Fyne Process

ultra-filtration technology for the treatment of variable surface water quality

by Darren Reed & Malcolm Woods

Supplying drinking water to small remote communities often requires the supply companies to overcome the difficulties and costs associated with the operation and maintenance of a large number of small, isolated treatment plants, all of which must meet the same water quality standards as the larger treatment plants. In remote areas with extensive farming, the catchment areas are at risk from bacteriological contamination including *Cryptosporidium*. Where surface waters are very soft, exhibiting low mineralisation, they can contain high concentrations of natural organic matter (NOM), iron and manganese. Peaty soils give water a yellow-brown colouring due to organic substances, predominantly humic and fulvic acids, which upon chlorination result in the formation of disinfection by-products (DBPs) in the form of trihalomethanes (THMs). The treatment of these waters is further compounded by the flashy nature of the raw water with traditional basic treatment coagulation/filtration being ineffective and incapable of allowing compliance with the water quality standards.

A typical installation in Scotland - Courtesy of Ross-shire Engineering

Fyne process

The Fyne process from PCI Membranes utilises ultra-filtration technology, has been proven at sites across Scotland, Canada and Alaska. The advanced membrane filtration technology treats water from sources that are poor, or of variable quality, including those containing carbonaceous organic colour from humic or fulvic acids common in peat-rich areas. This technology, together with course screening, post conditioning and disinfection, treats water sources for municipal drinking water supply in small rural communities of up to 2,000 people.

Tubular membrane technology

PCI Membranes' C10 Series modules and 12mm diameter tubular membranes are used in the Fyne process due to their ability to handle suspended solids without blocking, unlike spiral membranes.

The tubular membranes retain contaminants on the raw water side and allow potable water to permeate through. The deposition of impurities on the membrane's surface is minimised by maintaining a high cross-flow velocity using a partial re-cycle flow, which sustains high filtration efficiency. As the waste stream contains nothing other than the naturally-occurring minerals and deposits, which are present in the water before treatment and is simply concentrated raw water, there are no environmental concerns to prevent its return back into the local water course.

Although tubular membranes have a higher comparative capital cost than spiral membranes or hollow fibre membranes per square metre, as well as increased power requirement due to the higher recycle flow rates required, they have proved to possess a number of other advantages over the spiral wound and hollow fibre membranes. These advantages include:

- No pre-treatment is required as the larger feed channels are less susceptible to blockage, hence relatively high turbidity waters can be treated without the need for pre-filtration.
- The membranes can be cleaned mechanically by passing foam balls automatically along the tube to clean the membrane surface.
- Chemical cleaning is no longer a regular requirement and can be limited to quarterly cleaning.
- The chemical clean can be removed off site if necessary to avoid associated disposal issues.

These advantages outweigh the disadvantages and make tubular membranes economically and technically beneficial for small, remote supplies.

Cleaning Process

Figures 1, 2 and 4 depict the mechanism of the automated foam ball cleaning process. During process mode (Figure 2) a foam ball is retained in the pipework at the concentrate end of each membrane module by a mesh strainer. Some of the reject water is recycled to give sufficient cross flow velocity across the membrane surface to minimise build-up of foulants as the coloured water is filtered.

At pre-set time intervals (typically 4 hours) the 3-way feed valves change position and the feed flow direction is reversed, causing the foam ball to travel along the feed side of the membrane tubes and remove dirt into the reject stream (Figure 4).

It takes approximately seven minutes for the foam ball to travel along all 72 membrane tubes in a C10 module until it reaches the foam ball catcher at the feed outlet end. It will remain in this position until the flow is reversed again at the next clean.

The typical cost of operating a water treatment works is reduced following installation of the membrane plant as the site visit frequency is reduced from daily to once per week to collect statutory samples and replenish chemicals used for final water treatment.

C10 Tubular Membrane Module

The initial design of tubular membrane plants utilised PCI standard stainless steel B1 modules. In order to reduce construction costs, significant development went into producing a tubular membrane module that could compete with spiral wound designs at larger plant capacities. This module, known as the C10, contains over 4 times the membrane area of the B1 modules and is manufactured in ABS plastic. The plant is skid mounted for ease of manufacture and installation on site. The C10 module is available in three lengths (twelve, six & three foot) to suit the needs of each site and the space available.

A typical installation - Courtesy of Ross-shire Engineering

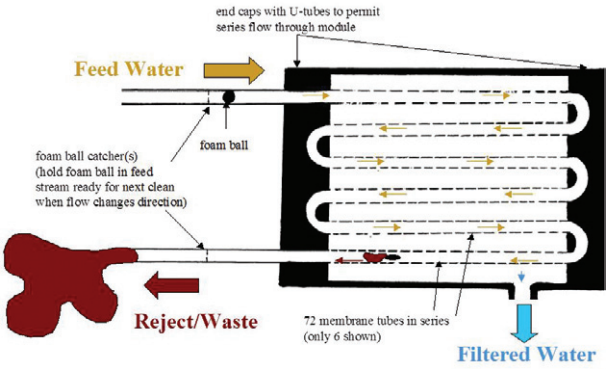


Figure 1 - Tubular Membrane Foam Ball Cleaning (Cross Section of Tubular Membrane Module)

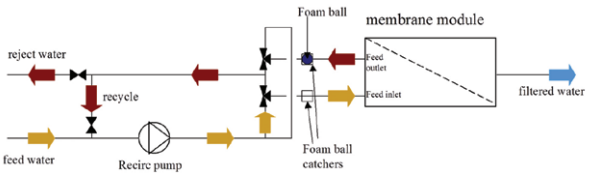


Figure 2 - Tubular Membrane Foam Ball Cleaning (Process Mode)

Figure 3
Membrane foam ball cleaning technique is an innovation unique to PCI

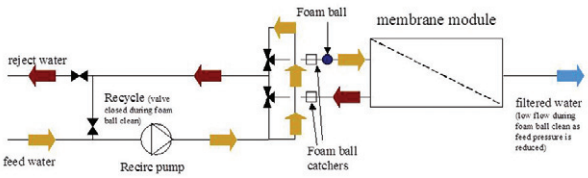


Figure 4 - Tubular Membrane Foam Ball Cleaning (Clean Mode)

A PCI C10 series tubular membrane module Courtesy of PCI Membranes

Trials in Tasmania

In Tasmania drinking water is currently treated and supplied by three Public Water Authorities, namely Southern Water, Ben Lomond Water and Cradle Mountain Water. Most of the population is concentrated in a number of large towns where a network of treatment works and pipelines supply drinking water to the customers. The remaining area of Tasmania is sparsely populated with many, small, remote communities.

Typically each community is supplied from a local treatment works, owned and operated by the Water Authority having been transferred from the local council. The majority of the treatment works supply less than 500 people.

Tunbridge WTP

Tunbridge is a small town near the centre of Tasmania and managed by Southern Water. The current treatment is based on the abstraction and chlorination of the Blackman River water and pumped to a high level storage tank. From the tank, potable water is distributed around the area by gravity to the houses containing approximately 192 people as determined in the 2006 census.

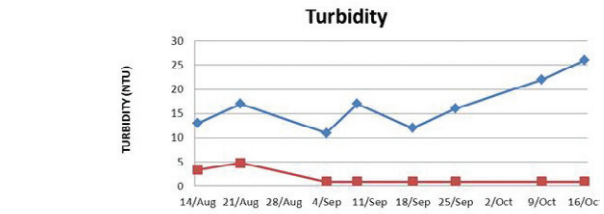
Trials data

The tables on the right show the performance of the pilot unit abstracting water from the Blackman River using ES404 membranes. The unit has been operating for 12 months off and on, but the data provided demonstrates the variable nature of the source water.

It is important to note that the actual permeate turbidity is less than one (<1 NTU), but due to limitations with the NATA accreditation the laboratory has it is not possible to report anything below this level. We did discuss this with the laboratory manager and they said that while reporting was not possible the ability to disinfect the water would not be impacted.

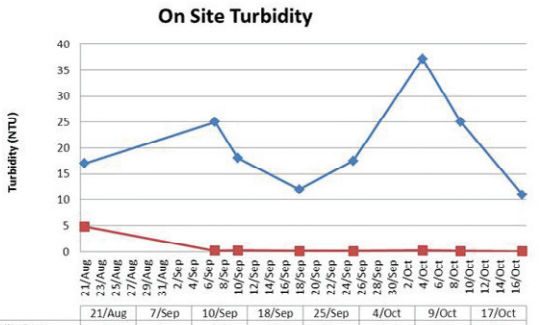
View toward the highlands and the source of the Blackman River
Courtesy of PCI Membranes

Blackman River in Flood
Courtesy of PCI Membranes



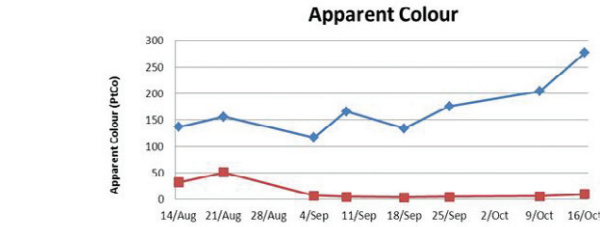
	14/Aug	21/Aug	4/Sep	9/Sep	18/Sep	25/Sep	9/Oct	16/Oct
TURBIDITY Turbidity RAW	13	17	11	17	12	16	22	26
TURBIDITY Turbidity PERMEATE	3.4	4.8	1	1	1	1	1	1

The actual turbidity readings taken on site are recorded below.



	21/Aug	7/Sep	10/Sep	18/Sep	25/Sep	4/Oct	9/Oct	17/Oct
Turbidity RAW	17	25	18	12	17.5	37.2	25	11
Turbidity PERMEATE	4.8	0.19	0.21	0.12	0.12	0.26	0.11	0.04

This demonstrates a permeate turbidity averaging 0.2 NTU while the turbidity of the feed water varies with the weather conditions. The high reading towards the end of August is due to a seal issue which was corrected on the 3rd September.



	14/Aug	21/Aug	4/Sep	9/Sep	18/Sep	25/Sep	9/Oct	16/Oct
Apparent Colour RAW	137	156	117	166	134	176	204	277
Apparent Colour PERMEATE	32	51	7	5	4	5	6	10

Again the above graph demonstrates the variable nature of the Blackman River and the ability of the PCI membrane to cope with the challenge. It is important to note that site attendance was approximately once per week (excluding demonstration visits) and the plant performed as expected.

Conclusion

The pilot unit has demonstrated that the source water is variable based on the local weather and the weather in the catchment area. While this variable water source would present a challenge to conventional treatment or membrane technology with coagulation as a supplement to aid the filtration of small organics from the raw water, the tubular membrane system has continued to treat the raw water and provide a suitable permeate quality.

The aim of this trial was to demonstrate the capability of the tubular membrane plant to manage these variations without the need for additional pre-treatment as required by other membrane technologies. Natural organic material (Humic and Fulvic acids) are of a particular size range and as such can affect the performance of a treatment works as the ratio changes due to a number of factors, but the main reason is a change in the raw water quality.

This paper was prepared by Darren Reed, Business Development Manager with Xylem Water Solutions UK Ltd , and Malcolm Woods, Sales Representative with Xylem Water Solutions Australia Ltd.

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A valley view in Wester Ross, Scotland.
Home to one of our Fyne Process sites.

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with UF & NF Modules

The Fyne Process

'Fyne process and Package Membrane Plants (PMP's) are well suited for water systems for small rural communities'

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