

HOT WATER DISINFECTION :

Transforming hemodialysis water treatment



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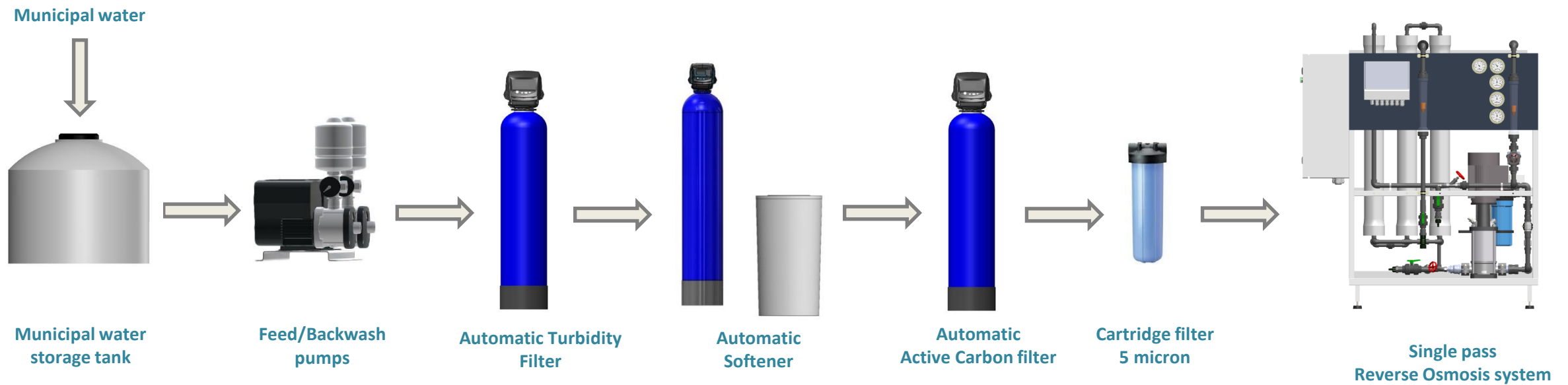
Key requirements of Medical staff from a water treatment system ?

Physicians : *Uninterrupted treatments* to patients with high quality water according to AAMI/EC standards

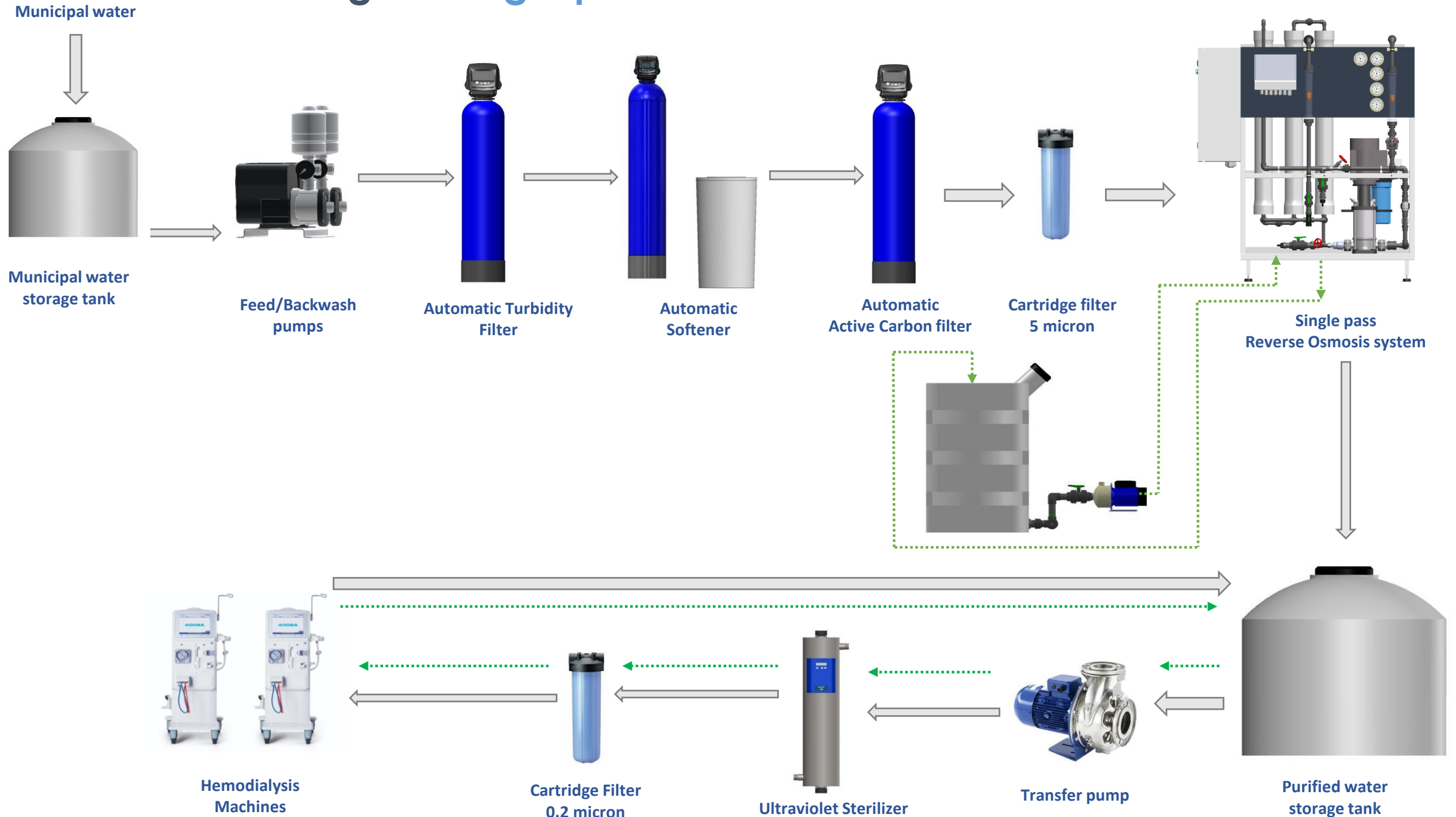
Nurses : *Ease of Use*, saving more time for patient treatments.

Technicians : *Smart Design* for ease of maintenance and disinfection

The basics of a water treatment system



Design 1: Single pass RO & Purified water Tank



Design 1: Single pass RO & Purified water Tank

- ❖ **Not ULTRA PURE quality:** Single pass rarely ultra pure & close to the limits set by international standards for dialysate water
- ❖ **No Redundancy:** Any failure would lead to complete system shutdown



Purified Water tank essential to act as a buffer. Must be sized to cover at least one shift demand

Issues with purified water tank

- ❖ **Source for microorganism growth** : Stagnant water leads to microbial growth.
- ❖ **Additional steps of treatment:** After the tank, microbial filter + UV necessary *(The problem is that they themselves were a source of microorganism growth)*
- ❖ **Larger plant footprint:** The tank volume had to cover at least 1 shift (4 hours) so > 2000L in capacity

Disadvantage of Chemical disinfection

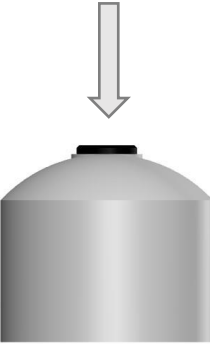
- ❑ **Residual Chemicals:** The presence of residual chemicals can pose health risks to patients undergoing dialysis so several flushing / testing required to ensure it is within safe levels
- ❑ **Manual procedure/ time consuming:** not an automated process but rather performed by a biomed technician

- ❑ **Costly :**
 - ❖ Requires the regular purchase of chemicals
 - ❖ Consumes large amounts of water to effectively disinfect and flush out the ring

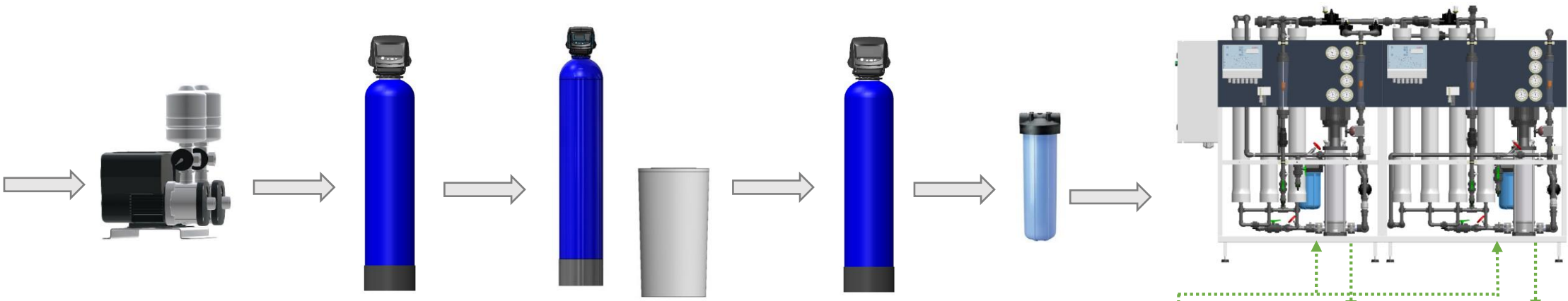
- ❑ **Chemical Handling and Storage:** The storage and handling of disinfectant chemicals require strict protocols to prevent accidents or spills. Improper storage or handling can result in chemical exposure risks.
- ❑ **Effectiveness:** Not that effective against biofilm and other microorganisms so may require high doses of chemicals and several rounds of treatment.

Design 2: Double pass RO & Purified water Tank

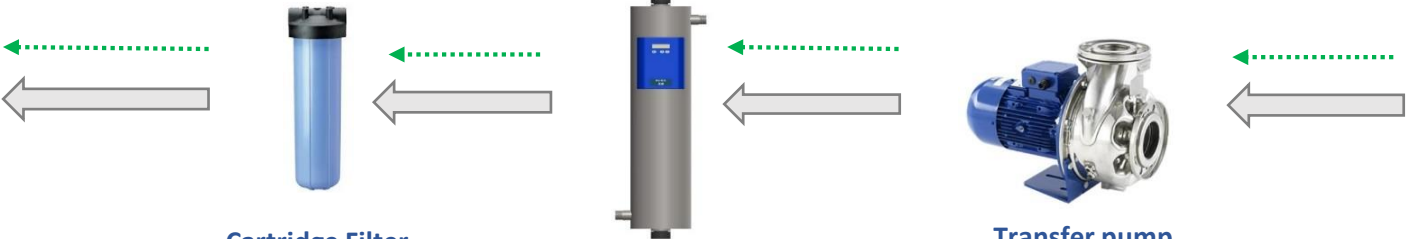
Municipal water



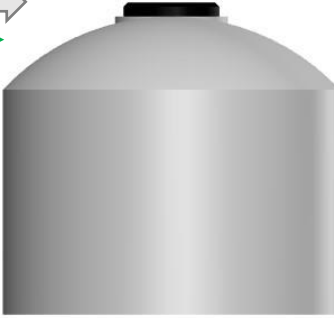
Municipal water storage tank



Hemodialysis Machines



Single pass Reverse Osmosis system



Purified water storage tank

Cartridge Filter 0.2 micron

Ultraviolet Sterilizer

Transfer pump

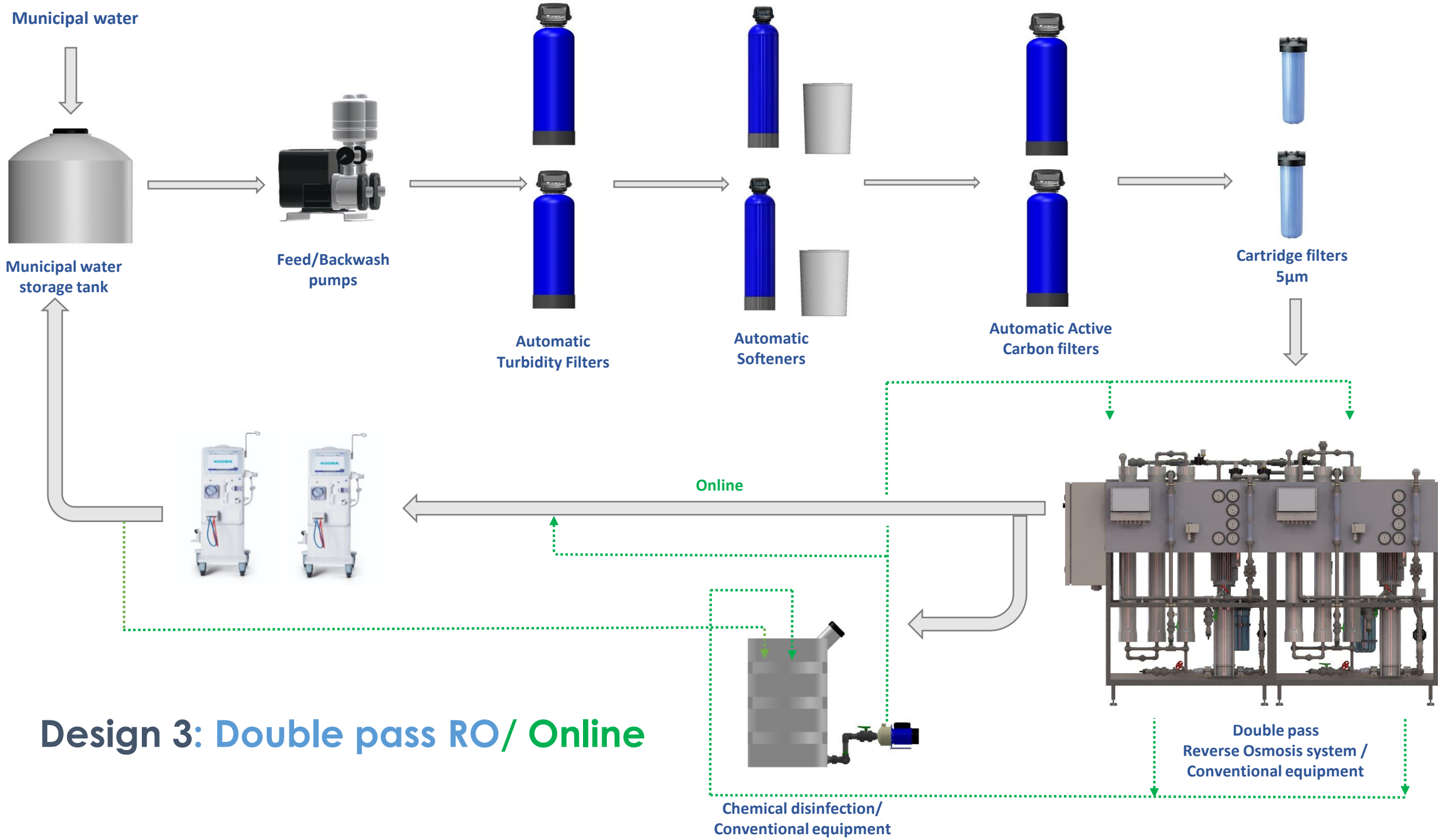
Design 2: Double pass RO & Purified water Tank

Improvements:

- ✓ When Two (2) RO operating in series output water quality at *Ultra pure Water quality*

Issues:

- **Purified Water tank still necessary**
 - ❖ **Manual intervention required:** Although one RO can supply the “quality” and quantity required, a purified water tank is still necessary since manual intervention required for the other RO to keep operating.
 - ❖ **Single pre-treatment:** No redundancy so any failure would lead to complete system shutdown
- **Chemical disinfection :** Disadvantages mentioned in the previous slides.



Design 3: Double pass RO/ Online

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Improvements:

- ✓ **Duplex/Double pre-treatment** : redundancy allows for “ online” operation
- ✓ **Automatic switchover** : In the case of stoppage of one of the two RO, immediately and automatically the other one takes over thus allowing for “ online operation”

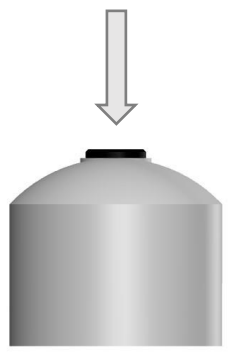
Advantage of “online” distribution

- Purified water goes directly to HD machines
- Eliminates the need for purified water tank : smaller footprint
- Eliminates the need for downstream steps (1 micron and UV system)

Issues:

- **Chemical disinfection** : Disadvantages mentioned in the previous slides

Municipal water



Municipal water storage tank



2 x Feed/Backwash pumps



Automatic Turbidity Filters



Automatic Softeners



Automatic Active Carbon filters

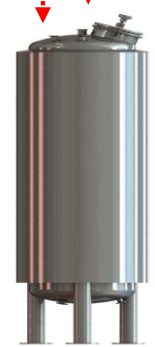


Cartridge filters 5µm

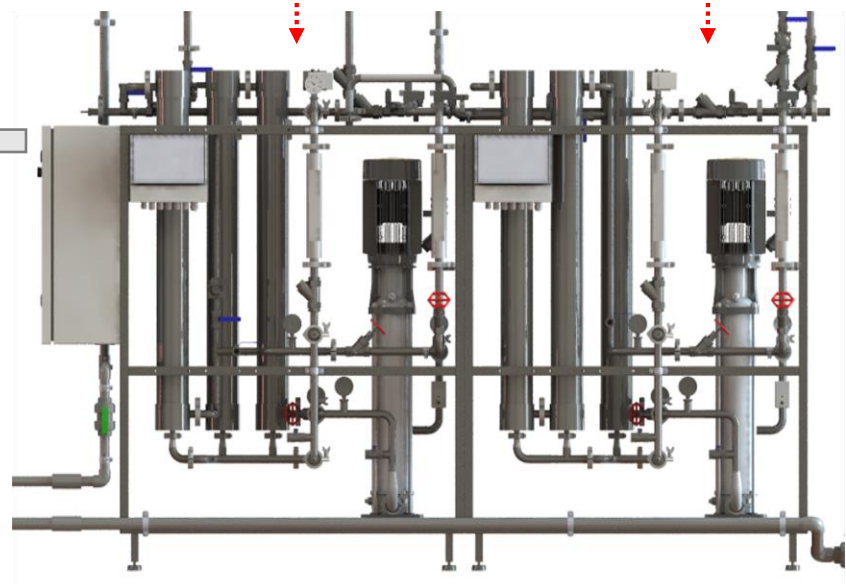


Design 4

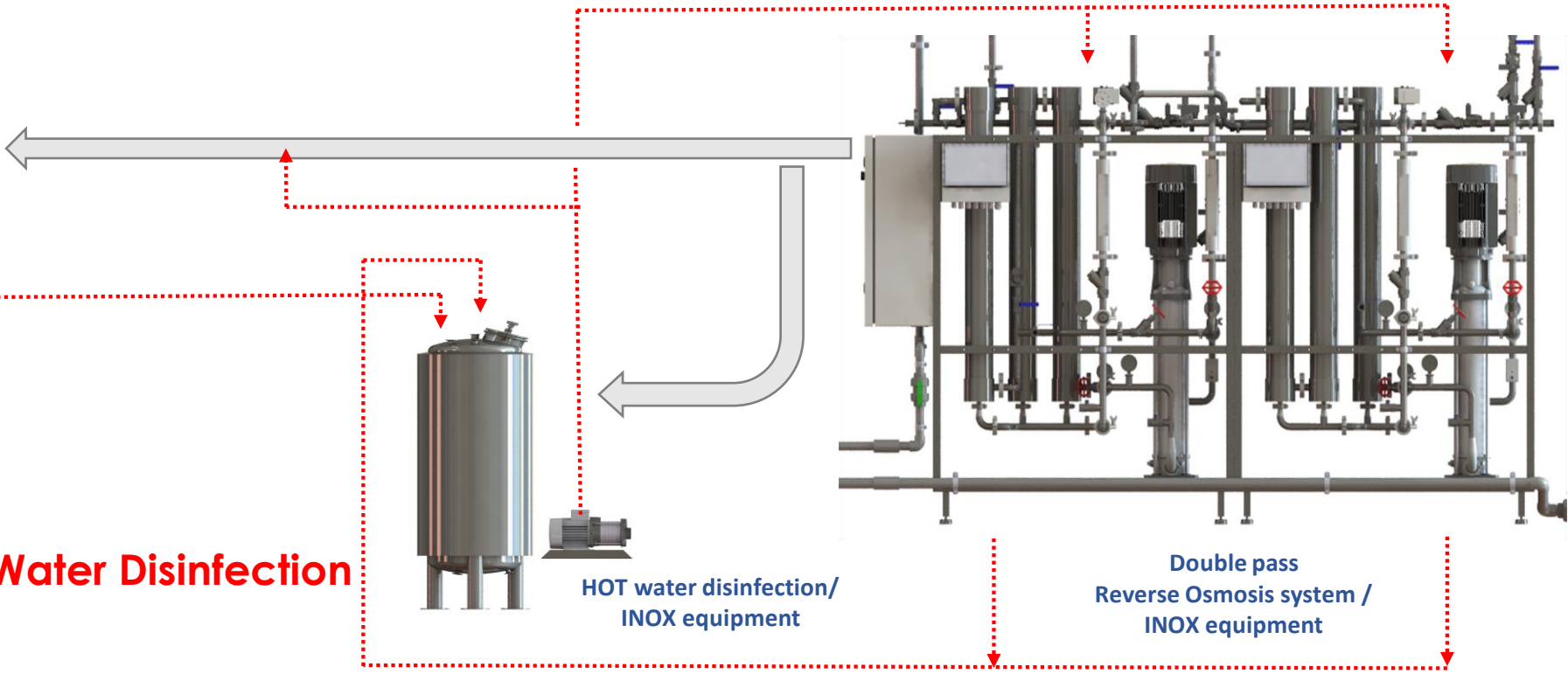
Double pass RO/ Online/Hot Water Disinfection



HOT water disinfection/INOX equipment



Double pass Reverse Osmosis system /INOX equipment



Design 4: Double pass RO/Online/**Hot Water Disinfection**

Improvements:

- ✓ **Hot water Disinfection** of Distribution Ring & Reverse Osmosis membranes

What is **HOT** water disinfection?

- ❖ It is the utilization of heated water instead of chemicals to disinfect the distribution ring, the RO membranes or both together.
- ❖ Via a dedicated PLC (HMI) the disinfection process is entirely automated.
 1. Purified water is collected in the hot water tank. Size range between (300L – 500L)
 2. It is heated up to a temperature of 80 – 85°C. (Suitable to effectively kill all microorganisms)
 3. Once the temperature is reached, a pump circulates the water to the RO membranes/ Distribution ring or both depending on the option chosen.
 4. The disinfection process (exposure time) is set as a standard for 1 hour but this can be changed in the settings depending on each situations requirements.
 5. At the end of the disinfection process, the water is all collected back in the hot water tank where it cools down after which it is disposed in the drainage system.

Advantage of **Hot** water Disinfection technology

- **Effective microbial reduction:** Highly effective at killing or de-activating microorganisms delivering consistently lower bacterial and endotoxin counts
- **Biofilm removal :** Effective at removing and preventing biofilm formation both in the membranes and in the Distribution ring
- **Silica Removal :** Effective at removing Silica from the membranes
- **Chemical free disinfection:** Eliminates the possibility of introduction of chemicals improving patient safety
- **Labor Savings:** Automated procedure replacing the otherwise manual procedure with chemicals reducing staff labor hours
- **Improved performance:** Automated procedure allows for **more regular disinfection (preventive maintenance)**
- **Eco friendly:** Less water consumption as multiple flushing to remove chemical residue not necessary. *Also no chemical is disposed into the sewer.*
- **Cost –effective:** Eliminates purchase and handling of chemicals & Less water consumption

TMED2SERIESHOT



TMED2SERIESHOT

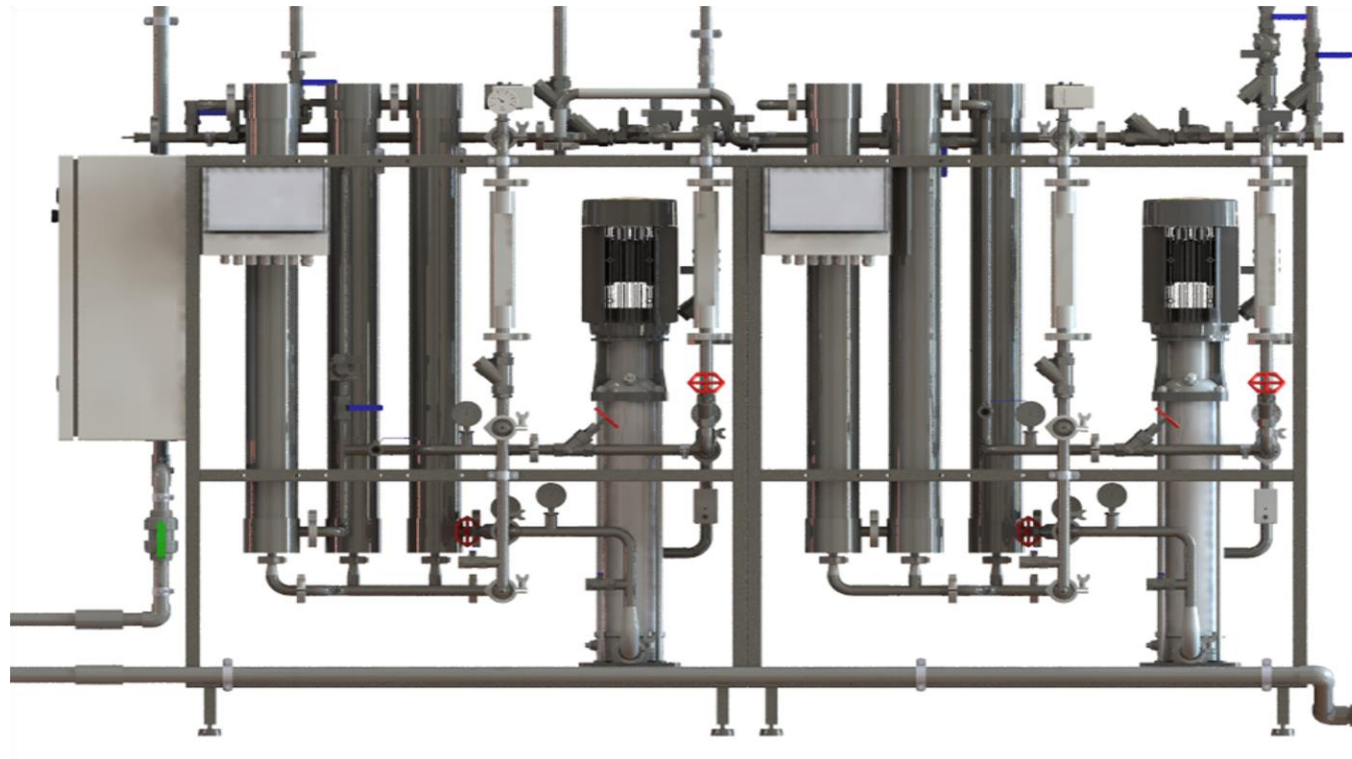
Duplex pre-treatment

- ✓ If one fails, the other one can continue to treat the water without stoppage of the system
- ✓ If **backwashing/regeneration** occurs during operation, the other one continues to treat the water without stoppage of the system.
- ✓ **Operate in parallel** during normal operation to avoid water stagnancy
- ✓ The one softener alone is sized such that it can handle one entire day (max. 4 shifts) without interruption of the water supply.



Reverse Osmosis systems

- ✓ **Double Pass** (in series) for [ultra pure water production](#)
- ✓ **Automatic by-pass** : In the case that one of the two RO trip/fails, the other one automatically takes over
- ✓ **Hot water Sanitizable membranes**



(MOC) 316L with special roughness (Ra < 0.8)

- Necessary To withstand temperatures of 85°C during hot Sanitization
- To reduce build up of microorganisms



SS316L Hygienic - Tri-Clamp connection

- **Dead-end free design:** No threaded connections which are a source for buildup of debris, contaminants, and microorganisms.
- **Easier and quicker maintenance:** Faster connection / disconnection



Hot Sanitization System

- SS316L Hot Water Tank (300- 500L) with **special roughness** against microbial growth.
- Microbial Air Filter
- **Double walled** to avoid heat dissipating and protection of users.
- Hot Water Distribution pump (SS316L)
- In the PLC - Single button operation for disinfection (Ring/ RO / Both)



PLC/AUTOMATION

- Fully automatic process
- Control panels: Easy to use & service
- “ Automatic periodical flushing” when the system is stopped, after a set time, automatically the system starts to flush the water in the distribution ring and prevent from microbial build



PLC/AUTOMATION

- Each of the two RO system in series has its dedicated PLC system
- The Hot Water System has its dedicated PLC

This allows for FULL redundancy compared to having a central PLC system which in the case of failure, the complete system would shut down.



Successful Installations

TEMAK has installed over 150 Water treatment for hemodialysis in Greece and Internationally

Masirah Hospital– Sultanate of Oman



Production	800L/h
Raw Water	500 ppm
Product Water	AAMI/EC standards
Hemodialysis beds	11

Shinas polyclinic– Sultanate of Oman



Production	1600L/h
Raw Water	500 ppm
Product Water	AAMI/EC standards
Hemodialysis beds	22

Amiri Hospital - Kuwait



Production	1500L/h
Raw Water	500 ppm
Product Water	AAMI/EC standards
Hemodialysis beds	20

Venizeleio Hospital– Athens, Greece



Production	1500L/h
Raw Water	500 ppm
Product Water	AAMI/EC standards
Hemodialysis beds	20

Aretaieo Hospital – Athens, Greece



Production	900L/h
Raw Water	250 ppm
Product Water	AAMI/EC standards
Hemodialysis beds	13

Thank you all for your Attention!

Any Questions?