THE EFFECTS OF ANTIFOAM AGENT ON MEMBRANE FILTRATION

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***Abstract*— In order to overcome the problems caused by foaming, antifoam agent or known as deformer has been introduced in various industries especially for cell culture use. Since then, it has been the important compound to minimize the effects of foaming. Proclaimed researches have shown that every antifoam is not just ruin the foam with various efficiency, but will give effect to the same cell and protein. The concentration and type of antifoam that are needed to relieve the foam must be same with the potential consequences obtained from the process. The benefit to the process depends on the higher the concentration of antifoam than would normally be used [4]. The purpose of this study is to determine how antifoam effect the filter performance. For this studies, the result can be divide into 2 which are by using 1000 LMH and 2000 LMH. Flowrate of pump have been constant to 25ml/min for 1000 LMH and 50 ml/min for 2000 LMH. The concentration of antifoam is varies between 0.2%, 0.6% and 1%. The pressure and time taken per 5 ml of volume pass through the membrane filter has been recorded. From the data, flux, volumetric flowrate, resistance and loading capacity can be determined. The results show that the higher the concentration of antifoam, the resistance will get higher that will result to reduced time taken for the filter membrane to get clogged. Moreover, there also increase in pressure due to the formation of cake or modification of the membrane pore size. Due to this, the loading capacity of the filter has been reduced. The result also demonstrated that the flux rate is decreasing with time. Thus, the presence of antifoam in the feed load of a filtration process may disturb the filtration performance.**

***Keywords*— antifoam, filter performance, flux, loading capacity,resistance**

I. INTRODUCTION

The foaming-effect actuates critical problems in large-scale anaerobic digesters, for example troubles in fluid phase partition [9], valve-obstructing because of blending of biomass with the vaporous stage [5], and overflow of foam that capture the microbial biomass. Foam is an issue because it adjusts the liquid flow and blocks oxygen transfer were blocked from air. These prevent the microbial respiration in aerobic fermentation process. For these reasons, antifoaming agents, like silicone oils, are added to minimize the formation of foam.

Antifoam or defoamer is a chemical preservative which minimize and avoid the construction of foam in the industrial process liquids. Antifoaming agent are substances which are applied before the formation of the foam to prevent foaming, whereas antifoams are aggregate that applied after foam formation in order to overcome it [2]. The biological effects of antifoam are also poorly understood due to various range of models and different kind of antifoam types available in the market other than the inadequate data about their configuration and composition prepared by the manufacturers. Nonetheless, the correct system or mechanism of antifoams is not quite known yet [1]. Antifoam are usually appended to bioprocesses industry without awareness of the possible sequences, and these effects must be evaluated. Although it can serve the foaming issues, it may also possess the harmful effects. Nonetheless, it has also been recommended that antifoams could corrupt fermentation material [3] and antifoam also affect downstream processing by contaminate the membranes [6]. Consideration for the whole process must be taken. For these reasons, it is crucial to completely check the consequences by adding antifoam to fermentation culture in small and large scale.

This project covers the experimental exercises to evaluate the performance of filtration process with samples-containing antifoam agent. It focuses on the dead-end type of filters from the same membrane materials and having similar membrane area. (15.2 cm^2). Apart from that, silicone-based antifoam was used and different load of antifoam concentrations will be tested. Throughout the experimental works, the data on volumetric rate and differential pressure were recorded in order to assess the changes of pressure applied on the filter membrane. The volumetric flow rate was analyzed to develop the flux rate pattern of each of the process runs.

II. METHODOLOGY

A. Experimental Procedure

The materials used in this experiment were LB Broth and 10% antifoam solution. A disc filter with filter area of 15.2 cm^2 from Cobetter was alsoused for each of the process runs. Two flux rate was set for the experiment which are 1000 LMH and 2000LMH. Thus, 25 ml/min flowrate was used to filter 300 ml of media. The study was designed to have one control sample for each of the flux rate and three running sample for three different antifoam concentration loaded.

The disc flat membrane was loaded in the membrane holder. The tubing was connected and assembled accordingly. The feed and filtrate container were also prepared. The antifoam was titrated in the beaker using micropipette with concentration of 0.2, 0.6, and 1% v/v for each media of 150 ml and 300 ml. The flowrate was steadily increased to the desired value as the process was started. The value of pressure and time taken for every 5-ml volume of feed that pass through the filter membrane were recorded. When the filtration was completed, the solution was cleared from the filter membrane by an air purging.

III. RESULTS AND DISCUSSION

A. *1000 LMH*

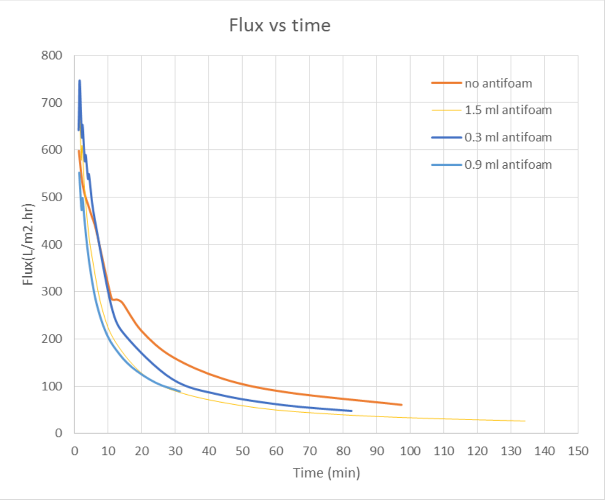

Figure 1: Flux vs Time

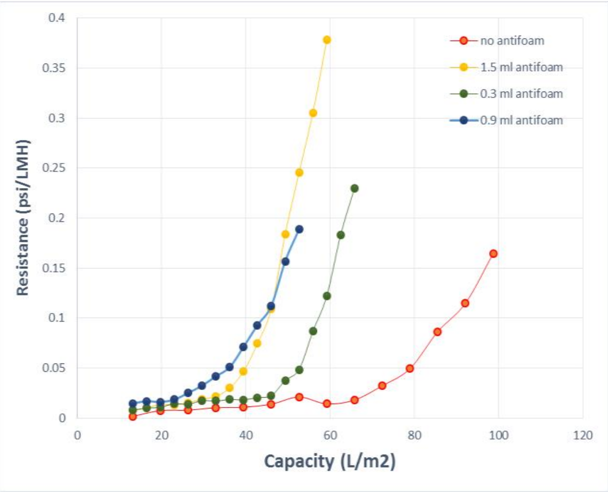

Figure 2: Resistance vs Capacity

From the graph flux vs time for 100 LMH (Figure 1), for each runs, the flux decreases with time. The trends of the graph about the same for every run. Control sample appeared to have the highest flux along the time. When antifoam is inserted, there were changes in the graph. The flux for sample that contain 0.2 % v/v antifoam has the second highest after the control which are between the range of 47.8 to 641.8 L/m^2.hr. For sample that contained 0.6 % v/v antifoam, the flux was slightly lower than the 1 % of antifoam which is from range 89.1 to 552.1 L/m^2.hr until the minutes of 30th. After 30 minutes, the flux for the 1 % antifoam appeared to be lower than 0.6 % which is from 26.41 to 82.04 L/m^2.hr as compared to 27.27 to 89.1 1 L/m^2.hr.

For resistance versus capacity graph (figure 2) for 1000 LMH, the trends of the graph were almost the same for all concentrations of the antifoam. The resistances increase with the loading capacity. When there was no antifoam (control), the loading capacity has the highest value which is from 13.16 to 98.68 L/m^2 and resistance is is also the lowest resistance which is from 0.0016 to 0.1645 psi/LMH. For sample with 0.2% of antifoam, the capacity is lower than the control which is from 13.15 to 65.78 L/m^2 but the resistance is higher (0.007-0.23 psi/LMH). The highest resistance was posed by the sample with 1% antifoam which is from 0.007 to 0.37 psi/LMH. For sample with 0.6% antifoam, the resistance is higher that result to low value of loading capacity compared to 1%(from 0.014 to 0.112 psi/LMH).

B. *2000 LMH*

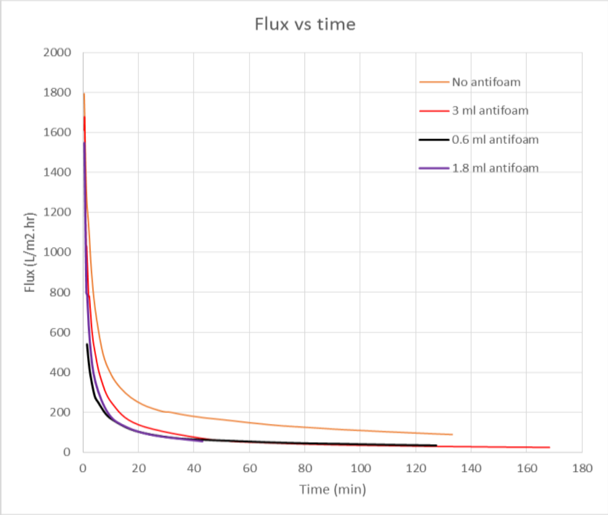

Figure 3: Flux versus time

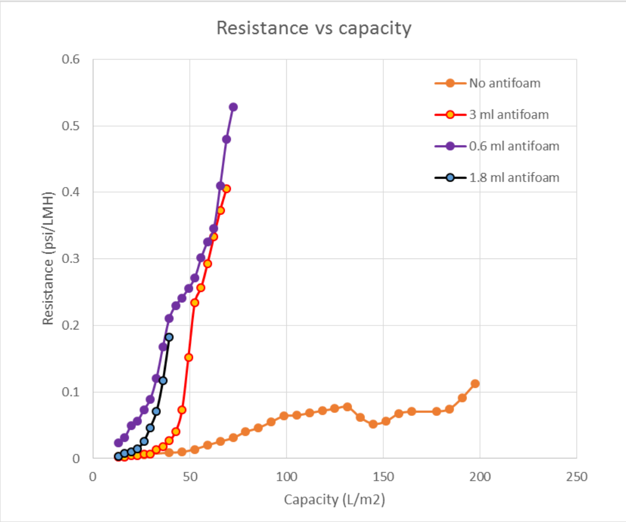

Figure 4: Resistance vs Capacity

From the graph flux vs time for 2000 LMH (figure 3), for each run, the flux rates decreased with time. The trends of the graphs were about the same for every run. Similar to flux rate of 1000 LMH, the control sample appeared to has the highest flux rate throughout the processing time which is from 88.9 to 1794 L/m^2.hr.The flux rate of sample that contained 1 % has the second highest flux after the control (24.64-1611 L/m^2.hr. The third highest flux was the sample that contain 0.6% of antifoam which is from 54.99 to 1547 L/m^2.hr and the lowest flux rate was observed for sample with 0.2% of antifoam which appeared to be between 34.1 to 540.7 L/m^2.hr. However, after certain point of time that was after the minutes of 40, all samples containing the antifoam resulted to almost the similar rate of flux with respect to process time. This was probably because the filter maybe started to get clogged after 40 minutes.

The flux of the three varies antifoam (0.2, 0.6 and 1%) give almost the same value of flux across the time. This is probably because the filter maybe start to clogged after 40 minutes.

For resistance versus capacity graph of 2000 LMH (figure 4), the trends of the graph were almost the same for all concentrations of antifoam. The resistances inversely increase with the loading capacity. When the loading capacity was high, the resistances were low. When there is no antifoam (control), the loading capacity has the highest value (13.15 to 197.4 L/m^2) and lowest resistance (0.003 to 0.11 psi/LMH) was observed.

By comparing all of the samples containing different concentration of antifoam. 1% of antifoam demonstrate the highest loading capacity (13.15 to 69.07 L/m^2) and also lowest resistance after the control (0.001 to 0.4 psi/LMH). 0.2 % antifoam give the highest resistance value (0.02 to 0.52 psi/LMH.

The data was supported using the study by Koch and colleagues that determined how antifoam affect foam destruction [7]. The research reviewed about the scope of impact by using different concentration of antifoam that could be applied upon the culture. The media used was silicone oil/PPG mixture (VPII33) and the antifoam used is 10% S184. In the study, the antifoams were added to E coli K12 cultures to create B-galactosidase fusion protein. Based on the finding, the volumetric and specific product activity decreased with increasing the concentration of antifoam (S184). However, increasing of antifoam concentration do not gave major effect to the growth of cell.

IV. Conclusion

Usage of antifoam has been suggested previously to alter the growth of cell and it is also may influence protein yield in bioprocess but their addition to the culture has never been examine systematically [8]. In this study, the aim was to determine if the antifoam may affect the performance of membrane filtration. The concentration of antifoam was manipulated between 0.2%, 0.6% and 1% Based on the result, antifoam may affect the performance of the filtration process.

The results showed that the higher the concentration of antifoam, the resistance will be higher and time taken for the filter membrane to be clogged reduced. Other than that, higher the antifoam concentration, there will be increase of pressure due to formation of cake and the membrane pore may be modified. Thus, suitable filtration capacity must be used for samples containing antifoam and the suitable operating parameters must be considered accordingly.

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