

CLAIMS

What is claimed is

1. A fluid filtration assembly, comprising:
 - a filter housing having first and second ends, and a coupling for fluid connection with a fluid storage vessel;
 - a filter element disposable within the filter housing; and
 - a first pump coupled at the first end of the filter housing and a second pump coupled at the second end of the filter housing, the first and second pumps for moving fluid from the fluid storage vessel through the filter element.
2. The fluid filtration assembly of claim 1, wherein at least one of the first and second pumps is a diaphragm pump.
3. The fluid filtration assembly of claim 1, wherein at least one of the first and second pumps is a plunger pump.
4. The fluid filtration assembly of claim 1, wherein the filter element is a hollow fiber filter.
5. The fluid filtration assembly of claim 4, wherein the first and second pumps are controllable to generate alternating tangential flow of the fluid between the filter housing and the first and second pumps.

6. The fluid filtration assembly of claim 1, wherein the first and second pumps are separately controllable.
7. The fluid filtration assembly of claim 1, wherein the first and second pumps are controllable such that a vacuum stroke of the first pump is synchronized with a pressure stroke of the second pump.
8. The fluid filtration assembly of claim 1, wherein the first and second pumps are controllable so that a diaphragm of the first pump applies a positive pressure to the fluid while a diaphragm of the second pump is under negative pressure.
9. A fluid filtration assembly, comprising:
 - a process vessel;
 - a filter housing having first and second ends, and a coupling for fluid communication with the process vessel;
 - a filter element disposable within the filter housing; and
 - a first pump coupled at the first end of the filter housing and a second pump coupled at the second end of the filter housing, the first and second pumps for moving fluid from the process vessel through the filter element.
10. The fluid filtration assembly of claim 9, wherein at least one of the first and second pumps is a diaphragm pump.

11. The fluid filtration assembly of claim 9, wherein at least one of the first and second pumps is a plunger pump.
12. The fluid filtration assembly of claim 9, wherein the filter element is a hollow fiber filter.
13. The fluid filtration assembly of claim 12, wherein the first and second pumps are controllable to generate alternating tangential flow of the fluid between the filter housing and the first and second pumps.
14. The fluid filtration assembly of claim 12, further comprising a controller including a processor programmed to execute instructions to control the first and second pumps.
15. The fluid filtration assembly of claim 14, wherein the processor is programmed to execute instructions to control the first and second pumps so that a vacuum stroke of the first pump is synchronized with a pressure stroke of the second pump.
16. The fluid filtration assembly of claim 14, wherein the processor is programmed to execute instructions to control the first and second pumps so that a diaphragm of the first pump applies a positive pressure to the fluid while a diaphragm of the second pump is under negative pressure.

17. A fluid filtration assembly, comprising:
- a process vessel;
 - a filter housing having first and second ends, and a coupling for fluid communication with the process vessel;
 - a filter element disposable within the filter housing;
 - a first pump coupled at the first end of the filter housing and a second pump coupled at the second end of the filter housing, the first and second pumps for moving fluid from the process vessel through the filter element; and
 - a controller in communication with the first and second pumps for simultaneously actuating the first and second pumps to cycle fluid between the first and second pumps and the process vessel.
18. The fluid filtration assembly of claim 17, wherein at least one of the first and second pumps is a diaphragm pump or a plunger pump.
19. The fluid filtration assembly of claim 17, wherein the controller comprises a processor programmed to execute instructions to control operation of the first and second pumps.
20. The fluid filtration assembly of claim 19, wherein the processor is programmed to execute instructions to control the first and second pumps to generate alternating tangential flow of the fluid between the filter housing and the first and second pumps.

21. The fluid filtration assembly of claim 19, wherein the processor is programmed to execute instructions to control the first and second pumps so that a vacuum stroke of the first pump is synchronized with a pressure stroke of the second pump.

22. The fluid filtration assembly of claim 19, wherein the processor is programmed to execute instructions to control the first and second pumps so that a diaphragm of the first pump applies a positive pressure to the fluid while a diaphragm of the second pump is under negative pressure.