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# Review: Application of Coagulation-Biological Aerated Filter (CBAF) System for Biodiesel Wastewater Treatment

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**ABSTRACT**

This study involved the preliminary study of coagulation and BAF process individually as well as CBAF treatment system monitoring. Up to this stage, the investigation of coagulation process has been carried out in order to find the optimum conditions needed. At conditions; pH: 7.13, mixing rate: 200 rpm, dosage: 2 g/L, settling time 65 min, the coagulation process using alum managed to reduce 34.5, 39.04 and 32% COD, SS and turbidity respectively. The experiment was further study by acclimatizing the sludge taken from the aeration pond. Nutrients and suitable conditions for microorganism's growth are figured out. The performance of BAF process was monitored by varying the organic loading rate (OLR) as well as the hydraulic retention time (HRT). The authors are going to proceed the experiment with the treatment of biodiesel wastewater using CBAF system.



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## INTRODUCTION

Biodiesel is produced through transesterification process in the presence of alcohol and catalyst, oil source is converting to biodiesel (methyl ester) and glycerol. This clean renewable fuel is one of the best alternatives to non-renewable energy sources (Abbaszaadeh, 2012) however its production leads to the generation of large amount of wastewater. Veljković *et al*. (2013) stated that approximately 28 million $m^3$ of biodiesel wastewater was produced in 2011 worldwide. Biodiesel wastewater is characterized by having high content of chemical oxygen demand (COD), biological oxygen demand ($BOD_5$), suspended solid (SS) and oil and grease (O&G). Table 1 summarizes the biodiesel wastewater characteristics from previous study.

Several treatments for biodiesel wastewater are shown in Table 2. Most of the treatments were done in order to find the better treatment in terms of performance, cost and simplicity. The authors are going to investigate and evaluate the performance of integrated system; coagulation-biological aerated filter (CBAF) system to be used as biodiesel wastewater treatment.

***Biodiesel treatment using integrated system:***

***Integrated Treatment System:***

Biodiesel wastewater which having high impurities could not be treated by single process. Integrated system was developed to enhance the treatment of biodiesel wastewater. As summarized in Table 3, several integrated system investigated before were (a) membrane bioreactor-biological activated carbon, (b) dissolved air flotation-coagulation, (c) photo-Fenton-aerobic sequential batch reactor and (d) electroflotation-electrooxidation.

**Table 1:** Characteristics of biodiesel wastewater.

| pH | COD (mg/L) | $BOD_5$ (mg/L) | SS (mg/L) | O&G (mg/L) | References |
|---|---|---|---|---|---|
| 8.5-10.5 | 60000-150000 | 30000-60000 | 1500-5000 | 7000-15000 | Rattanapan *et al*. (2011) |
| 9.25-10.26 | 29595-54362 | 1492-2286 | - | 1040-1710 | Pitakpoolsil and Hunsom (2013) |
| 4.34-6.56 | 19000-37000 | 260-1600 | 233-405 | - | This study (2013) |

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**Table 2:** Performances of different biodiesel wastewater treatment.

| Treatment | COD (%) | $BOD_5$ (%) | SS (%) | O&G (%) | References |
|---|---|---|---|---|---|
| Coagulation | 97.5 | 97.2 | - | 98.2 | Ngamlerdpokin *et al*. (2011) |
| Electro-coagulation | 55.4 | - | 96.6 | 98.4 | Chavalparit and Ongwandee (2009) |
| Biological | - | - | - | 98.0 | Suehara *et al*. (2005) |
| Adsorption | 90 | 76 | - | 67 | Pitakpoolsil and Hunsom (2013) |
| Microbial fuel cell | 60 | - | - | - | Sukkasem *et al*. (2011) |

**Table 3:** Integrated systems for biodiesel wastewater treatment.

| Treatment | COD (%) | $BOD_5$ (%) | SS (%) | O&G (%) | References |
|---|---|---|---|---|---|
| (a) | 89.9-99.9 | - | - | 97.6-99.9 | Tri (2002) |
| (b) | 40-50 | - | 98-100 | 85-95 | Rattanapan *et al*. (2011) |
| (c) | 76.1 | 69 | - | - | Ramírez *et al*. (2012) |
| (d) | 57 | - | 98 | 100 | Romero (2013) |

***Coagulation process:***

Coagulation process is proven in treating various type of wastewater includes biodiesel wastewater. Suehara (Suehara, 2005) stated that biological process itself is not suitable to treat biodiesel wastewater unless the SS content which considered as microorganism's growth inhibitor (Kumjadpai, 2011) has been reduced or removed. With less chemical used, simple operation and its economical reason [5], this process seems favorable to be chose prior to reduce the SS content before biological aerated filter process takes place.

In the preliminary study, the optimum conditions of coagulation process were investigated. Commercially used and economical coagulant; alum was used. Factors varied includes pH (4-9), mixing rate (100-300 rpm), coagulant's dosage (0.5-3.5 g/L) and settling time (10-120 min). Response parameters being investigated were COD, SS and turbidity. Response surface methodology (Box-behnken design) was used to evaluate the optimum conditions and validation analysis was conducted to verify its performance. From the validation analysis, the preliminary study shows that coagulation process with optimum conditions (pH: 7.13, mixing rate: 200 rpm, dosage: 2 g/L, settling time 65 min) managed to reduce 34.5, 39.04 and 32% COD, SS and turbidity respectively.

***Biological aerated filter (BAF) process:***

Srirangsan (Srirangsan, 2009) stated that the usage of biological process is helpful to remove the methanol and glycerol content in biodiesel wastewater. It is useful to increase the removal efficiency of overall process. BAF process offers several advantages such as easy operation, relatively compact which requires small working space (Hasan, 2009). Zhao (Zhao, 2006) study showed that BAF process managed to pre-treat oil field wastewater with 78% of total organic carbon (TOC) degradation and remove 94% of oil content. Study of integrated system of anaerobic baffled reactor and BAF system done by Delin (Delin, 2007) effectively removed 76.3-80.3, 31.6-57.9, 86.3-96.3 and 76.4-82.7% of oil, COD, BOD and SS respectively. Preliminary study of BAF was conducted and so far, acclimatizing of sludge taken from aeration pond was set up.

***Future Study: Coagulation-Biological Aerated Filter (CBAF) System:***

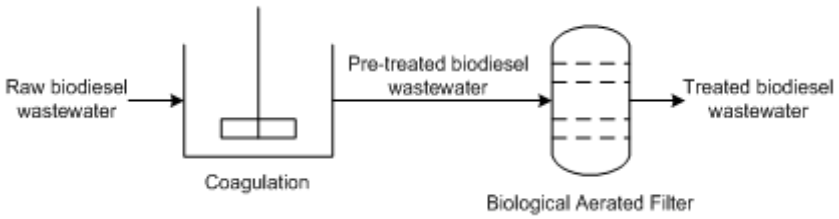


**Fig. 1:** Schematic of proposed CBAF system.

This study will be proceeding with the preliminary study of BAF process. The sludge will be exposed to the biodiesel wastewater. Nutrients needed and performances of BAF are studied to find out the suitable conditions for microorganisms growth prior to treat the pre-treated biodiesel wastewater from coagulation process. Organic loading rate (OLR) and hydraulic retention time (HRT) will be varied. Optimum conditions for both systems are important for the CBAF treatment system. The study will be further carried out by setting up the CBAF system and monitoring the overall performance of the treatment.

***Conclusion:***

Various way of treating biodiesel wastewater through various systems has been carried out. The integrated system between coagulation and biological aerated filter (BAF) process seems favorable to be used. The coagulation process itself managed to reduce 34.5, 39.04 and 32% of COD, SS and turbidity respectively. Meanwhile the performance of BAF process is still under investigation. The authors are looking forward to investigate the performance of integrated CBAF system in order to be used as biodiesel wastewater treatment.

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## REFERENCES

Abbaszaadeh, A., B. Ghobadian, M.R. Omidkhah, G. Najafi, 2012. Current biodiesel production technologies: A comparative review, Energy Conversion and Management, 63: 138-148.

Delin, S.U., W. Jianlong, L. Kaiwen, Z. Ding, 2007. Kinetic performance of oil-field produced water treatment by biological aerated filter. Chinese Journal of Chemical Engineering, 15(4): 591-594.

Hasan, H.A., S.R. Sheikh Abdullah, S.K. Kamarudin, N. Tan Kofli, 2009. A review on the design criteria of biological aerated filter for COD, ammonia and manganese removal in drinking water treatment. Journal-The Institution of Engineers, Malaysia, 70(4): 25-33.

Kumjadpai, S., K. Ngamkerdpokin, P. Chanaton, P. Lertsathitphongs, M. Hunsom, 2011. Management of fatty acid methyl ester (FAME) wastewater by a combined two stage chemical recovery and coagulation process. The Canadian Journal of Chemical Engineering, 89: 369-376.

Ngamlerdpokin, K., S. Kumjadpai, P. Chanaton, U. Tungmanee, S. Chuenchuanchom, P. Jaruwat, P. Lertsathitphongs, M. Hunsom, 2011. Remediation of Biodiesel wastewater by chemical and electrocoagulation: A comparative study. Journal of Environmental Management, 92: 2454-2460.

Srirangsan, A., M. Ongwandee, O. Chavalparit, 2009. Treatment of biodiesel wastewater by electrocoagulation process. Environment Asia, 2: 15-19.

Suehara, K., Y. Kawamoto, E. Fujii, J. Kohda, Y. Nakano, T. Yano, 2005. Biological treatment of wastewater discharged from biodiesel fuel production plant with alkali-catalyzed transesterification. Journal of Bioscience and Bioengineering, 100(4): 437-442.

Veljković, V.B., O.S. Stamenković, M.B. Tasić, 2013. Wastewater management in biodiesel production. Reporting For Sustainability, pp: 471-475.

Zhao, X., Y. Wang, Z. Ye, A.G.L. Borthwick, J. Ni, 2006. Oil field wastewater treatment in biological aerated filter by immobilized microorganisms. Process Biochemistry, 41: 475-1483.