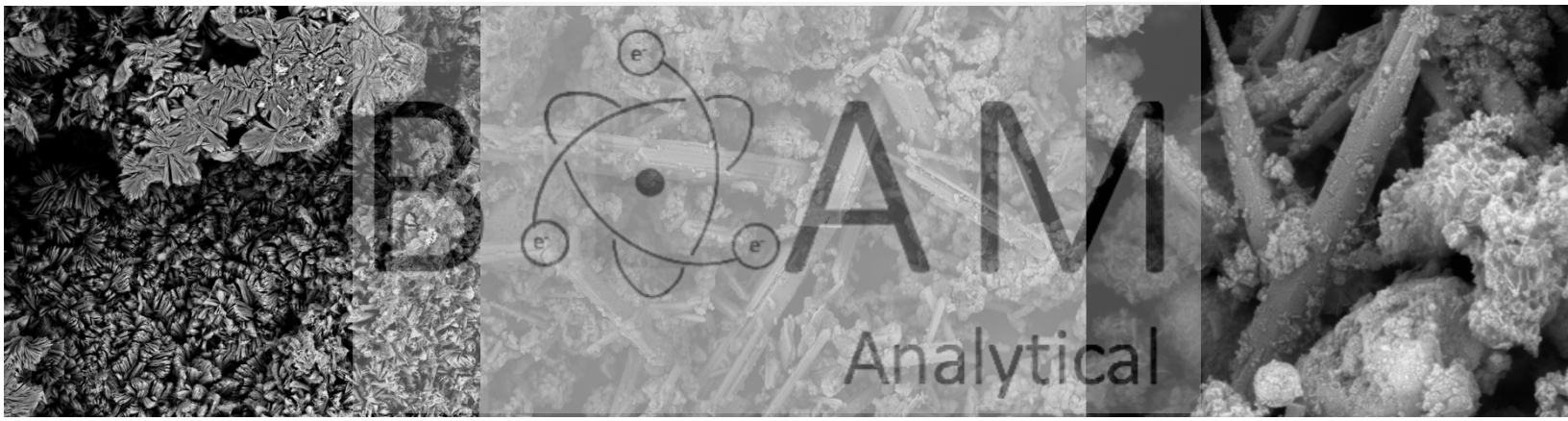

Membrane Autopsy

When questions about declining membrane performance are at hand, a membrane autopsy may be required. A membrane autopsy includes multiple specific tests on the membranes. Each test provides specific scientific data to identify and quantify fouling/scaling, or chemical/mechanical damage. At BEAM the membrane autopsies can identify the mechanism as to how the membrane failed, the type of fouling/scaling on the membrane surface, the presence of chemical or mechanical damage that has occurred during operation. At BEAM we also can recommend steps to take to resolve the issues. We use a destructive autopsy procedure to analyze the membrane itself. The results of the different tests are then compiled by experienced chemists and engineers to draw a conclusion. Conclusions drawn from the acquired autopsy data can help identify the cause of the problem, leading to solutions that can decrease or eliminate operational issues.

Membrane autopsies are essential to every membrane plant. They can be performed on high pressure membranes like reverse osmosis (RO) and nanofiltration (NF), or on low pressure membranes such as microfiltration (MF) or ultrafiltration (UF). Performing autopsies on pre-treatment cartridge filters, or even SDI filters can also provide very useful information about contaminants entering the membrane system. If not measured and controlled, fouling and scaling will lead to higher operational costs that potential could result in:

- higher energy demand,
- increased cleanings, and
- reduced lifetime of the membrane elements.

Chemical and physical damage to a membrane surface result in irreversible loss of performance, thus identifying the problem at an early stage can help save millions of Rands in membranes before excessive damage renders them inadequate.

When to do an Autopsy

Manufacturing plants should apply membrane autopsies as part of their routine system maintenance program. This affords the advantage of identifying any potential problems before they become unmanageable. However, in most cases, a membrane autopsy is only performed when a membrane is failing or underperforming. A noticeable loss in flow, permeate quality or visible fouling/detectable biofilm on the membrane itself would indicate a problem with the unit and the need to have it inspected.

Why Conduct an Autopsy?

- To identify scaling or fouling problems
- To identify chemical/mechanical damage
- To determine mechanism as to how the membrane failed
- To determine the proper cleaning regimen
- To improve system performance

How is an Autopsy done?

When the membrane is received at the analytical facility, a visual inspection is completed, photographs are taken, and detailed membrane condition is noted including the shipping and handling condition. A membrane performance test and a mechanical integrity test is performed on each module using the same testing procedures used by the membrane manufacturer. The element is then dissected. The leaves, feed spacers, and permeate spacers are visually inspected, photographed and conditions documented. Samples of any foulants are also collected. Some of the other tests performed are.

The samples are then analyzed using Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS). When used in combination, these instruments allow the user to determine the morphology (size and shape) as well as the overall chemical composition of a sample. This technique in combination allow the technician to distinguish the elemental composition of each compound on the membrane surface by providing elemental maps. The results are used to identify the exact chemical compositions of suspended solids, foulants and scales on a membrane surface. The use of these imaging techniques even identifies the presence of organics and biofoulants on the membrane, and determines whether existing scales and suspended solids are buried within biofoulants or reside on the surface. The Thickness of the foulants can be measured and delamination can be observed.

Fourier transform infrared spectroscopy (FTIR) or Raman Spectroscopy can be used to identify different types of chemical bonds. The molecular “fingerprint” of the material is then compared against a database. When these results are reviewed by an experienced chemist, even compounds that are not in an existing database can be identified. FTIR/Raman is extremely useful in identifying biofouling, anti-scalant fouling, inorganic scaling, and even changes to membrane chemistry due to damage by chlorination.

A good membrane autopsy report can accurately identify specific types of suspended solids, organics, microorganisms, and different types of inorganic scales. It should always include a conclusion that helps the plant owner/operator identify the cause of the problems, and provide possible solutions for their mitigation. These may include recommendations for changes to the cleaning protocol or alterations to the existing pretreatment program.

The autopsy report is an invaluable tool whether it is performed for routine maintenance or to determine the cause of an ongoing operational problem.