Domestic Waste Water Treatment By Electrocoagulation

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Abstract

Domestic wastewater from settlements and restaurants in big citie like Jakarta overburden on the waters. The high input of wastewater pollutants in urban areas demanding wastewater treatment system that has a high efficiency with a short time. Based efforts to reduce pollutants from the source, the electrocoagulation technology used to process the wastewater in order to obtain the quality of treated wastewater in accordance with quality standards. This study uses a laboratory scale. The wastewater treatment reactor consists of electrocoagulation and flocculation unit. Retention time for each treatment consisted of 5 seconds to discharge 24 l/min, 10 seconds to discharge 12 l/ min and 20 seconds at the rate 6 l/min. The parameters measured were COD, BOD, NO_3 and TSS. Retention time 20 seconds produces efficiencies were higher for all parameters than other treatments both in domestic wastewater and restaurant.

1. Introduction

Up to now the wastewater from settlements and restaurants in Jakarta has not been treated optimally. The wastewater get into the waters that will be cause of pollution. Increased water pollution in Jakarta occurs from year to year. In general this will be reduce the carrying capacity of the urban environment.

Urban land issues in the city need the force of the idea to implementation the wastewater treatment are easy to operate and do not need a large area. Eletrocoagulation wastewater treatment is known to have high efficiency.

Electrocoagulation process is a chemical process in wastewater treatment. Sources an aluminum cation generated from the metal electrolysis. Aluminium can be used as a coagulant in wastewater treatment. Sludge produced from the electrolysis process does not contain sulfate or chloride so it is more secure. Aluminum cations are wasted will be absorbed by the soil.

The aim of this study were to identify the characteristics of domestic wastewater and restaurants and assessing the performance of electrocoagulation reactor in reducing pollutants from domestic wastewater and restaurants with different retention times.

Implementation of wastewater treatment using electrocoagulation have the virtue of:

1. Develop domestic wastewater treatment process that were cheaper, easier, environmentally friendly, does not require a large area and can be operated by the community on a scale of communal.
2. Implementing the chemical treatment technology to treat domestic wastewater and restaurants.

2. Methode

2.1 Time and location of research

The study was conducted at 2012 by made a wastewater treatment units cosist of electrogoaculation and flocculation. Location of the research in the environmental laboratory of Environmental Engineering Departement, Faculty of Architecture Landscape and Environmental Technology, Trisakti University.

2.2 Equipment and material

Electro-coagulation unit with dimensions of length: width: height at 20:10:15 cm. On the inside of the reactor is placed aluminum as anode plate (at the top) and a stainless steel as cathode plate (at the bottom) each plate with a size 10x10x14 cm with 0.5 cm distance between the plates. Total plate used are 34.

Flocculation unit with volume 480 liter with rapid and slowly stirring. Rapid stirring 150 rpm and slowly strirring of 60 rpm during 20 minute.

Wastewater samples taken from drainage near settlements and restaurants in West Jakarta. Wastewater sampling of settlements conducted at 5-7 am and 5-6 pm and the restaurant was taken during the peak hours between at 9-10 am and 12-13 pm.

2.3 Analysis

Retention time for each treatment consisted of 5 seconds to discharge 24 l/min, 10 seconds to discharge 12 l/ min and 20 seconds at the rate 6 l/min. The parameters measured were TSS, COD, BOD and NO_3.

Sampling point was conducted at the inlet (before electrocoagulation unit) and outlet (after floculation unit). The performance of electrocoagulation process was evaluated from its ability to reduce pollutants and improve water quality. The water quality was compared to the quality standards according to Jakarta Governor Decree No. 122 Year 2005 on Determination of Allocation and River Water Quality Standards/Waters and Waste Water Quality Standard in Jakarta.

Factors that influence the performace of electrocoagulation were the type of electroda and retention time, were analyzed by comparing with those of the previous study.

3. Result and Discussion

3.1 Characteristics of wastewater

Characteristics of wastewater from settlements and restaurants illustrates the amount of pollutants it contains. Table 1 shows the characteristics of the waste water from the source.

Table 1 Characteristics of wastewater from domestic and restaurants

No	Pameter	Unit	Settlement	Restaurant	Quality standard
1	TSS	mg/l	84-125	134-162	50
2	COD	mg/l	112,60-149.22	166.78-323.02	80
3	BOD	mg/l	92.6-131.50	129.30-273	50
4	NO_3	mg/l	10.96-26.16	13.95-19.95	

In general, the quality of wastewater has been exceed the quality standard. Therefore, it absolutely must be done to treat the wastewater before discharge into waters.

Total suspended solid in the form of organic and inorganic materials. Suspended material having adverse impacts on water quality by reducing solar penetration into water bodies and increase the water turbidity.

COD and BOD_5 are an indicator of organic matter content in the water. The higher the value, the higher organic contaminants contained in the water. More oxygen is required to oxidize the organic materials, the oxygen in the water will be reduced. If this condition continues, it will be interfere the self-purification of the water and will be affecting to the aquatic biota.

Total Nitrogen is the sum of nitrate (NO_3), nitrite (NO_2), organic nitrogen and ammonia. The existence of Total N can affect the fertility rate in the waters.

Physically wastewater is gray, odorless, containing about 0.1% solids and 99% is water. In a domestic wastewater the comparison of organic and inorganic materials about 50%. The wastewater contains dissolved solids materials greater than suspended, approximately 85-90% of dissolved inorganic component and 55-60% of dissolved organic components. Wastewater containing a variety of pathogenic organisms that can cause various diseases (Metcalf and Eddy, 1991).

Domestic wastewater treatment covering types of individual and communal. In the activities of domestic wastewater management, communities have the right to participate in the wastewater planning process, obtain information about the policy and plan development of domestic waste water management and to implement management activities (Regulation of the Governor of Jakarta Capital Special Region No.. 122 Year 2005).

Decentralized approach for wastewater treatment more flexible in the management and simpler technology. Decentralized system is not only a long-term solution for a small community, but it is more reliable and cost-effective (Massoud et al., 2008). The purpose of wastewater treatment in small scale and decentralization are (1) to protect public health, (2) to protect the environment from degradation or pollution, and (3) reducing processing costs because the unit was built near sources (Tchobanoglous, 1998).

3.2 The performance of electrocoagulation process

Efficiency of electocoagulation process to treat the wastewater from settlement and restaurant saw at the Table 2.

Retention time 20 seconds produces efficiencies of TSS, COD, BOD and NO_3 were higher than other treatments both in domestic wastewater and restaurant. Wastewater output has been in accordance with the quality standards of domestic wastewater according to Decree No. Gub Jakarta. 122 in 2005.

The content of detergent and electrical conductivity in the domestic wastewater higher than the other sources of wastewater that will be affect to COD removal efficiency. The content of detergents and oils/fats enables the formation of the water-oil emulsions which will be increase the COD removal. Total dissolved Al^{3+} in the settlement wastewater greater than the other, which describes the binding strength of aluminum hydroxide with koloid in the wastewater (Iswanto, 2011).

Tabel 2 Wastewater quality and efficiency performance of electrocoagulation for each retention time

Source of wastewater	Efficiency (%)											
	TSS			COD			BOD			NO_3		
	5"	10"	20"	5"	10"	20"	5"	10"	20"	5"	10"	20"
Settlement	76.73	75.47	80.50	75.49	78.16	82.10	758.	82.13	85.72	64.00	55.67	57.06
Restaurant	70.64	71.97	77.26	56.05	53.63	55.93	59.84	53.47	58.10	51.67	58.74	59.70

Electrical conductivity in the water is a numeric expression that indicates the ability of a solution to conduct electrical current. Therefore, the more dissolved salts that can be ionized, the higher the value of electrical conductivity. The value of electrical conductivity depends on the presence inorganic ions, valence, temperature, and concentrations of total and relative. The greater the electrical conductivity value means the greater the ability of cations and anions present in the water to conduct electricity and a growing number of pollutant particles that attach to the anode and cathode.

Several factors influence the process of electrolysis were

1. Electric current density
   The increase in current density would accelerate charged ions form a floc . The amount of electric current that flows directly proportional to the material produced during the process.
2. Time
   According to Faraday's law, the amount of charge that flows during electrolysis is proportional to the amount of contact time used.
3. Tension
   Because the electrical current that produces chemical changes in the medium flowing through the (metal or electrolyte) due to the potential difference, because the electrical resistance of the medium is greater than the metal, then that needs to be considered is the boundary between the medium and the medium metallic.
4. Acidity (pH)
   In the electrolysis process of water electrolysis reactions that produce hydrogen gas and hydroxide ions , with the longer contact time is used , the faster is also forming hydrogen gas and hydroxide ions , pH of the solution affects the overall efficiency and effectiveness of electrocoagulation . pH of the solution can be easily changed . optimal pH to increase the effectiveness of electro-coagulation process contained in solution values ranged between 6.5 to 7.5.
5. Thickness of plate
   The thicker the plate electrodes are used , electrostatic attraction in reducing and oxidizing metal ions in solution will be even greater.
6. Distance between the electrodes
   The magnitude of the distance between the electrodes affect the resistance of electrolyte , the greater the distance the greater the resistance , so the smaller the current flowing

Some advantages of electrocoagulation process was to eliminate the metal oxide, removes solids, breaking oil-in-water emulsion, removes oil and grease, eliminating the complex organic matter and eliminate bacteria, viruses and cysts. While the electro-coagulation process is not using chemicals (Holt, Barton and Mitchell, 2004). Electrocoagulation is a process of coagulation by using a direct current through the electrochemical events symptomatic electrolyte decomposition is used to treat wastewater (Pravitasari, 2008).

Reduction efficiency of COD, turbidity and suspended solids 60-98% higher by a retention time <40 minutes (Kobya et al., 2006). Wastewater treatment by electrocoagulation slaughter house using four electrodes showed shorter operating time to achieve the maximum removal efficiency. The use of four electrodes operation takes 70 minutes and removal of TSS and TDS maximum of 99%, while the two electrodes operation takes 90 minutes with the removal of TSS and TDS maximum of 98% (Ardhani and Ismawati, 2007). Electrocoagulation process used to process waste vegetable oil. Results showed that electrocoagulation able to reduce COD by 98.9% in the 90-minute operation (Un, Koparal dan Ogutveren, 2009). Processing of waste oils by electrocoagulation using iron and aluminum electrodes showed that aluminum electrodes better. COD reduction of 93%, oil 95.6% fat and 99.4% hydrocarbons with operating time of 60-90 minutes (Asselin, et al., 2008). reduction of pollutants from industrial wastewater electro-coagulation by comparing the aluminum, iron and aluminum + iron showed optimal results by using a mixture of aluminum + iron (Jernandez, et al., 2009). From the comparison of the results of research conducted

with the results of previous study, shows that the results of this study were able to reduce pollutants with shorter time with a target reduction of pollutants to below the quality standard. Aluminium electrodes used also proved to be good enough in reducing pollutants.

Coagulation/flocculation was the process of collecting fine particles that can not be deposited by gravity, into larger particles that can be deposited. Aluminum produced from electrolytic aluminum metal used as a coagulant in this wastewater treatment.

4. Conclusion

Quality of waste water from settlements and restaurants exceeded the quality standard determined. Therefore, it absolutely must be done to treat the wastewater before discharge into waters. Processing by electrocoagulation and flocculation process can reduce contaminants to below the quality standard by Jakarta Governor Decree No. 122 of 2005.

Retention time 20 seconds produces removal efficiencies of TSS (80.50%), COD (82.10%), BOD (85.72%) and NO_3 (57.06%) from the settlement wastewater and TSS (77.26%), COD 55.93%), BOD (58.10%) and NO_3 (59.70%) from restaurant wastewater were higher than other retention time. The performance reactor was influenced by the type of waste, retention time and electrode used.

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