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Air/water cleaning for biofouling control in spiral wound membrane elements

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Abstract

The main operational problem of nanofiltration or reverse osmosis membrane plants is fouling of feed spacers in membrane elements due to biofouling and particulate fouling. In order to remove biomass and particulate matter from membrane elements, both hydraulic and chemical action are investigated respectively by daily air/water cleaning (AWC) and daily copper sulphate dosing (CSD). In a pilot set-up three parallel spiral wound membrane elements were fed by tap water enriched with a 100 µg/l sodium acetate solution. The first reference membrane element (REF) fouled severely within 21 days indicated by an increase of the normalized pressured drop to 200%. In the second membrane element (AWC) the normalized pressure drop increased 51% during a period of 110 days, while the third membrane (CSD with occasional AWC) increased 18% during this period. It was concluded that both air/water cleaning and daily copper sulphate dosing proved to be very effective methods in reducing membrane fouling due to feed spacer fouling.

Keywords: Reverse osmosis; Biofouling; Particulate fouling; Air/water cleaning; Copper sulphate dosing

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1. Introduction

Application of membrane filtration in water treatment is in many cases hampered by membrane fouling. Biofouling is the most persistent problem and usually occurs when membranes are applied for the production of drinking water, process water and for desalination of seawater. As a result of biofouling, the pressure drop over membrane elements increases which is an operational problem. Many means and methods are available in practice to inactivate biomass during membrane cleaning or during biocide dosing [1]. However, chemical cleaning alone is usually not enough to control biofouling, since the biomass has to be physically removed [2]. In order to remove (inactivated) biomass from membrane elements, both daily air/water cleaning (AWC) and daily copper sulphate dosing (CSD) are investigated in this paper in order to prevent and control spacer fouling due to biofouling.

2. Experimental matters

A pilot study was carried out for 110 days with three parallel spiral wound membrane elements which were fed by tap water enriched with a biodegradable compound (100 µg Acetate-C/L). The reference element (REF) was sporadically air/water cleaned only when the normalized pressure drop exceeded 350 mbar. The AWC element was daily treated with an air/water cleaning. Air/water cleaning was carried out at an increased flow velocity of 700 l/h water with 1400 Nl/h pressurized air. The CSD element was treated by daily 1.0 g/l copper sulphate dosing and twice by an air/water cleaning. The normal-ized pressure drop over the membrane elements was measured.

Membrane autopsy studies were carried out on the three membrane elements at the end of the test period of 110 days of continuous operation. The biomass parameters adenosinetriphosphate (ATP) and total direct cell counts (TDC) are described by Vrouwenvelder et al [3].

3. Results and discussion

Fig. 1 shows the development of the normalized pressure drop of the reference element, the AWC element and the CSD element. The pressure drop increase due to biofouling was controlled by the use of daily air/water cleaning and dosing of copper sulphate. A lower pressure drop at the end of the experiment resulted in lower biomass

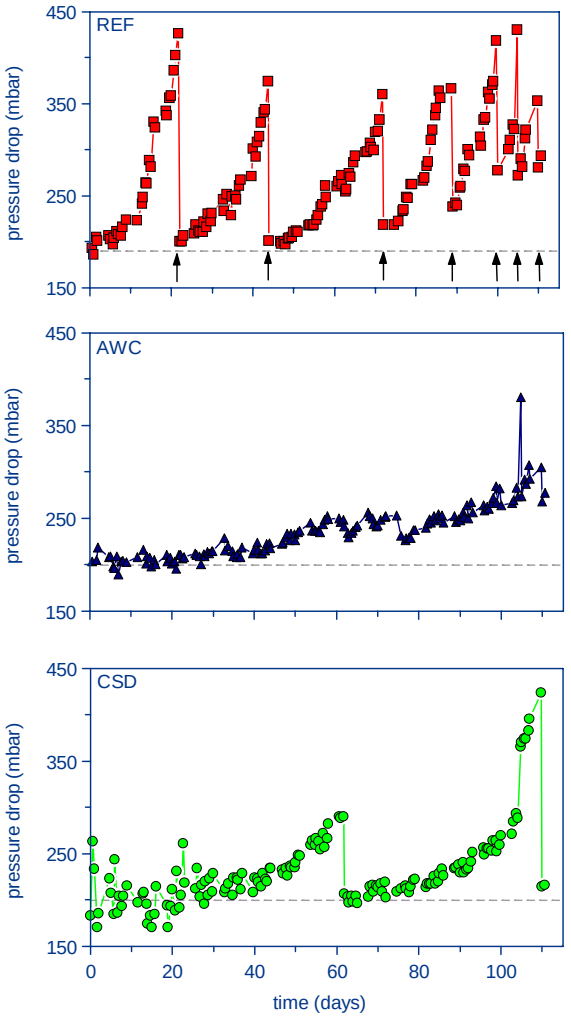

Fig. 1. Pressure drop in time for reference (REF), AWC and CSD membrane element. Air/water cleanings are indicated by the arrows (except for AWC which was air/water cleaned daily).

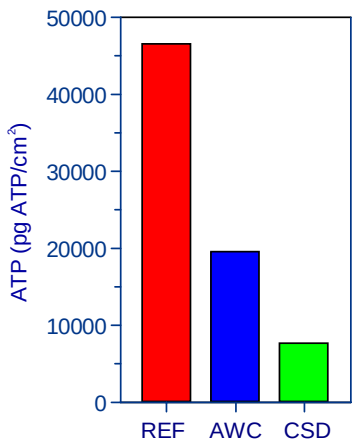

Fig. 2. ATP measurement results at day 110 of REF, AWC and CSD membrane elements.

concentrations determined by membrane autopsy studies (see Fig. 2). A sharp increase in pressure drop as a result of an incidental particulate fouling on day 104 could be reversed by the use of air/water cleaning only.

4. Evaluation

Control of biofouling was obtained by using a combination of daily copper sulphate dosing and air/water cleaning (CSD). Under worse case conditions (water supplemented with relative high concentrations of nutrients) the increase of pressure drop was 18% after 110 days of operation. The alternative daily air water cleaning (AWC) was somewhat less effective in control of biofouling than CSD, but better than the reference membrane (51%).

Both investigated methods, air/water cleaning and copper sulphate dosing are very promising in controlling both particulate fouling and biofouling. Both methods are very simple to implement in both new and existing spiral wound membrane plants. The costs of operation may be reduced strongly by applying this cleaning method.

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