

SA Joins the Ultrafiltration Production Market



The completed module. There are about 5 000 capillary membranes in a single module.

South Africa's first capillary ultrafiltration manufacturing plant has opened its doors in Somerset West, in the Western Cape. Lani van Vuuren paid a visit.

All photographs by Lani van Vuuren

Capillary ultrafiltration is arguably the fastest growing filtration technology in the world. The water produced by these types of membranes is said to be of a very high quality, mostly exceeding the quality of water produced by conventional treatment methods. This is achieved without excessive use of chemicals or operator intervention.

Ultrafiltration membranes essentially clean water through a 'sieving' process. These membranes have extremely small pores (in the nanometre size range), which prevent particles, colloids, micro-organisms and dissolved solids that are

larger in dimension than the pores in the membrane surface from passing. The membranes therefore act as a physical, size-exclusion barrier.

SOUTH AFRICAN PRODUCT

In South Africa, investigations into the possibility of establishing locally-produced membrane and filtration systems for potable and industrial water management started in the 1990s at the Institute of Polymer Science at the University of Stellenbosch. Over 15 years, with financial support from the Water Research Commission (WRC), the

institute managed to, among others, produce a suitable cost-effective capillary ultrafiltration membrane to replace expensive imported equivalents.

The membranes, manufactured from polyether sulphone (PES), have an outside diameter of 1,6 mm and a lumen (bore) diameter of 1,2 mm. The membranes are internally skinned, which means that the feedwater enters into the lumen from where it filters outwards under a pressure driving force.

The membranes are housed in a module (typically a tube-in-shell arrangement).

“Converting and modernising this laboratory-scale plant into a fully-fledged manufacturing plant proved considerably challenging.”

An unusual feature is that these modules do not have to be discarded if a membrane breaks. Individual compromised capillary membranes can be identified and isolated by plugging the inlet and outlet ports of the damaged membrane. This extends the lifetime of a module considerably.

Rigorous testing over four years showed that the membranes consistently produce high-quality water. Virtually any type of water can be treated, and pre- or post-treatment can be added depending on the quality of the raw water.

The product was later patented by the University of Stellenbosch and the WRC, and, in 2008, black economic empowerment firm Ikusasa Water acquired the necessary licences to commercialise the process.

FROM THE LAB TO THE FACTORY

Ikusasa purchased parts of the experimental plant employed in research at the University of Stellenbosch for its full-scale production facility in Somerset West. “Converting and modernising this laboratory-scale plant into a fully-fledged manufacturing plant proved considerably challenging,” notes Ikusasa Chair Andrew Theunissen. The company managed to successfully set up shop, and started producing capillary ultrafiltration units in March this year under the watchful eye of Plant Manager Anja Eysvogel.

Stephanus Victor, responsible for further development of the membranes at Ikusasa, explains that the membrane is produced through a process of diffusion-induced phase separation (also known as wet-wet spinning). “The PES is dissolved in an organic solvent and additives are added to control filtration properties, such as pore size distribution and porosity. This polymer-rich solution is then extruded through an extrusion die called a spinneret to form the thin, straw-like capillary.”

Thereafter, a non-solvent is injected on the lumen. The capillary is then cut into the required lengths and dried, whereafter the correct number of dried capillaries are inserted into a pressure vessel made from polyvinylchloride piping. Each end of the pressure vessel is then sealed with an epoxy resin.



Ikusasa Water Plant Manager Anja Eysvogel inside the capillary ultrafiltration production facility.



The capillary membranes are produced through a process of diffusion-induced phase separation.

"The membranes are wetted under controlled conditions and tested to ensure performance and quality," Victor tells *the Water Wheel*. "The membrane modules are finally preserved with a biocide and sealed, ready for shipment and installation into a treatment plant."

SAFE DRINKING WATER FOR RURAL AREAS

At present, the plant is operational eight hours a day, with two modules being manufactured every three days. This is expected to increase as demand for the product grows. Ikusasa has already received several enquiries, especially from municipalities seeking drinking water treatment solutions for rural applications. At the time of writing, two pilot plants incorporating the technology were operating at Overberg Water.

"Capillary ultrafiltration suits a number of applications, it can be used for the primary treatment for drinking water, pre-treatment prior to desalination of sea or

brackish waters or as post-treatment of conventional systems, for example," says Dr Gerhard Offringa, Marketing Manager at Ikusasa. "These membranes can also be effectively employed in industrial processes, such as oil water separation, dye removal, caustic recovery, and whey fractionation."

The company has developed a small, mobile water treatment plant incorporating capillary ultrafiltration, especially suitable for rural or emergency applications. A robust system, it sports a telemetry control system enabling remote operator control. Unlike conventional membrane technology this system does not use much energy (it requires pressure of less than 1 bar), and can be gravity driven.

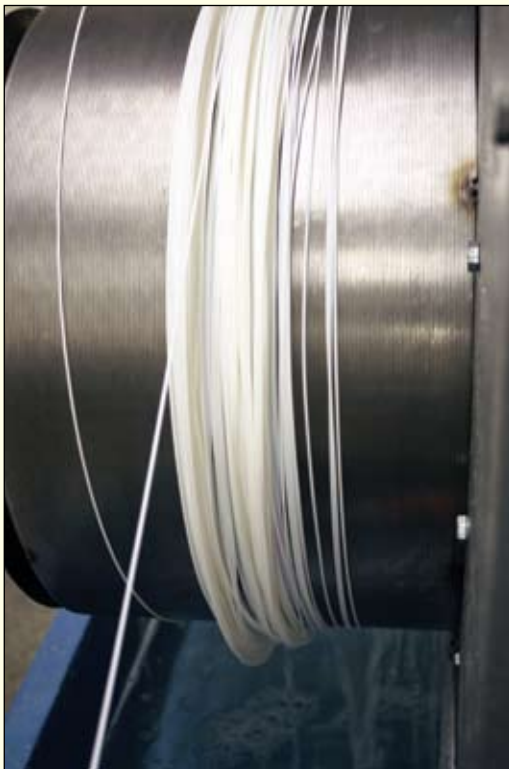
The unit can be cleaned-in-place and requires chemical cleaning only two to three times a year. Damaged modules are simple to replace. Depending on the quality of the raw water, the units can produce 200 l/h to 400 l/h per module installed. Such a system proved successful

in supplying additional drinking water to the community of Struisbaai, in the Western Cape, during the peak holiday season. The systems can, however, be scaled up to any size required.

INVESTING IN THE FUTURE

The work on locally-developed and manufactured membranes is continuing and Ikusasa has signed a Memorandum of Understanding with the University of Stellenbosch, which will, among others, allow students to make use of the capillary ultrafiltration production plant for their studies. It is hoped that this will enable further research into especially lower cost and lower maintenance systems, and more efficient membranes.

"The idea that membranes are a costly alternative technology is fading. We believe that, with continued investment in research and development, these systems could provide effective and efficient water treatment, especially for South Africa's far flung communities," concludes Dr Offringa. 



The thin, straw-like capillaries prior to being cut to size.



The cut capillaries being hung out to dry.