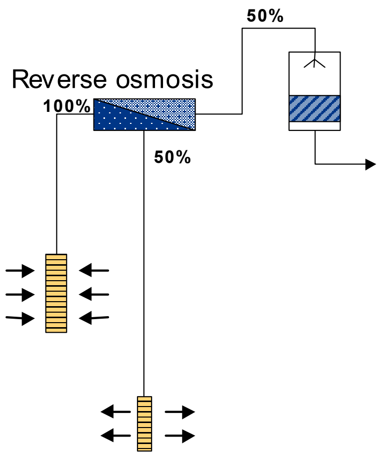

Figure 2 *Application of the membranes.*

The membranes can be applied without any pre-treatment of the anaerobic brackish water (figure 2). Choosing a low recovery rate minimizes the need for chemicals to prevent the membranes from fouling. This results in a moderately brackish concentrate, with minimal additions, to be disposed of.

RESEARCH FOCUS

The technique obviously has technical, economical and legislative aspects to be investigated.

Technical aspects

A simple computer program (Quick Salt) was developed as a quick scanning tool, to predict the breakthrough of brackish groundwater in a given geohydrological setting. This program helps to assess the feasibility of the fresh holder concept not only for existing plants, but also for plants to be developed at locations that were discarded in the past for their risk of salinization.

Besides geohydrological circumstances, water quality is a key issue, because the risk of membrane fouling depends on the chemical composition of the brackish water. The mechanism of fouling of membranes by natural brackish groundwater is currently under research.

Choosing a low recovery rate of the membranes (in order to confine the need for adding chemicals to prevent fouling to the minimum) implies choosing to use more energy than strictly needed. We investigate the applicability of energy recovery techniques to minimize costs and environmental impact.

Economical aspects

The costs of membrane filtration depend strongly on the salinity of the groundwater. They appear to be comparable to extensive groundwater treatment, including softening or active carbon filtration, and will most likely be cheaper than surface water treatment.

Legislative aspects

The legislative aspects are being investigated in cooperation with a provincial water authority. Finding durable ways to get rid of the concentrate is one of the challenges of the project. The options are to discharge it to surface waters or to re-inject it into the subsoil. Both options require governmental approval. We investigate the environmental impact of the whole concept and compare it to the environmental impact of conventional alternatives (being fresh groundwater and surface water).

RECOVERY OF BRACKISH GROUNDWATER

Although the idea was inspired by the wish to safeguard drinking water plants that are threatened by upconing brackish groundwater, the technique of membrane filtration is rapidly becoming so economical that the exploitation of fully brackish aquifers has come in sight, opening up brackish regions for drinking water production (figure 1c).

PROSPECTS

The prospects are that the fresh holder concept applies to all groundwater catchments areas that are prone to salinization. In the Netherlands alone they amount up to more than 20% of all pumping stations. Recovery of brackish groundwater has good prospects in the western part of the Netherlands, where fresh groundwater is hardly, if at all, available (figure 3). The concept is not confined to the Rhine delta, of course. It applies globally, anyplace where fresh groundwater is scarce.

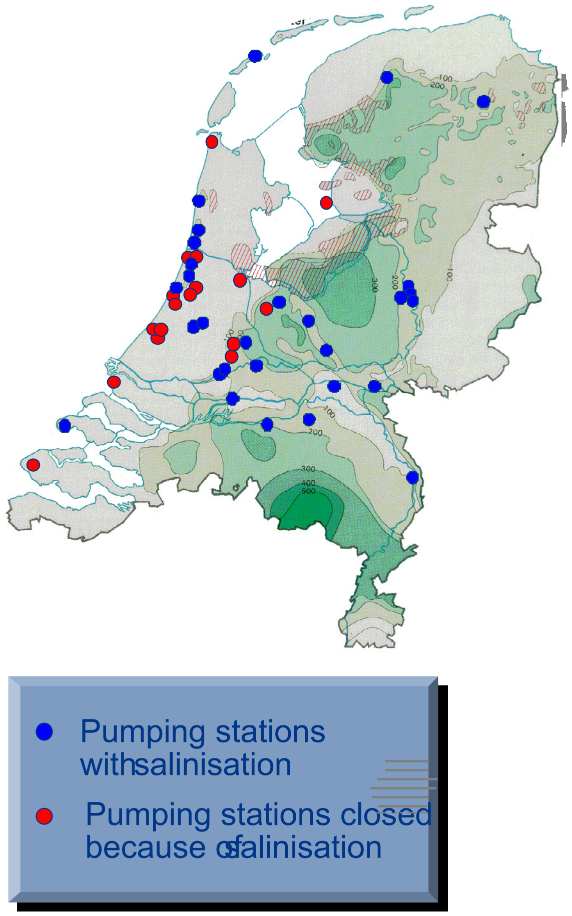

Figure 3 *Availability of fresh groundwater.*

RIDDERKERK PILOT

The drinking water production plant of HYDRON South Holland at Ridderkerk is one of the many Dutch examples of pumping stations that are gradually becoming brackish. It will be only a matter of years for the chloride content to pass the 150 ppm guideline. By that time the concession can no longer be fully exploited. It is here that the fresh holder concept comes to the rescue. A 10 % fraction of the discharge will be extracted from the brackish part of the aquifer and treated by reversed osmosis. The product will be added to the fresh main stream, while the concentrate will be re-injected at some distance into the aquifer.

Legislation is the main issue

Technically speaking, the separate parts of the fresh holder are well known and not expected to bring up surprises. Legislation is the main issue at Ridderkerk. Recovery of brackish groundwater for drinking water purposes being a brand new phenomenon of widespread applicability, the Provincial water authority needs to formulate a policy. For that reason the effects of the fresh holder concept on the present distribution of brackish groundwater is being investigated in some detail. A topic of special interest to the water authority is the fate of the concentrate after closure of the plant.

Figure 4 shows the expected chloride breakthrough in the course of the coming 30 years, as computed by Quick Salt. The upper branch of the graph gives the chloride content of the brackish water that is to undergo membrane treatment, while the lower branch is the chloride content of the main stream that is kept at the 150-ppm level. The central branch gives the chloride content that would have evolved if no measures were taken. These results were obtained by the computer program Quick Salt.

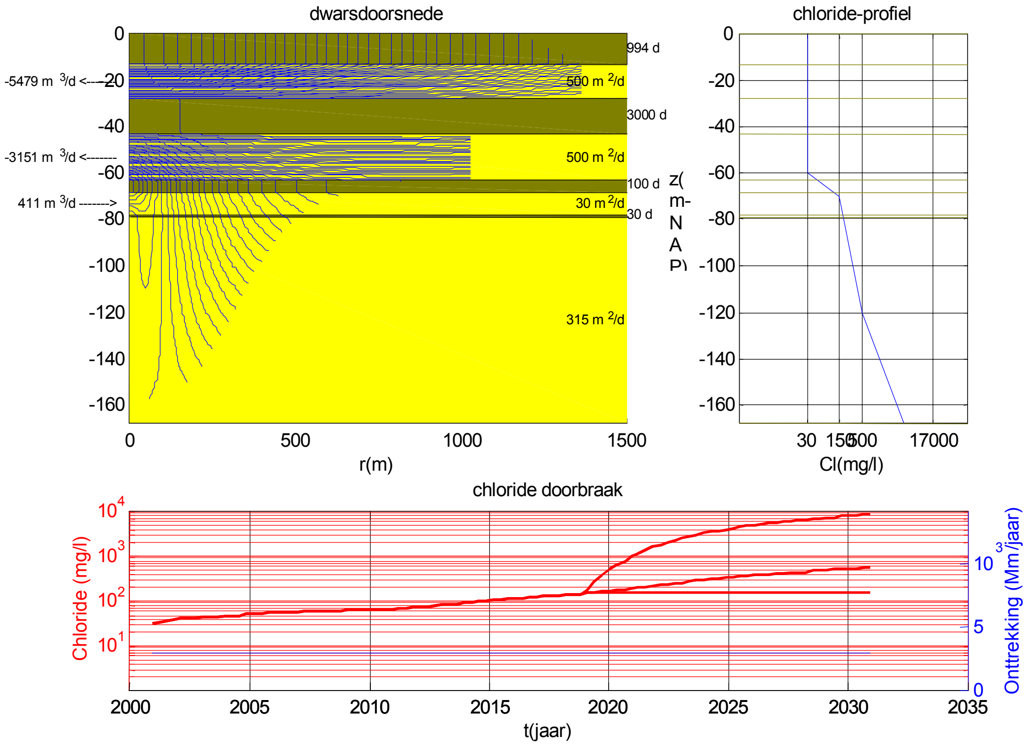

***Figure 4** Expected chloride breakthrough.*

Figure 5 simulates the fate of a cone of brackish groundwater after closure of the plant. The geohydrological profile at Ridderkerk can be schematized as four aquifers (yellow in the picture) separated by aquitards. The initial boundary between fresh and brackish water was supposed to be horizontal. A cone develops due to pumping from the first en second aquifers (pumps not shown). After a number of years the pumps were shut down and the brackish cone is being carried away by the natural flow of groundwater, which is directed towards the left. To the right a fresh water body is seen to build up by a nearby infiltrating river. The simulation period was 500 years. Notice the strong deterioration of the cone in the second aquifer.

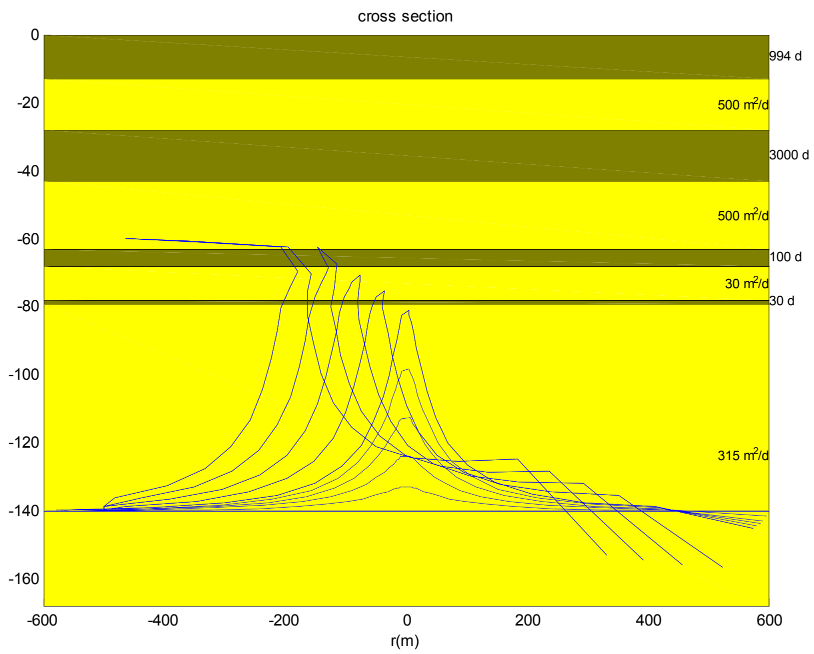

***Figure 5** The fate of a cone of brackish groundwater after closure of the plant*