DIALYSIS WATER TREATED BY REVERSE OSMOSIS

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Abstract

This paper has as objective research efficiency of *reverse osmosis system applied to water used in hemodialysis treatment. Plant is composed of four columns (modules) connected in series, with a maximum production of permeate at 20° C: 1 module = 300 l/h,* 2 *modules = 600 l/h,* 3 *modules = 900 l/h, 4 modules = 1200 l/h. Monitoring conductivity as a parameter defining the efficiency of osmosis plant was made during the month of winter (February) and summer (August). There was a slight increase efficiency reverse osmosis in August (97.75 to 98.18%) compared with values obtained in February (97.18 to 97.5%).*

Key words: dialysis, water treatment, conductivity, reverse osmosis.

INTRODUCTION

A dialysis patient who is treated 3 times a week with approximately 150 liters of dialysis fluid each time is exposed to 23,400 liters per year. In hemodialysis, huge amounts of water are used for diluting the concentrates to produce dialysis fluid. The water is produced on site by reverse osmosis units. The chemical and microbiological quality of the water is essential for dialysis patients (Lonnemann G. et.al.,1996).

Water used for dilution of hemodialysis concentrates has to meet official quality recommendations regarding microbiology and chemistry. Several recommendations/ standards exist; in all of them, limits for microbiological quality are given (Nystrand Rolf, 2008, Ordin 1718/2006).

Besides cardiovascular disease, infections are the most common cause of death patients because infections occur both internal and dialysis-related infections and water used to prepare dialysate.

In addition, endotoxins derived from Gram-negative bacteria can penetrate the membrane dialysis apparatus and are responsible for pyrogenic reactions in patients. Also, the chemical composition of water can cause acute and chronic complications during dialysis. For example, a high content of magnesium and calcium will lead to headache or hypertension. Heavy metals can accumulate in the body leading to various toxic side effects. A too high content of aluminum can cause anemia, encephalopathy or osteopathy (Bommer J, Ritz E., 1987, Hoenich Nicholas A.et.al., 2008)(Meister Vorbeck Irene, et.al,1999) (Wills R. Michael et al.,, 1985, P.C.D Haese et.al, 1996).

A water treatment system to provide sufficient cleaning should involve the use of reverse osmosis and ionization. Reverse osmosis units produce water of acceptable chemical quality that can be kept throughout the water system. The dialysis fluid consists of up to 99% of reverse osmosis water; in addition, chemicals are added, such as acids, salts and bicarbonate.

RO is based on a tangential flow filtration process in which water is pushed by high pressure through semipermeable membranes that can reject the majority of contaminants: up to 95–98% of dissolved salts, and up to 99% of bacteria, endotoxins and substances with a molecular weight of >200 Da are removed this way (Pontoriero Giuseppe,et al., 2003).

RO membrane performance is measured by percent rejection, and final product water quality can be measured by either conductivity in micro-siemens/cm or total dissolved solids (TDS) displayed as mg/L or parts per million (PPM).

Conductivity is the ability of a solution to pass an electric current between two electrodes. The current is carried by ions; therefore, the conductivity increases with the number of ions present in solution and their mobility. The conductivity of water provides information on its chemical composition (Pantea Emilia, 2011).

MATERIAL AND METHOD

The reverse osmosis (RO) membrane is the heart of the water treatment system. Reverse osmosis plant installed in the clinic has the following specifications: size 1000 X 1550 X 550 (W x H x L), maximum production of permeate at 20°C: 1 module = 300 l/h, 2 modules = 600 l/h, 3 modules = 900 l/h, 4 modules = 1200 l/h, permeate pressure 2-5 bar pressure.

To ensure the smooth operation of reverse osmosis plant was adopted prefiltration system consisting of a sand filter (multiple layers), charcoal, iron and manganese retention filter, softeners (provides water to 0.1^{o}hardness), so to be seen in Figure 1. The feed water of the entire treatment system is the water from the mains supply Oradea.

Fig. 1. Reverse osmosis

In an RO system, conductivity is generally measured before (input) and after (output) the water passes through the RO membrane.
By using the "percent rejection"$(Ci_1\text{-}Cf_2)/Ci_1\%$ formula, you can determine the percentage of a given solute that is removed by the RO membrane.
The conductivity monitor should be temperature compensated to give a consistent conductivity reading.

RESULTS AND DISSCUSIONS

The study followed the feed water conductivity monitoring of reverse osmosis plant and permeate in February (winter) and August (summer) and to establish its efficiency depending on operating conditions.

Table 1

Monitoring of reverse osmosis in February

Date	Temperature (^oC)	Flow (l/h)		Conductivity (µS/cm)		Productivity $(Ci_1\text{-}Cf_2)/Ci_1$ (%)
		Permeat (F1)	Concentrated (F2)	Influent (Ci1)	Effluent (Permeat) (Cf2)	
01.02.2011	9	1400	500	165	4	97,57
02.02.2011	9	1400	500	165	4	97,57
03.02.2011	9	1400	500	160	4	97,50
04.02.2011	9	1400	500	160	4	97,50
05.02.2011	10	1400	500	160	4	97,50
07.02.201	9	1450	500	160	4	97,50
09.02.2011	9	1450	500	165	4	97,57
10.02.2011	9	1400	500	165	3	97,18
11.02.2011	9	1400	500	160	4	97,57

Table 1

Monitoring of reverse osmosis in February

Date	Temperature (^oC)	Flow (l/h)		Conductivity (μS/cm)		Productivity $(Ci_1-Cf_2)/Ci_1$ (%)
		Permeat (F1)	Concentrated (F2)	Influent (Ci1)	Effluent (Permeat) (Cf2)	
12.02.2011	9	1350	500	160	4	97,57
14.02.2011	10	1350	500	160	4	97,57
15.02.2011	10	1350	500	160	4	97,57
16.02.2011	9	1350	500	160	4	97,57
17.02.2011	9	1350	500	160	4	97,57
18.02.2011	9	1350	500	160	4	97,57
19.02.2011	10	1350	500	160	4	97,57
21.02.2011	9	1350	500	160	4	97,57
22.02.2011	9	1350	500	160	4	97,57
23.02.2011	9	1350	500	155	4	97,57
24.02.2011	9	1350	500	155	4	97,57

Table 2

Monitoring of reverse osmosis in August

Date	Temperature (^oC)	Flow (l/h)		Conductivity (μS/cm)		Productivity $(Ci_1-Cf_2)/Ci_1$ (%)
		Permeat (F1)	Concentrated (F2)	Influent (Ci1)	Effluent (Permeat) (Cf2)	
02.08.2010	19	1850	500	220	5	97,73
03.08.2010	19	1850	500	220	5	97,73
04.08.2010	19	1850	500	220	5	97,73
05.08.2010	19	1850	500	220	5	97,73
06.08.2010	19	1850	500	220	5	97,73
07.08.2010	19	1900	500	220	5	97,73
09.08.2010	19	1900	500	221	5	97,73
10.08.2010	19	1900	500	220	5	97,73
11.08.2010	19	1900	500	220	5	97,73
12.08.2010	19	1900	500	220	4	98,18
13.08.2010	19	1900	500	220	4	98,18
14.08.2010	19	1900	500	221	4	98,18
15.08.2010	20	1900	500	223	4	98,20
16.08.2010	19	1900	500	224	4	98,20
17.08.2010	19	1900	500	221	4	98,18
18.08.2010	19	1900	500	220	4	98,18
19.08.2010	19	1900	500	220	4	98,18
20.08.2010	19	1900	500	220	4	98,18
21.08.2010	19	1900	500	220	4	98,18
22.08.2010	19	1900	500	220	4	98,18
23.08.2010	19	1900	500	220	4	98,18

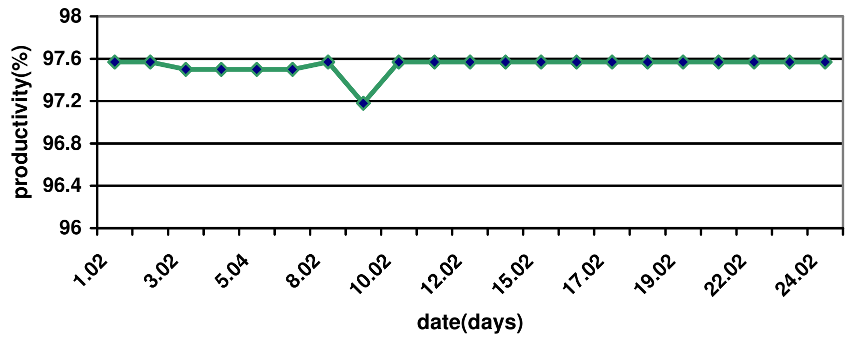

Fig. 1 Efficiency of reverse osmosis in February

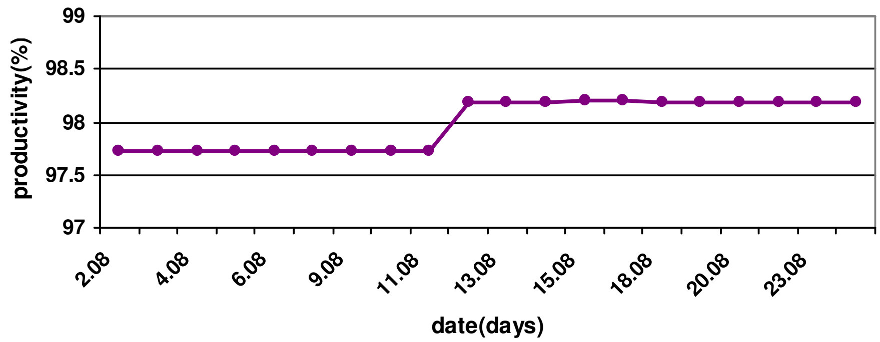

Fig. 2 Efficiency of reverse osmosis in August

CONCLUSIONS

The water used in dialysis centers has a critical role in quality of care. The reverse osmosis for water treatment, is used in hemodialysis to reduce the concentration of ions that can have negative effects on the patient. Reverse osmosis operating conditions influence the efficiency of the entire treatment system.

The colder the incoming water, the more resistant it is to cross the RO membrane, thereby decreasing purified water production. With increasing operating temperature increases the efficiency of reverse osmosis process (summer). During the winter months and there was a decrease permeate flow. Adequate water pre-treatment, pH control, and cleanliness of the RO membrane surface also influence performance of the membrane.

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