GENESYS INTERNATIONAL

Application Guide

Application Guide 3

R.O. Pre-treatment Optimisation and Alternative Autopsy Techniques.

Extract from the paper "Simple laboratory techniques improve the operation of RO pre-treatment systems", presented at the IDA World Congress on Desalination and Water Reuse. Maspalomas, Gran Canaria, Spain, 21-26 October 2007

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Comprehensive studies of membrane autopsy results show that 60% of failures tested in the Genesys laboratory are caused by poor pre-treatment design and/or poor operation. Alternative cost-effective techniques to membrane autopsy allow us to optimise pre-treatment dosage and design specific membrane cleaning programmes based on accurate deposit identification.

Membrane fouling issues

Membrane autopsy has been widely accepted as the standard tool for evaluating and identifying deposits on membrane surfaces.

The cost of the extensive analytical procedures involved in a membrane autopsy coupled with the need for element replacement can make this technique prohibitive for small to medium sized systems.

Typically, the autopsy option is used when system performance is already dramatically affected and operational costs are increasing. This has driven our research for complementary and/ or alternative laboratory techniques.

Poor feed water quality causes membrane problems – irreversible fouling, flux loss and an increase in salt passage. These issues will increase membrane cleaning frequency and system downtime leading to higher water production costs.

In more than 200 autopsies at the Genesys Laboratories 60% of membrane damage cases can be linked, directly or indirectly, to problems or inefficiencies in pre-treatment processes (see Figure 1).

Particulate matter present in Reverse Osmosis, (R.O.) feed water due to pre-treatment issues can be inorganic in nature, e.g. Alumino-Silicates, (Clays) and metallic oxides, or organic matter such as humic acids and polysaccharides. Micro organisms such as bacteria, fungi, moulds or protozoa, invariably present as a biofilm also have a role to play in membrane fouling.

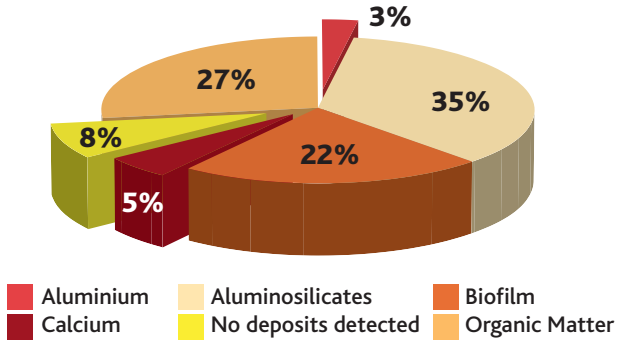

Fig 1: Main types of foulant found on membrane elements in first position during autopsy (2001-2007) Source: GMP laboratory statistics

To prevent these membrane deposits from occurring, improvements in pre-treatment design or operation were specifically recommended in each autopsy case for each type of deposit.

Reducing membrane fouling

Optical Particle Counting Technology

Particle counters are proving to be an essential tool for improving RO pre-treatment design and system operation, not only when evaluating coagulant and flocculant performance, but also when evaluating sand filter and cartridge filter performance.

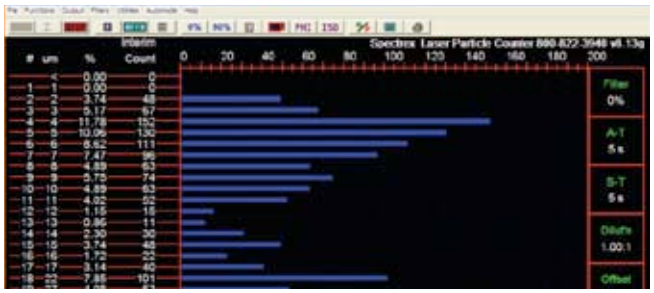

Fig 2: Example of a particle size distribution graph of an RO pre-treatment system

Optimising Pre-Treatment

Particle size is one of the most important parameters when selecting or designing a filtration system and yet in many cases is seldom considered.

Turbidity has commonly been used as a reference parameter, but turbidity is affected by factors such as size, shape, colour and particle refraction index.

The turbidity of RO feed water tends to be significantly lower than that of waste water. Alternative procedures to coagulation or flocculation assays have therefore been developed to study coagulant and flocculant behaviour and evaluate their efficiency.

Particle counters help to determine the best product and the optimum dosage for improving the performance of existing pre-treatment systems. The objective of coagulation is to aggregate particulate matter to form flocs of sufficient size to guarantee retention by the filtration system. Comparison of particle size distribution under different experimental conditions is a valuable tool to aid decision making. Dose rate data can then be obtained in the laboratory simply using different compounds, testing variable dose rates and pH conditions.

Deposit identification

SEM – EDAX of SDI & Cartridge Filters

SEM, (Scanning Electron Microscopy) and EDAX, (Energy Dispersive X-Ray Spectroscopy) techniques are used to study deposits on membrane surfaces, cartridge and security filters and even SDI papers. The information gained is invaluable when proposing preventative and corrective actions in pre-treatment operation. In many cases the examination of cartridge filters and SDI papers avoids the need for sacrificing membrane elements to autopsy.

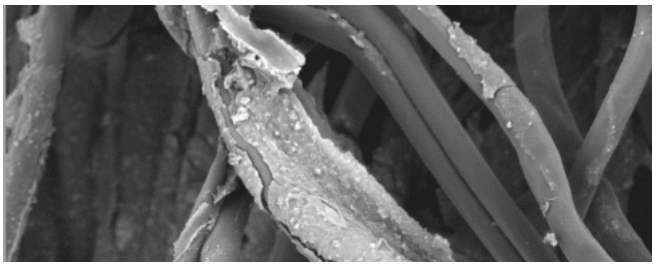

Fig 3: **SEM Micrograph of a 5µm cartridge filter surface. Organic deposits and aluminosilicates (clays)**

Improved membrane cleaning protocols using particulate matter characterisation by SEM-EDAX

A decrease in normalized product flow and an increase in differential pressure or permeate conductivity are symptoms of membrane fouling. Colloidal fouling dramatically affects the product flow rate particularly of membrane elements in the first position.

Although SDI measurement has been used for many years to determine the fouling potential of RO feed water, the SDI measurement cannot provide any scientific information about the nature and type of fouling expected.

When fouling occurs, the nature of the foulant must be identified if an effective cleaning program is to be suggested.

An alternative procedure to membrane autopsy is to evaluate colloidal matter retained on an SDI filter paper. RO feed water is passed through a 0.45µm paper membrane filter, then the filter surface is analyzed by SEM-EDAX and the nature of the colloidal matter is characterized.

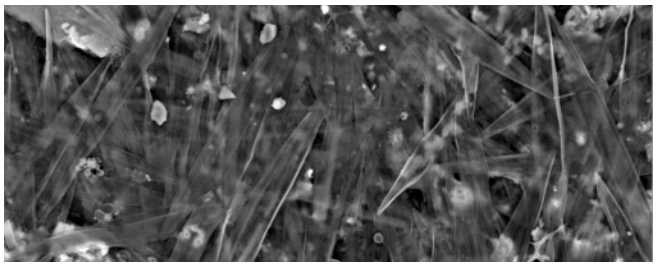

Fig 4: **SEM micrographs of SDI paper**

Deposits from the surface of the SDI papers can then be analysed using SEM, Scanning Electron Microscopy, EDAX, Energy Dispersive X-Ray Spectroscopy which identifies the elemental composition of the deposit.

The results of analysis of these SDI papers allow our technicians to recommend specific cleaning protocols. An effective cleaning programme minimizes operational costs and helps to increase membrane life.

Summary

While full membrane autopsy techniques remain financially viable for the majority of RO systems, deposit analysis of the surface of cartridge filters and SDI papers provides a cost effective alternative for troubleshooting smaller size RO plant. In addition to optimising the treatment programme results can also be used to identify correct membrane cleaning techniques helping to reduce operational costs and downtime.

Genesys membrane autopsy results show that particle counting techniques can be an important method for optimising RO pre-treatment systems and determining technically correct chemical treatment programmes.

When used correctly these methods provide vital scientific evidence in troubleshooting RO systems and also as part of a programme to optimise operation.

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