

PREVENTION OF MEMBRANE FOULING USING ELECTRIC PULSE IN DEAD END MICROFILTRATION OF TITANIUM SUSPENSIONS

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Abstract. Electric pulse is an effective means of removing particulate materials from polymeric membrane and preventing the membrane fouling. The experimental results for dead end microfiltration of titanium suspension to prevent membrane fouling using electric pulses are presented. The effect of processing variables such as the pulse interval, pulse duration, pH of the solution, ionic strength of the electrolyte and the strength of the applied voltage for dead end microfiltration of titanium suspensions were studied on the performance and effectiveness of this prevention of membrane fouling. The flux was significantly increased by both electrophoretic motion of particles away from the membrane surface and electroosmosis occurring in the filtercake. The results were analyzed for its average flux, average cake concentration, average percentage recovery of cake and average percentage recovery of water. It is found that the physical and chemical properties of the solution (pH and ionic strength of the electrolyte) have a great effect on this membrane fouling prevention method. Titanium suspension at pH 8 and ionic strength of 0.01M electrolyte strength gave the best membrane cleaning performance. Shorter pulse interval with 10 seconds pulse duration with 100V applied voltage were the optimum conditions to remove the filtercake from the membrane surface.

Key words: membrane separation, microfiltration, membrane fouling, electric pulses, titanium dioxide

Abstrak: Denyutan elektrik merupakan salah satu kaedah yang berkesan untuk menyingkirkan bahan-bahan endapan pada permukaan membrane polimerik dan mampu mencegah permukaan daripada tersumbat. Hasil-hasil dapatan ujikaji pencegahan permukaan membran dari tersumbat menggunakan denyutan elektrik bagi proses penurasan mikroampaian titanium dibentangkan. Kesan beberapa pembolehubah proses seperti selang masa antara denyutan elektrik, jangkamasa sesuatu denyutan elektrik, pH larutan, kekuatan ionik bagi elektrolit dan kekuatan voltan sesuatu denyutan elektrik telah dikaji dari segi prestasi dan keberkesanannya dalam mencegah membran dari tersumbat. Didapati bahawa fluks meningkat secara ketara dengan adanya pergerakan elektroforetik butiran bahan endapan menjauhi permukaan membran dan berlakunya proses elektroosmosis didalam bahan endapan itu sendiri. Keputusan-Keputusan telah dianalisa dari segi purata fluks, purata kepekatan bahan endapan, puratus purata perolehan semula bahan endapan dan puratus perolehan semula air. Didapati bahawa sifat fizikal dan kimia larutan (pH dan kekuatan ionik elektrolit) memberi kesan yang besar ke atas kaedah pencegahan permukaan membran dari tersumbat ini. Ampaian titanium pada pH 8 dan dengan kekuatan ionik elektrolit 0.01M memberi prestasi terbaik dalam pembersihan permukaan membran. Selang masa antara dua denyutan yang singkat dan jangkamasa 10 saat sesuatu denyutan dengan kekuatan voltan 100V merupakan

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keadaan optimum bagi denyutan elektrik untuk menyingkirkan bahan-bahan endapan dari permukaan membran menggunakan denyutan elektrik.

Kata kunci: pemisahan membran, penurasan mikro, membran tersumbat, denyutan elektrik, titanium dioksida.

1.0 INTRODUCTION

Microfiltration membrane is a means for separating particles in the size range of 10 μm – 0.1 μm . This process has become increasingly important in recent years in such widely diversified field as biotechnology, pharmaceutical, mineral, food and wastewater treatment processes. One of the main disadvantages of this process is the declining of flux with time due to the growth of the cake on the membrane surface. The flux of permeate can be kept only if little or no cake is allowed to form on the membrane surface. In order to prevent deposition of cake completely it would be necessary to eliminate all molecular or particulate components from the region immediately adjacent to the membrane surface [1].

Membrane fouling and filtercake formation may be limited in a number of ways. Suitable methods include feed pretreatment such as pH and ionic strength adjustment, choice of membrane materials, selection of membrane configuration and control of membrane hydrodynamics [1–2]. The use of electric fields in preventing the membrane fouling and filtercake formation has been studied by a number of researchers. Many have attempted to use electric fields continuously (conventional electrofiltration) to prevent the membrane fouling and filter cake formation [3–10]. It has been shown that by applying the electric fields, the deposit on the membrane surface can be reduced effectively. It utilizes the inherent surface charge of dispersed materials when brought into contact with a polar (*e.g.* aqueous) solvent such as water that arises from a combination of mechanisms including ion dissociation, ion adsorption or ion dissolution.

The electrochemical properties of the membrane surface and the dispersed materials or solute can have a significant influence on the nature and magnitude of the interaction between the membrane and the substances being processed and their separation characteristics [11]. The utilization of such properties by the application of the external electric fields can potentially give substantial improvement on the performance of separation. In particular, such process makes use of two electrokinetics phenomena. The first phenomenon is electrophoretic which is the transport of charged surface relative to a stationary liquid by an electric field. An example of this includes the movement of ions or particles between electrodes, which occurs when an electric field is imposed on a dispersed system (ion or particles).

The second electrokinetics phenomenon is electroosmosis which is the transport of the liquid relative to an immobile charged surface by electric fields. An example of this category is the movement of an electrolytes solution relative to a membrane pore or filter cake under the influence of potential gradient [12].

Both electrokinetic and electroosmosis are similar phenomena. The only distinction between them is on the frame of reference either solid or liquid. The magnitude of both phenomena depends on the applied electric field gradient and the zeta potential (electric potential at the particle's shear plane between the mobile and immobile parts of the double layer).

The use of continuous electric fields has proven very effective in both reducing concentration polarization and deposition of filtercake on the membrane surface but it has several disadvantages. These include the limitation to process streams of relatively low conductivity, a high energy requirement, substantial heat production and changes in the feed process due to the reactions in at the electrodes. The latter may only be avoided by the use of modules of relatively complex construction in which the process feed is protected from the electrodes by additional membranes. The possible establishment of electrically enhanced membrane process as acceptable unit operation will also require the minimization of energy used and heat production. The latter is especially important in the processing of biological materials due to instability of this type of material to temperature.

For this reason, attention has been directed to the use of pulsed electric fields for cross flow filtration [13–16]. This process has the same mechanism of work in preventing fouling as conventional electrofiltration. The distinction is that the application of electric field is at certain intervals, which can be adjusted to the process need. In some cases, the process can be enhanced further to produce flux that is higher than that obtained from the conventional electrofiltration [7]. By applying the electric pulse on dead-end filtration, it has been reported that the rate of fouling was reduced [10, 16–19]. The advantages of dead-end filtration process over the cross-flow filtration are higher average percentage of water recovery and filter cake concentration.

For effective membrane fouling prevention using electric pulse, the applied voltage must be higher than the critical voltage required to push particles or molecules away from the membrane surface [20–21]. Chemical and physical properties of the solute such as the ionic strength of the electrolyte, solute concentration and the pH of the solution [11, 20] and the properties of each electric pulse such as the pulse interval and pulse duration [15, 18–19, 22] can also affect the performance of this membrane fouling prevention method. A force balance model has been developed for both cross flow filtration [14] and for the dead end filtration [21] in the process of preventing membrane fouling using electric pulses. Both models showed a linear relationship between the magnitude of applied voltage and the electrophoretic mobility of the solute or particle with the electrophoretic force; the backward force to push the solute or particle away from the membrane surface under the influence of the electric fields.

In the present work, dead end microfiltration of titanium dioxide as the test system was used to investigate the effectiveness of membrane fouling prevention using

electric pulse. In order to give more efficient and accurate representation of experimental results, an automated test rig equipped with data acquisition system was designed, developed and constructed to enable direct collection of reliable and reproducible data over a wide range of conditions. Effects of the following processing variables were investigated on the membrane cleaning method for dead end microfiltration of titanium suspensions. The selected processing variables were:

- (a) Variation of the application of the pulse interval
- (b) Variation of the pulse duration
- (c) Variation of the pH of the feed
- (d) The variation of ionic strength of the electrolyte
- (e) Variation of the electric field strength (voltage)

2.0 ANALYSIS AND CALCULATION OF DATA

In analyzing the data, 4 parameters of results are considered:-

- (a) Average filtration rate
- (b) Average percentage cake recovery
- (c) Average percentage water recovery
- (d) Average cake concentration

Average filtration rate is calculated as follows:-

$$\frac{\text{Total permeate volume collected (L)}}{[\text{Active membrane area (m}^2\text{)}][\text{Total time taken (h)}]} \quad (1)$$

Average percentage cake recovery is calculated as follows:-

$$\frac{(\text{Weight of particle collected})}{c_f \cdot V_f + c_c \cdot V_c} \times 100 \quad (2)$$

Where c_f is the feed concentration (g/L), V_f is the filtrate volume (L), V_c is the volume of liquid collected with the cake (L).

In calculating average percentage cake recovery, it was assumed that the volume of particles in the cake was very small compared to the total volume of the slurry collected on discharge of the cake.

Average percentage water recovery is calculated as follows:-

$$\frac{\text{Volume of filtrate}}{\text{Volume of filtrate} + \text{Volume of retentate (discharge with cake)}} \times 100 \quad (3)$$

Average cake concentration is the average concentration in the cake determined using spectrophotometer.

3.0 MATERIALS AND METHODS

Figure 1 shows the schematic diagram of the experimental set-up. In this work, the filtration rate, the pressure, the temperature and the pH were monitored and recorded online. The electric pulse was applied at certain intervals and duration. The filter cake was released immediately upon completion of pulse application by opening the valve at the bottom of the filtration module.

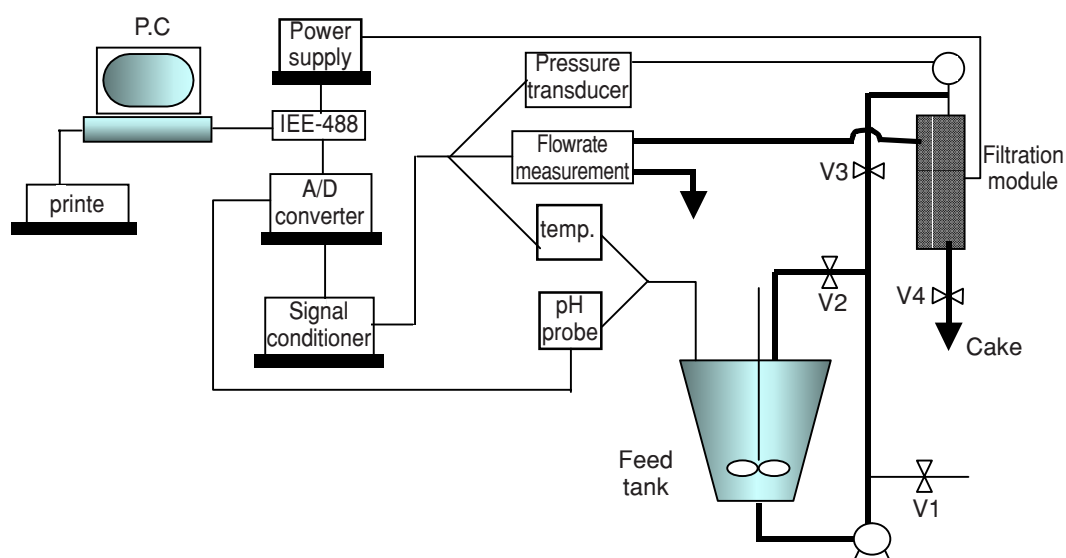


Figure 1 Schematic diagram of the flow of microfiltration process

A PC was connected to the system to collect data, control and adjust operational parameters using software called “GW-Basic computer programme”. The PC was connected to devices such as temperature probe, pressure transducer probe, level sensors and solenoid valves via the General Purpose Interface Bus (GPIB). The other main components were an A/D converter (to convert analog signals into digital signals readable to PC), signal conditioner, membrane module, feed reservoirs, pressurized gas (nitrogen free oxygen), pH meter, pressure transducer, temperature probe, balance, and nylon tubes (to complete the flow of feed to membrane module via the ‘serkit’ reinforced Nylon 66 tube fitting).

The filtration module was divided into two sections called the feed chamber and the permeate chamber, respectively. Both sections were fastened together using bolts and silicon rubber gasket. The overall dimensions of the process feed chamber were 11.2 cm × 3.4 cm × 0.2 cm with an effective working area of membrane equals

23 cm². The membrane was held on a stainless steel support and mesh. Both support and mesh form the cathode. Electrical contact was provided to the electrode through a stainless steel rod inserted through the wall of the permeate chamber and connected to the negative pole of the power source. In the feed chamber a flat sheet (platinised titanium) was used to serve as anode.

A DowDanmark flat sheet membrane with a nominal pore size of 0.2 mm was selected for the dead-end microfiltration process. A ¾ inch, 3.0L pressurized vessel made from reinforced polypropylene which can withstand pressure up to 833 kNm⁻² and temperature of 52°C was used as the feed tank. The feed was made from titanium dioxide of technical grade (B.D.H). Potassium Nitrate is used as the electrolyte where TiO₂ is dispersed in 0.01M KNO₃ except for the variation of ionic strength of the electrolyte. The concentration of TiO₂ was selected to be 1 g/L and pH maintained at 8 for most experiments except for the variation of feed pH and feed concentration.

The objective of the present work was to study the effectiveness in the prevention of membrane fouling using electric pulse for dead-end microfiltration process. Similar work but using cross-flow filtration has proven that electric pulse was a very effective mean in cleaning the membrane [8–9, 13, 15]. The advantages of the present work using dead-end filtration process over the cross-flow filtration are higher average percentage of water recovery and filter cake concentration while operating the process at acceptable permeation rate. Higher filter cake concentration refers to the filter cake collected on the membrane surface at the end of the process. Higher average water recovery is extremely important especially in a process where water becomes the final or desired product. On the other hand, higher recovery of dispersed particle from dilute slurry is desirable in a process where the amount of the particle becomes the final product. The main focus of this work is to study the effect of operating conditions such as pulse interval, pulse duration, pH of feed, ionic strength of the electrolyte and electric field strength on the effectiveness of this prevention of fouling technique.

4.0 RESULTS AND DISCUSSION

The average flux for normal filtration (without any application of electric pulse) for 1 g/l TiO₂ dispersed in 0.01M KNO₃ at pH 8 is found to be 175 L/m²h. As shown clearly from Figure 2 (graph a), the average flux drops was observed continuously with time as the TiO₂ particles form a filtercake continuously on the membrane surface throughout the filtration process. Figure 2 (graph b) shows how the average flux varies with time for 1 g/l TiO₂ at pH 8 disperse in 0.01M KNO₃ with membrane fouling prevention using electric pulse. For that particular graph, 100V electric strength (applied voltage) with 10 seconds pulse duration is applied for every 40 minutes interval. It is clearly shown that the average flux increases immediately after every

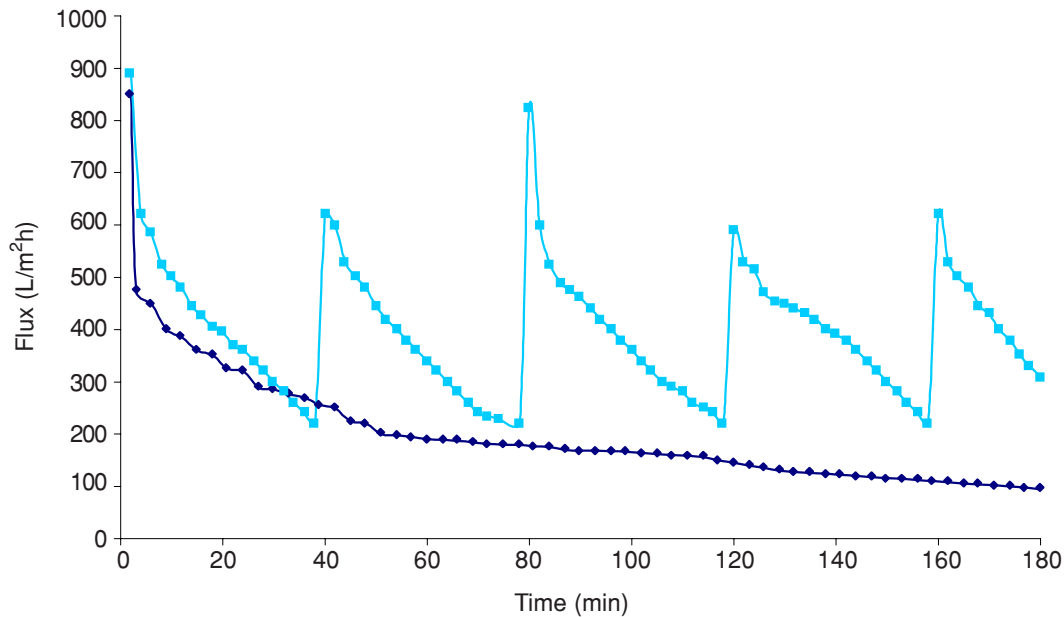


Figure 2 Flux vs time for microfiltration process (a) normal filtration, (b) 10s pulses and 40 mins intervals of 1 g/L TiO_2 at pH 8, 0.01M KNO_3 and 100V

40 minutes interval of application of the pulses. This shows that the electric pulse is an effective means to remove TiO_2 from the membrane surface and preventing membrane fouling. For other pulse intervals and pulse duration, it also shows the same trend. The following discussions will study the effect of various processing variables on the effectiveness of this membrane fouling prevention.

4.1 Effect of Pulse Interval

Application of pulses was varied from 5 to 60 minutes interval for feed 1 g/L TiO_2 in 0.001M KNO_3 at pH 8 using 10 seconds pulse duration with a potential of 100 V. Figure 3 shows the effect of pulse interval on average flux and average cake concentration. As the pulse intervals increase from 5 to 60 minutes, the average flux decreases from 482.3 $\text{L/m}^2\text{h}$ to 294.8 $\text{L/m}^2\text{h}$ respectively. Obviously at shorter pulse interval, the TiO_2 particles accumulated on the membrane surface are removed more often. In other words, the shorter the interval, the faster the interval to clean the filtercake on the membrane surface. This causes the average flux to increase as the pulse interval was decreased. Figure 3 also shows the effect of pulse interval on the average cake concentration. It shows that as the pulse interval increase from 5 to 60 minutes, the average cake concentration increases from 4.44 g/L to 16.20 g/L. At longer pulse interval, more TiO_2 particles are deposited on the membrane surface before any collection of filtercake after application of electric pulses. For every dis-

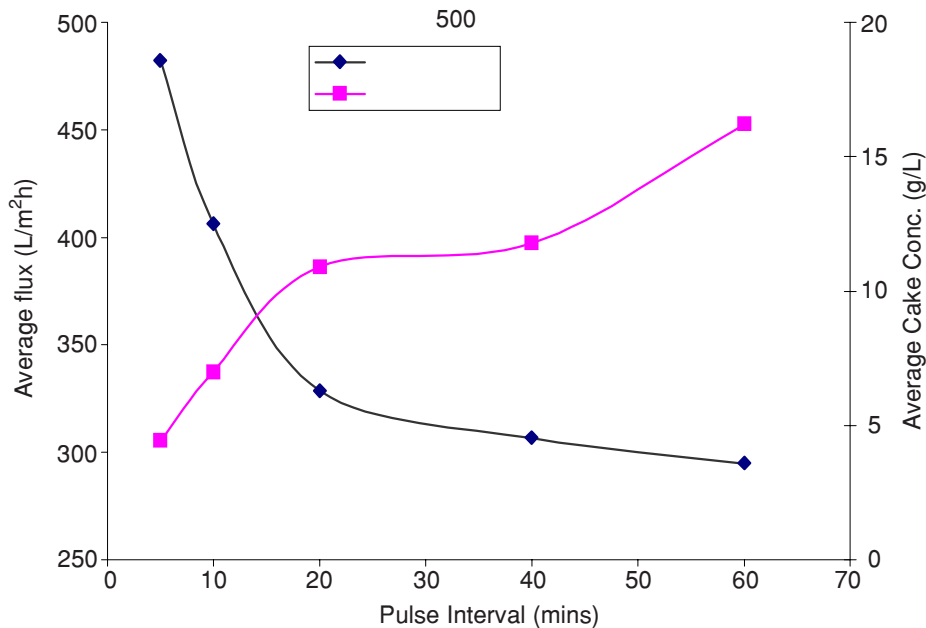


Figure 3 Effect of pulse interval on average flux and average cake concentration for 1 g/L TiO₂ in 0.01M KNO₃ at pH 8 using 10s pulse duration with potential 100V

charge of filtercake at every pulse interval, the retentate volume is essentially the same since the withdrawal of this retentate is controlled automatically at the same period of withdrawal and under the same running pressure difference. The average cake concentration is dependent on the volume of retentate as shown by equation (2). Relatively at longer pulse interval, the total TiO₂ particles accumulated on the membrane surface is more compared to the shorter pulse interval. As a result, the average cake concentration increases as the pulse interval increase, as shown in Figure 3.

Effect of pulse interval on average percentage of cake recovery and average percentage of water recovery is summarized in Figure 4. As the pulse interval increases from 5 to 60 minutes, the average % of cake recovery reduces from 102% to 80% whereas the corresponding average % of water recovery increases from 77% to 96%. At 5 minutes intervals, the average % of cake recovery is more than 100% due to the error arising in the accuracy of the experimental used in carrying out those measurements.

It is easier to sweep all TiO₂ particles with shorter pulse interval compared to the longer pulse interval. This due to the fact that relatively less TiO₂ particle accumulated on the membrane surface before any membrane cleaning takes place relative to longer interval.

The results show an opposite trend for the average % of water recovery. It values increases as the pulse interval increases. As show by Equation (3), the average per-

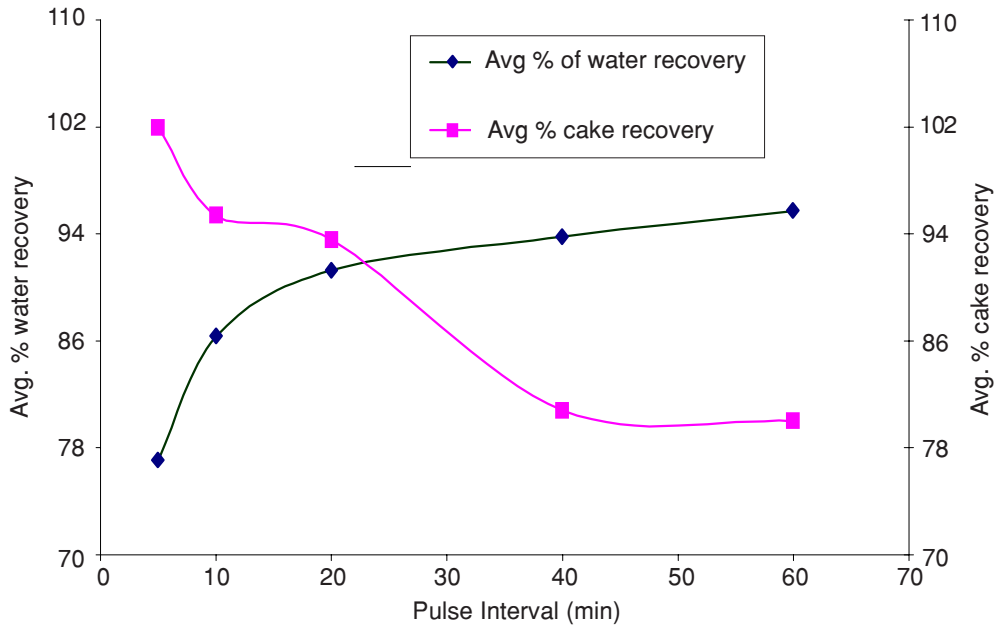


Figure 4 Effect of pulse interval on average % water recovery and average % cake recovery for 1 g/l TiO₂ in 0.01M KNO₃ at pH 8 using 10s pulse duration with potential 100V

centage of water recovery depends on the total volume of retentate (discharged with cake) collected. At longer pulse interval, less discharge of the filtercake hence less total volume of retentate discharge with the cake. This results an increase of average percentage of water recovery as the pulse interval increases from 5 to 60 minutes.

4.2 Effect of Pulse Duration

Figure 5 and Figure 6 shows the effect of pulse duration. The pulse duration is varied from 5 seconds to 40 seconds for a feed of 1 g/L TiO₂ at pH 8 in 0.01M KNO₃ using 20 minutes pulse interval of potential 100 V.

As the pulse duration increases from 5 seconds to 40 seconds, the average flux increases from 321 L/m²h to 386 L/m²h. For longer pulse duration, more TiO₂ particles are removed from the membrane surface, even the inner layer of the cake nearest to the membrane surface may be removed, which result in a higher average flux. Except at 5 seconds pulse duration, the rest (10s, 20s and 40s), the average percentage of water recovery and the average percentage of cake recovery are relatively close to each other. At 5 seconds pulse duration in particular only 65.2% of cake is recovered whereas for larger duration (10s, 20s and 40s) the average percentage of cake recovery are in the range of 93% to 97% been achieved. Five seconds pulse duration may not be long enough to remove most of TiO₂ particles deposited on membrane surface especially the inner layer of the cake nearest to the membrane

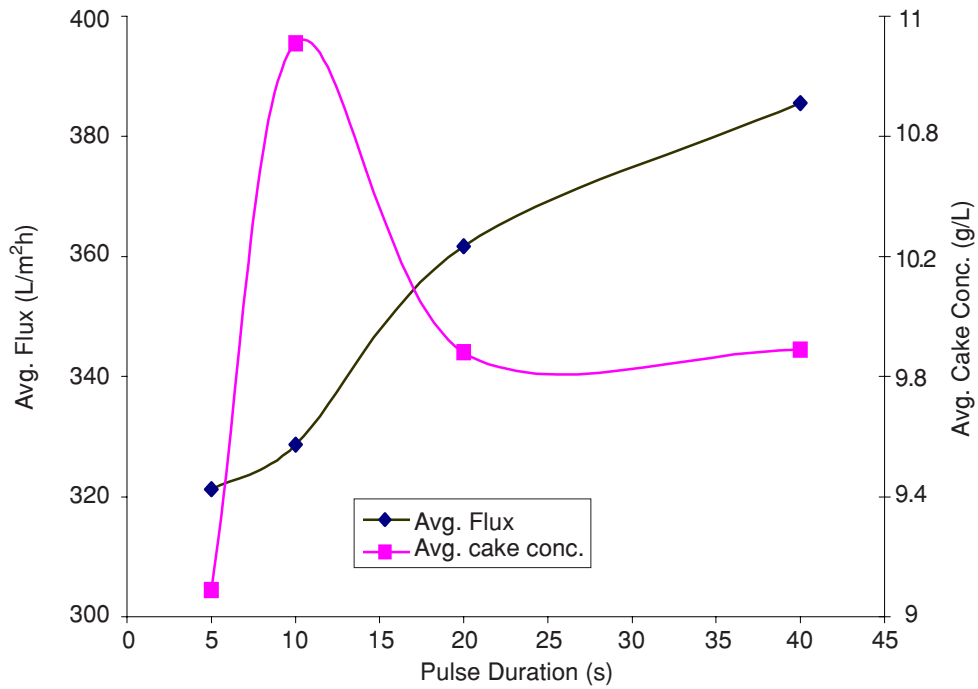


Figure 5 Effect of pulse duration on average flux and average cake concentration for 1 g/L TiO₂ in 0.01M KNO₃ at pH 8 using 20 mins pulse interval with potential 100V

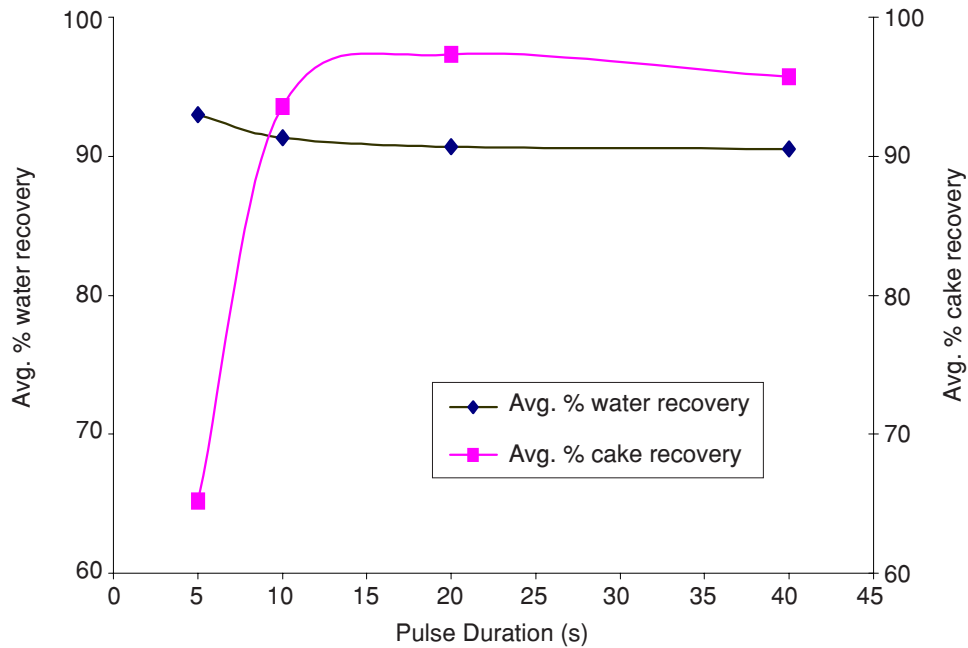


Figure 6 Effect of pulse duration on average % water recovery and average % cake recovery for 1 g/L TiO₂ in 0.01M KNO₃ at pH 8 using 20 mins pulse interval with potential 100V

surface. Effect of adsorption of TiO_2 particles onto the membrane surface need to be considered and for microfiltration membrane, the membrane surface is rough on the micron scale [14]. Hence, the release of the particles from the membrane surface may be hindered by the surface roughness (a particle might be trapped in rough 'pocket' on the membrane surface). Therefore, longer pulse duration would be required to remove these trapped particles from the membrane surface.

4.3 Effect of pH

The effect of pH of the feed is studied for 1 g/L TiO_2 in 0.01M KNO_3 using 10 minutes pulse intervals and 10 seconds pulse duration with potential of 100V. Three different pH were chosen which are 4, 6, and 8. Results are summarized in Figure 7 and Figure 8. These figures clearly show that as the pH increased from 4 to 8 the followings are observed.

- (1) Decrease in average flux (from 706 to 406 $\text{L/m}^2\text{h}$)
- (2) A little variation on average cake concentration (between 7.67 to 8.44 g/L)
- (3) Increase in average % of cake recovery.
- (4) Decrease in average % of water recovery.

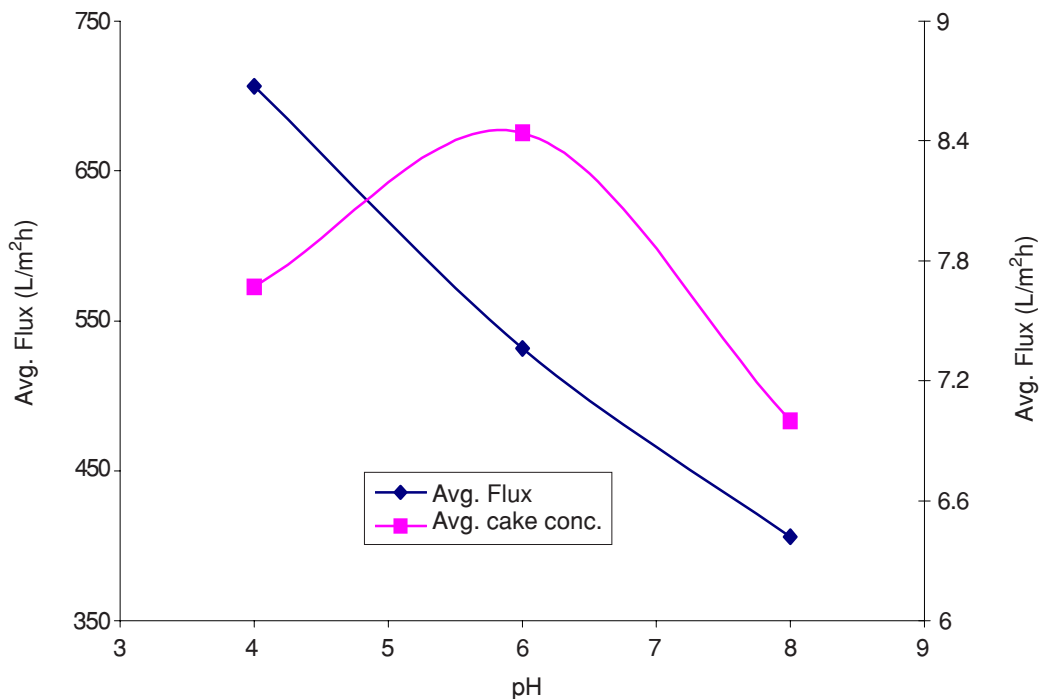


Figure 7 Effect of pH on average flux and average cake concentration

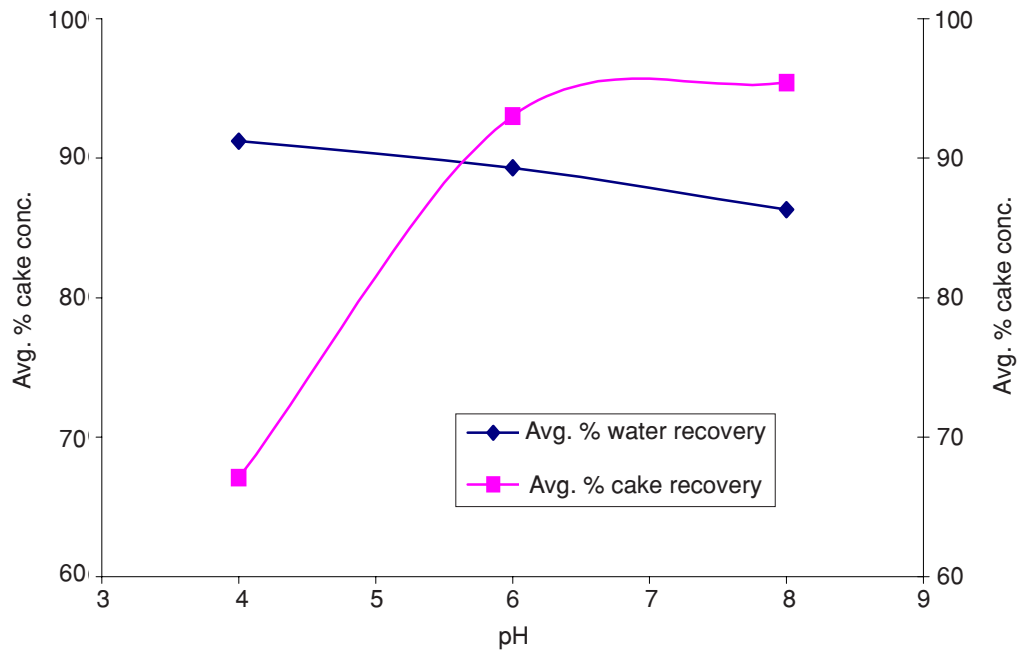


Figure 8 Effect of pH on average % water recovery and average % cake recovery

The properties of the TiO_2 particles, which will vary with pH values of 4, 6 and 8 are the particle size and the electrophoretic mobility of the particle. Table 1 shows some degree of flocculation as pH is decreased. As pH decreases from 8 to 4, the particles size increase from 153 nm to 195 nm. Since the degree of flocculation increases as pH decreased, the packing of TiO_2 particles in the filtercake needs to be considered. Larger size particle will produce a TiO_2 filtercake of higher hydraulic permeability. This is one of the most important reasons why at lower pH where the degree of flocculation is higher, the average flux is higher ($706 \text{ L/m}^2\text{h}$) compared to at pH 6 ($532 \text{ L/m}^2\text{h}$) and at pH 8 ($406 \text{ L/m}^2\text{h}$).

Our previous work [21] shows that the current membrane cleaning method makes use of the TiO_2 surface charge, resulting in the movement of TiO_2 away from the membrane at a rate that depends on their electrophoretic mobility. Table 1 also shows the electrophoretic mobility of TiO_2 particles dispersed in 0.01M KNO_3 at pH 4,6 and 8. The magnitude of electrophoretic mobility decreases as the pH decreased. Hence, it is expected that the average percentage of cake recovery would

Table 1 Effect of pH on the properties of TiO_2 at 0.01M Ionic Strength

pH	Particle Size (nm)	Mobility $10^{-8} \text{ m}^2/\text{sV}$
4	195	-1.51
6	166	-3.96
8	153	-3.79

decrease as the pH decrease (as the electrophoretic transport rate of TiO_2 particles is decreased).

The average percentage of water recovery only changes slightly from 86% to 91% as the pH decreases from pH 8 to 4. This is because the percentage of water recovery is more depending on the volume of the retentate and volume of the filtrate as shown by equation (3). The volume of TiO_2 particle is negligible compared to the water volume in retentate. Though TiO_2 particles are released more at higher pH (higher percentage cake recovery at pH 8), its volume is not significant compared to the water volume. Keeping the pulse interval and pulse duration constant (20 units and 10 seconds respectively) the volume of the cake collected would be essentially equivalent for every pH value. Hence the average percentage of water recovery should not change very much.

4.4 Effect of Ionic Strength

The Effect of ionic strength on the results is summarized in Figure 9 and Figure 10. Both figures show that the optimum conditions is found with electrolyte strength of 0.01M. At this particular electrolyte strength, the average flux is 482 $\text{L/m}^2\text{h}$. The average percentage of cake recovery and the average percentage of water recovery are 102% and 77% respectively.

For ionic strength of 0.1, 0.001 and 0.0001M, both the average percentage cake recovery and the average percentage of water recovery are relatively lower. Even

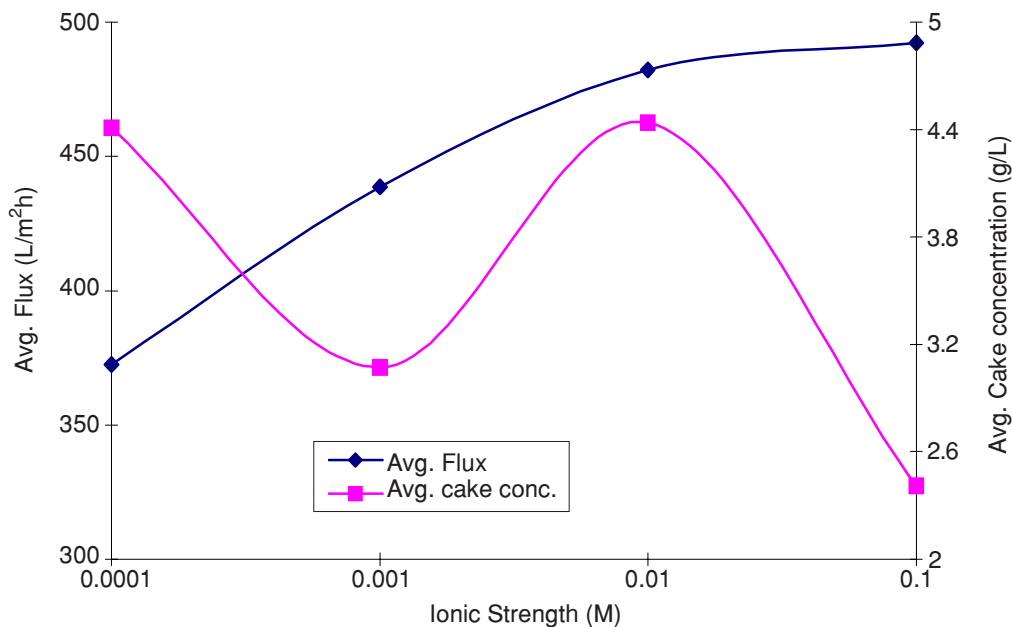


Figure 9 Effect of ionic strength on average flux and average cake concentration

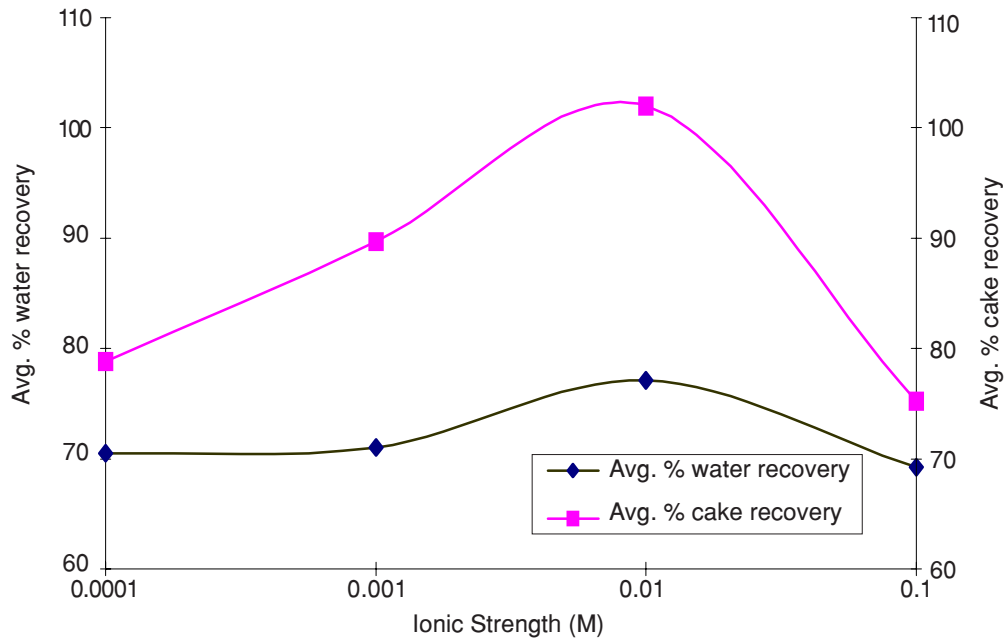


Figure 10 Effect of ionic strength on average % water recovery and average % cake recovery

though the average flux at ionic strength of 0.1M is quite high at 492.2 L/m²h (higher than at 0.01M), its average percentage of cake recovery is only 75.2% compared to 102% for ionic strength of 0.01M. These phenomena can be explained by analyzing the physical and chemical properties of TiO₂ particles dispersed with those 4 different ionic strength of electrolyte.

Table 2 shows the effect of ionic strength at pH 8 for particle size and electrophoretic mobility of TiO₂ particles. It shows that at ionic strength 0.1M, the particle size is at its greatest value. The diameter of TiO₂ particle at 0.1M is found to be 398 nm compared to 153 nm at 0.01M and 143 nm at both 0.001M and 0.0001M. Hence, the degree of flocculation is higher at 0.1M. This will produce looser packing of filtercake with higher hydraulic permeability and lower resistance to flow which gives relatively higher average flux compared to other electrolyte strengths. Prevention of membrane fouling using electric field is very much depending on the electrophoretic mobility of the particle [8]. Table 2 also shows that the magnitude of elec-

Table 2 Effect of Ionic Strength on the properties of TiO₂ at pH

pH	Particle Size (nm)	Mobility 10 ⁻⁸ m ² /sV
0.1	398	-2.70
0.01	153	-3.79
0.001	143	-3.64
0.0001	143	-3.26

trophoretic mobility is relatively lower at ionic strength of 0.1M ($-2.70 \times 10^{-8} \text{ m}^2/\text{sV}$) and 0.0001M ($-3.60 \times 10^{-8} \text{ m}^2/\text{sV}$). This could be one of the factors why their average percentage of cake recovery at these two applied ionic strengths are also lower which are 75.2% and 78.8% respectively.

4.5 Effect of Applied Voltage Strength

Figure 11 shows the effect of applied voltage strength on average flux and average cake filtration, whereas Figure 12 shows its effect on average percentage of cake and water recovery. Generally as the applied voltage strength increases from 12.5V to 100 V, all the results; average flux, average cake concentration, average percentage cake recovery and average percentage water recovery are also increased. From the analysis of force balance model of similar work [21] it shows that the magnitude of electrophoretic force which is the main driving force to push away the TiO_2 from the membrane surface under the influence of electric field will increase with increasing the applied voltage strength from 12 V to 100 V.

Figure 12 shows that there is a big increment of average percentage cake recovery when the applied voltage strength is increased from 12.5 V to 25 V (from 19.8% to 52.4% recovery of cake). The results also indicates that at least 25 V should be applied to start the membrane fouling prevention process effectively. This behavior can be concluded that for effective membrane cleaning method using any form of electric field such as electric pulse, the applied voltage must be greater than the

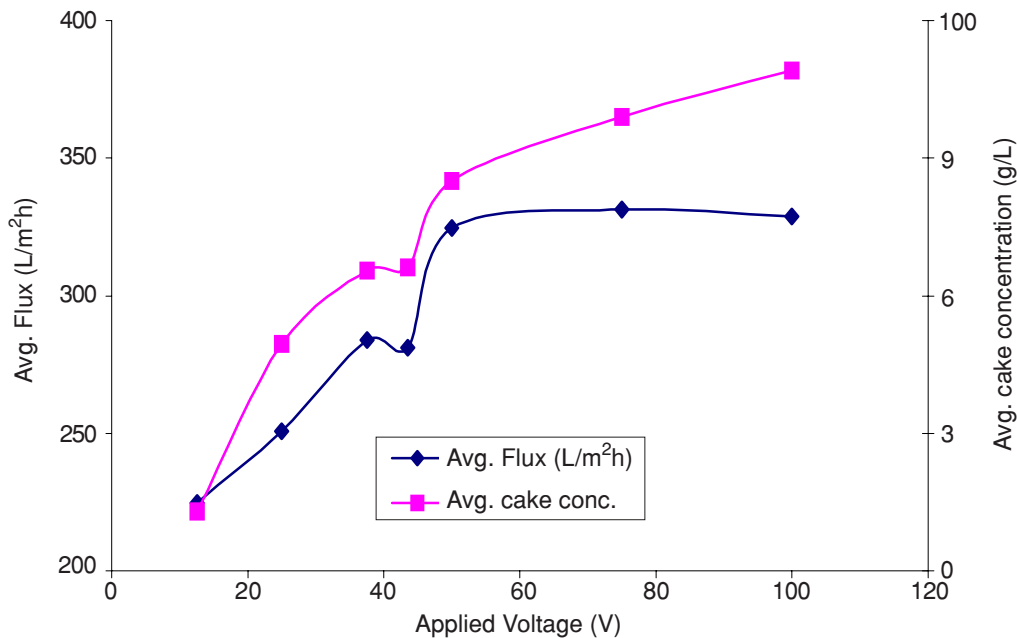


Figure 11 Effect of applied voltage on average flux and average cake concentration

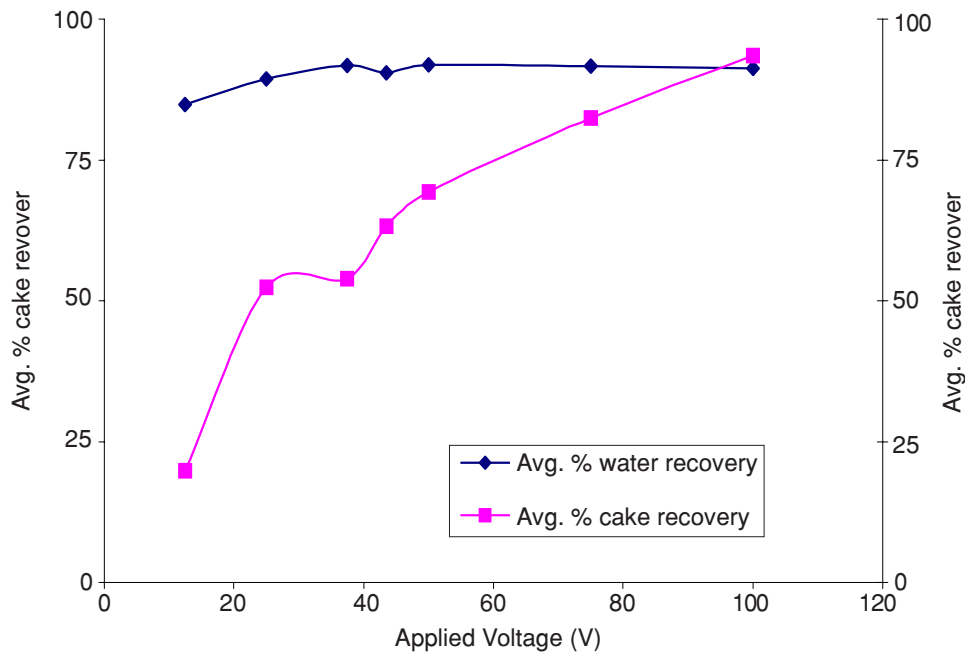


Figure 12 Effect of applied voltage on average % water recovery and average % cake recovery

critical voltage required [4, 20, 23–24]. In this case obviously electric field strength of 25 V is the critical voltage required.

5.0 CONCLUSIONS

Membrane fouling is the major drawback in applying membrane separation technology. If there is no effective action taken to prevent the membrane fouling, the flux will continuously drop as the filtercake keeps building up on the membrane surface as the filtration process proceeds which eventually the filtration process will stop. It has been shown from the current study that electric pulses can be one of the alternative means to prevent membrane fouling for dead end microfiltration of titanium suspension. The results show that the flux increases almost back to its original flux immediately after application of the electric pulses. The processing variable can affect the effectiveness of the membrane fouling prevention using electric pulse. Analysis from the results has shown that the prevention of membrane fouling is more effective with a shorter pulse interval (5 minutes), relatively not too long pulse duration (10 seconds), and the highest strength of applied voltage (100 V). It has also been found that the physical and chemical properties of the titanium suspensions such as pH and electrolyte strength of the feed can also affect the membrane fouling prevention. This is due to the changes of electrophoretic mobility and the nominal size of the particle with pH and the electrolyte strength of the feed. Results show that the optimum condition is at pH 8 with 0.01M electrolyte strength.

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