sensors operating with the blood and dialysis fluid circuits, such as pressure sensors, conductivity sensors, air detection sensors, blood detection sensors, ammonia and other chemical sensors.

[0011] Structure and methodology are provided for removing a controlled amount of ultrafiltration ("UF") from the patient, such as a separate UF pump or one or more weigh scales outputting to the control unit. Volumetric UF control, such as balance chambers in the dialysis fluid circuit, may be provided alternatively. Any of the blood and dialysis fluid pumps and valves may be operated electrometrically, e.g., via peristaltic pumps and electrically actuated solenoid valves, or alternatively pneumatically, e.g., via volumetric pumps and pneumatic valves.

[0012] At the end of treatment using the above-described HD system, the sorbent cartridge is removed from the dialysis fluid circuit and at least some of the layers of material within the sorbent column are cleaned and regenerated according to the embodiments described below. It is contemplated to regenerate the sorbent materials in at least two different manners. In a first manner, the patient or caregiver collects the used sorbent cartridges. The collected used cartridges are either picked up or delivered periodically to a facility where they are cleaned and regenerated in a batch manner along with used sorbent materials from other patients. Here, the patient or caregiver receives a delivery of fresh sorbent cartridges periodically. In a second manner, at least a portion of the used sorbent cartridges are cleaned and regenerated onsite, either in a clinic or at home. In one example, any zirconium containing layers are cleaned and regenerated and then repacked into the sorbent column along with new single use layers. Single use layers in various embodiments include any one or more of a mechanical purification layer, a urease layer, an anion exchange layer and/or an activated carbon layer.

[0013] As discussed in detail below, the sorbent conditioning of the present disclosure may also be employed to refurbish used sorbent materials from peritoneal dialysis ("PD") systems and treatments.

[0014] With the above in mind, two primary embodiments are contemplated for cleaning and regenerating at least a portion of the sorbent layers, such as the zirconium containing layers.

[0014a] In one aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via the steps of regenerating the non-disinfected ZP or ZO using an acid solution, disinfecting the regenerated ZP or ZO using a disinfecting agent, at least one of washing or filtering the regenerated and disinfected ZP or ZO, titrating the washed or filtered ZP or ZO to a desired pH, at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached, drying the rewashed or refiltered ZP or ZO, and sieving the dried ZP or ZO.

[0014b] In another aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via regenerating the non-disinfected ZP or ZO using an acid solution, disinfecting the regenerated ZP or ZO using a disinfecting agent, at least one of washing or filtering the regenerated and disinfected ZP or ZO, drying the washed or filtered ZP or ZO, and sieving the dried ZP or ZO.[0014c] In another aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via regenerating the non-disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution, disinfecting the regenerated ZP or ZO using a disinfecting agent, at least one of washing or filtering the regenerated and disinfected ZP or ZO, titrating the washed or filtered ZP or ZO to a desired pH, at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached, drying the rewashed or refiltered ZP or ZO, and sieving the dried ZP or ZO.

[0014d] In another aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via regenerating the non-disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution, disinfecting the regenerated ZP or ZO using a disinfecting agent, at least one of washing or filtering the regenerated and disinfected ZP or ZO, drying the washed or filtered ZP or ZO, and sieving the dried ZP or ZO.

[0014e] In another aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via disinfecting the non-regenerated ZP or ZO using a disinfecting agent, regenerating the disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution, at least one of washing or filtering the disinfected and regenerated ZP or ZO, titrating the washed or filtered ZP or ZO to a desired pH, at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached, drying the rewashed or refiltered ZP or ZO, and sieving the dried ZP or ZO.

[0014f] In another aspect, there is provided a method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising: refurbishing the ZP or ZO via disinfecting the non-regenerated ZP or ZO using a disinfecting agent, regenerating the disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution, at least one of washing or filtering the disinfected and regenerated ZP or ZO, drying the washed or filtered ZP or ZO, and sieving the dried ZP or ZO.

Batch Refurbishing

[0015] In one primary embodiment, sorbent material refurbishing is performed in a batch operation in which used sorbent materials from multiple sorbent cartridges are combined and cleaned together. The sorbent refurbishing process in one embodiment provides an adequate

CLAIMS

The invention is claimed as follows:

Claim 1: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via the steps of

regenerating the non-disinfected ZP or ZO using an acid solution,

disinfecting the regenerated ZP or ZO using a disinfecting agent,

at least one of washing or filtering the regenerated and disinfected ZP or ZO,

titrating the washed or filtered ZP or ZO to a desired pH,

at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached,

drying the rewashed or refiltered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 2: The refurbishing method of Claim 1, wherein at least one of (a) the acid solution is HCl, H_2SO_4, H_3PO_4, HNO_3 or acetic acid or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 3: The refurbishing method of Claim 1, wherein the desired pH is between and including 5.5 to 8.5.

Claim 4: The refurbishing method of Claim 1, wherein the desired conductivity is below 50 µS/cm.

Claim 5: The refurbishing method of Claim 1, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before regeneration.

Claim 6: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via

regenerating the non-disinfected ZP or ZO using an acid solution,

disinfecting the regenerated ZP or ZO using a disinfecting agent,

at least one of washing or filtering the regenerated and disinfected ZP or ZO,

drying the washed or filtered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 7: The refurbishing method of Claim 6, wherein at least one of (a) the acid solution is HCl, H_2SO_4, H_3PO_4, HNO_3 or acetic acid or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 8: The refurbishing method of Claim 6, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before regeneration.

Claim 9: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via

regenerating the non-disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution,

disinfecting the regenerated ZP or ZO using a disinfecting agent,

at least one of washing or filtering the regenerated and disinfected ZP or ZO,

titrating the washed or filtered ZP or ZO to a desired pH,

at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached,

drying the rewashed or refiltered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 10: The refurbishing method of Claim 9, wherein at least one of (a) the sodium based alkaline solution or a sodium salt solution is NaOH, $NaHCO_3$, Na_2CO_3 or NaCl or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 11: The refurbishing method of Claim 9, wherein the desired pH is between and including 5.5 to 8.5.

Claim 12: The refurbishing method of Claim 9, wherein the desired conductivity is below 50 µS/cm.

Claim 13: The refurbishing method of Claim 9, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before regeneration.

Claim 14: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via

regenerating the non-disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution,

disinfecting the regenerated ZP or ZO using a disinfecting agent,

at least one of washing or filtering the regenerated and disinfected ZP or ZO,

drying the washed or filtered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 15: The refurbishing method of Claim 14, wherein at least one of (a) the sodium based alkaline solution or a sodium salt solution is NaOH, $NaHCO_3$, Na_2CO_3 or NaCl or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 16: The refurbishing method of Claim 14, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before regeneration.

Claim 17: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via

disinfecting the non-regenerated ZP or ZO using a disinfecting agent,

regenerating the disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution,

at least one of washing or filtering the disinfected and regenerated ZP or ZO,

titrating the washed or filtered ZP or ZO to a desired pH,

at least one of washing or filtering the titrated ZP or ZO until a desired conductivity is reached,

drying the rewashed or refiltered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 18: The refurbishing method of Claim 17, wherein at least one of (a) the sodium based alkaline solution or a sodium salt solution is NaOH, $NaHCO_3$, Na_2CO_3 or NaCl or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 19: The refurbishing method of Claim 17, wherein the desired pH is between and including 5.5 to 8.5.

Claim 20: The refurbishing method of Claim 17, wherein the desired conductivity is below 50 µS/cm.

Claim 21: The refurbishing method of Claim 17, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before disinfection.

Claim 22: A method for refurbishing a sorbent cartridge including zirconium phosphate ("ZP") or zirconium oxide ("ZO") that has been used for treatment comprising:

refurbishing the ZP or ZO via

disinfecting the non-regenerated ZP or ZO using a disinfecting agent,

regenerating the disinfected ZP or ZO using a sodium based alkaline solution or a sodium salt solution,

at least one of washing or filtering the disinfected and regenerated ZP or ZO,

drying the washed or filtered ZP or ZO, and

sieving the dried ZP or ZO.

Claim 23: The refurbishing method of Claim 22, wherein at least one of (a) the sodium based alkaline solution or a sodium salt solution is NaOH, $NaHCO_3$, Na_2CO_3 or NaCl or (b) the disinfecting agent (i) is sodium based, such as including NaOCl, (ii) is hydrogen based, such as including HOCl, or (iii) includes isopropyl alcohol ("IPA").

Claim 24: The refurbishing method of Claim 22, wherein refurbishing the ZP or ZO includes combining ZP or ZO removed from multiple sorbent cartridges before disinfection.