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Combination of Solid-Liquid Separation Process to Remove Grease, Oil and Organic from Food and Dairy Wastewater

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Abstract : Oily wastewater pollution could affect source water quality since the industrial will discharge the treated wastewater into river body. Treatment methods of oily wastewater, including floatation, coagulation, biological treatment, has different capability to remove pollutant. Aim of this study is to compare the efficiency removal of combination of solid-liquid separation process to remove, organic grease, oil and organic compound simultaneously. This study applied four treatments that is floatation only (F), coagulation-floatation (CF), floatation-activated sludge (FAS), coagulation-floatation-activated sludge (CFAS). Poly aluminum chloride (PAC) coagulant 50 mg/L was added as pretreatment, floatation was setup under pressure at 30, 50, 70 psi and recycle ratio 0.25; 0.5; 75. The results shown that combination solid-liquid separation, such as FAS have shown a good performance. It was observed that PAC coagulation as pretreatment had successfully enhanced solid-liquid separation process, such as in CF and in CFAS. CFAS system performed the highest removal of BOD 70% and 95% removal of grease and oil.
Keywords : coagulation, floatation, activated sludge, grease, oil, organic, separation.

1. Introduction

Food and diary industrial development generate amount of grease and oily wastewater in the production process, and high organic matter as well. Oily wastewater pollution could affect source water quality since the industrial will discharge the treated wastewater into river body. Therefore, food and diary industries must treat their wastewater, and activated sludge process is the most widely used in wastewater treatment. Activated sludge, a biological process, converts organic matter into energy for the organism and a settleble biomass that could be removed by sedimentation[1]. Existence of oily materials impacted the biological activated sludge sludge process. Oil introduced into an activated sludge system are absorbed on the floc and slowly degrade. If the loading rate is higher than the degradation rate and the rate of wastage, the oil accumulates on the sludge. This accumulation causes a loss of density and a loss of acceptable settling characteristics. The biological system fails due to the loss of sludge but ability of the microbial system to remove other substrates is not inhibited[2]. In addition, given grease and oily wastewater pollution Indonesia determined the maximum allowable emission of grease and oily wastewater concentration of 15 mg/L. It clearly indicated that oily wastewater treatment is urgently needed in field of environmental problems.

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Treatment methods of oily wastewater have been applied in either laboratories scale or industrial, including floatation, coagulation, biological treatment, membrane separation technology, and its combined technologies. Each method has its advantages and disadvantages, therefore it needed different studies in order to determine the appropiate process to remove grease and oil in wastewater[3]. Currently, the most commonly used method is floatation because floatation device processing capacity produces less sludge and separation efficiency advantages. Solid –liquid separation through air floatation will create fine bubbles which will become associated with the solids grease or oil, increasing their buoyancy, and cause them float to the surface. The effectiveness of air floatation depends on how well the solids can be agglomerated with air bubbles in order to allow it float to the surface. The main factors to generate solid floating in air floatation are air pressure, recycle ratio, and air to solid ratio[4].

Nevertheless, biological treatment have been observed as a mature technology and is used frequently in removing decomposed organic matter and grease-oil compound simultaneously. For example: the ultrafiltration membrane bioreactor remove oil almost 99.99%, COD 97% and TOC 98% removal[5]. Upflow anaerobic sludge blanket (UASB) coupled with immobilized biological aerated filters (IBAFs) could treated heavy oil wastewater with amount of removal of organic matter about 74% [6]. Activated sludge process is an aerobic biological process that can be divided into two phase, aeration phase and solid-liquid separation phase. In the aeration phase, pollutant is contacted with an aerated mixed of microorganism. In the solid-liquid separation, the activated sludge is separated from the liquid through sedimentation, and recycled to aeration tank to maintain a high concentration of biomass. Solid-liquid separation occurs when a suitable environment is created to flocculate the activated sludge and be separated from the wastewater at the end of the biological treatment[7]. Recently, coagulation have been used to enhanced many processes for removing organic matter, suspended solid and complex metal[8,9]. Coagulation could be one of the alternative treatment in wastewater since this unit always be applied in the field.

Based on those information from literature, it can be implied that the objectives of this research is to observe the application of floatation to perform activated sludge and its efficiencies in removing grease, oil and organic compound simultaneously.This study compared the efficiency removal among four treatment, that is floatation only (F), coagulation-floatation (CF), floatation-activated sludge (FAS), coagulation-floatation-activated sludge (CFAS).

2. Materials and Methods

Sample was taken from an industrialpark wastewater treatment in Mojokerto, Indonesia. The jar test apparatus was used for coagulation to determine the optimum dosage. Laboratory scale experimental was setup for continues process with flowrate 1 L/min. Coagulation with optimum dosage of polyaluminium chloride (PAC) 50 mg/L was adjusted for rapid mixing 100 rpm. Floatation separation under various pressure at 30, 50, 70 psi and recirculation ratio (r): 0.25; 0.5; 0.75 was determined to remove grease and oil. Activated sludge process, consisted of aeration tank and settling tank, performed after floatation process. Schematic diagram of the laboratory scale floatation-activated sludge process is shown in Figure 1. Treated water sample was taken at floatation tank and settling tank for grease and oil measurement and BOD value with Winkler Method[10].

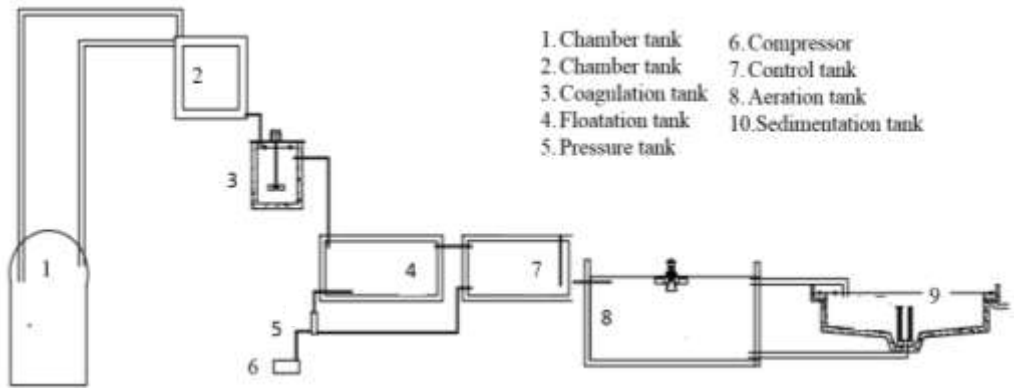

Figure 1. Schematic diagram of the laboratory scale floatation-activated sludge process

3. Results and Discussion

3.1. Effect of polymer coagulant on oil and organic removal

Figure 2 described the comparison between floatation with and without PAC coagulation (F versus CF) in removing grease, oil and BOD value. First, the figure shown that additionof PAC generated a higher removal than without PAC addition under different air pressure and recirculation ratio. When PAC was added at concentration 50 mg/L, the optimum average grease and oil removal and BOD efficiencies were 90% and 47%, respectively. It obviously shown that coagulant could improve floatation performance to remove grease, oil and organic materials.Physicochemical coagulation between PAC and organic material was achieved sufficiently, but solid-liquid separation in the floatation only was not accomplished well[11].

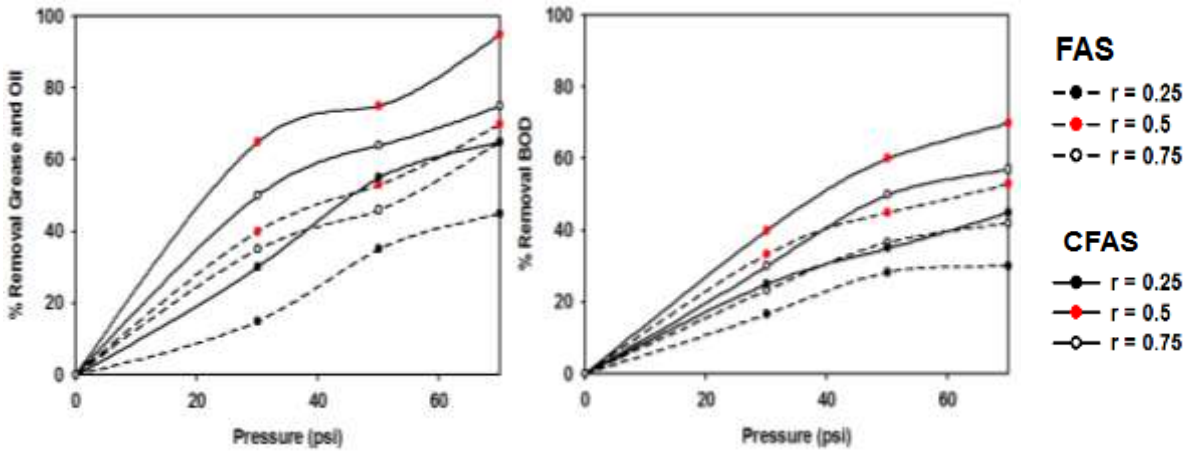

Figure 2. Comparison between floatation with and without PAC coagulation in removing grease, oil and BOD value under various pressure and recycle ratio (r)

Second, it shown that the highest air pressure 70 psi and the medium recirculation ratio 0.5 could produce the highest removal of grease, oil and organic pollutant. According to recycle ratio, it is determined as the fraction of the final effluent produced which is returned and saturated under pressure prior to entering the flotation chamber and released. The higher value of recycle ratio, the higher will be the amount of bubbles released to the floatation tank, then the bubbles will cause an turbulence on the flow, which will increase the connections of the particle-bubble aggregate, improving the performance of the treatment[4]. However, the highest recycle ratio 0.75 probably caused the excess turbulences inside of the floatation tank, then shear forcess acting on the surface of the particle-bubble aggregate are high, breaking up the floc structure[2]. Air pressure influences directly the size of the bubbles generate. It has been observed that the bubble size and pressure has a negative strong correlation. It means that as the pressure applied to the recycle effluent gets higher, the size of the bubbles get smaller. However, a very fine bubble can form a very fragile floc, while too large bubble size can not attach to the particles[3].

3.2. Performance activated sludge process with coagulation-floatation

Figure 3 shown the comparison between activated sludge with PAC coagulation-floatation and with floatation only in removing grease, oil and BOD value.First, the figure shown that activated sludge process with coagulation-floatation (CFAS) performed a higher removal for grease and oilthan floatation-activated sludge(FAS), about 95%.It occurred after pretreatment floatation at 70 psi and recycle ratio 0.5. According to previous result, effect of polymer coagulant to remove grease and oil in floatation, it have revealed that coagulant could improve floatation performance due to hydrolysis species could agglomerate and catch the particle. Comparison among coagulation, coagulation-floatation, FAS, CFAS for removing grease and oil suggested that CFAS system provided a higher efficiency than other process (Figure 2 and Figure 3). Generated fine bubble in floatation will help floc to interact each other and increase particle removal. In settling tank of activated sludge, the formed floc from coagulation-floatation process will be bigger than ever and heavier than water, has a higher settling velocity, and settled eventually under laminar flow conditions[3]. Sedimentation is no

longer a suitable treatment to perform a solid-liquid separation if a big population of filamentous bacteria existed, and it will affect the floc density properties in the activated sludge, hindering the settling capacity[1].

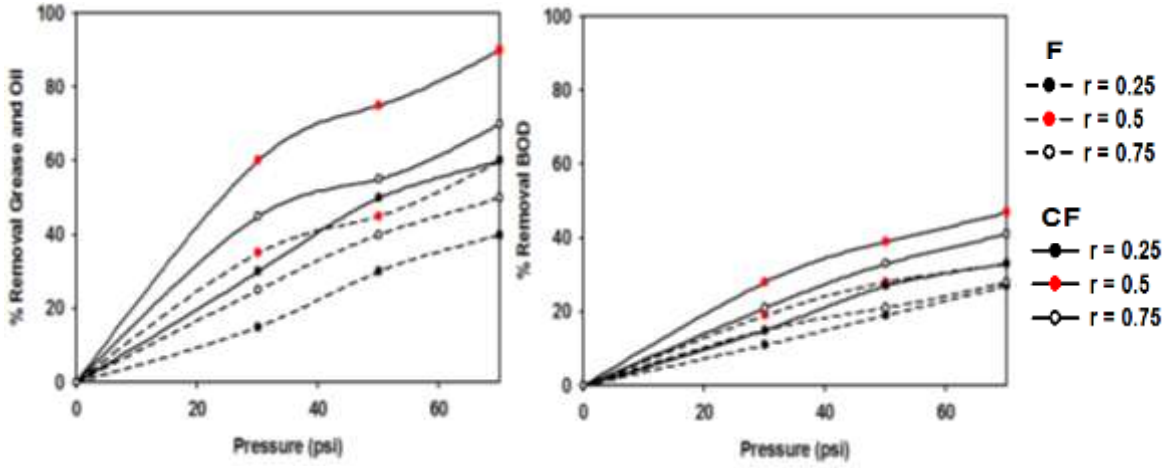

Figure 3. Comparison between activated sludge with PAC coagulation-floatation (CFAS) and with floatation only(FAS) under various pressure and recycle ratio (r)

Second, organic compound removal in term of BOD have removed significantly, about 70% BOD removal, after activated sludge with pretreatment coagulation-floatation (CFAS) at 70 psi and 0.5 recycle ratio. Even CFAS shows the highest eficiency removal of BOD than other treatment, such as floatation only (F), cogulation-flotation (CF), floatation-activated sludge (FAS), as shown in Figure 2 and 3. Activated sludge is aerobic biological process in which wastewater is treated with microorganisme, and its efficiency removal up to 80% for BOD[1]. Comparison of percentage removal BOD between Activated sludge has aeration phase which is used to remove organic and solid-liquid phase in order to remove solid particle. The formed floc in coagulation-floatation probably help organic removal through aggregation mechanism during solid-liquid phase, includingg a combination of charge neutralization, entrapment, adsorption and complexation with formed floc into insoluble particulate aggregates[9,12].

4. Conclusion

This study observed various solid-liquid separartion processes to treat food and diary wastewater in removing organic matter BOD, grease and oil. The results indicated that floatation at 70 psi and recycle ratio 0.5 performed an optimum operation process. Combination solid-liquid separation, such as floatation-activated sludge (FAS) have shown a good performance as well. PAC coagulation as pretreatment had successfully enhanced solid-liquid separation process, as shown in coagulation-floatation (CF) and in coagulation-floatation-activated sludge (CFAS). CFAS system performed the highest removal of BOD about 70% and 95% removal of grease and oil.

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