PHYSICO-CHEMICAL CLEANING OF BAG FILTERS

Submitted By

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Dedication

I dedicate my work to my beloved parents, my teacher Prof. Dr. Muhamad Zafar Noon & Dr. Tanveer Iqbal, My dearest friend Muhammad Arif Manzoor & again special dedication to Dr. Tanveer Iqbal who helped me in accomplishing this thesis. I thank to Almighty Allah who gave me such thoughts due to which I be able to make this participation in research.

Acknowledgments

As a research scholar to begin this work in the department of chemical engineering University of Engineering and Technology Lahore I acquired many useful techniques regarding problem solving and the way in getting help from my respected professors, fellows and professionals. I believe that without their cooperation this research work would not possible.

Firstly, I especially thankful to Prof. Dr. Muhammad Zafar Noon for his kind supervision that groom up my confidence and abilities to achieve my challenging task. He always gave special attentions and was always ready to help any time. He responds to my messages and mails on time that shows a high quality of humbleness and dedication to his students.

In my life I found Dr. Muhammad Zafar Noon the most dedicated professor in my work not only for me he always welcome his student. May he live a long life with always enjoying good health so that we students can get guidelines easily.

After that I am also thankful to Dr. Tanveer Iqbal for their kind cooperation. I always remember them in good words of kindness also remember my other professors who guide me in a way to accomplish this work.

I also thankful to my fellows who helped me positively and encourage me that made my work interesting and I enjoyed their company in completing this project. Muhammad Arif is one of the best fellow who helped me sincerely.

Other fellows who motivated me are Inyat Abdullah, Hafiz Muhammad Asghar, Muhammad Ismail Akhtar, and Rana Nasir dang. I always remember their help in useful words in my life. May they all enjoy good health.

Finally, once again I would like to say that this achievement was not possible without the prayers of my family, respected teachers and friends.

Abstract:

In last years, desalination by reverse osmosis (RO) process has experienced a significant development, and it has become one of the major technologies for producing potable water throughout the world.

Despite this relevant growth, reverse osmosis, and membrane processes in general, has several drawbacks to overcome.

Specifically, fouling of filtration media (bag filters, cartridge filters and membranes) is the most important problem in reverse osmosis. Economics of this process is highly influenced by filtration media fouling rate and effectiveness of fouling control.

The main purpose of this work is the cleaning of bag filter (filtration media) in order to make this useable again. Bag filter is used in reverse osmosis process to protect membrane. They are replaced by new ones after the accumulation of scales. This work involves cleaning and enables them to reuse to be economical.

HCl solution of very low concentration is used to remove the scales in this cleaning method. After dipping the bag filter in this solution and then washing with high pressure water it become fit to reuse by calculating pressure drop.

This is not a long life method but can be adapted to reuse the bag filters 3 to 5 times. So as for as the cost is concern this will prove economical that is a vital requirement for an industry.

CHAPTER NO.1

INTRODUCTION

1.1 Introduction

Reverse osmosis is mainly used process to provide desalinated water for drinking. As it is mentioned before that bag filters are applied as pre-treater for reverse osmosis membranes in order to filter the particles greater than 5 microns that may bullock the RO membrane.

The area of discussion is bag filters which are used to protect reverse osmosis membranes that stop the particulates to be accumulate on reverse osmosis membrane. After few days the salinated water spoils the surface of bag filters by salts called fouling layer results in more pressure drop. So in order to keep the process running bag filters are replaced by new bag filters.

Process can be made economical by cleaning and reusing the bag filters. The objective of this work is to save the costly membranes used in reverse osmosis process by making the safeguard i.e. bag filters fit for reuse.

1.2 Bag Filters

Following are general properties of bag filters. They are

- reusable
- replaceable
- un-rigid
- low cost materials

Bag filters are made up of poly ester, poly propylene fiberglass and nomex [1]. They widely used in dust removing as a pollution control; have many industrial applications and in water treatment as well as in cement industry [2].

This discussion is about water treatment. The particulates dissolved in water stick on the surface of bag filter which make scales results in a severe fouling layer.

Main foulants found are as follows

- Calcium carbonate
- Calcium sulfate
- Metal oxide
- Scales of silica
- Collides of inorganic matter
- Organic &inorganic/mixed collides
- Biological matter
- Organic scales[3]

These Bag filters are typically adjusted in a pressure vessel. Fluids flow from the inside of the filters to the outside [4]. These bag filters do not remove bacteria, viruses, or fine colloids but can remove TDS to stop blocking in membranes. Bag filters are replaced by new ones after 7 to 10 days because of scaling. Scaling reduces the productivity and life due to elevation of pressure drop. That is why replacing is carried out.

1.3 Problem Statement:

Water free from impurities is a necessary need for human & for all other organisms because 80 % disorders are caused by contaminated water e.g. typhoid, hepatitis, cholera and other fetal diseases [5].

Other than life risks contaminated water is unfit for industrial purposes. Hardness of water is one of the major problem regarding industrial concerns because of scaling in boiler cause more energy consumption and may results in bursting of boilers by narrowing the tubes [6].

So the problem is highlighted in the above discussion. To solve the problem there is a need to purify the water. Reverse osmosis is process generally used for water purification. That is stated as "a process by which a solvent passes through a porous membrane in the direction opposite to that for natural osmosis when subjected to a hydrostatic pressure greater than the osmotic pressure" [7].

Capacity of advancement is the beauty of this process. A lot of work is being done before as for as or the advancement of the process. Material deposition on the membrane is responsible of scaling that forms scaling layer. To control this deposition there is a need of pre-treaters for costly membranes [8].

So the above study is mentioning a solution of the problem in the form bag filters. Bag filters that are used in pressure vessels as explained before in this chapter. Bag filters act as protectors for membranes as they stop the particles of size 5 micron to permeate through them that improves the life and efficiency of membranes used in RO process [9]. The problem is to save these bag filters so that they can be reused instead of replacement because here is also the problem of formation of fouling layer that results in elevated pressure drop results in more energy losses. So after 7 to 10 days installed bag filters are disposed and new filters are replaced, this work is improved by cleaning of bag filters & their reuse.

1.4 Research Objectives:

The cleaning agent used in this work is HCl solution of very low concentration as it is a corrosive in nature .following are the main points by which I met my research objectives.

- Evaluating the effect of HCl solution concentration on cleaning of bag filter by using 0.37, 1.12, 2.24, 3.36, 4.48, 5.61, 6.73 and 7.85% concentrated solution followed by physico-chemical cleaning method
- Determine the most suitable concentration of HCl solution for cleaning of bag filter by physico-chemical method at constant (10 mints) dipping time into the solution.
- Study the effect of concentration on pressure drop, TDS and conductivity.
- After that determined the most suitable concentration that results in optimum pressure drop.
- At the end graph is plotted on concentration vs pressure drop.

CHAPTER NO.2

LITERATURE REVIEW

2.1 Review of Literature:

Twentieth century was the time when water treatment was focused as a prominent separation process. Main objective were particulates that cause water pollution after that fine, ultrafine particles and microorganism were taken into consideration. Reverse osmosis process played marvelous role in order to remove pollutants from water [10]. There is no other process that is compatible with reverse osmosis process regarding capacity & efficiency. We know that blocking of membrane due to scaling is a severe process in membrane processes as this is mentioned before in the start of the work. The foulants stick on the surface by pore clogging or by adsorption [11]. Chemical interaction & biological contamination are also factors responsible for economical loss & efficiency. There is a solution to overcome these mentioned issues in the form of fouling control process or pretreatment. The main fouling layers in reverse osmosis membranes are as follows [12].

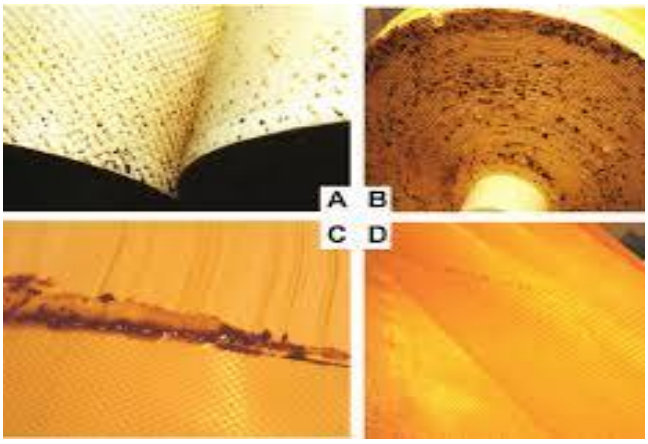
Fouling layer	Causes	Pretreatment
Biological fouling	Microorganisms	Chlorination
Particle fouling	Clay & sand	Filtration
Colloidal fouling	Organic & inorganic matter	Coagulation &Filtration
Mineral fouling	Carbonates & Sulfates of calcium and magnesium	Chemical & physical treatments

The above table shows that these are collides, suspended particulates and solutes that are responsible for scaling. Physical, chemical or physicochemical interaction may be responsible interactions between the particles and the membrane material [13].

Inappropriate working of membrane bioreactor (MBR) results in the deposition of mineral and organic fouling layer on the surface of membranes. Cake formation is another

issue this is due to sticky particles that bullock the pores, bacterial clump accumulation, organic, inorganic & polymeric particles [14].

The action to remove the fouling layer is according to the interaction that is responsible i.e. physical, biological or chemical. Some layers are of temporary nature that can be removed by physical means. Permanent fouling layer needs chemical or physiochemical action [15]. The key thing in chemical Cleaning is the selection of cleaning agent its reactivity and corrosive nature should be taken into consideration in order to clean the bag filters properly. Concentration of cleaning agent and dipping time are also important factors for proper cleaning [16].



Fouled membrane

The fouling layers microscopically looked like this.

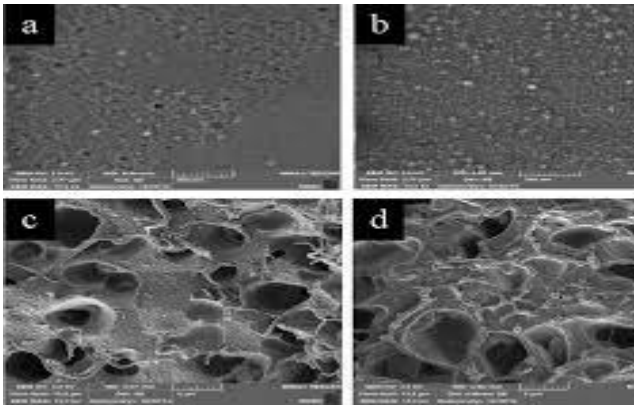


Fig. 1

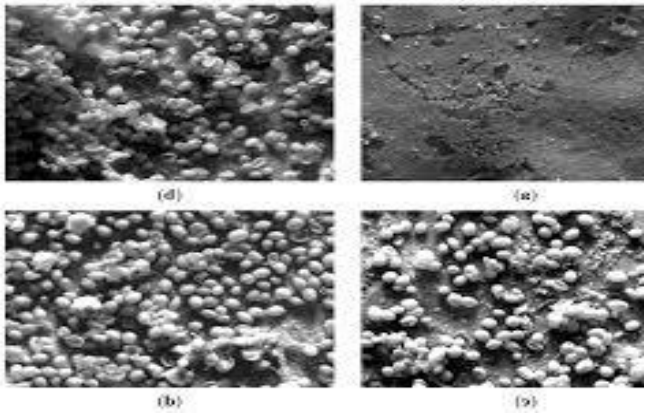
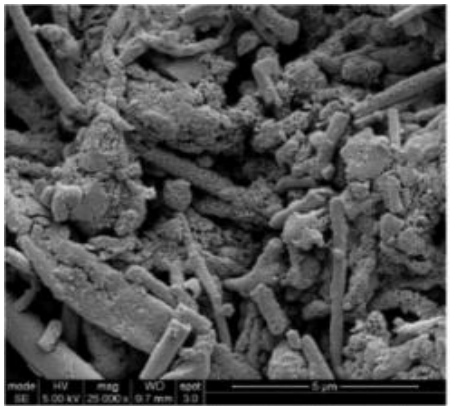
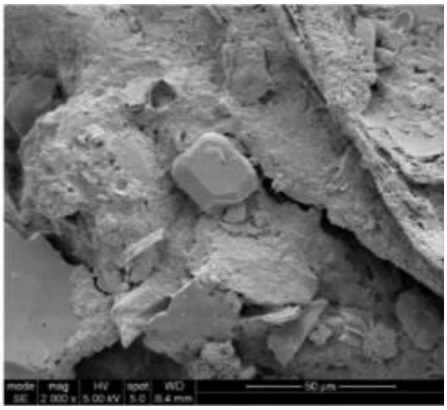


Fig. 2

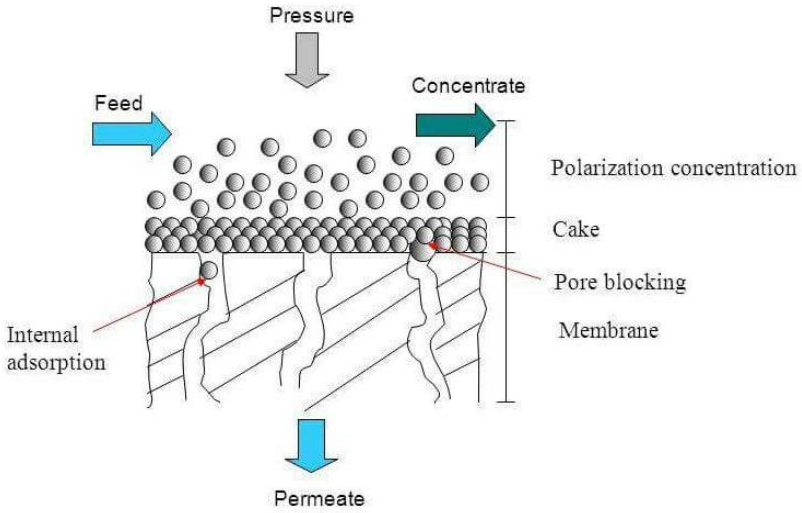
In fig. 1 a &b related to temporary fouling but fig. 1 c & d and fig. 2 as a whole representing severe fouling on the surface of membrane. More figures are shown below [17].

Fouling layer





Microscopic view of fouling layer



2.2 Role of Bag filters as Pre-treaters:

Pretreatment can overcome all the problems up to maximum extent. Although membranes can be cleaned but it is a waste of money. Particulates can be filtered using bag filters which is pre-treater. But the interesting is that we are saving this pre-treater too to make the process more economical, generally the bag filters are replaced after 7 to 10 days due to the above mention fouling problem. My objective is to clean the bag filters rather than membranes which can prove more valuable for us.

Suitable cleaning agents depending upon the nature of foulants can be applied to clean the bag filters.

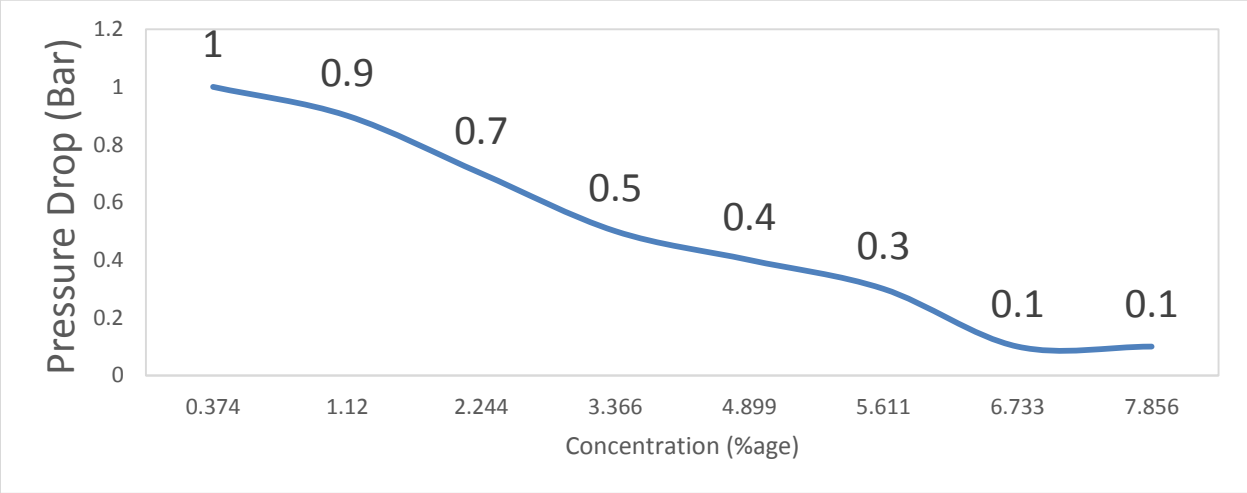
2.3 characteristics of Cleaning Agents:

Following are the main characteristics cleaning reagent

I. concentration
II. operating sequence
III. time interval
IV. nature of foulants
V. extent of fouling layer

2.4 Concentration of Cleaning Agents:

Concertation of cleaning agent is the ratio of cleaning agent volume to the total volume of the solution. Concentration of cleaning agent consequently measures its strength. Suitable concentration of cleaning agent is very important to clean the fouling surface safely and effectively. Low concentration of cleaning agent cannot clean the surface properly while the high concentration of cleaning agent can damage (wire and tear) the physical condition of media surface. Before using chemical cleaning method it is necessary to select proper/suitable concentration of cleaning agent to obtain the effective results. The effect of concentration of cleaning agent (HCl) on cleaning is shown in following graph.



This graph show that by increasing concentration of cleaning agent (HCl) the pressure drop decrease gradually with concentration. The decrease in pressure drop show that the foulants layer decrease gradually with increase in concentration of cleaning agent.

2.5 Chemical Activity of Cleaning Agents:

Activity actually is a representation of effective concentration of cleaning agent. This determine the actual chemical potential for a solution.

Both activities and concentrations of solution are used to determine equilibrium constants and reaction rates. Mostly we take concertation to determine the equilibrium constants and reaction rates. For diluted solution concentration give satisfactory results therefore for diluted solution concentration is used to calculate equilibrium constants and reaction rates.

In case of concentrated solutions the difference between observed concentration and the calculated concentration in equilibrium become more. Due to this reason the activity was initially introduced. The activity can be calculated as

$$a = e^{\mu - \mu_o RT}$$

Where

a = Activity

μ = Chemical potential

μ_0 = Standard chemical potential

R = General gas constant

T = Absolute temperature

2.5-1 Non-ideality in gases:

For non-ideal gas the fugacity is effective pressure. In case of same chemical potential the pressure of real gas and ideal gas become equal. The fugacity and pressure can be related as following.

$$F = \Phi P$$

Where

F = fugacity

P = pressure

Φ = fugacity coefficient

In case of ideal gases the value of fugacity coefficient become one.

2.5-2 Non-ideality in Solution:

For pH of solution we usually use the following equation.

$$pH = -\log[H^+]pH$$

This equation do not give accurate results at every concentration of solution because activity of chemical is not accounts in this equation.

For satisfactory results at all concentration following equation is use which accounts for activity os chemical agent.

$$pH = -\log[a_{+H}]$$

Where

a = activity

2.5-3 Nature of foulants:

Before choosing the cleaning agent for washing of any filtering media of reverse osmosis it is very important to know about the nature of foulants. Because there are different types of foulants. These different types of foulants layers cam be cleaned by selecting cleaning agent according to the nature of foulants.

When the type of membrane fouling is identified, then suitable cleaning chemicals are used to remove fouling layers from the surface of membrane and to increase the membrane flux. These Chemicals are usually used for cleaning of filtering media of reverse osmosis in water industry are divided into five categories, which are given below.

Table 1

Types	Functions	Cleaning agent
Oxidants	Oxidation	NaOCl, H2O2.
Chelating Agents	Chelation	Citric acid
Acids	Solubilization	Citric acid, nitric acid, HCl
Caustic	Hydrolysis, Solubilization	NaOH
Surfactants	Emulsifying, dispersion.	Surfactants, detergents

Only physical cleaning method doesn't work efficiently when membrane is rigorously fouled. It is essential to use chemical reagents for proper or economical cleaning.

2.6 Common Cleaning Reagents:

1. acidic detergents
2. alkaline detergents [18]

1. Acidic Detergents:

Inorganic scales and metal oxides are normally removed by acidic detergents and low concentration of acidic solution not effect on pore size.

Most common example is hydrochloric acid (HCl) [19].

2. Alkaline Detergents:

Alkaline detergents are specially used to remove organic foulants e.g. Sodium hydroxide.

Physical methods are more favorable for bag filter material but severe scaling require chemical interactions. Chemical interactions have severe aftereffects that should be kept in mind and care should be taken in order to minimize the severity so that performance and efficiency can be maintained.

According to Al-Amoudi (2013) "the nominal pore size of a nanofiltration (nf) membrane would be increased by more than 12% when the membrane was soaked in either a caustic soda solution or a mixture of tri-sodium phosphate + sodium tri-polyphosphate in 18 h [19]."

2.7 Cleaning Methods:

Following are the methods used for cleaning the bag filters.

2.5.1 Physical cleaning
2.5.2 Chemical cleaning
2.5.3 Physicochemical cleaning
2.5.4 Biological cleaning [20]

2.7.1 Physical Cleaning:

Mechanical interaction is used to remove foulants. Physical methods are categorized as

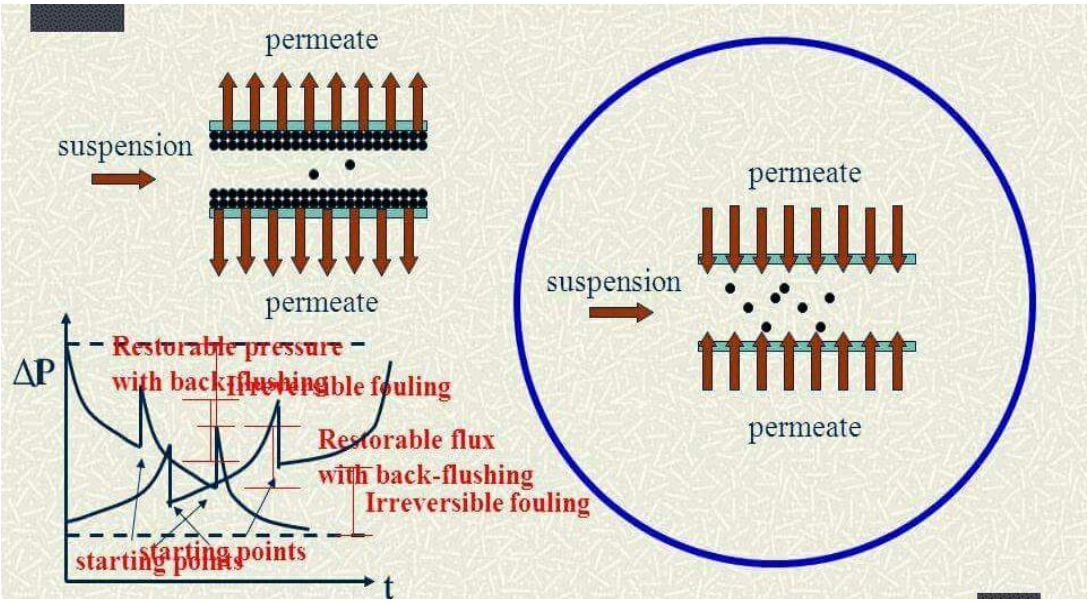
i. Periodical back flushing
ii. Vibrational method
iii. Air sparging

iv. Sponge ball cleaning

v. Ultrasonification [21]

i. Periodical back flushing:

Back pressure pushes back the water on the permeate side through membrane some membrane modules can be cleaned by this method [22].



eriodic back flashing method

ii. Vibration Method:

In this physical method mechanical energy is shifted to the pressure vessels by pneumatic hammer that generates strong vibrations to remove the fouling layers from the surface.

iii. Air Sparging Method:

Periodic bursts of air are exerted in the forward side of the permeate that are strongly favors to open the clogged pores.

iv. Sponge Ball Cleaning:

Polymeric material sponge balls acts as a scrubber that scrubbed away the scales from surface of the membrane. Tubular modules are specially cleaned by this method.

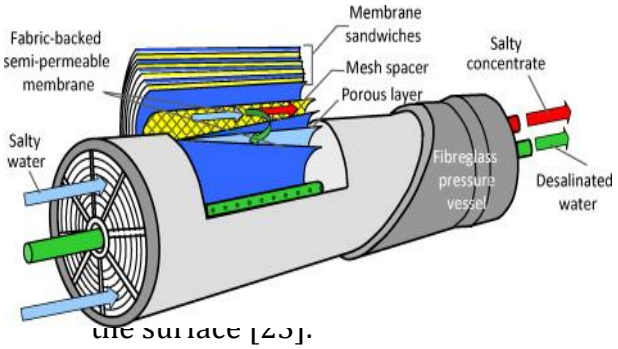
Sponge balls for membrane cleaning.

v. Ultrasonification:

In case of cross flow membrane modules, ultrasound radiations are passed which is 6 time effective than any other method.

2.7.2 Chemical Cleaning Method:

As this is discussed earlier that severe fouling has remedy in the form of chemical cleaning when physical cleaning is failed to clean



the surface [23].

2.5.3 Biological Cleaning Methods:

Some detergents have microbial activity to clean away biological fouling layer. These reagents may be enzymes & microorganisms.

2.7.4 Physicochemical Cleaning Method:

This is a double activity method having physical as well as chemical actions. This is advanced method and is typically termed as hybrid method or physicochemical method.

As a comparison physiochemical method is the most suitable as compare to all physical and chemical processes in order to run the process effectively and economically [24].

New bag filter in pressure vessels Fouled bag filter

Because in physiochemical method bag filter is clean twice once it is clean chemically and then it is clean physically by using water. During chemical cleaning the bag filter is soaked in aqueous HCl solution of different concentration so that the acid react with foulants to clean the bag filter surface. Due to chemical reaction fouling layers of foulants become nonadhesive and then it can be easily removed from the surface of bag filter. After chemical reaction to remove this nonadhesive foulants material the physical cleaning become very effective. Therefore after chemical cleaning the physical cleaning is important. During physical cleaning the water is used to clean the bag filter surface. Water is used with high pressure that is why it clean the bag filter surface efficiently. According to this discussion the physiochemical cleaning is more effective than other cleaning methods because it remove foulants layers by double action. Therefore physiochemical cleaning can be used to clean the bag filter.

CHAPTER NO. 3

EXPERIMENTAL METHODOLOGY

3.1 Experimental Methodology

- Bag filter is used for separation operation. In NBC Gujranwala the bag filter is used in RO to filter water for removing TDS. After 7 to 10 days the bag filter is replaced due to scaling.
- On 25/11/16 new bag filter was installed. Readings from 25/11/16 to onward are given below.

Date	Time	Inlet Pressure(Bar)	Outlet Pressure(Bar)	Pressure Difference(Bar)
	10:00 am	4.6	4.4	0.2
25-11-2016	06:00 pm	4.6	4.4	0.2
	02:00 am	4.6	4.4	0.2
	10:00 am	4.6	4.4	0.2
26-11-2016	06:00 pm	4.6	4.4	0.2
	02:00 am	4.6	4.4	0.2
	10:00 am	4.6	4.4	0.2
27-11-2016	06:00 pm	4.6	4.4	0.2

	02:00 am	4.6	4.4	0.2
	10:00 am	4.6	4.4	0.2
28-11-2016	06:00 pm	4.6	4.4	0.2
	02:00 am	4.6	4.4	0.2

Date	Time	Inlet Pressure(Bar)	Outlet Pressure(Bar)	Pressure Difference(Bar)
	10:00 am	4.6	4.4	0.2
29-11-2016	06:00 pm	4.7	4.3	0.4
	02:00 am	4.6	4.2	0.4
	10:00 am	4.6	4.2	0.4
30-11-2016	06:00 pm	4.6	4.2	0.4
	02:00 am	4.6	4.2	0.4
	10:00 am	4.6	4.2	0.4
01-12-2016	06:00 pm	4.6	4.2	0.4
	02:00 am	4.6	4.1	0.5

	10:00 am	**4.6**	**4.1**	**0.5**
02-12-2016	**06:00 pm**	**4.6**	**4.0**	**0.6**
	02:00 am	**4.6**	**4.0**	**0.6**
	10:00 am	**4.6**	**4.0**	**0.6**
03-12-2016	**06:00 pm**	**4.7**	**3.8**	**0.9**
	02:00 am	**4.8 (At 11:00 pm)**	**3.5**	**1.3 (Bag filter was changed at 12:00 am)**
	10:00 am	**4.6**	**4.2**	**0.2**
04-11-2016	**06:00 pm**	**4.6**	**4.2**	**0.2**
	02:00 am	**4.6**	**4.2**	**0.2**

- On 3/12/16 due to higher pressure drop as shown in above table the bag filter was changed.
- Bag filter was washed with HCl solution and with high pressure water. The process of washing and results after washing are given below.

3.2 Process of washing:

Washing of bag filter is done by aqueous HCl solution. HCl solution of various concentration is prepared by following method.

CONCENTRATION OF HCl SOLUTION:

- Concentration of HCl solution can be measured by following method.
- Take 1000 ml distilled water.
- Take 5 gram of HCl solution and mixed with 1000 ml distilled water.
- Fill this solution into burettes.
- Take 10 ml of 0.1M NaOH solution into titration flask.
- Add 2 drops of P-indicator into NaOH solution.
- And titrate it with HCl solution
- Note reading at end point and then calculate the concentration of HCl solution by following method.
- **1. Concentration of HCl**

  = Strength of HCl/wt. of HCl*100

- **2. Strength of HCl =** Molarity of HCl*mol. Wt. of HCl

Molarity of HCl:

= molarity of NaOH*Vol of NaOH/Vol of HCl

3.3 Sample # 01

Molarity of HCl = 0.1*10/19.8 = 0.05

Strength of HCl = 0.05*36.5 = 1.84

Concentration of HCl = 1.84/5*100 = 36.8%

3.4 Sample # 02

Molarity of HCl = 0.1*10/19.2 = 0.052

Strength of HCl = 0.052*36.5 = 1.90

Concentration of HCl = 1.90/5*100 = 38.02%

Avg concentration = 38.02+36.8/2 = 37.41%

Solution used for Experiment # 01

Vol of water used= 99 lit or 99000 ml

Vol of HCl sol used=1 lit or 1000ml

Density of HCl sol = 1.154

Solution used for Experiment # 01

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*1000 ml

=374.1 ml

So,

Concentration of washing sol = 374.1*100/100000

= 0.3741%

Solution used for Experiment # 02

Vol of water used= 97 lit or 97000 ml

Vol of HCl sol used= 3 lit or 3000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*3000 ml

=1122.3 ml

So,

Concentration of washing sol = 374.1*100/100000

= 1.1223%

Solution used for Experiment # 03

Vol of water used= 94 lit or 94000 ml

Vol of HCl sol used= 6 lit or 6000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*6000 ml

=2244.6 ml

So,

Concentration of washing sol = 2244.6*100/100000

= 2.244%

Solution used for Experiment # 04

Vol of water used= 91 lit or 91000 ml

Vol of HCl sol used= 9 lit or 9000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*9000 ml

=3366.9 ml

So,

Concentration of washing sol = 3366.9*100/100000

= 3.366%

Solution used for Experiment # 05

Vol of water used= 88 lit or 88000 ml

Vol of HCl sol used= 12 lit or 12000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*12000 ml

=4489.2 ml

So,

Concentration of washing sol = 4489.2*100/100000

= 4.489%

Solution used for Experiment # 06

Vol of water used= 85 lit or 85000 ml

Vol of HCl sol used= 15 lit or 15000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*15000 ml

=5611.5 ml

So,

Concentration of washing sol = 5611.5*100/100000

= 5.611%

Solution used for Experiment # 07

Vol of water used= 82 lit or 82000 ml

Vol of HCl sol used= 18 lit or 18000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*18000 ml

=6733.8 ml

So,

Concentration of washing sol = 6733.8*100/100000

= 6.733%

Solution used for Experiment # 08

Vol of water used= 79 lit or 79000 ml

Vol of HCl sol used= 21 lit or 21000ml

Concentration of HCl sol = 37.41%

Pure HCl used in HCl sol = 0.3741*21000 ml

=7856.1 ml

So, Concentration of washing sol = 7856.1*100/100000

= 7.856%

Time of washing

The bag filter was dipped in HCl solution for ten minutes in all experiments. After ten minutes bag filter take out from solution and then washed this bag filter with high pressure water, than fit this bag filter into the bag filter house and note readings for all experiments. Results of various experiments are give

Sr. #	No of beaker	Conc. of sol	Inlet P(bar)	Outlet P(bar)	ΔP (bar)	TDS at inlet	Cond at inlet	TDS at outlet	Cond at outlet
1	1	.3741	4.7	3.7	1.0	241	506	231	485
2	3	1.122	4.7	3.8	0.9	243	509	234	491
3	6	2.244	4.7	4.1	0.6	237	498	231	485
4	9	3.366	4.7	4.2	0.5	239	501	231	485
5	12	4.489	4.6	4.2	0.4	243	509	233	490
6	15	5.611	4.6	4.3	0.3	241	506	232	488
7	18	6.733	4.6	4.5	0.1	243	509	237	498
8	21	7.856	4.6	4.5	0.1	241	506	236	496

TABLE 3.1

Above results show that when 12 beakers of HCl solution is used then 5.611% HCl solution is obtain which is most suitable for washing, because above this concentration TDS at outlet are increased which show the effect on bag filter pore.

CHAPTER NO. 4

RESULTS & DISCUSSIONS

4.1 **Results and Discussions**

- The bag filter washed with HCl solution and high pressure water. Washing of bag filter is done by aqueous HCl solution. HCl solution with various composition is used as given above in chapter 03.

After washing with every concentration the dipped bag filter was taken out from solution after 10 minutes and then washed this bag filter with high pressure water, the readings of pressure drop, TDS and conductivity for all experiments by using this washed bag filter are given bellow.

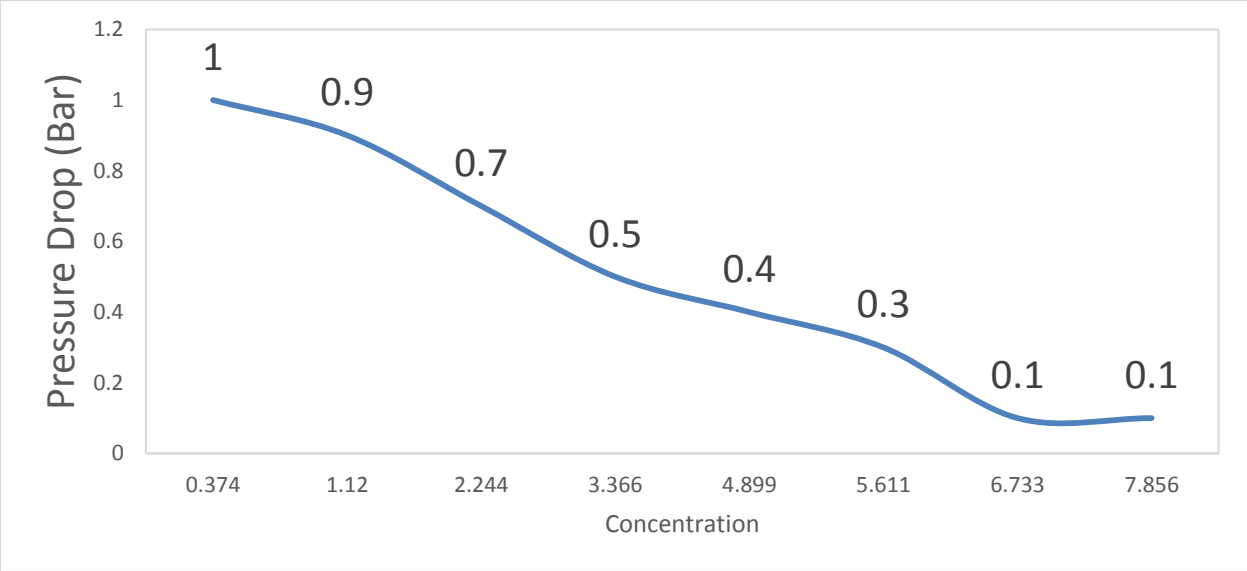
TABLE 4.1

Sr. #	No of beaker	Conc. of sol	Inlet P(bar)	Outlet P(bar)	ΔP (bar)	TDS at inlet	Cond at inlet	TDS at outlet	Cond at outlet
1	1	.3741	4.7	3.7	1.0	241	506	231	485
2	3	1.122	4.7	3.8	0.9	243	509	234	491
3	6	2.244	4.7	4.1	0.6	237	498	231	485
4	9	3.366	4.7	4.2	0.5	239	501	231	485
5	12	4.489	4.6	4.2	0.4	243	509	233	490
6	15	5.611	4.6	4.3	0.3	241	506	232	488
7	18	6.733	4.6	4.5	0.1	243	509	237	498
8	21	7.856	4.6	4.5	0.1	241	506	236	496

As the concentration of HCl solution increased the pressure drop decrease gradually with concentration. After washing the bag filter with 0.3774% concentrated solution the pressure

drop was note 1.o bar as shown in table 4.1.The graphical representation between changes in pressure drop with change in concentration is given below.

4.2 Concentration vs Pressure Drop



As shown in above graph after washing bag filter with 0.374% concentrated HCl solution the pressure drop decrease from 1.3 bar to 1.0 bar. The physical condition of bag filter found good. When 1.12% concentrated aqueous HCl solution is used then the pressure drop decrease up to 0.9 bar. Still the physical condition of bag filter is good. And when concentration increase to 2.244 the pressure drop will decrease to 0.7 bar. The physical condition of the bag filter is still good. After that up to 3.366% concentrated aqueous HCl solution was used the pressure drop was observed 0.5 bar. The physical condition of bag filter remains in good condition.

As shown in Graphical representation further increase in the concentration of HCl solution from 3.366 to 4.899. At this concentration pressure drop found 0.4 and no physical wear and tear of bag filter were observed. Further increase in concentration from 4.899 to 5.611% the pressure drop decrease up to 0.3 bar and no physical damage occur to bag filter.

After that increase the concentration form 5.611 to 6.733 the pressure drop will occur 0.1 bar at this concentration the physical wear and tear occur. The pore size of bag filter increase due to which value of TDS also increase. The increase in the value of TDS show that the pore size of bag filter increase. So form all concentration vs pressure drop I will observed that the concentration of HCl solution 5.611 is suitable.

CHAPTER NO. 5

CONCLUSIONS

5.1 **Conclusion**

In last years, desalination by reverse osmosis (RO) process has experienced a significant development, and it has become one of the major technologies for producing potable water throughout the world. Despite this relevant growth, reverse osmosis, and membrane processes in general, has several drawbacks to overcome. Specifically, fouling of filtration media (bag filters, cartidgefilters and membranes) is the most important problem in reverse osmosis. Economics of this process is highly influenced by filtration media fouling rate and effectiveness of fouling control. The main purpose of this work is the cleaning of bag filter (filtration media) in order to make this useable again. Bag filter is used in reverse osmosis process to protect membrane. They are replaced by new ones after the accumulation of scales. This work involves cleaning and enables them to reuse to be economical.

HCl solution of very low concentration can be used to remove the scales in this cleaning method. After dipping the bag filter in this solution and then washing with high pressure water it become fit to reuse by calculating pressure drop. This is not a long life method but can be adapted to reuse the bag filters 3 to 5 times. So as for as the cost is concern this will prove economical that is a vital requirement for an industry

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