CLAIMS

What is claimed is:

1. A method of controlling a diaphragm pump, comprising: actuating a pumping operation of a fluid from a first container by alternating a supply of a positive air flow and a negative air flow to an air side of a diaphragm pump through an air flow line connected to an output of an air flow regulator; suctioning the fluid from the first container by applying the supply of negative air flow to the air side of the diaphragm pump; directly monitoring, by a plurality of sensors along a permeate fluid pathway at least one of a permeate flow rate and a permeate pressure; regulating a duration of a partial or full cycle of displacement of the diaphragm pump in response to at least one of the permeate flow rate and the permeate pressure; filtering the fluid suctioned from the first container; and directing part of the filtered fluid back to the first container and directing a permeate through the permeate fluid pathway to a second container.

2. The method of claim 1, further comprising: regulating a degree of opening of the regulator to control the supply of positive and negative air flow.

3. The method of claim 1, further comprising cleaning the filter by controlling the timing of a burst of increased fluid flow from the fluid side of the diaphragm pump to clean the filter.

4. The method of claim 1, further comprising controlling a timing of delivery of the amount of air flow to the air flow line.

5. The method of claim 1, further comprising: detecting, via at least one sensor in a vicinity of the diaphragm, a position of a portion of the diaphragm at both ends of its displacement.

6. The method of claim 1, further comprising displacing a volume of fluid over a predetermined time period.

7. The method of claim 1, further comprising adjusting a duration of a partial or full cycle of displacement of the diaphragm pump to satisfy a process requirement.

8. A method of controlling a diaphragm pump with a controller, comprising: alternating

between supplying a positive air flow and a negative air flow to an air side of a diaphragm pump to actuate pumping of a fluid associated with a bioreactor; suctioning the fluid from the bioreactor by supplying a negative air flow to the air side of the diaphragm pump; filtering the fluid suctioned from the bioreactor through a filter into a permeate; extracting the permeate to direct the same to a container; directly monitoring, by a plurality of sensors along a permeate fluid pathway at least one of a permeate flow rate and a permeate pressure; and regulating a duration of a partial or full cycle of displacement of the diaphragm pump in response to at least one of the permeate flow rate and the permeate pressure; wherein the controller controls delivery of the permeate to the container in accordance with a process requirement.

9. The method of claim 8, wherein a portion of the filtered fluid is directed to the bioreactor and another portion of the filtered fluid is directed to another container.

10. The method of claim 8, further comprising selecting a duration of a pumping operation, including a predetermined amounts of positive air flow and a predetermined amount of negative air flow at a given process step, to generate a performance profile appropriate for a specific application.

11. The method of claim 8, wherein the fluid comprises a biological fluid.

12. The method of claim 8, wherein the controller is configured to monitor turbidity of the fluid.

13. The method of claim 11, wherein the biological fluid is a fluid containing animal, human, or microbial cells.

14. The method of claim 8, wherein the controller is configured to control the pumping function of a plurality of pumps connected in a pumping system.