Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to hemodialysis apparatus, and more particularly to a system for minimizing the effects of water pressure transients on the accuracy and consistency of patient dialysis.

2. Description of the Prior Art

Hemodialysis machines used to extract waste from human blood of patients having kidney failures or disorders utilize a dialyzer in which the blood flows through one chamber and a dialysate solution flows through another chamber separated from the first chamber by a membrane. The dialysate picks up metabolic waste products and ultrafiltrate from the blood passing through the dialyzer. In many such machines, incoming water is first treated externally to the machine to remove impurities, and thereafter pressure controlled, filtered, heated, and applied to a proportioning pump which is also connected to a supply of concentrated dialysis solution. The proportioning pump produces a carefully controlled dialysate solution from the water and concentrate. For example, a 34 parts water and 1 part dialysate concentrate is typical. The dialysate may be applied to a flow controller or other means which controls the rate of flow of the dialysate through the dialyzer.

To maintain the exact flow, pressure, and concentration of the dialysate through the system for consistent dialysis performance, it is necessary that the water flow and transients be minimized. Otherwise, such transients in the incoming water pressure will occur and will degrade the accuracy of the ultrafiltration control system. Although systems utilize pressure regulators to maintain the pressure, these regulators suffer from normal hysteresis and inertial effects which permit a drop or rise in pressure before correction can occur.

SUMMARY OF THE INVENTION

A hemodialysis apparatus is known in accordance with the precharacterization clause of Claim 1, for example, the model SPS-450 hemodialysis machine manufactured by Baxter International Inc.

Elements of the invention as disclosed in the characterization clause of claim 1 alleviate the problems and disadvantages of the prior art.

It is therefore a principal object of the invention to provide a hemodialysis apparatus which will prevent source water pressure and flow transients and variations from affecting the ultrafiltration control system and dialyzer performance.

These and other objects and advantages of the invention will become apparent from the following detailed description when read in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified block diagram of a water system for a hemodialysis machine in the prior art;

Figure 2 is a cross-sectional view of a deaeration pressure regulator and a back pressure regulator used in the present invention;

Figure 3 is a simplified schematic diagram of the deaeration loop of the invention utilizing the devices shown in Figure 2;

Figure 4 is a cross-sectional view of a modified deaeration pressure regulator and a back pressure regulator in accordance with an alternative embodiment of the invention;

Figure 5 is a simplified schematic diagram of the alternative embodiment of the invention utilizing the elements shown in Figure 4; and

Figure 6 is a schematic diagram of a portion of the deaeration loop showing a means for obtaining water flow for rinsing of fluid circuits in a hemodialysis apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows a simplified block diagram of the water and dialysate portion of a typical hemodialysis machine. For example, the model SPS-450 hemodialysis apparatus manufactured by Baxter, Inc. utilizes this system. Water is treated in a water treatment system and thereafter enters pressure regulator 1, nominally at 2.758×10^5 N/m^2 (40 psig pressure). Typically, pressure regulator 1 controls the output pressure to 8.274×10^4 N/m^2 (12 psig). The water is passed through a filter-heat exchanger unit 2 which heats the water to a predetermined temperature. The heated water is then sent via line 8 to a deaerator pressure regulator 3 shown in schematic form in Figure 1.

As will be noted, deaerator pressure regulator 3 includes an input/output chamber 13 into which heated water flows from line 8. Deaerator pressure regulator 3 is a part of a deaeration loop which includes deaerator 6 and positive displacement gear deaerator pump 7. Water flowing into the deaeration loop from line 8 will normally contain air which must be removed to optimize dialyzer performance and measurement of ultrafiltration through the dialyzer in the hemodialysis apparatus. The deaeration 6 performs the air removal function. The

function of the deaeration pressure regulator is to subject the incoming water to a negative pressure of about -120.735 N/m^2 (-23 inches of mercury) by means of deaeration pump 7.

When the system is not in operation, it may be noted that spring 33 will force diaphragm 34 to the right, closing valve seat 31 with valve body 30. When deaeration pump 7 is operating, a -120.735 N/m^2 (-23 inches of mercury) pressure occurs in chamber 13 moving diaphragm 34 to the left and opening regulator valve seat 31. Bleed orifice 32 permits an initial flow of water from chamber 13 into chamber 14 prior to the opening of valve 30, 31 to prevent excess pressure in chamber 13 from pump 7. When valve 30, 31 opens, the water from chamber 14 is drawn into the deaerator 6. Although not shown, deaerator 6 includes a float and float chamber at the upper end thereof and an air outlet valve controlled by the float. The negative pressure in the deaerator will cause the air in solution to expand, producing large bubbles of air which will float to the top and be expelled through the float air outlet valve to a low pressure part of the hemodialysis apparatus. The deaerated water is drawn from the lower end of deaerator 6 over line 10 to pump via pump 7 and flows via line 11 back to chamber 13.

An output line 12 from chamber 13 is provided; however, pump 7 produces a flow rate in the deaeration loop which is considerably higher than the flow rate required by the dialyzer. For this reason, most of the water will circulate through the deaeration loop two or more times before leaving chamber 13 on line 12. Water which enters chamber 13 on line 8 at about 8.274 x 10^4 N/m^2 (12 psig) will then, due to continuity of flow, exit chamber 13 on line 12 at about 8.274 x 10^4 N/m^2 (12 psig), neglecting slight pressure drops through the other elements of the system. The internal porting in chamber 13 is arranged to ensure that flow inline 8 will always enter valve 30, 31. Water flows out on line 12 and is routed to dialysate proportioning pump 4 or other proportioning system.

As is common, the dialysate is stored in concentrated form and must be diluted in an exact proportion with water prior to use as the dialysate for a dialyzer. For example, in the system shown in Figure 1, a ratio of 34 parts of water to 1 part of dialysate concentrate is commonly used. The output from dialysate proportioning pump provides the proper dialysate solution for use by the dialyzer and its flow rate is controlled by flow controller 5 to a predetermined flow rate for the hemodialysis apparatus.

The prior art system of Figure 1 operates efficiently in steady state conditions. However, in instances where the inlet water is subject to pressure transients, pressure regulator 1 and deaeration pressure regulator 3, which are mechanical in nature, cannot respond instantaneously to maintain the predetermined pressure; for example in this instance, 8.274 x 10^4 N/m^2 (12 psig). Part of this problem results from the water treatment systems employed for dialysis which include softeners and reverse osmosis type treatment, and have limited capacity resulting in pressure transients on occasions. The many swings in inlet pressure will therefore be translated through the system to the flow controller 5 input. The Baxter hemodialysis machines utilize automatic flow control systems since the accurate operation of a dialyzer is dependent upon the relative flow rates in the apparatus. When transients occur at flow controller 5, in flow and out flow sensors will shift to a new operating point, introducing an error in their signals and thereby affect the accuracy of the ultrafiltration control system.

Another problem in such prior art systems results from operation of deaerator 6. As air comes out of solution in the deaeration loop, it collects at the top of deaerator 6. Normally, the air will exit continuously but, at times, it suddenly is purged from the deaerator 6. When this occurs, the void occupied by the air fills with water requiring a sudden inflow of water at the water inlet. Inlet pressure regulator 1 (Figure 1) adjusts to maintain pressure and the usual proportional operating band of the regulator produces a shift in pressure that can be as great as 1.379 x 10^4 N/m^2 (2 psig).

Figures 2 and 3 illustrate the improvement of the present invention which essentially eliminates the effects of input pressure transients on the accuracy of the dialysis operation in the hemodialysis apparatus. A back pressure regulator 20 shown in simplified cross-sectional view in Figure 2, is added into the deaeration loop. Back pressure regulator 20 has a diaphragm 24, spring 26, and adjusting screw 28 which control the regulator needle 22 in conjunction with valve seat 21. Deaeration pump 7 is connected to an input to back pressure regulator 20 with the pressure controlled output line 15 connected to chamber 13 of aeration pressure regulator 3. Line 12, from back pressure regulator 20, which formerly connected to deaeration pressure regulator 3, now connects to back pressure regulator 20 as best seen from the simplified schematic diagram of Figure 3.

Water from the filter heat exchanger 2 now enters chamber 13 via line 8 flowing through valve 30, 31 into chamber 14 and is drawn into the deaeration loop by the negative pressure on line 9. As will now be recognized, deaeration pump 7 can now be operated at a pressure higher than and independent of the 8.274 x 10^4 N/m^2 (12 psig) input pressure from line 8. Consequently, back pressure regulator 20 is adjusted to produce such

igher pressure, for example, 1.034 x 10^5 N/m^2 (15 psig) pressure, in the deaeration loop and on line 12 to dialysate proportioning pump 4. Thus, the water pressure to flow controller 5 is now independent of the incoming water pressure and therefore the transients in that pressure will not reflect through to flow controller 5.

The system will operate as in the prior art system of Figure 1 on startup. Back pressure regulator 20 will be closed as will control valve 30, 31 of the deaeration pressure regulator 3. When operation of the system is initiated, pressure from line 15 will permit water through bleed hole 32 into chamber 14 and pump 7 will cause back pressure regulator to operate at the adjusted pressure point. When the negative pressure in chamber 14 occurs, valve 30, 31 will open as previously discussed, enabling the deaeration process.

ALTERNATIVE EMBODIMENT

Turning now to Figures 4 and 5, an alternative embodiment of the invention is shown. A modified deaeration pressure regulator 40 is utilized having a single port into chamber 13 connected by line 8 to filter heat exchanger 2. Line 15, which in the first embodiment connected to chamber 13, now connects to chamber 14. The remainder of the deaeration loop connections remain the same as shown in Figure 5 with the output from back pressure regulator 20 being connected to dialysate proportioning pump 4. The advantage of this implementation is that the pressure regulator 1 of Figure 1 and related control solenoids (not shown) can be eliminated and the source pressure applied to chamber 13. On startup, valve 30, 31 will be closed and chamber 13 can easily handle the source pressure which would rarely exceed 6.895 x 10 N/m^2 (100 psig). The deaeration pump 7 will produce the required negative pressure in chamber 14 opening valve 30, 31 as required.

As in the first embodiment, water is supplied to dialysate proportioning pump via lines 12 directly from the deaeration loop with the pressure controlled by pump 7, ensuring isolation from pressure transients in the water supply system.

The deaeration pump 7, as mentioned above, produces a greater flow than required by the dialyzer in the hemodialysis apparatus described. For example, the dialyzer may utilize a flow in the range of 300-500 ml/min while the pump 7 may produce flows in the range of 1.5 - 21/min.

Referring now to Figure 6, a source of warm, deaerated water is periodically needed at rinse ports 44 and 46 for rinsing the proportioning pump concentrate lines and during system disinfection.

The arrangement of Figure 6 shows schematically the use of deaeration pump 7 to provide rinse water to ports 44 and 46. A flow restrictor 42 is inserted in line 11 between pump 7 and back pressure regulator 20. Rinse ports 44 and 46 are each required to provide a source of warm deaerated water at a flow of about 15 ml/min. Lines 41 and 43, which may be small tubing, are connected across flow restrictor 42. A pressure /l drop of about 2.758 x 10^4 N/m^2 (4 psig) across rinse restrictor 42 will produce the required flow through lines 41 and 43 without interfering with the normal deaeration loop operation.

Normally closed ports 44 and 46 are connected to line 41 and may be temporarily connected to portions of the machine for rinsing by one or two rinse lines having a connector that opens port 44 or 46 when connected thereto. Continuous flows at all times through the loop formed by lines 41 and 43 independently of the rinse ports assures that no stagnation can occur and that proper rinsing will take place during disinfection cycles.

Claims

1. A hemodialysis apparatus for supplying heated, deaerated water to a dialyzer system in which pressure and flow transients occur comprising:

a source of heated water at a first pressure;

pump means (7) having an inlet and an outlet;

a deaerator (6) for removing air from water having a water inlet, an air outlet, and a deaerated water outlet connected to said pump inlet;

a first pressure regulator (3,40) having a first inlet connected to said source of heated water and an outlet connected to said water inlet of said deaerator (6);

an outlet for providing heated deaerated water to said dialyzer system, said pressure regulator (3), said deaerator (6) and said pump (7) forming a deaeration loop having heated water circulating therearound, said pump (7) producing a negative pressure in said regulator (3) outlet and in said deaerator (6), characterised in that the apparatus further comprises;

a second pressure regulator (20) having an inlet connected to said pump outlet, a first outlet connected to a second inlet of said first pressure regulator, and a second outlet for providing heated deaerated water to said dialyzer system;

the deaeration loop further includes said second pressure regulator (20), the negative pressure in said first regulator (3) outlet and in said deaerator (6) is controlled by said first pressure regulator (3), and said second pres-

igher pressure, for example, 1.034 x 10^5 N/m^2 (15 psig) pressure, in the deaeration loop and on line 12 to dialysate proportioning pump 4. Thus, the water pressure to flow controller 5 is now independent of the incoming water pressure and therefore the transients in that pressure will not reflect through to flow controller 5.

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As in the first embodiment, water is supplied to dialysate proportioning pump via lines 12 directly from the deaeration loop with the pressure controlled by pump 7, ensuring isolation from pressure transients in the water supply system.

The deaeration pump 7, as mentioned above, produces a greater flow than required by the dialyzer in the hemodialysis apparatus described. For example, the dialyzer may utilize a flow in the range of 300-500 ml/min while the pump 7 may produce flows in the range of 1.5 - 21/min.

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Normally closed ports 44 and 46 are connected to line 41 and may be temporarily connected to portions of the machine for rinsing by one or two rinse lines having a connector that opens port 44 or 46 when connected thereto. Continuous flows at all times through the loop formed by lines 41 and 43 independently of the rinse ports assures that no stagnation can occur and that proper rinsing will take place during disinfection cycles.

Claims

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a source of heated water at a first pressure;

pump means (7) having an inlet and an outlet;

a deaerator (6) for removing air from water having a water inlet, an air outlet, and a deaerated water outlet connected to said pump inlet;

a first pressure regulator (3,40) having a first inlet connected to said source of heated water and an outlet connected to said water inlet of said deaerator (6);

an outlet for providing heated deaerated water to said dialyzer system, said pressure regulator (3), said deaerator (6) and said pump (7) forming a deaeration loop having heated water circulating therearound, said pump (7) producing a negative pressure in said regulator (3) outlet and in said deaerator (6), characterised in that the apparatus further comprises;

a second pressure regulator (20) having an inlet connected to said pump outlet, a first outlet connected to a second inlet of said first pressure regulator, and a second outlet for providing heated deaerated water to said dialyzer system;

the deaeration loop further includes said second pressure regulator (20), the negative pressure in said first regulator (3) outlet and in said deaerator (6) is controlled by said first pressure regulator (3), and said second pres-

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sure regulator (20) controlling a pressure at said second outlet to a pressure independent of said first pressure.

2. The apparatus as recited in claim 1 in which said first pressure regulator (3) includes:

a first chamber (13) having a first input connected to said heated water supplying means and a second input connected to said second pressure regulator (20);

a second chamber (14) adjacent said first chamber (13) having an output connected to said input of said deaerator (6); and

a pressure regulating valve (30,31) disposed between said first and second chambers, said valve (30,31) biased to a closed position when said deaeration pump (7) is non-operative and to an open position responsive to said negative pressure.

3. The apparatus as recited in claim 2 in which said first and second chambers include a bleed orifice (32) therebetween.

4. The apparatus as recited in claim 1 in which said first pressure regulator (40) includes:

a first chamber (13) having an input connected to said heated water supplying means;

a second chamber (14) adjacent said first chamber (13) having an output connected to said input of said deaerator (6) and an input connected to said second pressure regulator (20); and

a pressure regulating valve (30,31) disposed between said first and second chambers; said valve (30,31) biased to a closed position when said deaeration pump (7) is non-operative and to an open position responsive to said negative pressure.

5. The apparatus as recited in any one of the preceding claims wherein the second pressure regulator (20) comprises

a housing having an inlet connected to said output of said pump means (7), an outlet connected to said first pressure regulator (3), and an outlet connected to supply a flow of said heated deaerated water to said hemodialysis apparatus at a first flow rate,

a valve seat (21) and valve (22), said valve operatively connected to a diaphragm (24) in said housing; and

biasing (26) and adjustments means (28) operatively connected to said diaphragm (24) for adjusting said pressure of said circulating heated water.

6. The apparatus as recited in claim 1 in which said pump means (7) is a positive displacement gear pump.

7. The apparatus as recited in claim 1 which further includes:

a flow restrictor (42) disposed between said housing inlet and said pump (7) output;

a rinse line (41,43) connected across said flow restrictor (42) to form a flow of heated deaerated water at a second flow rate much smaller than said first flow rate around said restrictor (42); and

at least one rinse port (44,46) connected to said rinse line.

Patentansprüche

1. Hämodialysevorrichtung zum Zuführen von erhitztem entlüftetem Wasser zu einem Dialysatorsystem, in dem Druck- und Strömungsschwankungen auftreten, wobei die Hämodialysevorrichtung folgendes aufweist:
   - eine Quelle für erhitztes Wasser mit einem ersten Druck;
   - eine Pumpe (7) mit einem Einlaß und einem Auslaß;
   - einen Entlüfter (6) zum Entfernen von Luft aus Wasser mit einem Wassereinlaß, einem Luftauslaß und einem Auslaß für entlüftetes Wasser, der mit dem Pumpeneinlaß verbunden ist;
   - einen ersten Druckregler (3, 40) mit einem ersten Einlaß, der mit der Quelle für erhitztes Wasser verbunden ist, und mit einem Auslaß, der mit dem Wassereinlaß des Entlüfters (6) verbunden ist; und
   - einen Auslaß, um das Dialysatorsystem mit erhitztem entlüftetem Wasser zu versorgen, wobei der Druckregler (3), der Entlüfter (6) und die Pumpe (7) eine Entlüftungsschleife bilden, in der erhitztes Wasser zirkuliert, und wobei die Pumpe (7) einen Unterdruck in dem Auslaß des Reglers (3) und in dem Entlüfter (6) erzeugt,

   dadurch gekennzeichnet,

   daß die Vorrichtung ferner folgendes aufweist:
   - einen zweiten Druckregler (20) mit einem Einlaß, der mit dem Pumpenauslaß verbunden ist, mit einem ersten Auslaß, der mit einem zweiten Einlaß des ersten Druckreglers verbunden ist, und mit einem zweiten Auslaß, um das Dialysatorsystem mit erhitztem entlüftetem Wasser zu versorgen;
   - wobei die Entlüftungsschleife ferner den zweiten Druckregler (20) enthält und wobei der Unterdruck in dem Auslaß des

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ersten Reglers (3) und in dem Entlüfter (6) von dem ersten Druckregler (3) geregelt wird und der zweite Druckregler (20) einen Druck an dem zweiten Auslaß auf einen von dem ersten Druck unabhängigen Druck regelt.

2. Vorrichtung nach Anspruch 1, wobei der erste Druckregler (3) folgendes aufweist:
   - eine erste Kammer (13) mit einem ersten Einlaß, der mit der Quelle für erhitztes Wasser verbunden ist, und mit einem zweiten Einlaß, der mit dem zweiten Druckregler (20) verbunden ist;
   - eine zweite Kammer (14), die an die erste Kammer (13) angrenzt und einen Auslaß hat, der mit dem Einlaß des Entlüfters (6) verbunden ist; und
   - ein Druckregelventil (30, 31), das zwischen der ersten und der zweiten Kammer angeordnet ist, wobei das Ventil (30, 31) in eine Schließstellung vorgespannt ist, wenn die Entlüftungspumpe (7) nicht wirksam ist, und aufgrund des Unterdrucks in eine Offenstellung vorgespannt ist.

3. Vorrichtung nach Anspruch 2, wobei die erste und die zweite Kammer eine Entlüftungsöffnung (32) zwischen sich aufweisen.

4. Vorrichtung nach Anspruch 1, wobei der erste Druckregler (40) folgendes aufweist:
   - eine erste Kammer (13) mit einem Einlaß, der mit der Quelle für erhitztes Wasser verbunden ist;
   - eine zweite Kammer (14), die an die erste Kammer (13) angrenzt und einen Auslaß, der mit dem Einlaß des Entlüfters (6) verbunden ist, und einen Einlaß hat, der mit dem zweiten Druckregler (20) verbunden ist; und
   - ein Druckregelventil (30, 31), das zwischen der ersten und der zweiten Kammer angeordnet ist, wobei das Ventil (30, 31) in eine Schließstellung vorgespannt ist, wenn die Entlüftungspumpe (7) nicht wirksam ist, und aufgrund des Unterdrucks in eine Offenstellung vorgespannt ist.

5. Vorrichtung nach einem der vorhergehenden Ahsprüche, wobei der zweite Druckregler (20) folgendes aufweist:
   - ein Gehäuse mit einem Einlaß, der mit dem Auslaß der Pumpe (7) verbunden ist, mit einem Auslaß, der mit dem ersten Druckregler (3) verbunden ist, und mit einem Auslaß, der angeschlossen ist, um der Hämodialysevorrichtung einen Strom des erhitzten entlüfteten Wassers mit einer ersten Durchflußrate zuzuführen,
   - einen Ventilsitz (21) und ein Ventil (22), wobei das Ventil betriebsmäßig mit einer Membran (24) in dem Gehäuse verbunden ist; und
   - eine Vorspannungs- (26) und Einstelleinrichtung (28), die mit der Membran (24) betriebsmäßig verbunden ist, um den Druck des zirkulierenden erhitzten Wassers einzustellen.

6. Vorrichtung nach Anspruch 1, wobei die Pumpe (7) eine Verdränger-Zahnradpumpe ist.

7. Vorrichtung nach Anspruch 1, die ferner folgendes aufweist:
   - einen Durchflußbegrenzer (42), der zwischen dem Gehäuseeinlaß und dem Auslaß der Pumpe (7) angeordnet ist;
   - eine Spülleitung (41, 43), die parallel zu dem Durchflußbegrenzer (42) geschaltet ist, um um den Begrenzer (42) herum eine Strömung von erhitztem entlüftetem Wasser mit einer zweiten Durchflußrate zu bilden, die viel kleiner als die erste Durchflußrate ist; und
   - wenigstens eine Spüllöffnung (44, 46), die mit der Spülleitung verbunden ist.

Revendications

1. Appareil d'hémodialyse pour alimenter en eau réchauffée, désaérée un système de dialyseur dans lequel se produisent des transitoires de pression et de débit, comprenant:
   une source d'eau réchauffée à une première pression;
   un moyen de pompage (7) ayant une entrée et une sortie;
   un désaérateur (6) pour éliminer l'air de l'eau, ayant une entrée d'eau, une sortie d'air et une sortie d'eau désaérée reliée à l'entrée de la pompe ;
   un premier régulateur de pression (3,40) ayant une première entrée reliée à cette source d'eau réchauffée et une sortie reliée à ladite entrée d'eau du désaérateur (6);
   une sortie pour alimenter ledit système de dialyseur en eau désaérée réchauffée, ce régulateur de pression (3), ce désaérateur (6) et cette pompe (7) formant une boucle de désaération dans laquelle circule de l'eau réchauffée, cette pompe (7) produisant une pression négative à la sortie de ce régulateur (3) et dans ce désaérateur (6), et caractérisé en ce que cet

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appareil comprend en outre:
un deuxième régulateur de pression (20) ayant une entrée reliée à ladite sortie de la pompe, une première sortie reliée à une deuxième entrée dudit premier régulateur de pression, et une seconde sortie pour alimenter en eau désaérée réchauffée ledit système de dialyseur;
le deuxième régulateur de pression (20) fait également partie de la boucle de désaération, le premier régulateur de pression (3) maintenant la pression négative à la sortie du premier régulateur et dans le désaérateur (6), et le deuxième régulateur de pression (20) donnant, à ladite deuxième sortie, une pression indépendante de ladite première pression.

2. Appareil selon la revendication 1, dans lequel le premier régulateur de pression (3) comprend:
une première chambre (13) ayant une première entrée reliée audit moyen d'alimentation d'eau réchauffée et une deuxième entrée reliée au deuxième régulateur de pression (20);
une deuxième chambre (14) adjacente à cette première chambre (13) ayant une sortie reliée à ladite entrée de la désaération (6); et
entre ces première et deuxième chambres, une soupape de régulation de la pression (30, 31) qui tend à prendre une position de fermeture quand la pompe de désaération (7) n'est pas en fonctionnement, et une position d'ouverture en réponse à ladite pression négative.

3. Appareil selon la revendication 2, avec, entre les première et deuxième chambres, un orifice de purge (32).

4. Appareil selon la revendication 1, dans lequel ledit premier régulateur de pression (40) comprend:
une première chambre (13) ayant une entrée reliée audit moyen d'alimentation en eau réchauffée;
une deuxième chambre (14), adjacente à la première chambre (13), ayant une sortie reliée à ladite entrée du désaérateur (6) et une entrée reliée au deuxième régulateur de pression (20); et
entre ces première et deuxième chambres, une soupape de régulation de la pression (30, 31) qui tend à prendre une position de fermeture quand la pompe de désaération (7) n'est pas en fonctionnement, et une position d'ouverture en réponse à ladite pression négative.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel le second régulateur de pression (20) comprend:
une enveloppe ayant une entrée reliée à ladite sortie du moyen de pompage (7), une sortie reliée au premier régulateur de pression (3) et une sortie reliée de façon à alimenter l'appareil d'hémodialyse en eau désaérée réchauffée, à un premier débit,
un siège de soupape (21) et une soupape (22) fonctionnellement reliée au diaphragme (24) dans ladite enveloppe; et
des moyens de rappel (26) et d'ajustements (28) fonctionnellement reliés au diaphragme (24) pour ajuster ladite pression de l'eau réchauffée désaérée.

6. Appareil selon la revendication 1, dans lequel le moyen de pompage (7) est une pompe volumique à engrenage.

7. Appareil selon la revendication 1 comprenant en outre:
entre ladite entrée de l'enveloppe et ladite sortie de la pompe (7), un limiteur de débit (42);
une conduite de rinçage (41, 43) court-circuitée par ce limiteur de débit (42) qui laisse passer un second débit d'eau désaérée réchauffée beaucoup plus petit que le premier débit qui contourne ce limiteur de débit (42); et
au moins un orifice de rinçage (44, 46) relié à ladite conduite de rinçage.