CLAIMS

1. A method comprising:

monitoring, for a current filtration cycle, at least one of a change in fluid filtrate throughput during constant pressure operation or a change in pressure during constant filtrate throughput operation;

determining a fouling mechanism based on at least one of a determination that the change in filtrate throughput for the current filtration cycle is greater than a change in filtrate throughput for a previous filtration cycle or a determination that the change in pressure for the current filtration cycle is greater than a change in pressure for a previous filtration cycle;

selecting a cleaning protocol based on the determined fouling mechanism; and

performing a cleaning procedure according to the selected cleaning protocol.

2. The method of claim 1, further comprising:

capturing video of one or more membrane elements.

3. The method of claim 1, wherein monitoring a change in filtrate throughput comprises measuring filtrate flow over a predefined period of time, and wherein monitoring a change in pressure comprises measuring pressure over a predefined period of time.

4. The method of claim 1, wherein determining a fouling mechanism comprises a mathematical analysis of the change in filtrate throughput or the change in pressure according to one or more predetermined fouling models.

5. The method of claim 1, wherein the fouling mechanism comprises one or more of concentration polarization, organic adsorption of chemically-active molecules, scale due to precipitation of salts and hydroxides, cake and pore blocking due to deposition of large suspended particles or small colloidal particles, gel-formation due to deposition of inert macromolecules, or bio-fouling due to deposition and growth of biologically active organisms.

6. The method of claim 4, wherein the one or more predetermined fouling models comprises one or more of a Hermia's model, a modified Hermia's model, and a resistance-in-series model.

7. The method of claim 1, wherein selecting the cleaning protocol comprises selecting a cleaning method and one or more parameters associated with the cleaning method.

8. A method comprising:

monitoring an instantaneous change in one or more parameters associated with one or more membranes of a filtration system;

determining, based on the instantaneous change in the one or more parameters, that a flux decline rate for a current filtration cycle is greater than a flux decline rate for a previous filtration cycle;

determining a fouling mechanism based on the instantaneous change in the one or more parameters;

selecting a cleaning protocol based on the determined fouling mechanism; and

performing a cleaning procedure according to the selected cleaning protocol.

9. The method of claim 8, wherein the one or more parameters comprise at least one of a change in fluid filtrate throughput during constant pressure operation or a change in pressure during constant filtrate throughput operation.

10. The method of claim 8, wherein the instantaneous change in the one or more parameters are monitored during the current filtration cycle.

11. The method of claim 8, wherein determining a fouling mechanism comprises fitting a representation of a change in fluid filtrate throughput with respect to time to a series of pre-determined fouling mechanism models.

12. The method of claim 8, wherein the fouling mechanism comprises one or more of concentration polarization, organic adsorption of chemically-active molecules, scale due to precipitation of salts and hydroxides, cake and pore blocking due to deposition of large

suspended particles or small colloidal particles, gel-formation due to deposition of inert macromolecules, or bio-fouling due to deposition and growth of biologically active organisms.

13. A non-transitory computer-readable storage medium comprising processor-executable instructions that, when executed by a processor of a computing device, cause the computing device to:

cause a flow sensor of a filtration system to monitor, for a current filtration cycle, at least one of a change in fluid filtrate throughput during constant pressure operation or a change in pressure during constant filtrate throughput operation;

determine a fouling mechanism within the filtration system based on at least one of a determination that the change in fluid filtrate throughput for the current filtration cycle is greater than a change in fluid filtrate throughput for a previous filtration cycle or a determination that the change in pressure for the current filtration cycle is greater than a change in pressure for a previous filtration cycle;

select a cleaning protocol for the filtration system based on the determined fouling mechanism; and

cause the filtration system to perform a cleaning procedure according to the selected cleaning protocol.

14. The non-transitory computer-readable storage medium of claim 13, wherein the processor-executable instructions that, when executed by the computing device, cause the computing device to determine a fouling mechanism further cause the computing device to perform a mathematical analysis of the change in fluid filtrate throughput.

15. The non-transitory computer-readable storage medium of claim 14, wherein the mathematical analysis of the change in fluid filtrate throughput is performed according to one or more predetermined fouling models.

16. The non-transitory computer-readable storage medium of claim 15, wherein the one or more predetermined fouling models comprises a Hermia's model.

17. The non-transitory computer-readable storage medium of claim 15, wherein the one or more predetermined fouling models comprises a modified Hermia's model.

18. The non-transitory computer-readable storage medium of claim 15, wherein the one or more predetermined fouling models comprises a resistance-in-series model.

19. The non-transitory computer-readable storage medium of claim 13, wherein the processor-executable instructions that, when executed by the computing device, cause the computing device to cause a flow sensor of a filtration system to monitor a change in fluid filtrate throughput further cause the computing device to cause the flow sensor to measure filtrate flow over a predefined period of time.

20. The non-transitory computer-readable storage medium of claim 13, wherein the fouling mechanism comprises one or more of concentration polarization, organic adsorption of chemically-active molecules, scale due to precipitation of salts and hydroxides, cake and pore blocking due to deposition of large suspended particles or small colloidal particles, gel-formation due to deposition of inert macromolecules, or bio-fouling due to deposition and growth of biologically active organisms.