Influence Of Water Soluble Polymer On Nano-Filtration Membrane For Separation Of Nickel Ion.

Praful.G.Bansod, Dinesh.S.Bhutada, Shyam M Kodape

Abstract. : In this study, Polyethylene glycol is used as a water-soluble polymer to enhance separation efficiency of heavy metal nickel ion The complexion- Nanofiltration technique was used for separation of heavy metal ions. Polyethene glycol form complex with heavy metal ion and increases the separation efficiency. The effects various parameters like pH, Concentration and flow rate on the separation efficiency of heavy metal ion were evaluated. The optimum condition for separation of heavy metal ion was found at pH 10, Concentration (heavy metal ion) 200ppm, and flow rate 3(l/hm2). It was found that the addition of water-soluble polymer gives higher separation efficiency than without water-soluble polymer PEG.

Keywords: water-soluble polymer, heavy metal, metal complex, Nickel ion, membrane, separation.

1. INTRODUCTION.

One of the most important factors of environmental pollution is industrial effluent wastewater [1], Industrial effluent wastewater containing heavy metal ion are thrown directly in the stream of water.it causes serious problem [2],It can accumulate and deposit in muscle, bone and joints, and causes various hazards diseases like cancers, lack of nutritious, fatness, abortions, respiratory, cardio disorder, damage of the liver, kidney, and brain [3]. The heavy metal ions are separated by a conventional technique like adsorption, chemical precipitation, coagulation, flocculation, floatation, ion exchange etc., but it has certain limitation like high energy requirements, incomplete removal and production of toxic sludge. [4].But, Nanofiltration technology is found more effective for separation of heavy metals [5], It operates at low pressure, high permeate flux instead of reverse osmosis[6]. Gazem Basaran et al .studied on the separation of heavy metals using nanofiltration membrane, rejection of both heavy metal chromium and nickel ions increased with increasing pH, but did not considerably change with pressure difference [7]. Amin Maher et.al.2014 investigated the effect of pH, Flow rate, and pressure on heavy metal (Ni) removal using polyamide Nanofiltration membranes [8]. Z.V.P Murthy and Latesh Choudhari 2008 studied on the application of thin-film composite polyamide membrane for rejection of Nickel ion from aqueous water and it evaluated that rejection of Ni ion increases with an increase in feed pressure and decrease with an increase in feed concentration at constant flow rate [9]. In previous research, ultrafiltration and microfiltration membranes were used for separation of heavy metal ions with complexation technique(water-soluble polymer), but it had disadvantages, like percentage separation efficiency was limited which made the processes unsuitable for separation of heavy metals ions to large volume with dilute concentration [10]. The number of water-soluble polymers can be used for separation of heavy metal, but polyethene glycol has shown good chemical stability, high efficiency and selectivity towards the separation of heavy metal ions.[11][12]

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The separation of heavy metal ions for large volume with small concentration by convention technology is not economically feasible and eco-friendly [13].In this case, the complexation Nanofiltration technique is seen to be more effective and promising for separation of heavy metal ion nickel [14][12].In order to separate heavy metal ion by complexation nanofiltration, heavy metal ions form a complex with a water-soluble polymer, thus the size of the metal ion increases in aqueous solution and it can separate with higher efficiency [15] [16].In previous research, ultrafiltration and microfiltration membrane was used for separation of heavy metal ions by complexation technique (water-soluble polymer), but it had found some limitation, like less percentage separation efficiency which made the processes unsuitable for separation of heavy metal ion to large volume with small concentration[10]. The number of water-soluble polymers is available for separation of heavy metal ions, but polyethene glycol has shown good stability, high efficiency and selectivity towards the separation of heavy metal ions (nickel)[12][11] The complexation –Nanofiltration is proved to be a new promising technique for separation of heavy metals ions for dilute concentration with large volume. The use of water-soluble (metal binding) polymer in combination with Nanofiltration is a hybrid approach to separate selectively and recover valuable elements of heavy metal. In complexation –NF process cationic of heavy metal ion form complexes with micro ligand in order to increase their molecular weight with size larger than the pore size of the selected membrane, that can be retained by the membrane, whereas permeate water is separated from heavy metal. The advantage of the complexation separation is high selectivity, low energy requirement and high separation efficiency. The water-soluble polymeric ligand has shown powerful substance to remove traces of heavy metal ions from aqueous solution and industrial wastewater by using membrane technique. In the present study, an attempt is made for application of complexation Nanofiltration technique to separate heavy metal nickel into study effect of parameters like pH, concentration, and flow rate and its optimization on the separation efficiency of heavy nickel-metal ion.

2. METHODS.

All the chemicals were used for an analytical grade. All the salt solution was prepared in distilled water. The chemicals were accurately measured on Top Load Digital Electronic Balance. Standard metal solutions of Nickel with a concentration of 1000 ppm were used. The complexation experiments were carried out with PEG as water-soluble polymer. The pH of aqueous solutions was adjusted using 1M HCL and 1 NaOH.The Nanofiltration membrane module of length 40 inches and diameter 4 inches was used for separation. The module consisted of cylindrical shell made up of stainless steel, and spirally wound membranes are installed in the shell. The membrane was made up of HPA (Hydrophilized Polyamide). The metal ion concentration of the synthetic solution and sample solutions after experimentation was examined using Chemito AAS 201(Atomic Absorption Spectrophotometer). The instrument was calibrated before every reading. The standard solutions prepared were used to calibrate AAS. The standard solutions were prepared from a stock solution of 1000ppm concentration by further dilution to 4, 6, 8 and 10 ppm for a nickel. Calibration curves of the tested metals were constructed with different concentrations.

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2.1. Metal complex preparation and separation.

Initially, 15 litres of known concentration of 50,100,150,200 ppm of nickel were prepared separately.The complex of nickel was prepared from the corresponding solution using water-soluble polymer polyethene glycol, (PEG). These metals ions and metal complexes were separated by using Nanofiltration membrane unit as shown in figure1. It consists of a feed tank (20liters capacity); the feed tank solution was passed to the membrane unit. The Nanofiltration membrane module made up of HPA (Hydrophilized polyamide), having a diameter 40 inches and length 40 inches. The module consists of a cylindrical shell made up of stainless steel and the spirally wound membrane was installed in the shell. The flow rate of feed, permeate and rejection was measured using flow meter. The operating pressure was 50-130 psi. The leak check was taken at the time of backwashing. The samples collected from permeate and rejected was measured continuously using atomic absorption spectrometry.

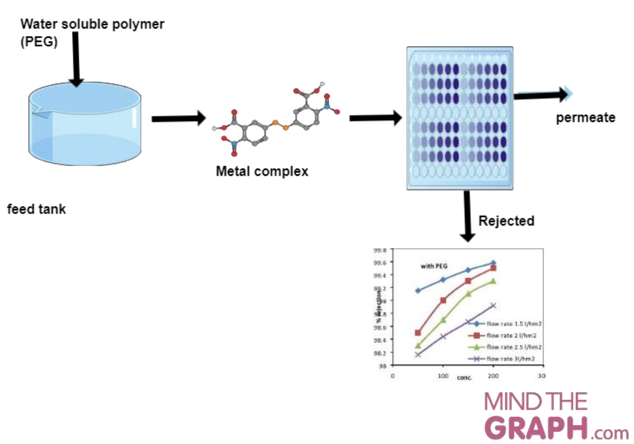

***Figure1. Schematic** diagram of the pilot plant*

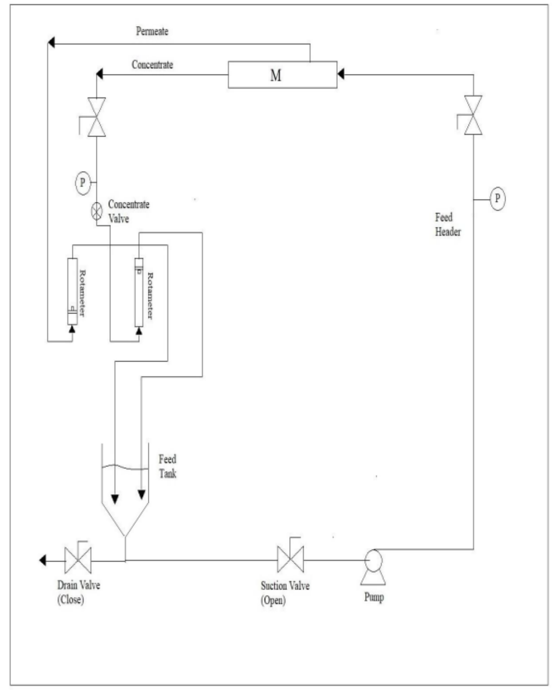

***Figure 2.** Effect of nickel ion concentration on percentage rejection of at different flow rate with out PEG.*

2.2. Characterization. The concentration of metal and metal complexes from permeate and rejection of the membrane unit was tested using AAS(Atomic absorption spectrometry)Chemito AAS,201, Atomic Absorption Spectrometry (AAS) is a technique for measuring quantities of chemical elements present in samples by measuring the absorbed radiation by the chemical elements of interest. This is done by reading the spectra produced when the sample is excited by radiation. The atoms absorb ultraviolet or visible light and make transitions to higher energy levels. It utilizes the principle that elements in the gas phase absorb light at a very specific wavelength which gives the technique excellent specificity and detection limits.

3. RESULT AND DISCUSSION.

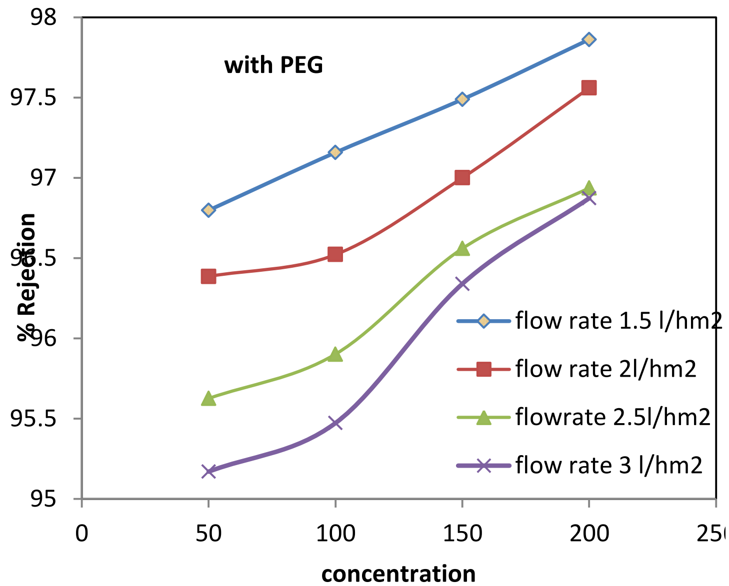

Figure 2, illustrates the percentage rejection versus nickel ion concentration at different flow rate with addition of water-soluble polymer (PEG). From figure 2, it showed that percentage rejection increased with increased in nickel ion concentration at various flow rates. It found that with an increased inflow rate, percentage rejection decreased, whereas, for lower flow rate, percentage rejection increased. At the flow rate, 1.5 l/hm2 maximum rejection obtained, whereas, for 3 l/hm2 flow rate, the lowest percentage of rejection evaluated. For all flow rate (1. 5, 2,2.5,&3 L/hm2), percentage rejection of Ni2+ ions increased with increased in Ni2+ion concentration from 50 to 200ppm, with addition of water soluble polymer PEG, the percentage rejection of Ni2+ ions increased as per the following sequence of flow rate 3,2.5,2 and 1.5 l/hm2 respectively.

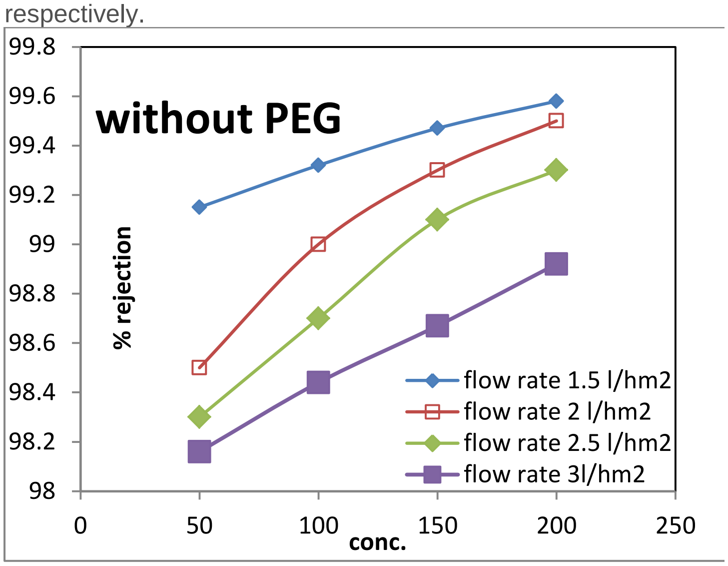

Figure 3.*Effect of concentration of nickel ion on percentage rejection at different flow rate without PEG.*

Figure 3, shows the effect of concentration of nickel ion on percentage rejection of heavy metal ion at different flow rate, without addition of water soluble polymer PEG.it shows from figure 2 and 3 that percentage rejection with addition of water soluble polymer PEG obtained higher than without addition water soluble polymer PEG.

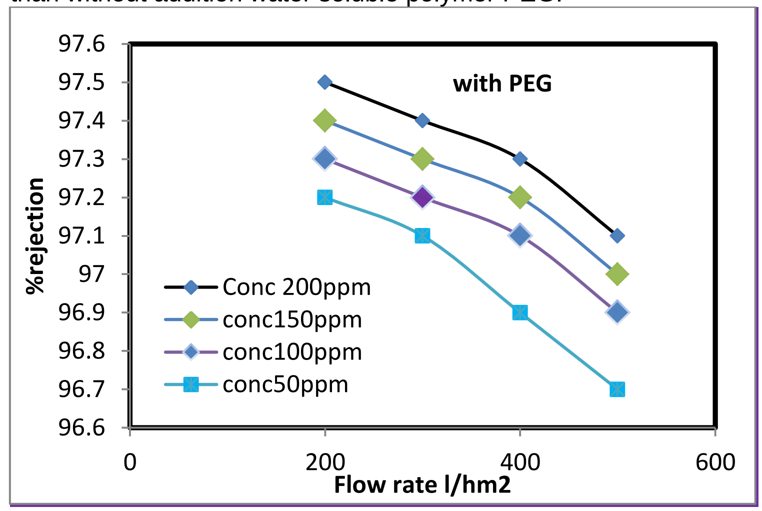

Figure 4*.Effect of flow rate on percentage rejection at different concentration with addition of water soluble polymer.*

Figure 4, shows the percentage rejection of heavy metal ion feed flow rate at various concentrations with water soluble polymer PEG, it observed that increase in feed flow rate, percentage rejection of heavy metal ion decreases, whereas, at 200 ppm concentration, maximum rejection of heavy metal ion obtained.

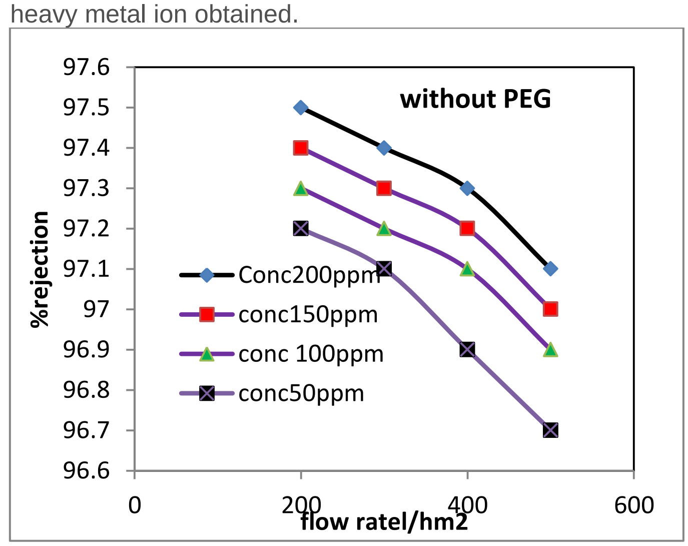

Figure 5, *Effect of flow rate on percentage rejection at various concentrations without PEG*

Figure 5, illustrates the percentage rejection of heavy metal ion versus feed flow rate at various concentrations without water-soluble polymer PEG, At feed flow rate,200,300,400,500 L/hm2 and at 200 ppm concentration, percentage rejection of Nickel-metal ion without water-soluble polymer was found higher than without water soluble polymer. It was found that with water-soluble polymer PEG, percentage rejection for heavy metal ion was found 2 to 2.5 per cent more than without the addition of water-soluble polymer PEG, it was due to the fact that water-soluble polymer formed complexes with heavy metal ions, larger the concentration of heavy metal ions, it formed more a complex with water-soluble polymer PEG, and thus, percentage rejection of heavy metals ion was increased with increase in concentration. Figure 6, shows, percentage rejection of heavy metal ion (Ni2+) with different pH at a constant feed concentration of heavy metals ion (150 ppm) without PEG. The percentage rejection of heavy metal ion increased with increase in pH. The maximum percentage rejection of heavy metal ion Ni2+ was obtained at 10 pH.

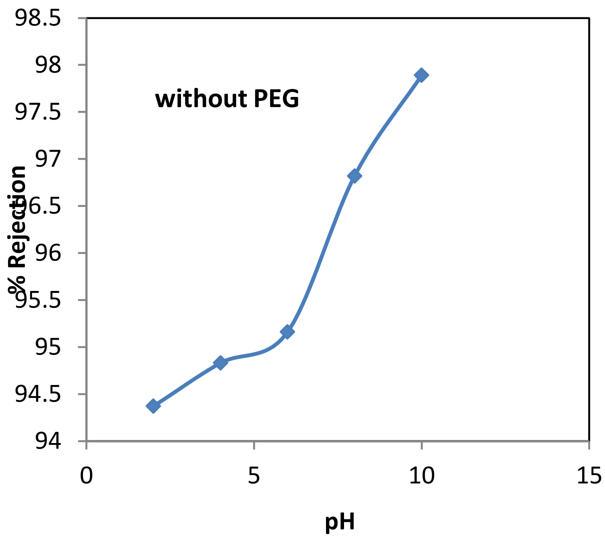

Figure 6.*Relation between percentage rejections of heavy metal ion Ni2+ with variation in pH value without PEG.*

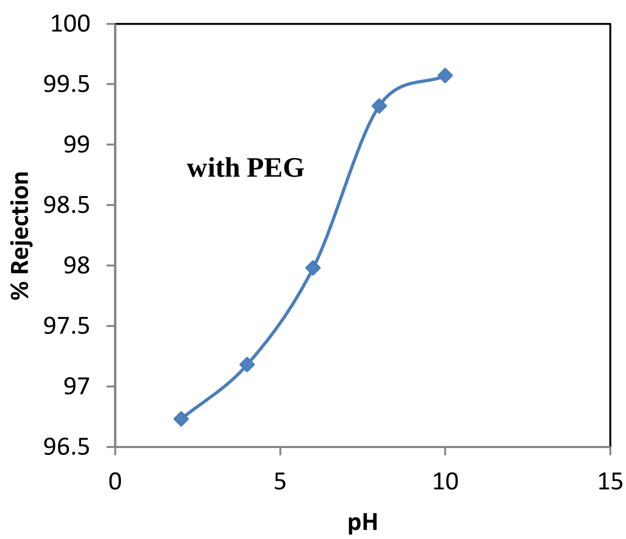

Figure7.*Relation between percentage % rejections of heavy metal ion Ni2+ and pH value with PEG.*

Figure 7, shown the percentage rejection of heavy metals ion with respect to various pH of feed solution at constant feed concentration (150ppm), with the addition of water-soluble polymer PEG.it found that percentage rejection of heavy metal ion increased with addition of water-soluble polymer PEG. The percentage rejection of heavy metal ion was found higher with addition water soluble polymer PEG. it was observed that with the addition of water-soluble polymer (PEG),percentage rejection of heavy metals ion increased with increase in pH of feed solution at 150ppm concentration. It was due to the fact that metal ion rejection increased with increase in pH value, and reaching maximum rejection at pH 10. It shows that the stability of complex formation is pH-dependent. At low pH, affinity of PEG towards metal is weak, due to the presence of positive charges and hence stability is low, As pH increased, affinity and stability towards metal complex formation with PEG increases [17] and thus the addition of PEG(water-soluble polymer) increases, percentage rejection of heavy metal ions. The previously, it resulted that at low pH value, percentage rejection decrease and at low pH values almost no metal ions form complex. This indicates the possibility of a recovery process for reuse of polymeric agent by readjusting pH. [12]

4. CONCLUSION.

The heavy metal Complexation with water-soluble polymer via nanofiltration is a suitable technique for removal of heavy metal nickel ion. Water-soluble polymer PEG showed better performance for removal of heavy metal nickel ions. The nickel ion concentration, flow rate, and pH were found an effective parameter to control the percentage rejection of heavy metal nickel ions. At pH 10, and at 200ppm concentration, and at 1.5(L/hm2) flow rate highest percentage rejection of heavy metal ion Ni2+ was obtained. The result indicates that with the addition of PEG gave higher rejection of heavy metal ion.

5. REFERENCES

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Patents.
1] Patent 1-
Title of the invention- Portable three layer water purification bottle
Patent application number-201721023788A
Publication date-21/7/2017
2] Patent-2
Title of invention-water purification membrane cleaner
Application no.201821011963
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