

CLAIMS

1. An apparatus for assessing a state of fouling of a reverse osmosis system, the apparatus comprising:
 - 5 two or more electrodes configured to be arranged on opposing sides of a reverse osmosis membrane,
an alternating current generator configured to generate an alternating electrical current of various frequencies between the two or more electrodes,
a detector configured to measure (i) a voltage across the membrane, (ii) a
10 current through the membrane, and (iii) a phase difference between the voltage and the current, at the various frequencies, and
a processor configured to derive an impedance value in a diffusion polarization layer adjacent to the membrane using the measured voltage, current, and phase difference, and
15 a device configured to determine a state of fouling of the reverse osmosis system based on a plurality of the derived impedance values, by:
 - (i) determining a critical flux of the reverse osmosis membrane so as to ascertain a sustainable flux condition of the reverse osmosis membrane, wherein
20 determining the critical flux of the reverse osmosis membrane comprises plotting the plurality of the derived impedance values as a function of membrane flux to generate a curve, and determining the membrane flux at a point of change of a slope of the curve,
 - (ii) determining a critical flux point of the reverse osmosis membrane as a signal for an incipient fouling event, wherein determining the critical flux point
25 comprises plotting the plurality of derived impedance values as a function of time to generate a curve, and determining a time at a point of change of a slope of the curve, or
 - (iii) monitoring occurrence of biofouling at the reverse osmosis membrane
30 comprised in the reverse osmosis system, wherein each impedance value is a conductance value and is derived while the reverse osmosis membrane comprised in the reverse osmosis system is operating at a same membrane flux or substantially the same membrane flux, determining the state of fouling of

the reverse osmosis system based on the plurality of impedance values comprises plotting the conductance values as a function of time to generate a curve and determining presence of a point at which a slope of the curve transitions to a negative slope as indication that biofouling has occurred.

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2. The apparatus according to claim 1, wherein the processor is configured to derive the impedance value in the diffusion polarization layer adjacent the membrane by fitting the measured voltage, current, and phase difference to a Maxwell-Wagner model.
- 10 3. The apparatus according to claim 1, wherein each derived impedance value is a conductance value and determining the membrane flux at the point of change of the slope of the curve comprises determining the membrane flux at a point at which the slope of the curve transitions to a positive slope.
- 15 4. The apparatus according to claim 1, wherein each derived impedance value is a conductance value and determining the time at the point of change of the slope of the curve comprises determining a time at a point at which the slope of the curve transitions to a positive slope in the case of inorganic fouling.
- 20 5. The apparatus according to claim 2, wherein the apparatus is configured to assess the state of fouling of the reverse osmosis system on-line.