

## Application Guide 11 Genairclean

### Enhanced cleaning of RO/NF spiral wound membranes using "microbubble" technology

#### Background

The Genesys GENAIRCLEAN system is the result of a 3 year research and development programme conducted by the Genesys membrane specialist team. There are an increasing number of reverse osmosis (RO) systems operating on waste water, water reuse and post MBR/UF feeds. These are typically high SDI feed waters with a high potential for organic fouling and biofilm growth. These systems can require frequent cleaning. Operational costs and system down time are often significantly higher than well water fed brackish water systems.

The Genairclean system was designed to increase the removal of foulants. More efficient cleaning gives the following benefits:

- ◆ lower operational costs
- ◆ reduced cleaning frequency
- ◆ reduced chemical costs
- ◆ reduced system down time
- ◆ increased membrane life

The GENAIRCLEAN method can be used on any RO system – Sea Water, Brackish water or Waste water as a cost effective method to optimise cleaning.

#### Genairclean Science

The Genairclean process is designed to increase the efficiency of membrane cleaning using a dual approach to generate microbubbles which circulate in the cleaning solution increasing turbulence at the membrane surface. These bubbles create shear forces which agitate and dislodge the foulant giving greater removal in a reduced time period.

All RO systems begin to foul as soon as they go on line, as the foulant layer builds up the surface becomes "rougher" and the rate of fouling increases as more particles adhere to the surface. If membranes are not thoroughly cleaned the fouling rate following cleaning is higher when compared to that of an efficiently cleaned membrane. The primary purpose of this method is to clean more efficiently, reducing the subsequent fouling rate and the required cleaning frequency.



Fig 1: The Genesys flat sheet test rig (FSTR)

#### Genairator – the importance of bubble size

Previous research on cleaning spiral wound membranes with bubbles generated by compressed air (Fig 2) proved unsatisfactory, the major draw backs being poor coverage of the membrane surface and damage caused by the size of the generated bubbles.

Research has shown that if the bubbles are too large they are unable to penetrate the membrane spacer and "channel" through the membrane surface causing minimal cleaning effect. Testing on the Genesys flat sheet test rig (FSTR) (Fig 1) allows us to film the interaction between bubbles and foulant and select the optimum size for foulant removal.

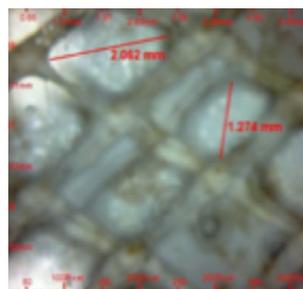


Fig 2: Physical bubble generation without Genesol cleaner

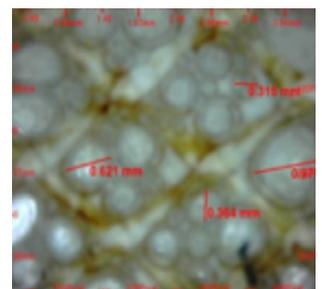


Fig 3: Physical bubble generation & Genesol cleaner

The Genairator system can be easily installed on existing CIP systems and induces air from the atmosphere during the CIP procedure. When combined with Genesol cleaning chemicals the bubble size is reduced (Fig 3) allowing complete coverage of the membrane surface and agitation within the spacer material. The full effects of Genairclean can therefore only be achieved when using Genesys specially formulated cleaning chemicals in combination with a Genairator device as shown in Figs 4 and 5.

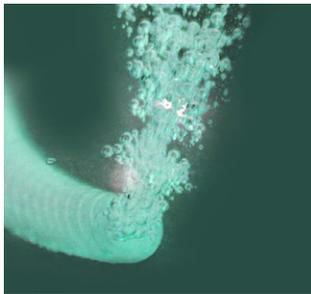


Fig 4: Showing bubbles without chemicals – large bubble size



Fig 5: Effect of Genesol chemicals on bubble size, smaller bubbles with greater coverage.

## Genesol & Genairator - Combined chemical effect

We have used our in depth knowledge of membrane fouling to design a cleaning system which incorporates different physical and chemical technologies to target the key characteristics of typical foulants. Combining the Genesol range of cleaners with microbubbles from the Genairator offers a simple method for enhanced membrane cleaning.

The GENAIRCLEAN system combines multiple cleaning mechanisms which have an effect on both bubble size and foulant removal.

**Normal Osmosis** – movement of permeate to lift deposits from membrane surface

**Effervescence** – turbulence & agitation of deposits

**Detergent, surfactant and chelants** – interact with properties of foulants facilitating easier removal.



Fig 6: Genesys International pilot plant testing for membrane compatibility & cleaning efficiency of fouled membranes

## Efficiency Results

Fouled membranes were selected from a variety of full scale operational systems for testing in the Genesys pilot plant. 8" membranes mainly fouled with aluminosilicates and biofilm from sources in the UK and Middle East were tested for foulant removal. Flux, salt rejection (SR) and colorimetric analytical techniques were used to evaluate cleaner performance. Application of Genesol cleaners without air gave an average increase in membrane flux of c30% while combining Genesol with the Genairator gave an average increase of c50%. The efficiency of commodity chemicals was also tested when used in conjunction with the Genairator system giving an increase in foulant removal of between 5 and 10%.

## Case Study

Field tests at an industrial water reuse site in the UK have been particularly successful. This is a high fouling feed water, previous cleaning procedures have achieved varying degrees of success. Prior to the trials CIP procedures were carried out every 7 to 10 days with an average first stage dP of 2.4 bar. The last set of elements were changed (poor permeate flow & quality) after only 18 months use. Permeate flow was 15m<sup>3</sup>/hr compared with a target of 20m<sup>3</sup>/hr. The new element gave an initial permeate flow of 25m<sup>3</sup>/hr which rapidly decrease to 15m<sup>3</sup>/hr over an 8 week period.

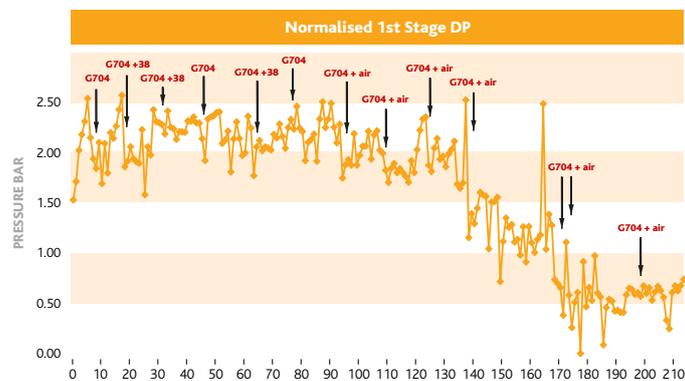


Fig 7: Chart showing 1st Stage DP

The Genairator system was installed and has been operational since 3rd October 2013, Fig 7 shows stage 1 dp, the normalised data shows a cumulative reduction in dP after adopting the Genairclean method.

After repeated cleanings (see Fig 7) normalised stage 1 dP is now stable at 0.5 to 0.75 bar, the CIP frequency has been significantly reduced with the procedure now occurring every 8 weeks (previously 7-10 days). The long term effects of this method on membrane life will be monitored on an ongoing basis.

## Membrane Compatibility

One of the key performance criteria of this cleaning method is to ensure that there is no damage to the membrane. To evaluate we selected a number of 8" membranes from the major manufacturers and performed repeat cleans over a 12 month period. Membranes were autopsied to analyse presence of damage and results showed that no damage was caused by using this method.

## Conclusions

- ◆ Genairclean method improves foulant removal in spiral wound membranes
- ◆ The method gives greater efficiency of foulant removal when compared to commodity and conventional cleaners with and without air.
- ◆ To optimise bubble size the Genairator must be used in conjunction with Genesol cleaners.
- ◆ The Genairator system has no moving parts, requires no energy and can easily be installed onto existing CIP systems.
- ◆ Design of cleaning protocol using the Genairclean Method is vital, please contact [marmstrong@genesysro.com](mailto:marmstrong@genesysro.com) for more details.