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Operational Condition research for a reverse osmosis water treatment

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ABSTRACT

The purpose of this study was to present a method for determining the optimum operating pressure and discharge for the treatment of high soluble solids in reverse osmosis pilot. For the purpose of technical studies of purification and determination of pressure and discharge, the effluent of resuspended ion exchange resins with high soluble salts of about 8000 mg / l was used. The results showed that increasing the pressure increased the permeability of salt and flux, but it was not possible to select the optimum pressure and discharge based on the highest amount of salt and flux. Therefore, considering the factors such as the probability of clogging and the permissible operating limits of the membrane used, the effluent characteristics, the quality and quantity required of the treated effluent, the optimum pressure, and inlet flow were determined. Accordingly, from 3 and 50 liters per minute, 15 and 18 times and 40 inlet discharge, respectively, between three pressure ranges of 12 pressures, 15 times, and 45 liters per minute were selected as optimum effluent discharge pressure and discharge.

Keywords: Reverse osmosis, waste-water treatment, Hydrodynamics, Water management, Destination

1. INTRODUCTION

The purpose of this study was to present a method for determining the optimum operating pressure and discharge for the treatment of high soluble solids in reverse osmosis pilot. In order to carry out technical studies of purification and determination of pressure and discharge from resin reclamation effluent Ion exchange with high soluble salts of about 8000 mg / l was used. The results showed that increasing the pressure increased the permeability of salt and flux, but it was not possible to select the optimum pressure and discharge based on the highest amount of salt and flux [1]. Therefore, considering the factors such as the probability of clogging and the permissible operating limits of the membrane used, the effluent characteristics, the quality and quantity required of the treated effluent, the optimum pressure, and inlet flow were determined. Accordingly, from 45 and 50 liters per minute, 15 and 18 bar and 40 inlet discharge, respectively, between three pressure ranges of 12 pressures 15 bar and 45 liters per minute were selected as the optimum effluent discharge pressure and discharge [2].

Usually, when using reverse osmosis method for treatment of water or wastewater with high soluble solids, due to a large number of operational variables, it is necessary for a researcher to be fully aware of these variables and their effect on the while briefly introducing the reverse osmosis process and its variables, by keeping the solute and temperature solids variables constant, the optimum pressure and discharge determination method for the treatment of a high soluble industrial effluent sample is introduced [4]. Reverse osmosis is a cross-flow filtration process. In this process, the inlet feed passes through the surface of the membrane under pressure and, during the passage, is divided into two parts with a lower salt product known as permeate or permeate and the condensed or reclaimed portion.

The following are the key concepts of the reverse osmosis process [5]:

- Recovery or Recovery: Percentage of feed that enters the system as a product or trash.
- Salt recovery: Percentage of salt concentration removed from feed into the system.
- Salt Passage: The percentage of soluble salts in the feed that passes through the membrane.
- Feed Flow: The amount of feed into the membrane system (m3 / hr)
- Flux: the amount of product or permeable water passing through the membrane surface unit (l/m2.hr)

In general, permeate flux and salt retention are the key parameters determining the efficiency of the reverse osmosis process that affect the variables of pressure, temperature, recovery, and salt concentration of feed into the system [6]. This is well illustrated in Figure 1 [7]. In this figure, while keeping the three variables constant, the pressure is increased, and its effect on permeate flux and salt recovery is shown. As can be seen, with increasing pressure, salt recovery, and permeate flux increase [8].

quality and quantity of treated water. Know [3]. In this paper,

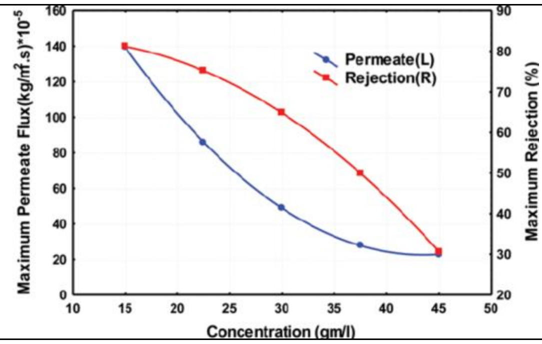

Figure 1. The effect of increasing pressure on permeate flux and salt recovery

Also, in one study, the effect of operating variables such as temperature, pressure, and soluble solids on the performance of reverse osmosis membrane was investigated [9]. The results showed that increasing the temperature decreased the output quality and increased permeability, and increased pressure also increased the salt and flux retardation [10].

2. METHODOLOGY

According to the material presented in the Introduction section, to illustrate how to determine the optimum operating conditions of reverse osmosis water or wastewater treatment and concepts of desalination, the method, and results of treatment of an industrial wastewater sample. A high solution of reverse osmosis is provided. The effluent used in this study was effluent obtained from the resuscitation of ion exchange resins of an industrial ionization unit. In this plant, cationic and anionic mixed resins are used to produce boiler feed water. Resin resuscitation should be performed after saturating the resins and reducing their performance. Sulfuric acid is used to reduce cationic resin, and caustic soda is used to reduce anionic resin. Acidic effluent of cationic resin resuscitation stage and alkaline resin of anionic resuscitation stage in the mixed effluent collection basin

The construction is shipped out of the plant without any treatment. In this study, the reverse osmosis membrane method was used for the treatment and reuse of this effluent. The chemical and physical properties of the effluent were measured by an acidic index of 0.8 and an electrical conductivity index of 10100 μs / cm, the results of which are shown in Table 1. The measurement method is based on the standard methods outlined in Reference Number [4]. The purpose of this effluent treatment is to provide part of the feed to the existing ion exchange resins, and since the maximum permissible electrical conductivity of the inlet water is about 300 microns/ s per unit instruction and also considering that the average electrical conductivity of the effluent is 10100. The microsecond was cm, so the minimum salt retention rate should be 97%. To purify this effluent by reverse osmosis and determine the required pressure and determine the optimum flux and recovery of the membrane pilot equipped with pressure, discharge and conductivity control and measurement facilities with a standard membrane number 40 in diameter and length. Used inches, according to Figures 2, 250 liters of effluent enters the pilot tank and is pumped from the bottom of the tank by a low-pressure centrifugal pump, and after passing through the spiral tubes or the cooling section, into the triple micron filter cartridge, These filters include a 20-micron particle removal filter, a 5 micron activated carbon filter and a 5-micron colloidal particle filter. Children. The effluent enters the high-pressure reciprocating high-pressure pump after leaving the cartridge filters.

Ions	mg/l	ppm CaCO3	meq/l	Total Conc.(m
Ammonium (NH4)	0	0.000	0.000	
Potassium (K)	0	0.000	0.000	
Sodium (Na)	14800	32187.910	643.758	1480
Magnesium (Mg)	1530	6293.188	125.864	153
Calcium (Ca)	460	1147.705	22.954	46
Strontium (Sr)	0	0.000	0.000	
Barium (Ba)	0	0.000	0.000	
Carbonate (CO3)	16.022	26.699	0.534	1
Bicarbonate (HCO	110	90.157	1.803	11
Nitrate (NO3)	0	0.000	0.000	
Chloride (Cl)	25500	35963.110	719.262	2550
Fluoride (F)	0	0.000	0.000	
Sulfate (SO4)	3210	3343.750	66.875	321
Silica (SiO2)	0	n.a.	n.a.	
Boron (B)	0	n.a.	n.a.	

Figure 2. Physical and Chemical Properties of Ionic Replacement Resin Reduction Wastewater [11]

After reaching the required pressure, the effluent passes through the pressure vessel into which the seawater membrane is inserted. In this section, the effluent pressure and discharge are adjusted using valves fitted to the condensed and passage paths to evaluate the efficiency of the system under various pressure and discharge conditions. After entering the pressure chamber, the effluent is divided into two refined or permeable effluents and the concentrated effluent. The treated effluent is returned to the effluent reservoir after measuring the discharge and electrical conductivity. The condensed effluent was also kept in the effluent tank after leaving the pressure chamber, and the feed concentration was kept constant. Regarding diabetic retention of temperature by inserting a heating system inside the effluent reservoir and cooling system at the beginning of the effluent path and using a temperature controller, the temperature was always maintained at about 30 ° C. Thus, the four main variables of the reverse osmosis system, two variables, feed intake concentration, and effluent temperature were kept constant and obtained by changing pressure and inlet discharge (recovery) and observing permeate discharge, flow rate and salt recovery rate.

Their analysis revealed optimum operating conditions.

3. RESULTS

even the amount of salt required and the solute content of the main effluent, and the fact that on average there is about one milligram per liter of total osmotic solute, [5] there should be more pressure than desalting. Osmotic applied to desalt; initial pressure was selected 15, 12, and 18 times. In the case of membrane inlet discharge, the average permitted recovery rate was 40, 45, and 50 liters per minute, based on the permissible membrane workload. Accordingly, two variables were studied in each of the three levels, and the number of experiments was performed based on a complete factorial of 9 (9-2 ^ 3) modes and each mode with three replications. Table 2 shows the results in the optimum salt recovery range and the permitted membrane work range. In this table, the mean of electrical conductivity indicates the average of three electrical conductivity measurements and the mean discharge of the average value of traversed discharge for three replications. As can be seen, the standard deviation is smaller than the mean values, so the changes are in the narrow range, and the data distribution is not high. Based on the results obtained by increasing the pressure from 12 bar to 18 bar, it was generally observed that the electrical conductivity was lower and the discharge higher, similar to the conditions described in the manufacturer's instructions for use [2]. Also, salt recovery increased with increasing pressure, and permeability and recovery rate generally increased, which were in accordance with standard membrane performance conditions [3]. The results of Table 2 can be used to determine the appropriate operating conditions of the existing effluent treatment, namely the pressure and inlet discharge of the membrane. Usually, membrane filtration is required to select the appropriate and compatible membrane effluent and to determine the optimum pH input conditions, including pressure, inlet discharge, temperature, and system. In this study, based on the results of Table 1, suitable conditions were obtained in terms of inlet pressure and discharge. As mentioned earlier, temperature, solute content, and solubility were kept constant to evaluate the effects of pressure and pH recovery variables. In order to select the proper pressure and discharge rate of wastewater treatment, it is necessary to first introduce some concepts and criteria for membrane treatment used in this study regarding the type of effluent and the membrane characteristics, and then introduce the appropriate discharge pressure and discharge steps.

- Maximum feed discharge: for the membrane used in this study 60 L / min;
- The fluid flow rate of 30 liters per hour per square meter of the membrane was 7.3 square meters
- Maximum recovery of 14% and an average of 8% for membrane used;
- The usual rate of permeable discharge for the membrane used is 3.6 liters per minute.

TABLE 1. Results of pilot operation for desalination of high soluble industrial wastewater

Temp.	**Flux(lmh)**	**Pressure(bar)**	**TDS (mg\L)**
13	12.44	73.58	91.05
15	13.19	72.29	102.42
20	15.29	69.77	136.55
25	17.73	68.02	180.36
30	20.55	67.25	235.71
35	23.82	66.85	305.19
Step 2			
13	35.67	22.08	0.53
15	37.84	20.14	0.59

20	43.86	16.30	0.77
25	50.85	13.39	1.01
30	58.95	11.13	1.33
35	68.34	9.38	1.74

In view of the above, the results in Table 1 and observing at least 97% of the salt retention required for entry of water into ion exchange resin columns, only rows 4 and 5 of this table met most of the requirements. In both cases, row 5, which results in a flow rate of 45 liters per minute, was more appropriate. Because the amount of 3 liters per minute and the electrical discharge/discharge head of the 5 treated wastewater was also better than the result of row 4 and in the required range. In a salted water system, the quality of waste must be optimally utilized and economically feasible [6]. Therefore, the conditions of row 5 of the table, i.e., 15 bar pressure and 45 liters/minute inlet effluent discharge to the membrane, were selected as suitable conditions for existing effluent treatment. In other cases available in the table or recovery rate was more than 8% (median 8 and 9) and Yen discharged recovery) (rows 7, 8, and 9), or 7, was higher than usual (rows 6, recovery rate). Salt was lower than 97% (rows 1, 2, 3, and 4), and also the rate of permeable discharge from row 6 was higher than usual for this membrane, which was a reason for the rejection of these states. In the case of pervasive flux, we cannot consider the higher flux rate to be a better operating condition because we usually have a critical flux value for the membrane system, which if the membrane system exceeds this flux value. Clogging can occur quickly [7,8]. In selecting the appropriate recovery, it should be noted that higher recovery usually increases the probability of membrane clogging and is due to the increased probability of clogging due to the lower horizontal passage rate of water across the membrane. And sufficient turbulence reduction at the membrane level [9] In order to adapt to the affluent, the membrane usually has to be free of residual chlorine or oxidizing agents, using a potential index of 1. This value (ORP) of oxidation-reduction The index to be sure that the membrane is not damaged should be less than 175 mV [10], which in this study is due to the presence of activated carbon in the PC Treatment was always a consideration. Temperature variables are also important variables in reverse osmosis systems, and as the temperature increases, water and salt permeability and mass transfer intensify [11]. In this study, the temperature was kept constant, but the effect of temperature on the permeate flux and quality must always be considered [12].

4. CONCLUSION

The use of reverse osmosis method for the treatment of wastewater with high solute solids requires recognition of effluent, membrane, and operational variables of this process. In this study, considering the amount of soluble wastewater and the fact that the maximum permissible electrical conductivity of the treated wastewater for re-entry into The ion exchange resins was 300, and a pilot operation was carried out to recycle the water, and the amount of purification was performed. The four variables of pressure, recovery (discharge), solute concentration and temperature, solute, and temperature variables were kept constant, and the operating conditions were adjusted in a way that changed the input pressure and discharges to the system to provide the desired electrical conductivity. And by examining and comparing the results with the permissible operating limits of the membrane, determine the most appropriate pressure and flow rate to the pilot. The results showed that as the pressure increased, the electrical conductivity decreased, and the flux rate increased. In selecting the appropriate pressure and discharge, maximizing the values of permeable discharge, salt recovery, and recovery was not only the criterion of operation but should also select the operating pressure and discharge, which provided the conductivity with permeable discharge, the optimum flow rate of 300 permissive and recovery. The functional range of membrane used. As can be seen, the pressure of 18 bar and the inlet flow rate of 50 liters per minute, which had the highest salt and permeated fluxes, could not be considered as optimum operating conditions because it may be superior in other respects in the short run [13]. However, in the long run, due to working outside the normal membrane conditions, the effects of clogging and the decrease in the quality and quantity of the permeable material are obvious and may necessitate excessive chemical washing or failure of the membrane system. As a general conclusion, it can be said that pressure of 15 bar and discharge of 45 liters per minute is the operating condition of this wastewater treatment assuming temperature constant at 30 ° C and also the solute concentration of the effluent entering the system for a number of membranes. Used and with a recovery rate of about 8%. This selection was made by observing the membrane operating range and factors such as membrane compatibility with the effluent used, the effect of flux enhancement and its role in increasing the probability of clogging, and observing the average recovery allowed. Obviously, in order to recover more than 50% of this affluent, a pilot chamber with six membrane capacities and possibly two-step purification is required [14].

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