Separating the Saline Effluent of Petrochemical Industries in order to Optimize the Recycling and Reuse in the Cooling Towers with Compilation Benefit from Promethee and Decision lab Software (Case study: Shazand Petrochemical)

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Received: Nov. 2014 & Published: Jan. 2015

Abstract

Development, on the one hand, has significant relationship with updated and effective industry and on the other hand, with destruction of valuable environmental resources of our country including surface water and ground water and needs more attention of specialists and owners of big industries. Aim of this research is to find an appropriate solution for problem of saline effluent production in Shazand petrochemical company that there is no possibility of reuse in it due to high amount of salts. In this complex, it is produced daily volume equivalent 150 m/hr of effluent with electric conductivity 4000µs/cm and total dissolved solids 2500mg/lit that now, it is directly sent to evaporative basins without filtration. In the research, filtration with Ro, MED, EDR methods, hybrid RO, MED and hybrid RO and EDR are investigated after gathering and analyzing data related to saline effluent including EC, TDS, SS, TOC, PH, TH and COND and investigating and comparing amount of these data with standard of consumed water of cooling towers. And best method is considered with criteria such as initial price of machine, finished price over 10 years, lifetime of machine, finished price over 20 years, washing time, repairs cost, fundamental repairs time. Defined criteria and related options are scored and weighted and finally, reverse osmosis system with electric conductivity 50-100µs/cm and total dissolved solids less than 500mg/lit with 75% of recycling power are proved for filtrating saline effluent.

Keywords: saline effluent, petrochemical industries, promethee model, Decision lab software, cooling towers

1. Introduction

Water supply with less salts or without salts is the concern of industries in the world for years and so, methods of water supply without salts has found large span (Koochak Zadeh, 2005). Evaporation and distillation, reverse electro dialysis, ionic replacement and reverse osmosis are among common methods of saline water filtration and its conversion to water without salts. Among these methods, ion replacement method has been more common due to high performance, ease of operational conditions control and relative cheap cost compared to other methods (Najar Zadeh, 2011). In this method, we have to revival them after resins saturation and doing revival operations with high volume of effluent, we face high amount of total dissolved

(DOI: dx.doi.org/14.9831/1444-8939.2015/3-1/MAGNT.17)

solids having variable pH. Usual methods of removal of such an effluent, are the controlled injection to deep wells, discharge in urban wastewater collection network with given ratio, discharge in sea and ocean and sends to evaporative basins (Nikazar, 2005). In Shazand petrochemical complex, filtration operations of raw water are applied using ionic replacement resins in order to use in the steam unit and reverse electro dialysis method for filtration effluent produced in the complex in order to use in compensation for cooling towers that saline effluent resulted from effluent filtration of reverse electro dialysis unit and revival of the resin after neutralization and pH control is sent to evaporative basins (Abdolmaleki et al, 2012).

1.1 Research Background

A research titled "use of saline effluent of Isfahan Iron Works for using compensatory water of circulating cycles and internal and external agricultural uses of factory". As a result, the research is named processed water and its return to industrial cycles of the complex or agricultural use in the internal and external environment of the complex. And all existing methods of the productivity are examined for creating possibilities and existing conditions technically and economically. And finally, chemical filtration system is offered for agricultural uses and reverse osmosis technology for industrial uses of the complex or combination of them for both types of uses (Zahedi et al, 2007).

A research titled reuse of filtered effluent of refinery in cooling towers in Tehran. As a result of the research, results obtained from outlet effluent from refinery in the reverse osmosis way is offered in order to use in cooling towers. Doing operations with pressure difference 7-6 times and 30^{o} c temperature (ambient temperature) is appropriate conditions for conducting process. Analysis of filtered effluent shows 95%, 100%, 93%, and 97% reduction respectively in total dissolved solids (TDS), total hardship (TH) ,chloride ion and SiO_2 that their comparison with urban water quality used in cooling towers shows favorability of reverse osmosis method for reaching the purpose (Nik Azar et al,2005).

2. Material and Methods

First, primary data is done with library studies and searching on the internet. Then, production of resins, revival of effluent and saline effluent from effluent filtration of electro dialysis unit and generally, steps of conducting water filtration operation are studied in the step of doing preliminary studies in the complex site and precious and detailed understanding of production process of water without salts. Then, analysis of the parameters on the produced saline effluents and its comparison with limit of use in the cooling towers is conducted that selection of the filtration methods considering initial price of machine, finished price over 10 years, lifetime of machine,, finished price over 20 years, washing time, repairs, fundamental repairs time is examined and the use of reverse osmosis system for filtration of produced saline effluent in Shazand petrochemical company s proved.

Shazand petrochemical complex is one of the important and underlying designs of the country that created and exploited along general policies of petrochemical industries development and with the aims of the country internal need supply and exports with area about 738ha in the vicinity of Emam Khomeini refinery of Arak in 22km from Arak-Borujerd road. The petrochemical complex as a first petrochemical complex of Iran starts its work in 1374 with production in chemical sector of all products including ethylene oxide, glycol oxide, acetic acid, vinyl acetate, and two ethyl hexanol and ethanol amine and in polymer sector, valuable products such as special

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grids of disposable syringe production, serum bag, the body of the battery, flour sack, primary materials of automotive rubber and in present, it is one of the big industrial centers of Iran with production more than 17 types of products. Production unit of water without salts, steam production unit, filtration unit of industrial effluent and five cooling towers are lateral service units. Because circulating water in the cooling towers is as an open cycle, Blow Down or sub water is used for controlling concentration of salts and supply of compensatory water of the cooling towers is mix of filtered raw water or soft water and filtered effluent of wastewater filtration unit. Also, combinations of Zn, Phosphate, Phosphonate and Polymer are used for controlling corrosion in the cooling towers. Four series of column of cation-taking and anion-taking are used for supplying water without salts in demineralization unit to meet need of 400-500m^3 to water without salts. Raw water entering into ionic replacement unit that supplies from ground water enters into ionic replacement unit after preliminary filtration and removal of suspended and colloid particles having four series of cationic and anionic ion replacement column and always one series of the columns is in standby mode or revival of resins. Each series of the columns of ion replacement produces 6000m^3 of water without ion in 24h that conducting operations of resins revival and volume equivalent 700m^3 of effluent with electric conductivity 6000µs/cm and total dissolved solids 2500mg/lit are produced. It is necessary to note that strong cation-taking resin and strong and weak anion-taking resin are used in this unit and hydrochloric acid 5% is used for revival cation-taking resin and NaOH solution 4% is used for revival anion-taking resin in the saturation time. And during resins operations, usually effluent with pH>7 is produced with mixing effluent from revival of cation-taking that is acidic and effluent from anion-taking that is alkali that now, it is sent with saline effluent from filtration of reverse electro dialysis effluent with volume equivalent 170m^3 with electric conductivity 4000µs/, total dissolved solids 2500mg/lit toward evaporative basins.

2.1 Multi criteria decision- making models

Multi criteria decision making is a structural frame for analyzing decision making issues with multiple complex objectives. Usually, multi criteria decision process defines objectives, options, conversion of criteria scale to fifed units, determination of criteria weights for determining their relative importance, selection and application of mathematical algorithm for ranking options and selection of higher option Keeny, 1993). MCDM method is divided into two main groups, continuous and discrete, based on nature of options that should be evaporated. Discrete method is used for selecting decision issues that their objectives accept infinite amount. Techniques such as linear planning and target planning for continuous conditions are considered. Discrete multi criteria decision methods are used for decision issues having limited options. In these methods, set of objectives and criteria is used for judging on options and options are ranked by an option ranking method based on satisfying of objectives and criteria (Hajkowicz, 2004).

3. Findings

Following results are obtained after conducted investigations, field examination and different studies on types of separation methods of saline effluent from petrochemical industries. Best option for using saline effluent of petrochemical industries in the cooling towers section is the use of reverse osmosis system. The method is examined and proved considering all existing parameters in Table 1. Required parameters are determined in Table 1.

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Table 1 comparison of filtration methods of saline effluent considering main parameters					
Hybrid	MED	RO	EDR	unit	criteria
306	800	195	317	(m³/day)€	Initial price of machine
20	25	20	10	year	lifetime
2268000	4228000	1464000	2347680	€	Finished price over 10 years
2700000	4456000	1992000	4695360	€	Finished price over 10 years
600	500	700	700	Hr/y	Washing repairs time
43200	22800	52800	75000	€/ year	Repairs cost
8000	8200	8000	8000	Hr/year	basic repairs time

3.1 Prioritizing the options of saline effluent filtration method

Figure 1 MED and RO method

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Figure 2 EDR and Hybrid method

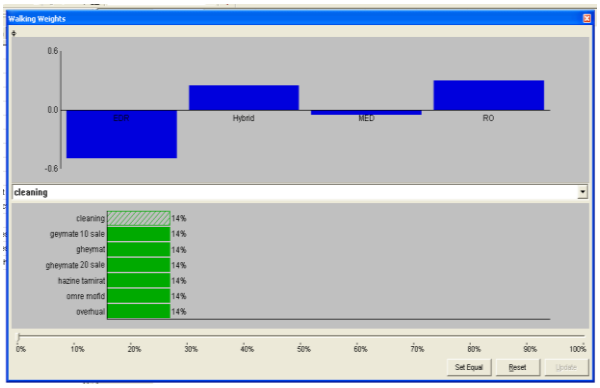
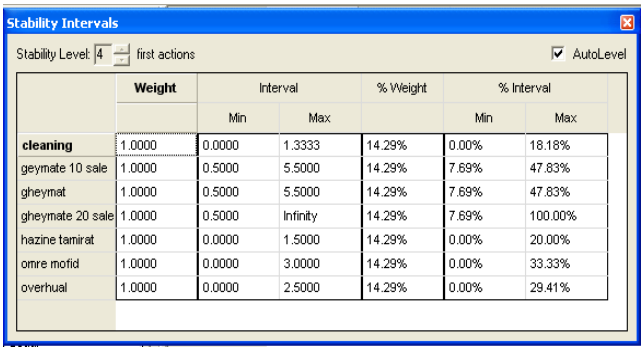


Figure 3 comparison of filtration methods based on selected criteria



	Weight	Interval		% Weight	% Interval	
		Min	Max		Min	Max
cleaning	1.0000	0.0000	1.3333	14.29%	0.00%	18.18%
geymate 10 sale	1.0000	0.5000	5.5000	14.29%	7.69%	47.83%
gheymat	1.0000	0.5000	5.5000	14.29%	7.69%	47.83%
gheymate 20 sale	1.0000	0.5000	Infinity	14.29%	7.69%	100.00%
hazine tamirat	1.0000	0.0000	1.5000	14.29%	0.00%	20.00%
omre mofid	1.0000	0.0000	3.0000	14.29%	0.00%	33.33%
overhual	1.0000	0.0000	2.5000	14.29%	0.00%	29.41%

Figure 4 align the selected criteria

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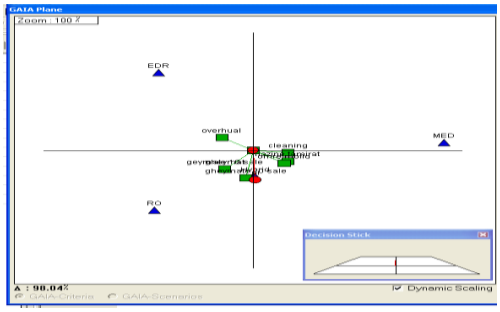
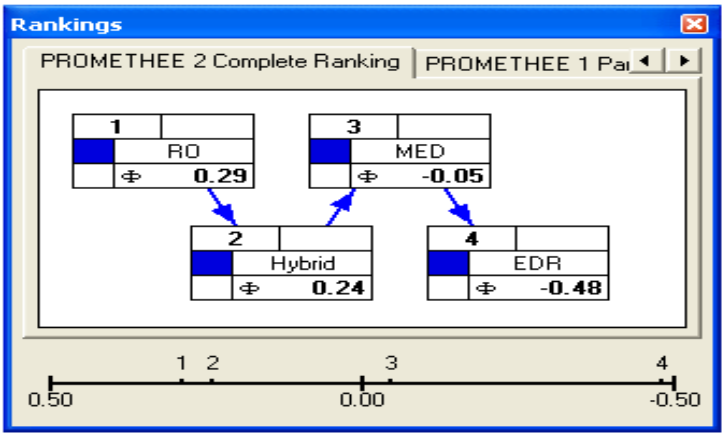


Figure 5 Prioritizing the options of saline effluent



4. Conclusion

Results obtained from the research, possibilities of reusing saline effluent from resins revival and saline effluent from effluent filtration of reverse electro dialysis unit in the cooling towers with respect to the diversity of criteria is the best solution of using multi criteria decision making techniques. In the research, Promthee model and Decision lab software are used and criteria scoring to the options and criteria score is done using specialists ideas and results of past studies comprising filtration methods of saline effluent based on mentioned criteria, reverse osmosis method is placed in first rank and reverse osmosis hybrid with multi steps distillation is placed in next rank. Result of the research is the prevention of wasting and harvesting underground water tables. Next results indicate reduction of leakage possibilities of this effluent from floor of evaporative basins to ground water resources, obtaining high volume of evaporative basins for other applications such as concentrated effluent of RO unit. Creation of opportunities for developing complex activities is another result. Due to decreased raw water consumption and with respect to the limitations that region water organization has created for the complex for water supply has put development plans of the complex in the shadow of the doubt. But, by conducting the research and obtaining desired results and solving problems using reverse osmosis system in the filtration of the effluent and its generalization for other similar effluents and/or substitution of this method with common chemical methods of water filtration in the complex, large achievements are obtained such as reuse of filtered effluent with better quality and consumption optimization, significant reduction

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of chemical consumption for revival resins, minimizing the resin buy and reduction of repairs and reconstruction of resin columns costs. As we know, environment protection is the main aspects of stable development and the use of reverse osmosis system in the filtration of saline effluent of petrochemical industries leads to maintain and promote the health of the environment.

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