SUMMARY

In one aspect, a regenerative dialysis system includes an input pump that pumps fresh dialysate fluid into a dialyzer at an input rate. An output pump pumps used dialysate fluid from the dialyzer at an output rate. An ultrafiltration rate of the system is related to the output rate relative to the input rate. A sorbent cartridge filters the used dialysate fluid to generate the fresh dialysate fluid. A controller controls the ultrafiltration rate of the system in response to a compliance model of the sorbent cartridge that provides a predefined model of compliant behavior related to the sorbent cartridge that is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of a flow rate of the dialysate fluid through the sorbent cartridge.

In one embodiment, the system further comprises: a reservoir that stores the fresh dialysate fluid; and a scale that monitors a scale weight of the fresh dialysate fluid stored in the reservoir; wherein the controller further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

In another embodiment, the controller further: calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; calculates a corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and controls the ultrafiltration rate of the system in response to the corrected dialysate fluid weight.

In another embodiment, the controller further: calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

In another embodiment, the controller controls the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

In another embodiment, the predefined model of the sorbent cartridge is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge.

In another embodiment, the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

In another embodiment, the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

In another embodiment, the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

In another embodiment, the ultrafiltration rate of a dialysis procedure performed by the dialysis system is prescribed.

In another aspect, a method of controlling ultrafiltration rate of a regenerative dialysis system comprises: pumping fresh dialysate fluid into a dialyzer at an input rate; pumping used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate; filtering the used dialysate fluid to generate the fresh dialysate fluid at a sorbent cartridge; and controlling the ultrafiltration rate of the regenerative dialysis system in response to a compliance model of the sorbent cartridge that provides a predefined model of compliant behavior related to the sorbent cartridge based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of a flow rate of the dialysate fluid through the sorbent cartridge.

In one embodiment, the method further comprises: storing the fresh dialysate fluid at a reservoir; monitoring a scale weight of the fresh dialysate fluid stored in the reservoir; and further controlling the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

In another embodiment, the method further comprises: calculating a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; calculating a corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and further controlling the ultrafiltration rate in response to the corrected dialysate fluid weight.

In another embodiment, the method further comprises: calculating an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and calculating the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

In another embodiment, the method further comprises controlling the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

the dialysate fluid through the sorbent cartridge; and a weight correction function module that calculates a corrected dialysate fluid weight by summing the dynamic weight and the scale weight, wherein the ultrafiltration rate function module further controls the ultrafiltration rate in response to the corrected dialysate fluid weight.

In another embodiment, the ultrafiltration rate function module further comprises an absorption weight calculation function module that calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption, wherein the weight correction function module calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

In another embodiment, the ultrafiltration rate function module further controls the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

In another embodiment, the predefined model of the sorbent cartridge is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge.

In another embodiment, the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

In another embodiment, the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

In another embodiment, the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

In another embodiment, the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

In one embodiment, there is provided a regenerative dialysis system, comprising: an input pump that pumps fresh dialysate fluid into a dialyzer at an input rate; an output pump that pumps used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the system being related to the output rate relative to the input rate; a sorbent cartridge that filters the used dialysate fluid to generate the fresh dialysate fluid; a controller that controls the ultrafiltration rate of the system in response to a flow rate of the dialysate fluid through the sorbent cartridge, wherein the controller controls the ultrafiltration rate of the system in response to a corrected dialysate fluid weight; a reservoir that stores the fresh dialysate fluid; a scale that monitors the scale weight of the fresh dialysate fluid stored in the reservoir, wherein the controller further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir, wherein the controller further: calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; calculates the corrected dialysate fluid weight by summing the dynamic weight and the scale weight; calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

In one embodiment, there is provided a method of controlling ultrafiltration rate of a regenerative dialysis system, comprising: pumping fresh dialysate fluid into a dialyzer at an input rate; pumping used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate; filtering the used dialysate fluid to generate the fresh dialysate fluid at a sorbent cartridge; controlling the ultrafiltration rate of the regenerative dialysis system in response to a flow rate of the dialysate fluid through the sorbent cartridge, and in response to a corrected dialysate fluid weight; storing the fresh dialysate fluid at a reservoir; monitoring the scale weight of the fresh dialysate fluid stored in the reservoir; further controlling the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir; calculating a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; calculating the corrected dialysate fluid weight by summing the dynamic weight and the scale weight; calculating an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and calculating the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the embodiments of the invention will be apparent from the more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings in which

What is claimed is:

1. A regenerative dialysis system, comprising:

an input pump that pumps fresh dialysate fluid into a dialyzer at an input rate;

an output pump that pumps used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the system being related to the output rate relative to the input rate;

a sorbent cartridge that filters the used dialysate fluid to generate the fresh dialysate fluid; and

a controller that controls the ultrafiltration rate of the system in response to a flow rate of the dialysate fluid through the sorbent cartridge.

2. The system of claim 1 wherein the system further comprises:

a reservoir that stores the fresh dialysate fluid;

a scale that monitors a scale weight of the fresh dialysate fluid stored in the reservoir; and

wherein the controller further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

3. The system of claim 2 wherein the controller further:

calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge;

calculates a corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and

controls the ultrafiltration rate of the system in response to the corrected dialysate fluid weight.

4 The system of claim 3 wherein the controller calculates the dynamic weight of the dialysate fluid over a time period of a treatment procedure.

5. The system of claim 3 wherein the controller further:

calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and

calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

6. The system of claim 1 wherein the controller controls the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

7. The system of claim 6 wherein the predefined model of the sorbent cartridge is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge.

8. The system of claim 7 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

9. The system of claim 7 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

10. The system of claim 1 wherein the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

11. The system of claim 1 wherein the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

12. A method of controlling ultrafiltration rate of a regenerative dialysis system, comprising:

pumping fresh dialysate fluid into a dialyzer at an input rate;

pumping used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate;

filtering the used dialysate fluid to generate the fresh dialysate fluid at a sorbent cartridge; and

controlling the ultrafiltration rate of the regenerative dialysis system in response to a flow rate of the dialysate fluid through the sorbent cartridge.

13. The method of claim 12 further comprising:

storing the fresh dialysate fluid at a reservoir;

monitoring a scale weight of the fresh dialysate fluid stored in the reservoir; and

further controlling the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

14. The method of claim 13 further comprising:

calculating a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge;

calculating a corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and

further controlling the ultrafiltration rate in response to the corrected dialysate fluid weight.

15 The method of claim 14 wherein calculating the dynamic weight of dialysate fluid stored in the sorbent cartridge is performed over a time period of a treatment procedure.

16. The method of claim 14 further comprising:

calculating an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and

calculating the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

17. The method of claim 12 further comprising controlling the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

18. The method of claim 17 wherein the predefined model of the sorbent cartridge is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge.

19. The method of claim 18 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

20. The method of claim 18 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

21. The method of claim 12 wherein the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

22. The method of claim 12 wherein the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

23. A controller comprising a plurality of function modules stored in a storage system and executable by a processor to control an ultrafiltration rate of a regenerative dialysis system, the controller comprising:

an input pump function module that outputs an input pump control signal effecting the pumping of fresh dialysate fluid into a dialyzer at an input rate;

an output pump function module that outputs an output pump control signal effecting the pumping of used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate, whereby the used dialysate fluid is filtered at a sorbent cartridge to generate the fresh dialysate fluid; and

an ultrafiltration rate function module that controls the ultrafiltration rate of the regenerative dialysis system in response to a flow rate of the dialysate fluid through the sorbent cartridge.

24. The controller of claim 23 wherein the ultrafiltration rate function module further comprises a scale weight sampler function module that monitors a scale weight of the fresh dialysate fluid stored in a reservoir, wherein the ultrafiltration rate function module further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

25. The controller of claim 24 wherein the ultrafiltration rate function module further comprises:

a dynamic weight calculation function module that calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; and

a weight correction function module that calculates a corrected dialysate fluid weight by summing the dynamic weight and the scale weight,

wherein the ultrafiltration rate function module further controls the ultrafiltration rate in response to the corrected dialysate fluid weight.

26. The controller of claim 25 wherein the ultrafiltration rate function module further comprises an absorption weight calculation function module that calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption, wherein the weight correction function module calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

27. The controller of claim 23 wherein the ultrafiltration rate function module further controls the ultrafiltration rate of the system in response to the flow rate of the dialysate fluid through the sorbent cartridge based on a predefined model of compliant behavior by the sorbent cartridge.

28. The controller of claim 27 wherein the predefined model of the sorbent cartridge is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge.

29. The controller of claim 28 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

30. The controller of claim 28 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

31. The controller of claim 23 wherein the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

32. The controller of claim 23 wherein the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

What is claimed is:

1. A regenerative dialysis system, comprising:

an input pump that pumps fresh dialysate fluid into a dialyzer at an input rate;

an output pump that pumps used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the system being related to the output rate relative to the input rate;

a sorbent cartridge that filters the used dialysate fluid to generate the fresh dialysate fluid; and

a controller that controls the ultrafiltration rate of the system in response to a compliance model of the sorbent cartridge that provides a predefined model of compliant behavior related to the sorbent cartridge that is based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of a flow rate of the dialysate fluid through the sorbent cartridge.

2. The system of claim 1 wherein the system further comprises:

a reservoir that stores the fresh dialysate fluid;

a scale that monitors the scale weight of the fresh dialysate fluid stored in the reservoir; and

wherein the controller further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

3. The system of claim 2 wherein the controller further:

calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge;

calculates a corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and

controls the ultrafiltration rate of the system in response to the corrected dialysate fluid weight.

4. The system of claim 3 wherein the controller calculates the dynamic

weight of the dialysate fluid over a time period of a treatment procedure.

5. The system of claim 3 wherein the controller further:

calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and

calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

6. The system of claim 1 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

7. The system of claim 1 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

8. The system of claim 1 wherein the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

9. The system of claim 1 wherein the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

10. A method of controlling ultrafiltration rate of a regenerative dialysis system, comprising:

pumping fresh dialysate fluid into a dialyzer at an input rate;

pumping used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate;

filtering the used dialysate fluid to generate the fresh dialysate fluid at a sorbent cartridge; and

controlling the ultrafiltration rate of the regenerative dialysis system in

response to a compliance model of the sorbent cartridge that provides a predefined model of compliant behavior related to the sorbent cartridge based on a relationship between a volume of dialysate fluid stored by the sorbent cartridge as a function of a flow rate of the dialysate fluid through the sorbent cartridge.

11. The method of claim 10 further comprising:

storing the fresh dialysate fluid at a reservoir;

monitoring a scale weight of the fresh dialysate fluid stored in the reservoir; and

further controlling the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir.

12. The method of claim 11 further comprising:

calculating a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge; and

calculating the corrected dialysate fluid weight by summing the dynamic weight and the scale weight; and

further controlling the ultrafiltration rate in response to the corrected dialysate fluid weight.

13. The method of claim 12 wherein calculating the dynamic weight of dialysate fluid stored in the sorbent cartridge is performed over a time period of a treatment procedure.

14. The method of claim 12 further comprising:

calculating an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and

calculating the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

15. The method of claim 10 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is linear.

16. The method of claim 10 wherein the relationship between the volume of dialysate fluid stored by the sorbent cartridge as a function of flow rate of the dialysate fluid through the sorbent cartridge is non-linear.

17. The method of claim 10 wherein the ultrafiltration rate is a rate at which fluid is removed from a patient at the dialyzer.

18. The method of claim 10 wherein the ultrafiltration rate of a dialysis procedure performed by the regenerative dialysis system is prescribed.

19. A regenerative dialysis system, comprising:

an input pump that pumps fresh dialysate fluid into a dialyzer at an input rate;

an output pump that pumps used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the system being related to the output rate relative to the input rate;

a sorbent cartridge that filters the used dialysate fluid to generate the fresh dialysate fluid;

a controller that controls the ultrafiltration rate of the system in response to a flow rate of the dialysate fluid through the sorbent cartridge, wherein the controller controls the ultrafiltration rate of the system in response to a corrected dialysate fluid weight;

a reservoir that stores the fresh dialysate fluid;

a scale that monitors the scale weight of the fresh dialysate fluid stored in the reservoir, wherein the controller further controls the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir, wherein the controller further:

calculates a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge;

calculates the corrected dialysate fluid weight by summing the dynamic weight and the scale weight;

calculates an absorption weight of dialysate fluid stored in the sorbent cartridge as a result of time-based absorption; and

calculates the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.

20. A method of controlling ultrafiltration rate of a regenerative dialysis system, comprising:

pumping fresh dialysate fluid into a dialyzer at an input rate;

pumping used dialysate fluid from the dialyzer at an output rate, an ultrafiltration rate of the regenerative dialysis system being related to the output rate relative to the input rate;

filtering the used dialysate fluid to generate the fresh dialysate fluid at a sorbent cartridge;

controlling the ultrafiltration rate of the regenerative dialysis system in response to a flow rate of the dialysate fluid through the sorbent cartridge, and in response to a corrected dialysate fluid weight;

storing the fresh dialysate fluid at a reservoir;

monitoring the scale weight of the fresh dialysate fluid stored in the reservoir;

further controlling the ultrafiltration rate in response to the scale weight of the fresh dialysate fluid in the reservoir;

calculating a dynamic weight of dialysate fluid stored in the sorbent cartridge in response to the flow rate of the dialysate fluid through the sorbent cartridge;

calculating the corrected dialysate fluid weight by summing the dynamic weight and the scale weight;

calculating an absorption weight of dialysate fluid stored in the sorbent

cartridge as a result of time-based absorption; and

calculating the corrected dialysate fluid rate by further summing the absorption weight with the dynamic weight and the scale weight.