Introduction

A brewery site reported suffering high differential pressure on the brine stage of two of the three trains of their BWRO plant. Acidic cleaning had improved the situation but had not returned the operation to normal. Test cleans were carried out to determine if another cleaning regime would be the answer. This showed membrane damage and an autopsy was commissioned to analyse the membrane surface. The surface analysis coupled with a review of the feedwater and control system determined that the plant had been mistakenly operated for a short period at 100% recovery. The Autopsy allowed this to be proven and instigated the control system changes necessary to prevent this being repeated.

Background

The BWRO plant was provided to soften the feed water and remove other specific ions in the feed to make it suitable for use in brewing an international brand of beer.

The unit consisted of three trains of 90m^3/hr each. These were operated as and when required with automatic shutdown and flushing sequences ensuring that scaling brine was not left in the plant.

CIP sequences were controlled automatically once a manual alignment of valves and preparation of CIP solution had been made.

One of the three trains exhibited high differential pressure across the brine stage of the plant. Avista carried out a test clean on an element and determined that the cause of the DP was a mix of inorganic scale.

To determine the exact cause of the scaling an autopsy was carried out.

Autopsy Procedure

The autopsy procedure was carried out as standard. This first necessitates the non destructive testing of the element including : visual inspection, weighing, wet testing and vacuum testing.

These tests revealed that the membrane was 6kg heavier than a new element of that type indicating the presence of a significant quantity of mineral scale. This was backed up by the wet test which showed high differential pressure, poor flow and low salt rejection (or poor product quality).

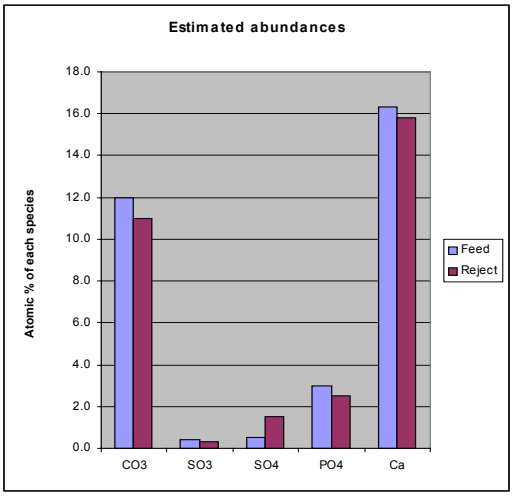
The membrane was then subjected to destructive testing to determine the makeup of the inorganic fouling.

The membrane was opened and the surface inspected. This revealed that the scaling was a light and fluffy white powder which was evenly distributed across the element from feed to brine. (See photo). A sample of this material was sent out for surface analysis by X-ray Photoelectron Spectroscopy (XPS).

Photo of membrane surface.

The XPS analysis revealed that the scale contained calcium, carbonate, sulphate, phosphonate and a little sulphite. (The graph below shows the relative abundances of the substances.)

The detail box provides information on the analysis technique.



XPS Results from membrane scale

Autopsy Finding Interpretation

From the results of the autopsy it was determined that the mix of scale and phosphonate (a major component of antiscalant) indicated that the plant had been operated with the reject valve closed. (The alternative that the antiscalant was not effective was ruled out as only two of the three operating trains had scaled up.)

With this conclusion the plant operating regime was reviewed and it was discovered that after cleaning it was possible to start the plant up without opening the reject valve.

Long Term Results

To prevent mal-operation of the plant further alarms were added to the system to inhibit startup with a closed reject valve.

In addition a consultant was engaged to review all aspects of the operation to ensure that adequate safeguards were in place to prevent other mal-operation of the units.

XPS

X-ray Photoelectron Spectroscopy (**XPS**), also known as **ESCA** (Electron Spectroscopy for Chemical Analysis), is an extremely surface sensitive non-destructive technique that provides quantitative surface chemical state information for all elements except hydrogen and helium. It is the most established and widely used surface analysis technique.

Method: XPS analysis involves irradiation of a low vapour pressure solid or liquid sample with soft X-rays in an Ultra High Vacuum (UHV) chamber, typically operating at a pressure of 10^{-9} mbar. Electrons are emitted from the energy levels of the elements in the sample with characteristic kinetic energies. These energies are such that only those electrons emitted from atoms close to the surface can escape the sample into the surrounding vacuum, where they are analysed, producing a spectrum of photoelectron intensity vs. energy.

Avista Technologies Ltd
Waterside House
PO Box 28612
Edinburgh
EH14 5ZL
Email: sales@avistatech.co.uk
www.avistatech.co.uk

Tel: 0131 449 6677
Fax: 0131 449 5599