ADVANCED WATER TECHNOLOGY
PETER TABOADA
TECNOLOGÍA AVANZADA DEL AGUA

WATER PURIFICATION SYSTEMS BY REVERSE OSMOSIS
PETSEA RO
SISTEMAS DE PURIFICACIÓN DE AGUAS POR OSMOSIS INVERSA

HAEMODIALYSIS TW-H HEMODIALISIS

Water Treatment System for Dialysis
PETER TABOADA Patent nº P200202491

Millarada, 68-Vilar de Infesta 36800 REDONDELA Pontevedra SPAIN. Tlf.: +34 986 226 622 · 986 226 186. Fax: +34 986 223 570
http://www.petertaboada.com e-mail: info@petertaboada.com

INDEX

INTRODUCTION

The **dialysis liquid** (DL) is a fundamental element of **hemo-dialysis** (HD). It is a liquid that comes in contact with blood through the semi-permeable membrane of the dialyzer during hemo-dialysis. It enables the exchange of substances, especially solutes with the blood in a bidirectional way.

It is an electrolytic solution prepared extemporaneously by the **monitor for hemo-dialysis** (MHD) from **purified water** and **solutes supplied** in the form of concentrated electrolyte **salts un-dissolved**. The composition of the DL is practically isotonic and has an electrolyte composition similar to plasma. The differences in their concentrations are a function of the gradients necessary to achieve the proper balance of each substance, depending on patient needs.

The quality and purity of the DL is one of the main technical requirements of hemo-dialysis. In fact, the presence of contaminants in the DL exposes the patient to a risk of accumulating toxic substances, resulting in both acute and chronic complications. Some pollutants can interact with cells or proteins bio-incompatibility triggering phenomena, which are added to those produced by other components of the extracorporeal blood circuit of hemo-dialysis.

Photo: Petsea Ro-TWH Installation in Meixoeiro's Hospital (Vigo).

The purity and quality of DL is the result of a chain of processes in which any error has great impact on the final product. It is therefore necessary to take care of all the elements and steps necessary for the DL production. The preparation, distribution and storage conditions should be designed to minimize the risk of chemical and microbiological contamination.

1 WATER PURITY AND QUALITY FOR HEMODIALYSIS

1.1 Purified water for hemo-dialysis (HD)

As a basic rule, any water treatment for hemo-dialysis should be designed to meet minimum specifications for chemical and bacteriological levels recommended in the Royal Spanish Pharmacopoeia and European Pharmacopoeia listed in this guide and its maintenance over time.

1.1.1 *Microbiology*

- Maximum allowable level:

Following the Royal Spanish Pharmacopoeia, the purified water used to dilute dialysis concentrate from the point of view of the bacteriological requirements, must contain less than 100 CFU / ml.

- Desirable microbiological purity levels:

Both prior to the ring as ultraviolet, polysulfone absolute filtration and ultraviolet present in the ring, ensuring the removal of endotoxins, bacterial bodies and agents of pyrogens in dialysis water.

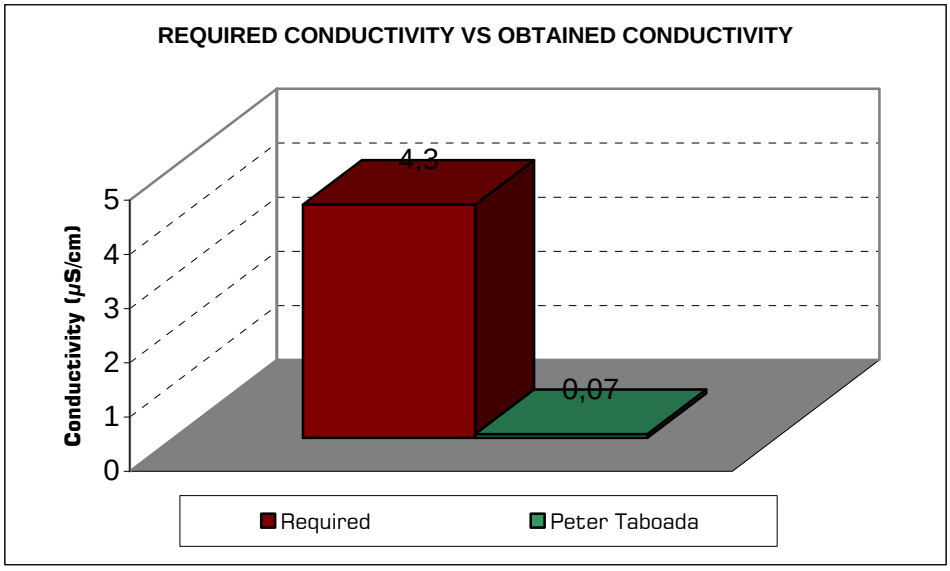
1.1.2 Maximum levels of chemical contaminants

The purified water for hemo-dialysis should not contain contaminants concentration greater than the following:

Aluminium: *AtomicAbsortion Spectrometry*	0,01 mg/l
Antimony: *AtomicAbsortion Spectrometry*	0,006 mg/l
Arsenic: *AtomicAbsortion Spectrometry*	0,005 mg/l
Barium: *AtomicAbsortion Spectrometry*	0,100 mg/l
Beryllium: *AtomicAbsortion Spectrometry*	0,0004 mg/l
Cadmium: *AtomicAbsortion Spectrometry*	0,001 mg/l
Calcium: *AtomicAbsortion Spectrometry*	0,001 mg/l
Chloramines: *Colorimetric*	0,100 mg/l
Free Chlorine: *Colorimetric*	0,500 mg/l
Chromium: *AtomicAbsortion Spectrometry*	0,0140 mg/l

Copper: *AtomicAbsortion Spectrometry*	0,100 mg/l
Cyanide: S*pectrophotometry*	0,0200 mg/l
Fluor: M*olecular Photoluminiscence*	0,200 mg/l
Magnesium: *AtomicAbsortion Spectrometry*	2 mg/l o 0,08 mmol/l
Mercury: *AtomicAbsortion Spectrometry*	0,001 mg/l
Nitrate, as N: *Colorimetric*	2,0000 mg/l
Silver: *AtomicAbsortion Spectrometry*	0,005 mg/l
Lead: *AtomicAbsortion Spectrometry*	0,005 mg/l
Potassium: Flame photometer	2 mg/l o 0,08 mmol/l
Selenium: *AtomicAbsortion Spectrometry*	0,0900 mg/l
Sodium: *Flame photometer*	50 mg/l o 2,2 mmol/l
Sulfate: *Turbidimetric Method*	100 mg/l
Thallium: *AtomicAbsortion Spectrometry*	0,0020 mg/l
Zinc: *AtomicAbsortion Spectrometry*	0,100 mg/l

The purified water should have a maximum conductivity of 4.3 mS • cm^{-1} 20 º C, as specified by the Royal Spanish Pharmacopoeia and European Guidelines.



With our patented water conductivity guarantee always lower than **0.07 µS • cm^{-1}**, the most appropriate to produce an ultrapure dialysate for hemo-dialysis molarities of conventional and high flux hemo-dialysis.

1.2 Water Tratment System Design.

There is no treatment of water equal to all the dialysis units, it depends on: chemical and bacteriological quality of treated water supply, source and possible variations of the elements dissolved in it throughout the time, architectural constraints, quantitative needs, qualitative needs, profit budget, evolution perspectives as many water treatments as new dialysis techniques.

The basic composition of our water treatment system for hemo-dialysis equipment should consist of pre-treatment, reverse osmosis, deionization, post-treatment and recirculation.

2 OPERATION PRINCIPLES AND SAFETY LEVELS

The water treatment plant for hemo-dialysis operates according to the known principles of the Reverse Osmosis (RO). This type of system is the method of water purification for hemo-dialysis for better quality, will improve the quality further by incorporating an deionizer (mixed bed ion exchange) achieving conductivity values up to 100 times better than those required by current regulations .

The main advantages and security levels of the water treatment plant for hemo-dialysis can be summarized as:

- **Security levels.**

A) Safety concerning the produced water quality

- Reverse Osmosis & Deionization.
- Bacteriological quality.
- Triple Monitoring of produced quality water.

1º REVERSE OSMOSIS + DEIONIZATION

The RO system PETSEA TW-H combines the techniques of reverse osmosis and deionization. The water produced by reverse osmosis is practically suitable for use in hemo-dialysis. Anyway it passes through a bed of deionization resin mixed bed (anion + cation) ensuring in all cases conductivities much lower than the values prescribed by the standard. (Always lower than 0.07 µS/ cm^2/cm).

The synergy resulting from combining these two techniques has other advantages:

- Correct any water deterioration caused by failures in preceding equipments, or by specific deteriorations in water quality of hospital admission.
- Corrected the reduced water quality caused by osmosis in the first moments after each start-up. (rejection of salts decreases by 10% during the first minute of operation).
- It increases the time between cleaning of membranes, thus reducing the operating costs of the plant: the gradual fouling of reverse osmosis membranes causes a reduction in the produced water quality. By having a deionizer in the osmosis output (in hemo-dialysis ring), we correct this deviation allowing operation during a longer time with each set of membranes.
- In comparison with systems that combine 2 reverse osmosis (one after another), the proposed system, osmosis + deionization with ion exchange resins, it is more effective because at low concentrations of dissolved salts we will obtain better efficiencies with deionization resins than with a second osmosis. There is also the great advantage of not throw pure water (one second osmosis would reject part of the incoming water, even as pure).

2º BACTERIOLOGICAL QUALITY

If the deionizer ensures the physical and chemical quality of water, microbiological quality is ensured by installing a second ultraviolet sterilizer at the deionizer output (the first installed in the ultraviolet pre-treatment).

The innovation of this system is to include after the UV one polysulpohone filter to remove pure water remains sterile and pyrogen endotoxin to levels less than 0,05 UE/ml.

These filters are typically installed in hemo-dialysis own posts. PETER TABOADA incorporates them into its plant to assure the bacteriological water quality even if the next equipments will fail.

3º TRIPLE MONITORING OF PRODUCED WATER QUALITY

The water treatment plant PETSEA RO TW-H is the only plant in the world to control the quality of water produced from three different points:

- First point: conductivity meter installed at the outlet of the reverse osmosis. We measured continuously the conductivity of the water produced by reverse osmosis. If at any time exceed a value set as Level 1 (1 μS/ cm^2/cm, value 100 times less than the maximum required by the standard for treatment with reverse osmosis) system alerts the checkpoint deterioration of the water produced and gives the option of

switching to the second team of osmosis. It's a warning of possible contamination of the membranes. This slight decline is corrected then by the deionizer installed at the outlet of the reverse osmosis. If the equipment operates and it exceedes other set-point sets to Level 2, (5 μS cm2/cm), the check system automatically switches to work with the second osmosis equipment.

- Second point: conductivity meter installed at the exit of the deionizers. We measured continuously the water conductivity at the outlet of the deionizer.
  We fix also here several levels of security:
  If the conductivity exceeds the Level 1 (water 2.5 times better than required by the standard for deionization treatments), the system alerts the checkpoint and given the option to go to work with the second ionizer. It's a warning of possible depletion of ion exchange resins and the need for replacemente.
  Level 2: If the conductivity of water at some point exceeds the minimum quality required by the rule, the system will alert via both audible and visual alarm to maintenance as well as nursing (Table alarms). Optionally, we can trigger the by-pass to enter automatically.

- Third level: Resistivity-meter installed on the return of dialysis rooms.
  As a last safety point PETER TABOADA will install a resistivity-meter in the water return of dialysis stations.
  This security system notifies us if there is any contamination in dialysis stations.
  Level 1: If the water comes with a resistivity close to the maximum tolerable, a visual alarm to notify the servicing.
  Level 2: If at any time exceed the maximum value, a visual alarm notifies both the servicing and the alarm box located in the nursing office attached to the dialysis room of Building D. Optionally we can actuate the by-pass to enter automatically.
  We have opted to measure the resistivity to contrast the two previous conductivity measures.

  They are a total of 6 water barriers that must be overcome to reach in some moment dialysis stations with unsuitable quality.

B) Security on the performance of each equipment

- Duplication.
- By-pass.

1º.- DUPLICATION

The main water treatment equipment are duplicated to increase system reliability: supply pumping systems, high pressure and recycling, multimedia filters, and deionizers osmosis equipment.

2º.- BY-PASS

If one equipment fails, the homologous can start to operate. If this also fails (or there is a broken pipe, water leak, or overall system failure), the treatment plant has a by-pass of the same capacity water production than the original system. And ensure water supply for the time necessary to re-launch the system.

While it has been the by-pass designed to be self-sufficient, we can connect its output to the deionizer as it is the system element with less risk of failure and can always be used as an end tuner of the water quality.

C) Security on the operation system

- Continuous check.
- Alarm log.

1º.-CONTINUOUS CHECK

The control system receives in real time pressure in pipes, flow of water produced, conductivity, temperature, levels of the tanks, pressure groups signals, etc..

2º CONTROL FOR LOGIC

The set-points and programming are done at field level. During normal operation of the system we can read these values and modify them in real time.

3º.- MANUAL CONTROL

If the PLC system fails, and can not be repaired immediately (replacement PLC) control of the plant becomes manual.

The main measurement and control systems are duplicated so that allows reading and manual handling from the equipment (all by-passed solenoid valves with manuakl valves, all pressure transducers with a pressure gauge glycerin, digital flow-meters with rotameters, etc...).

- **Scalable system.**

The extension is simply to incorporate one or more membrane over each reverse osmosis module. The other teams, pre filters, pumping equipment, ultraviolet sterilizers, etc.. could be sized to assume this potential increase in the plant capacity production.
If the hospital chooses to install this equipment expandable, during the time that the plant operates with its original capacity, we will have an added advantage over standard equipment: all systems are oversized.

- **Supervisor Control System using PC**

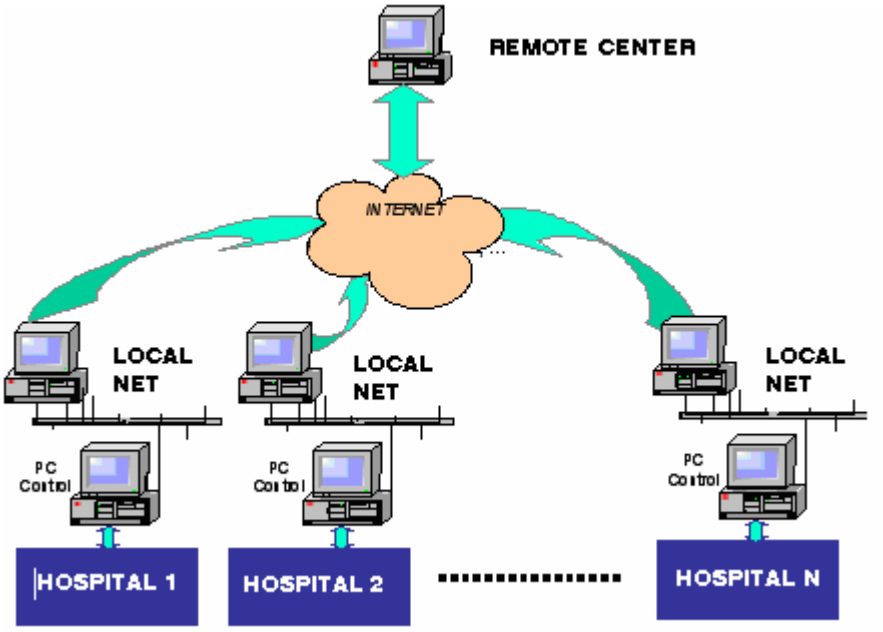
The supervisory control has several advantages versus other systems:

- Robustness of control by an industrial PLC supervised by a PC.
- Ease of modification of both the set points, as the minimum and maximum ranges that trigger alarms via the PC interface, much easier to use.
- Monitoring and historical record of the values of the most important variables of the treatment process.
- Logging of all maintenance carried out: filter changes, cleaning, charge, etc..
  Data recording is done in the PC database and allows further consultation if necessary due to any problems that arise.
- Advanced alarm management via PC. In addition to the registration thereof is registered or if there has been no corrective action and who has done.

Note: The PLC already has a PC connection, it is only necessary programming alarms in the hospital's central computer which recorded the signals sent by the PLC. The schedule will be made by the client.

- **Remote Monitoring and Centralized (OPTIONAL)**

There is the possibility of using a PC as the control center, allowing preventive maintenance from TABOADA PETER own offices as well as sending messages, alarms and display in real time on another PC.



3 DESINFECTION SYSTEM

Introduction.

PETER TABOADA proposes disinfection of all water treatment plant, not only the circuit of treated water by using ozone.

We wat to avoid and prevent microbiological contamination, not only correct it. If we disinfect only the treated water circuit the pre filtrating systems will not be treated with the germicidal treatment. This can cause we have a significant biological pollutants prior to osmosis.

Pre-filtration systems are equipments where the water remains stagnant, sometimes for long periods of time. This environments are good for the proliferation of microbiological growth. This risk of contamination is increased if we consider that it is not uncommon to find in some hospitals concentrations of free chlorine in the water below desirable levels.

This bacterial growth may affect the operation of reverse osmosis because some of this bactera (less than 1%) remains on the surface membrane, degrading it and declining the efficiency.

PETER TABOADA and SERGAS shares the philosophy of maintaining maximum aseptic conditions and disinfection of all water treatment plant, not only in the ring of treated water. One sign of this interest is the requirement to install stainless steel tanks of the highest quality, polished, no elbows, etc. already in the system input.

Desinfection Method

Periodically, the water treatment equipment and the pipes and hemo-dialysis ring will be allways disinfected to ensure maximum aseptic conditions throughout the installation.

Disinfection is carried out using the accumulation tanks, from the beggining of the installation, where water will be saturated with ozone. Once we reach the ozone concentration required, the water contained in the tank is passed through the water line sterilizing all components that be in contact with water, motors, filters, valves, piping, etc.

The saturated water in ozone dosage will be carried out in three different points in the circuit to ensure complete disinfection.

4 INSTALLATION AND COMPONENTS DESCRIPTION

It is a plant system "in-line", continuous production, including pre-treatment equipment, reverse osmosis, deionization, post-treatment and recycling.

The equipment combines the techniques of reverse osmosis and deionization system and incorporates a continuous quality check of the produced water in four different positions of the installation, ensuring anytime a purified water control.

All equipment is automated and controlled by a PLC, Moreover, there is a switchboard remote visual alarm in the nursing room and a light beacon with three levels of alarm (**green**, **amber** and **red**) in maintenance.

The installation consists of 5 parts:

1. **Pre-treatment**: The water passes through a stainless steel mesh, sand filter, coal filter, chemical conditioning, cartridge filter, and passes through an ultraviolet.

2. **Reverse osmosis**: Treated water passes through the reverse osmosis membranes and is stored in a tank.

3. **Post-treatment and recirculation**: The produced water passes through deionizers, ultraviolet and poly-sulfone filter and placed in the ring of dialysis, the surplus is recycled back to the entrance to the deionizer.

4. **By- pass**: In case of failure or repair of osmosis equipment, water supply passes through a battery of filters that ensure water supply for the time necessary to start-up the system.

5. **Ozone steriliztion system**

We describe below each of the components with their main features:

4.1 PRE-TREATMENT

Filter stainless steel mesh.

Photo: Mesh filter.

At the entrance, the water will pass first through a filter mesh stainless steel automatic self-cleaning 50 micron. With this filter we will retain the larger particles to reduce this load to subsequent filters.

The filter includes a timer that activates the solenoid valve cleaning.

Inlet Conductivity-meter (feed-water).

It indicates us if there are variations in the quality of feed-water that recommends adjustments of working parameters. An alarm text in the CONTROL PANEL DISPLAY tells us if the input water quality is getting worse.

Sand filter.

Photo: Media filters.

Then the water goes to a media filter with a filter bed of quartz sand and anthracite. Its operation is completely automatic. The cleaning is done using raw water.

This filter contains several beds of quartz sand of different sizes, and anthracite as topsoil and final filtration. The spherical shape of grains of quartz sand prevents the violent collision of water against the grain, just like other normal types of sand, and thus allows easy passage of water and better filtration capacity even with big.flows.

Activated charcoal filter.

Following filtration through sand, the next step is the elimination of chlorine in the water, an element that would irreparably harm the osmosis membranes. This will use a self-cleaning filter similar to the above with a filter bed of activated charcoal.

We use coconut shell charcoal that has the advantage of being the hardest and highest proportion of micro-pores, which makes it the most suitable coal for de-chlorination. Also incorporate a proportion of coal to use its ownership of physical adsorption for the removal of smells, tastes and all kinds of pollutants and water volatile solvents.

Chemical conditioning.

The final section of the feed-water conditioning prior to osmosis, includes a system for the anti-fouling dosage. The system consists of a diaphragm metering pump, a reservoir of accumulation of the chemical and anti-fouling chemical.

Anti-fouling membranes dosage protect the possible fouling. Its main missions are:

- Inhibition of any form of embedding, being particularly effective against fouling by calcium carbonates and sulfates, barium, strontium and calcium fluoride. It does not inhibit organic deposits.
- It allows to eliminate the acid addition and is a very effective alternative against the use of hexametaphosphate.
- It allows systems to operate with high recovery rates. It is compatible with all types of membranes.

The injection of this chemical will not affect, in any case, the final quality of produced water as it will be removed in the concentrate (reject) osmosis equipment. This product is approved for being used in potable water applications, it has no impact on total organic carbon levels.

Safety filtering.

The water, pre-filtered and chemically conditioned, will feed security filtering which will retain particles that may escape from the previous filters, protecting the high pressure pump and RO membranes
The micro-filtering was carried out by using 20-micrometer filter, 5 and 1 micron respectively which prevent the entrance into the membranes of particles bigger than this size..

Photo: micrometric-filter.

Ultraviolet sterilizer.

Because the carbon filter removes chlorine from water (disinfectant agent) and is always forced to maintain maximum aseptic conditions and disinfection, PETER TABOADA ® incorporates in this point an UV lamp to ensure a complete water sterilization.

Our experience advises to install this lamp because the media filters are equipments where the water remains stagnant creating favorable conditions for microbial development. This risk of contamination is increased if we consider that it is not

uncommon to find in some hospitals concentrations of free chlorine in the water below desirable levels.

The UV is installed after the security filtering to prevent fouling of the quartz sleeve that protects the lamp; spots or shadows in the lamp cause decreases in the germicidal power of ultraviolet light.

Photo: Ultraviolet sterilizers installation.

4.2 REVERSE OSMOSIS

The next step, reverse osmosis equipment, is the core of the water treatment system, whereby we will remove 99.6% (average value) of the dissolved salts.

Main components

High pressure pump

Multi-cellular vertical centrifugal pump stainless steel Grundfos. It ensures enough pressure to the membranes to obtain the specified production.

Speed driver (depending on the needs of the equipment)

For complete control of the high pressure pump: Flows, start / stop speeds, working control parameters, etc..

Enables automatic adjustment of pressure and flow entering the membranes to compensate the gradual decrease in the volume of produced water.

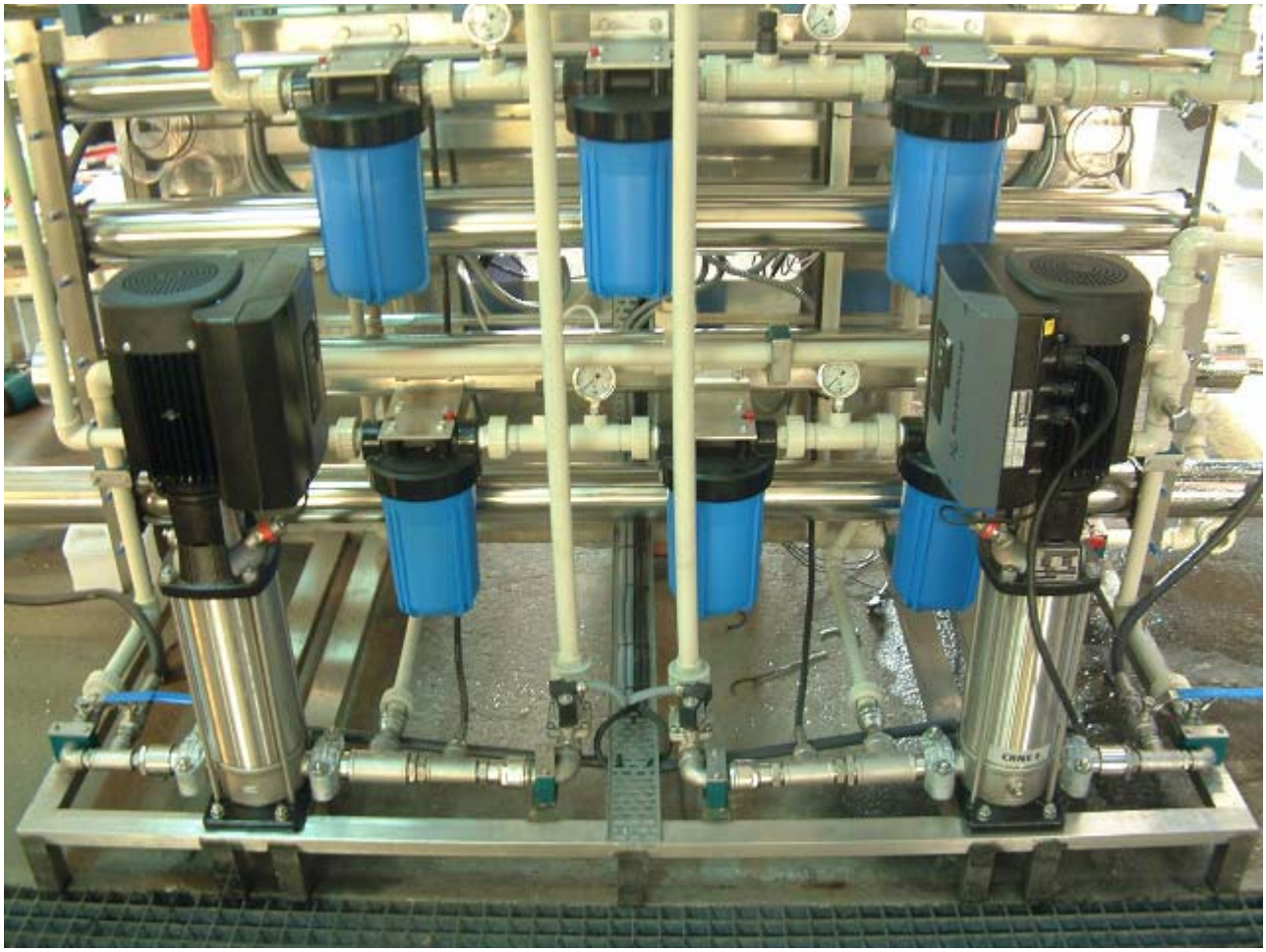


Photo: Reverse osmosis system components.

Reverse osmosis membranes.

After filtration and conditioning, feed water moves into the membranes, these membranes are located inside the pressure vessel of stainless steel AISI 316L.

Instrumentation

- Produced water Conductivity-meter

  It gives a constant reading of the salinity of the permeate and send alarm signals to the control panel when the product water conductivity exceeds a set limit.

- High pressure gauges (0 a 40 bar) and low pressure gauges (0 a 6 bar).

- High pressure transducer.

- Pressure switches of high and low pressure in stainless steel AISI 316L.

The low does not allow the pump starting high if water supplies do not arrive with enough pressure. The high pressure switch does not allow the high pressure pump works at a higher pressure than the recommended.

- 2 digital flowmeters / 2 rotameter to measure produced and rejected water flow. With current reading and totalizer.

- 1 produced water flow transducer.

- Thermometer for temperatura measurement of the feedwater. It helps to normalise the operation data (temperatura variations affect the flow and quality of produced water).

Autoflushing

Automatic system. By-passing the pressure regulating valve causes all feed water exit as rejection, dragging impurities that can be deposited on the mambrane.

The reverse osmosis equipment maintains the philosophy of the entire treatment system and is duplicated to avoid stops for any failures and allow the self-cleaning one of the lines entering the second line in operation automatically.

This self-cleaning for reverse osmosis is called autoflushing and prolongs the membran life and the time periods between between chemical cleanings.

Expandable systems

By client's request PETSEA RO systems are expandable, TW-H with only the installation of extra membranes. The equipment is designed with pre-filtration, pumps and other hydraulic equipment to let easy expandable. This feature makes PETSEA RO systems more versatile systems currently on the market.

4.3 POST-TREATMENT AND RECYCLING

Flector tank, pumping group and storage prior to ring

The tank collects water produced by the reverse osmosis system. This tank will be sized so that water remains accumulated only a short period of time, thus avoiding osmotic water pollution, and be constructed of stainless steel AISI 316L. The pump is responsible to pump the water from osmosis to the tank prior to the ring.

The storage prior to the ring will be further reduced in size and will also be constructed of stainless steel AISI 316L. Its mission is to overcome the pressure

drops inside the ring caused by small dialysis water consumption, thereby avoiding the continuous starting and stopping of pumps for small periods of time, which would result in heavy wear of pumps and an increased energy consumption.

Photo:Flector tank, pumping group and storage prior to ring.

The flector tank and the storage have Donaldson filtres, to avoid pollutants from air in the osmotic water (while performing cleaning of the tanks).

Photo: Donaldson filter.

Deionizer

After reverse osmosis, water passes into the mixed-bed resin deionizer, not regenerated. Anyway it passes through a bed of deionization resin mixed bed (anion + cation) to ensure always a conductivity much lower than the values prescribed by the standard.

Deionizer is designed depending on the volume of water running through it, for a lapse of 6 months resins.

Photo: Deionizers.

At the outlet of the deionizer will be two conductivity meters: one with high accuracy and with a tight range to the conductivity in the water inside the ring, and a second conductivity with a wider range to know (if possible shortcomings in the quality of water inside the ring) the deviation of water conductivity.

Ultraviolet sterilization

If the deionizer is an assurance to ensure the physical and chemical quality of water, microbiological quality is ensured by installing a second ultraviolet sterilizer.

After the ultraviolet, a polysulphone filter removes the remains of the same bacteria, endotoxins and pyrogens to levels less than 0.05 EU / ml.

Recycling

The ultrapure water and sterilized reaches dialysis units and the remainder is recycled back to the entrance of the reverse osmosis. Thus the following circuit provides recirculation of water produced: reverse osmosis, deionized, ultraviolet, polysulfone filter, dialysis units and return to the ionizer.

This circuit continuously gets the best water quality physicochemical and bacteriologically.

Photo: Ring recycling in Meixoeiro's Hospital (Vigo).

4.4 BY-PASS

In case of failure or simultaneous repair of the two reverse osmosis equipment or any of the previous systems, it is necessary to have an option to secure water supply for the time necessary to Stara-up the system.

Battery filters 20 " divided into three groups:

- Filtration of suspended solids: 3 rounds of 20, 5 and 1 micron respectively.

- Elimination of chlorine, and all kina-
- of pollutants and volatile solvents to water: 1 coal filter and 1 charcoal filter, both with 5 microns mini-layer.

- Elimination of dissolved salts: 3 cartridges deionization with mixed-bed resin.

We recommend testing the bypass quarterly analyzing the outlet water to ensure that cartridges maintain their properties and they can be used safely when necessary.

4.5 OZONE STERILIZATION SYSTEM

Ozone (O_3) is maby the strongest oxidizing agent. It has the redox potential higher than fluorine. This potential makes him a disinfecting agent, more effective than any of the commonly used, for this reason is used in water treatment and other applications.

The implementation of the ozonated water disinfection-sterilization of surfaces and materials has the following advantages:

1º) Do not leave remains in the installation, chemicals, detergents, chlorine ...

2º) The derivation is convenient and cheaper than chemical disinfection.

3º) It is a powerful oxidizing agent with greater efficiency and less irritant than chlorine and derivatives.

4º) It can be applied to materials that can not be disinfected and sterilized with heat plastics, etc..

5º) It requires less exposure time to heat or chemical disinfectants.

6º) The disinfection of materials by ozonated water is cleaner than the use of detergents.

7º) It acts bacteria, viruses and fungi.

Desinfection method

Periodically, water treatment equipment such as pipes and hemodialysis ring always be disinfected to ensure maximum aseptic conditions throughout the installation.

To make the disinfection is necessary to start up a series of components that are able to obtain a residual concentration of ozone in water enough to sanitize the circuit components passing through them.

The ozone generator system has the following components:

- Ozonation tank.
- Recycling system.
- Air dryer.
- Ozone generator

Photo: Ozone generator.


Photo:Ozonation tank.

The following represents an assembly scheme of the cleaning system with ozone:

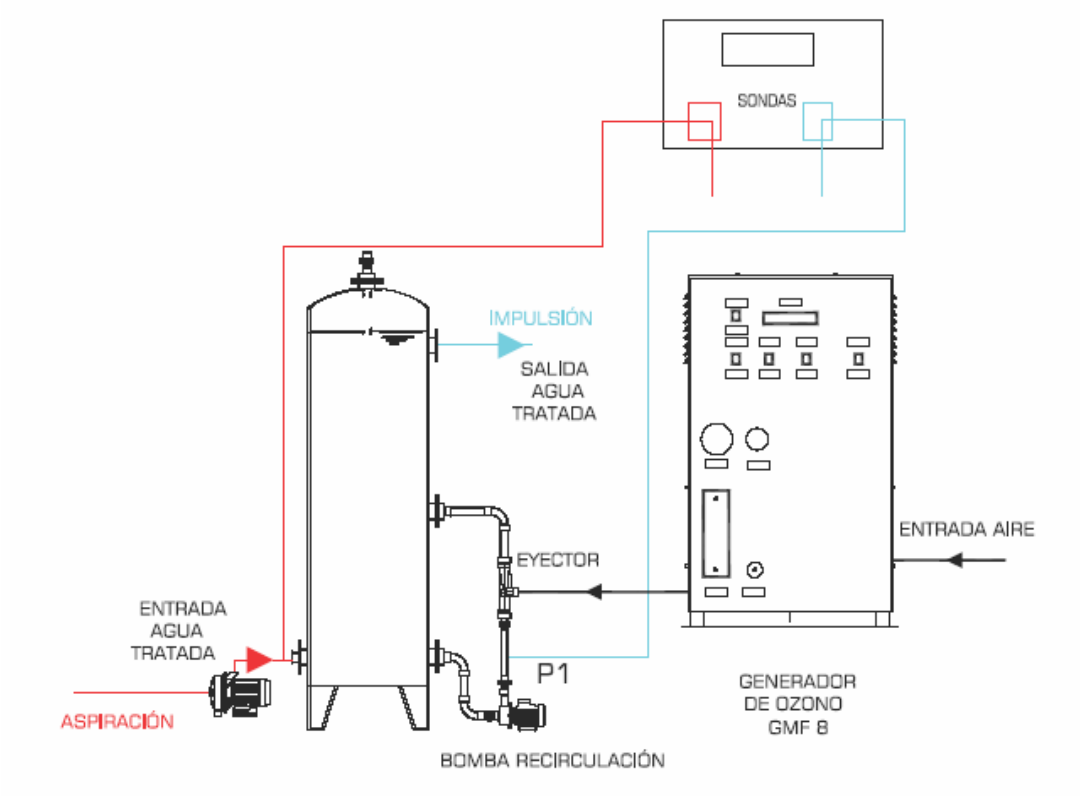


Photo: Ozone sterilizer assembly scheme.

5 DIALYSIS RING

MATERIAL

All installation of both the ring as the own "engine room" will be installed in copolymerized polypropylene pipes, elbows, T, etc.., Manual valves to by-pass for each switch, quick connectors and sampling appropriate for health use after each element of the water line.

6 TESTS & ADJUSTMENTS

All equipment offered by PETER TABOADA SL are tested in our installations in Vigo before consignment to the customer.

The tests include partial test of the main components during manufacture, testing, end sealing, hydraulic performance, electrical and electronics, security systems, calibration of measuring equipment, testing target yield at different temperatures and water quality feeding operation in extreme conditions by applying the maximum pressure, water quality produced, and so on.

7 QUALITY

The design and manufacture of reverse osmosis equipment for hemodialysis PETSEA RO TW-H is carried on the Quality Manual implanted in PETER TABOADA SL.

The demands of our philosophy of continuous quality improvement ensure a very rigid control on process design, manufacturing, technical services and maintenance, as in the raw materials used.

8 PROPOSAL OF BASIC MAINTENANCE CONTRACT

1. Monthly visit to the Hospital to review and test of the water treatment plant for hemodialysis and the by-pass.

2. Bimonthly with ozone disinfection of the entire circuit and probes calibration.

3. This contract excludes spare parts, consumables, and all pieces of negligence or wear them we are forced to replace or repair.

4. So long as they need to make some repairs, some parts replacement, or revision of any extra components, will present a budget.

9 REFERENCES

HOSPITAL	INSTALATION	PRODUCTION (liters/day)
Clínico Universitario de Santiago de Compostela	PETSEA RO 360 TW-H	36.000
Policlínico Vigo S.A. (POVISA)	PETSEA RO 270 TW-H	27.000
Pontevedra Hospital	PETSEA RO 270 TW-H	27.000
Virxe da Xunqueira Hospital (CEE)	PETSEA RO 90 TW-H	9.000
Meixoeiro Hospital	PETSEA RO 270 TW-H	27.000
Maspalomas Hospital	PETSEA RO 90 TW-H	9.000
Barbanza Hospital	PETSEA RO 90 TW-H	9.000

10 Summary of the patent PS200202491 advantages "Water treatment system for diálisis" by Peter Taboada S.L

» Ensuring a water conductivity always less than 0.07 microseconds / cm as input to the ring of hemodiálisis.

» Duplex system scheduled alternative operation of each of the lines, with the possibility in case of high demand to work both lines together. It is also an expandable system.

» Remove the accumulation, avoiding problems of increasing conductivity or sources of contamination.

» Ensuring the filtration of endotoxins and pyrogens from the use of polysulfone filter and ultraviolet radiation in the recirculation ring, avoiding contamination of the dialyzer filters.

» Recycling of water from the ring through the mixed bed resin, avoiding potential increases in water conductivity.

» Variable frequency drive pumps for recycling of the ring, during the supply to dialyzer and during the state of no demand, maintaining a speed of 1m / s, avoiding stagnation of water.

» Supply tank of reverse osmosis to the ring with safety probes. Pressure and speed control of water with the possibility of working in several different rings. Includes a venting filter, separator bacteria.

» Strict control of conductivity and sampling at all points of the process.

» Ozone generator for sterilization of the system.