CLAIMS

1. A method for monitoring deposit formation in a process comprising an aqueous flow, the method comprising

- providing a feed flow of aqueous liquid onto a receiving surface to be monitored, wherein the receiving surface is located in a monitoring cell;

- illuminating at least part of said receiving surface with a light source;

- collecting visual data at a multitude of positions across said receiving surface;

- analyzing said visual data;

- computing a quantitative scaling and/or fouling indication for said receiving surface based on said analysing,

wherein the monitoring cell has an inlet for the aqueous feed flow and an outlet for a reject flow from the monitoring cell, and the receiving surface comprises a selective barrier membrane,

wherein said feed flow is directed to the receiving surface to produce from said feed flow a permeate part that is passing through said selective barrier membrane and a concentrate part that forms said reject flow

the method further comprising the step of selecting or adjusting at least one of:

a) a volume flow rate of the aqueous flow to the monitoring cell to correspond, when using a first monitoring cell specific correlation factor, to the main process volume flow rate per main process membrane surface area; or

b) a pressure differential of the feed flow of the aqueous liquid at the receiving surface of the monitoring cell to correspond, when using a second monitoring cell specific correlation factor, to a pressure differential of the aqueous flow at a receiving surface of the main process.

2. A method for monitoring deposit formation in a process comprising an aqueous flow, the method comprising

- providing a feed flow of aqueous liquid onto a receiving surface to be monitored, wherein the receiving surface is located in a monitoring cell, wherein said monitoring cell includes at least one layer of a spacer applied on the receiving surface;

- illuminating at least part of said receiving surface and/or spacer with a light source;

- collecting visual data at a multitude of positions across said receiving surface and/or spacer;

- analyzing said visual data;

- computing a quantitative scaling and/or fouling indication for said receiving surface and/or spacer based on said analysing,

wherein the monitoring cell has an inlet for the aqueous feed flow and an outlet for a reject flow from the monitoring cell, and the receiving surface comprises a selective barrier membrane,

wherein said feed flow is directed to the receiving surface to produce from said feed flow a permeate part that is passing through said selective barrier membrane and a concentrate part that forms said reject flow

the method further comprising the step of selecting or adjusting at least one of:

a) a volume flow rate of the aqueous flow to the monitoring cell to correspond, when using a first monitoring cell specific correlation factor, to the main process volume flow rate per main process membrane surface area; or

b) a pressure differential of the feed flow of the aqueous liquid at the receiving surface of the monitoring cell to correspond, when using a second monitoring cell specific correlation factor, to a pressure differential of the aqueous flow at a receiving surface of the main process.

3. A method according to claim 1 or 2, wherein said pressure differential is an overpressure of 0.1 to 60 bar, and/or the selective barrier membrane is a semipermeable membrane.

4. A method according to claim 1, 2 or 3, wherein said pressure differential is an overpressure of 0.1 to 1 bar, typically 0.1 to 0.5 bar, and the membrane is a microfiltration membrane.

5. A method according to claim 1, 2 or 3, wherein said pressure differential is an overpressure of 1 to 5 bar, typically 1 to 3 bar, and the membrane is an ultrafiltration membrane.

6. A method according to claim 1, 2 or 3, wherein said pressure differential is an overpressure of 4 to 15 bar, typically 5 to 10 bar, and the membrane is a nanofiltration membrane.

7. A method according to claim 1, 2 or 3, wherein said pressure differential is an overpressure of 10 to 60 bar, typically 10 to 40 bar, and the membrane is a reverse osmosis membrane.

8. A method according to any of the preceding claims, wherein said feed flow is directed to the receiving surface at said pressure differential, such that

1 to 99%, at least 2%, at least 25%, at least 30%, at least 80%, or at least 85%, of said feed flow passes through said membrane, and

1 to 99%, less than 98%, less than 75%, less than 70%, less than 20%, or less than 15%, of said feed flow forms said reject flow.

9. A method according to any of the preceding claims, wherein said feed flow is directed to the receiving surface at said pressure differential, such that

1 to 99%, at least 2%, at least 25%, at least 30%, at least 80%, or at least 85%, of said feed flow forms said reject flow, and

1 to 99%, less than 98%, less than 75%, less than 70%, less than 20%, or less than 15%, of said feed flow passes through said membrane.

10. A method according to any of the preceding claims,

wherein the method comprises providing at least two monitoring cells, the method comprising

- providing a first aqueous feed flow onto a first receiving surface to be monitored, wherein the first receiving surface is located in a first monitoring cell and comprises a first selective barrier membrane,

- providing a second aqueous feed flow onto a second receiving surface to be monitored, wherein the second receiving surface is located in a second monitoring cell and comprises a second selective barrier membrane,

wherein the first and second aqueous feed flows are similar to each other or different from each other in terms of flow velocity, flow content, flow origin, and/or flow pressure, and the first and second selective barrier membranes are similar to each other or different from each other in terms of membrane material, membrane type, spacer type, and/or spacer thickness.

11. A method according to any of the preceding claims, the method further comprising:

- classifying the quality and type of deposition attached to said receiving surface based on information obtained from said analyzed visual data; and

- computing a quantitative scaling and/or fouling indication of said receiving surface based on said classification.

12. A method according to any of the preceding claims, the method further comprising:

based on information obtained from said analyzed visual data, computing an overall scaling and/or fouling indication of said receiving surface.

13. A method according to any of the preceding claims, the method further comprising:

adding to said feed flow of an aqueous liquid at least one fluorescent dye capable of staining at least one type of microbes;

illuminating at least part of said receiving surface with at least two light sources, at least one of which uses light with a selected wavelength that excites a biofouling deposition stained by said at least one fluorescent dye;

classifying the quality and type of biofouling deposition on said receiving surface based on fluorescence emission from said depositions in said analyzed visual data.

14. A method according to any of the preceding claims, wherein said light source is emitting ultraviolet light.

15. A method according to any of claims, 13 or 14 the method comprising:

illuminating at least part of said receiving surface with at least two light sources, at least one of which uses light with a selected wavelength that excites inorganic or organic deposition stained by said at least one fluorescent dye.

16. A method of any of the preceding claims, wherein the quantitative scaling and/or fouling indication of said receiving surface is based on one or more of the following: total fouling of said surface, fouling rate, color map of fouling, and/or share or ratio of each fouling type.

17. A method of any of claims 11 to 16, wherein the classification of the quality and type of said depositions on said receiving surface is done in a computer unit by using one or more of the following; shape factors such as aspect ratio, size factors such as size distribution or mean size, color factors such as mean color, color distribution and brightness, of the depositions imaged.

18. A method of any one of claims 1 – 3 and 8 – 17, wherein said selective barrier membrane includes a reverse osmosis, nanofiltration, ultrafiltration or a microfiltration semipermeable membrane.

19. A method of any of the preceding claims, the method comprising:

- connecting at least two monitoring cells to be monitored in parallel or in series with regard to the feed and reject flows;

- collecting visual data of the surfaces of said at least two monitoring cells.

20. A method of any of the preceding claims, wherein said feed flow is at least one of the following: saline water, brackish water, circulated water, wastewater, or industrial process water.

21. A method of any of the preceding claims, wherein

said feed flow is a side stream taken from a main process stream, and

said quantitative indication of said deposition on said receiving surface, compared to a clean surface used as a reference, is used as an input parameter for automatic control of the addition of one or more chemicals to said main process stream.

22. A method according to claim 21, wherein said chemical is selected from the group of antiscalants, biocides, coagulants, flocculants, oxidants, disinfectants, cleaning chemicals, polymers and/or any combination thereof.

23. An apparatus for monitoring deposit formation in a process comprising an aqueous flow, the apparatus comprising

- feeding means for providing a feed flow of aqueous liquid onto a receiving surface to be monitored, wherein the receiving surface is located in a monitoring cell,

- a light source configured to illuminate at least part of said receiving surface;

- an imaging device configured to collect visual data at a multitude of positions across said receiving surface;

- a data processing unit configured to analyze said visual data;

- computing means configured to compute a quantitative scaling and/or fouling indication for said receiving surface based on said analysing,

wherein the monitoring cell has an inlet for the aqueous feed flow and an outlet for a reject flow from the monitoring cell, and the receiving surface comprises a selective barrier membrane,

wherein said feeding means are configured to direct the feed flow to the receiving surface to produce from said feed flow a permeate part that is passing through said selective barrier membrane and a concentrate part that forms said reject flow

and wherein the apparatus is configured to select or adjust at least one of:

a) a volume flow rate of the aqueous flow to the monitoring cell to correspond, when using a first monitoring cell specific correlation factor, to the main process volume flow rate per main process membrane surface area; or
b) a pressure differential of the feed flow of the aqueous liquid at the receiving surface of the monitoring cell to correspond, when using a second monitoring cell specific correlation factor, to a pressure differential of the aqueous flow at a receiving surface of the main process.

24. An apparatus for monitoring deposit formation in a process comprising an aqueous flow, the apparatus comprising

- feeding means for providing a feed flow of aqueous liquid onto a receiving surface to be monitored, wherein the receiving surface is located in a

monitoring cell, wherein said monitoring cell includes at least one layer of a spacer applied on the receiving surface;

- a light source configured to illuminate at least part of said receiving surface and/or spacer with the light source;

- an imaging device configured to collect visual data at a multitude of positions across said receiving surface and/or said spacer;

- a data processing unit configured to analyze said visual data;

- computing means configured to compute a quantitative scaling and/or fouling indication for said receiving surface and/or spacer based on said analysing,

wherein the monitoring cell has an inlet for the aqueous feed flow and an outlet for a reject flow from the monitoring cell, and the receiving surface comprises a selective barrier membrane,

wherein said feeding means are configured to direct the feed flow to the receiving surface to produce from said feed flow a permeate part that is passing through said selective barrier membrane and a concentrate part that forms said reject flow

and wherein the apparatus is configured to select or adjust at least one of:

a) a volume flow rate of the aqueous flow to the monitoring cell to correspond, when using a first monitoring cell specific correlation factor, to the main process volume flow rate per main process membrane surface area; or

b) a pressure differential of the feed flow of the aqueous liquid at the receiving surface of the monitoring cell to correspond, when using a second monitoring cell specific correlation factor, to a pressure differential of the aqueous flow at a receiving surface of the main process.

25. An apparatus according to claim 24, wherein said pressure differential is an overpressure of 0.1 to 60 bar, and/or the selective barrier membrane is a semipermeable membrane.

26. An apparatus according to claim 23, 24 or 25, wherein said pressure differential is an overpressure of 0.1 to 1 bar, typically 0.1 to 0.5 bar, and the membrane is a microfiltration membrane.

27. An apparatus according to claim 23, 24 or 25, wherein said pressure differential is an overpressure of 1 to 5 bar, typically 1 to 3 bar, and the membrane is an ultrafiltration membrane.

28. An apparatus according to claim 23, 24 or 25, wherein said pressure differential is an overpressure of 4 to 15 bar, typically 5 to 10 bar, and the membrane is a nanofiltration membrane.

29. An apparatus according to claim 23, 24 or 25, wherein said pressure differential is an overpressure of 10 to 60 bar, typically 10 to 40 bar, and the membrane is a reverse osmosis membrane.

30. An apparatus according to any of the preceding claims 23 to 29, wherein said feeding means are configured to direct said feed flow to the receiving surface at said pressure differential, such that

1 to 99%, at least 2%, at least 25%, at least 30%, at least 80%, or at least 85%, of said feed flow passes through said membrane, and

1 to 99%, less than 98%, less than 75%, less than 70%, less than 20%, or less than 15%, of said feed flow forms said reject flow.

31. An apparatus according to any of the preceding claims 23 to 30, wherein said feeding means are configured to direct said feed flow to the receiving surface at said pressure differential, such that

1 to 99%, at least 2%, at least 25%, at least 30%, at least 80%, or at least 85%, of said feed flow forms said reject flow, and

1 to 99%, less than 98%, less than 75%, less than 70%, less than 20%, or less than 15%, of said feed flow passes through said membrane.

32. An apparatus according to any of the preceding claims 23 to 31,

wherein the apparatus comprises at least two monitoring cells, wherein

- a first monitoring cell comprises first feeding means for providing a first aqueous feed flow onto a first receiving surface to be monitored, wherein the first receiving surface is located in the first monitoring cell and comprises a first selective barrier membrane,

- a second monitoring cell comprises second feeding means for providing a second aqueous feed flow onto a second receiving surface to be monitored, wherein the second receiving surface is located in the second monitoring cell and comprises a second selective barrier membrane,

such that the first and second aqueous feed flows are similar to each other or different from each other in terms of flow velocity, flow content, flow origin, and/or flow pressure, and

wherein the first and second selective barrier membranes are similar to each other or different from each other in terms of membrane material, membrane type, spacer type and/or spacer thickness.

33. An apparatus of any of the preceding claims 23 to 32, further comprising:

- a classifying algorithm for classifying the quality and/or type of deposition attached to said receiving surface based on information obtained from said analyzed visual data; wherein the data processing unit is configured to compute a quantitative scaling and/or fouling indication of said receiving surface based on said classification.

34. An apparatus of any of the preceding claims 23 to 33, wherein the data processing unit is configured to:

based on information obtained from said analyzed visual data, compute an overall scaling and/or fouling indication of said receiving surface.

35. An apparatus of any of the preceding claims 23, 24 or 30 to 34, wherein said membrane includes a reverse osmosis, nanofiltration, ultrafiltration or a microfiltration semipermeable membrane.

36. An apparatus of any of the preceding claims 23 to 35, comprising

at least two monitoring cells to be monitored connected in parallel with regard to the feed and reject flows;

wherein said imaging device is configured to collect visual data of the surfaces of said at least two monitoring cells.

37. An apparatus of any of the preceding claims 23 to 36, comprising

means for taking said feed flow as a side stream taken from a main process stream,

control means configured to use said quantitative indication of said deposition on said receiving surface, compared to a clean surface as a reference, as an input parameter for automatic control of the addition of one or more chemicals to said main process stream.

38. An apparatus according to claim 37, wherein said chemical is selected from the group of antiscalants, biocides, coagulants, flocculants, oxidants, disinfectants, cleaning chemicals, polymers and/or any combination thereof.

39. Use of a method according to any of the preceding claims 1 to 22 and/or an apparatus according to any of the preceding claims 23 to 38, in

in a water treatment process, such as a waste water treatment process, and/or a drinking water treatment process,

in an industrial process, such as an industrial process of food and beverage industry, pulp and paper manufacturing, and/or oil and gas industry, and/or

in a mining process,

to predict or estimate fouling and/or deposition of impurities on a selective barrier membrane receiving surface in said process.