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Wastewater Treatment Plant Planning of Palm Flour Industry in Klaten as the Alternative of Environment Management

Identifikasi Dampak Lingkungan dari Kegiatan Industri Tepung Aren di Kabupaten Klaten

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ABSTRACT

This study aims to determine the characteristics of wastewater from palm flour industry, knowing the distribution of industrial wastewater, calculate the amount of wastewater discharge, and planned system of wastewater treatment plant (WWTP). The research methods are the combination of field surveys for data collection, analysis of samples in environmental quality laboratory, and analysis of design studio. The Sampling technique is purposive sampling. The data obtained are the number of industries, the volume of the tubs in each industry, the coordinate points, samples of wastewater and groundwater (well). Industrial distribution data were analyzed using Geographic Information Systems (GIS), while for the quality data of wastewater and groundwater performed analysis of quantitative descriptive and qualitative descriptions. The results obtained from laboratory tests were the parameters of Total Disolved Solid (TDS), Total Suspended Solid (TSS), Degree of acidity (pH), chrom, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and oil and fat exceeds the environment quality standards of Environmental Minister's Regulation KEP-51/MENLH/10/1995. The position of the largest industries in the settlements on the frontier between the Daleman Village and Pucangmiliran Village that bounded by the Belukan River. There are 54 palm flour-making industries with a total discharge of wastewater 216,06 m3/day. Cascade aeration 6 levels with a height of 1,8 m and rectangular sedimentation with a length 4,64 m, width 1,16 m, and height 2,5 m is used as Wastewater treatment plant (WWTP).

Key words: palm flour industry; wastewater; wwtp

ABSTRAK

Penelitian ini bertujuan untuk mengetahui karakteristik limbah cair dari industri tepung aren, mengetahui sebaran industri penghasil limbah cair, dan menghitung besaran debit limbah cair. Metode penelitian adalah kombinasi antara survei lapangan untuk pengumpulan data, analisis sampel di laboratorium kualitas ligkungan, dan analisis studio rancang bangun. Teknik pengambilan sampel yang digunakan adalah *purposive sampling*. Data yang diambil adalah jumlah industri, volume bak pada masing-masing industri, titik koordinat, sampel air limbah dan air sumur warga. Data sebaran industri dianalisis menggunakan sistem informasi geografis, sedangkan untuk data kualitas air limbah dan air tanah dilakukan analisis deskripsi kuantitatif dan deskriptif kualitatif. Hasil yang diperoleh

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dari uji laboratorium bahwa parameter Total Disolved Solid, Total Suspended Solid, Derajat Keasaman (pH), Chrom, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), dan Minyak melebihi baku mutu Kepmen LH No. KEP-51/MENLH/10/1995. Posisi industri terbanyak berada di permukiman di perbatasan antara Desa Daleman dan Desa Pucangmiliran yang dibatasi oleh Sungai Belukan sehingga berpotensi tercemar limbah. Terdapat 54 industri pembuatan tepung aren dengan debit total limbah cair sebesar 216,06 m^3/hari.

Kata kunci: Dampak lingkungan; Industri tepung aren; Limbah cair.

BACKGROUND

There are 52 palm four industries that are categorized as the food industry in Hamlet Bendo, Daleman Village, District Tulung, about 20 km to the north urban area of Klaten, Central Java. Area of Hamlet Bendo about 61.19 ha, with a population number about 1.164 inhabitants. According Jenie and Rahayu (2001), food industry wastes can cause various problems because it contains a number of carbohydrates, proteins, fats and mineral salts remaining chemicals used in processing and cleaning. In general, wastes of food industry does not endanger public health because it is not directly involved in the transfer of disease, but high organic matter content can act as a food source for microbes that will thrive and reduce dissolved oxygen in water.

There are two types of waste from flour palm industry, palm bark and fiber as solid waste and wastewater from the washing, filtration, and sedimentation powders palm trunks process. From the manufacturing process, the potential of solid waste arising in the process of making flour palm about 20-50 tons/day, while the discharge of wastewater generated at 216.06 m3/day. Industrial wastes from palm flour industries in Daleman Village do not processed. Solid waste in the form of fibers as the effluent from the filtering process palm steam powder, allowed to accumulate along the way and the banks of the river without treatment processes. In the same case, the wastewater discharged into water bodies without treatment. It potential to pollute the environment both in the air, surface water, groundwater, and soil pollution of farmland.(Sudaryanto, 2006).

Solid waste floured palm fibers can essentially be recovered through simple processes, such as is used for fuel or for animal feed ingredient (Rosariastuti, 2006). The problems that exist in the village Daleman has lasted more than 20 years. In the opinion of Firdayati and Handajani (2005), leachate of solid waste is estimated to have infiltrated into the ground and began polluted to water bodies and irrigation systems in the area. The effect of using the water source was contaminated by leachate from the dregs of palm flour is a skin disorder and the death of the fish in the pond's fish population. Pollution of water bodies in the industrial area of this palm flour can also be seen on the river conditions are almost entirely covered by a pile of waste. The low quality of river water can be seen physically by high turbidity levels and the number of extremely low water biota as biological pollution index parameters.

In this study, wastewater is the main focus of this research, which conducted the testing and measurement characteristics of the wastewater discharge. Test and measurement data are used as technical considerations in making the design of wastewater treatment plants in the area of the palm flour industry, it is intended as a first step to minimize the potential for environmental pollution, especially groundwater.

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RESEARCH METHOD

There are two times data collection, wich are the collection data of daily discharge and wastewater characteristic testing of the palm flour industry in Bendo Hamlet, Village District DalemanTulung, Klaten, Central Java Province. The sampling is used purposive sampling. Sampling locations are determined in location near to the source of pollutant, in each sample unit in the population have the same opportunities. This sampling was chosen because considering the condition of the study site is the area of home industry, the majority of residents in the Hamlet Bendohas the same activity and produce similar waste. The frequency of sampling is momentary sampling (Grab Sampling) where the volume of water taken directly from water bodies to be studied (Son, 2009).

This study performed some data analysis which are: 1) Analysis to measure the volume of wastewater discharge, 2) Analysis of the characteristics of clean water for production processes, 3) Analysis of wastewater characteristics for the determination of unit WWTP, 4) Analysis of spatial distribution for the generation of wastewater and the potential environmental impacts

Discharge analysis and wastewater characteristics were conducted on in-site (sampling locations) and ek-site (laboratory) wich is based on the determined parameters. By having wastewater discharge data, the next stage is to determine the amount of waste water treatment plant. For waste characteristic data of laboratory test results, compared to the environment quality standards in Indonesia, and is also used to determination of WWTP units, through appropriate technology approach in order to keep the sustainability.

The analysis of clean water quality studied in-site (sampling locations) and ek-site (laboratory) is based on parameters that have been determined. The methods used in data analysis is quantitative descriptive and qualitative comparative descriptive. Quantitative descriptive method is a method used to describe the data obtained in this study in order to get the conclusion, whereas descriptive qualitative comparative method is a method used to compare the water quality in the study area with water quality criteria in the Minister of Health Number 492/2010 about Requirements of Drinking Water. Analysis of water quality through laboratory testing required to determine the characteristics of clean water which has been used for the manufacture of flour sugar palm, and to know the water quality in order to know whether the water should be used by residents for everyday purposes, the constraints faced in terms of water quality, and the solution population.

Spatial analysis with Geographic Information System (GIS) performed using the coordinates of the palm flour industry location, and then correlated with the base map. In addition to presenting the results of the analysis in the form of maps, elevation data is also taken that the contour calculation is then performed by using the Shuttle Radar Topography Mission (SRTM), the results of these calculations used for determining the location of the wastewater treatment plant. The design of WWTP will promote the use of gravity to be more efficient and easily applied by the community. The descriptive analysis will also explain the possible sources of pollutants, the spread of wastewater generation, the potential for environmental degradation that has or will occur, until the concept of wastewater management plan.

RESULT

Wastewater And Clean Water Quality

The concentrations of liquid industrial waste is allowed to flow into water bodies, must comply the environment quality standards of Environmental Minister's Regulation KEP-51/MENLH/10/1995 About Wastewater Quality Standard for Industrial Activities.

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To determine whether the wastewater produced in the process of making flour in palm study sites exceeded the threshold set by the government, then compared the results of laboratory tests with applicable quality standards. The results of comparison between the results of laboratory testing and quality standards (Table 1).

The tested data appears that the value of Total Disolved Solid (TDS) is 13.220 mg/l and Total Suspended Solid (TSS) is 373.200 mg/l, it indicates that the colloidal particles which contained in the water is very high, so that the intensity of light (the sun) that goes into the water is low (Metcalf and Eddy, 2003). For heavy metal concentration, it is only chrome (Cr) that has a concentration exceed a predetermined quality standard, which is 1,45 mg/l, whereas for its quality standard is only 1 mg/l.

Table 1 Wastewater Quality

Parameters	Unit	Test Result	Standard Quality I	Standard Quality II
Temperature	^{o}C	28,5	38	40
Conductivity	µS/cm	5,42	-	-
Dissolved Oxygen	mg/l	1,85	-	-
Total Disolved Solid (TDS)	mg/l	13.220	2.000	4.000
Total Suspended Solid (TSS)	mg/l	373.200	200	400
pH	-	4,3	6-9	6-9
Iron (Fe)	mg/l	6,3	5	10
Manganese (Mn)	mg/l	1,04	2	5
Copper (Cu)	mg/l	0,1221	2	3
Zinc (Zn)	mg/l	1,63	5	10
Chrom (Cr)	mg/l	1,45	0.5	1
Plumb (Pb)	mg/l	0,318	0.1	1
Biologycal Oxygen Demand (BOD)	mg/l	276	50	150
Chemical Oxygen Demand (COD)	mg/l	2.666	100	300
Oil and Fat	mg/l	1.687	5	10
Coliform	MPN/100ml	≥1.898	-	-
E-Coli	MPN/100ml	2,9 x 10^{4}	-	-

Wastewater generated from the manufacture of flour palm industry has a relatively low degree of acidity which is 4,3. The degree of acidity is due to the degradation of organic matter contained in the tub washing and settling tanks. The high organic matter is indicated by the high concentration of BOD and COD sufficiently, 276 and 2.666. The high BOD and COD values indicated the need of oxygen by the organisms to degrade contaminants in waste water biologically and chemically is also high. Thus, the content of dissolved oxygen (DO) remaining in the waste water to be low at only 1,85 mg/l. The high organic matter in wastewater can decrease the quality of the environment because these compounds will have been around a stabilization or degradation by microorganisms' activity. In this process the concentration of oxygen in contaminated water bodies with these wastes will decline, so it can disrupt the life of water biota.

In addition to the high parameters of TDS, TSS, pH, BOD, COD and several chemical compounds, the wastewater contained Coliform bacteria. According Firdayati and Handajani (2005), In the grocery industry, the presence of coliform bacteria group is not expected, because it shows the presence of contamination from the waste that comes from the digestion of human and warm-blooded animals. Content of Coliform bacteria at ≥ 1.898, whereas the E-Coli 2,9 x 104. This biological contamination can be occured due to several factors, which are the release of starch from sugar palm fiber is done by trampling

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on palm fiber without any self-sanitizing aspects, and also due to its inadequate sanitation systems so that the bacteria already exists before the production process, which means that contaminant comes from clean water for the production process, in where that clean water is used as solvent and immersion. Therefore, the water quality is required.

To determine the quality of water used in the production process as well as to people's daily consumption, the results of laboratory tests comparated with water quality standards as a benchmark comparison.

Table 2 Clean Water Quality

Parameters	Unit	Test Result	Standard Quality
Temperature	^{o}C	26	Normal
Conductivity	µS/cm	453	-
Dissolved Oxygen	mg/L	0,76	6
Total Disolved Solid (TDS)	mg/L	406	500
Total Suspended Solid (TSS)	mg/L	3.180	50
pH	-	6,38	6-9
Iron (Fe)	mg/L	4,85	0,3
Manganese (Mn)	mg/L	0,225	0,4
Copper (Cu)	mg/L	0,0493	2
Zinc (Zn)	mg/L	0,077	3
Chrom (Cr)	mg/L	0,775	Null
Plumb (Pb)	mg/L	0,175	0,01
Oil	mg/L	66,1	Null
Coliform	MPN/100ml	≥1.898	0
E-Coli	MPN/100ml	≥1.899	0

From the data in Table 2, there are seven parameters exceed the standard of clean water quality from Minister of Health Number 492/2010 about Requirements of Drinking Water. TSS, metallic iron (Fe), Chrom (Cr), Plumb (Pb), Oil, Coliform, and E-Coli with the test results 3.180 mg/l, 4,85 mg/l, 0,775 mg/l, 0,175 mg/l, 66,1 mg/l, ≥1.898 MPN, and ≥1.898 MPN exceed the recommended standard of clean water quality, which are 50 mg/l, 0,3 mg/l, Null, 0,01 mg/l, Null, 0, and 0.

Distribution of Palm Flour Industry

Palm flour industry in Daleman Village and surrounding areas in Tulung, Klaten, is categorized as home industry. The total amount of that home industry are more than 52 (fifty two), so that the amount of waste produced is very large. The largest position is in the settlements of the frontier between Daleman Village and Pucangmiliran Village. The nearest river from that villages are Bentangan River and Belukan river. From that two rivers, Bentangan Rivers is more crittical to the waste contaminated because most numerous industries nearby. Based on digital distance measurement using geographic information system (GIS), the nearest industry to the Belukan River is 10,5 m, while to Bentangan River is 228,5 m.

From the coordinates of the field survey data, spatial analysis is used to presented in the form of a map. A map of the distribution and amount of palm flour industry (Figure 1). The distribution map of palm flour industries and wastewater discharge (Figure 2).

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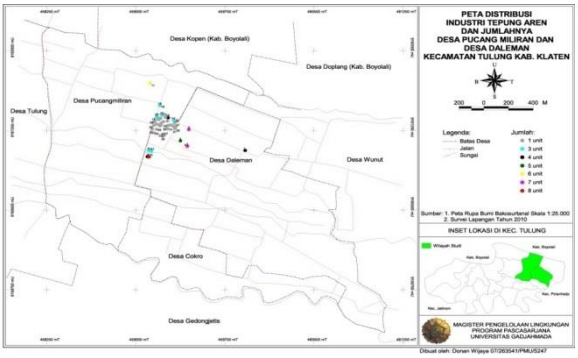

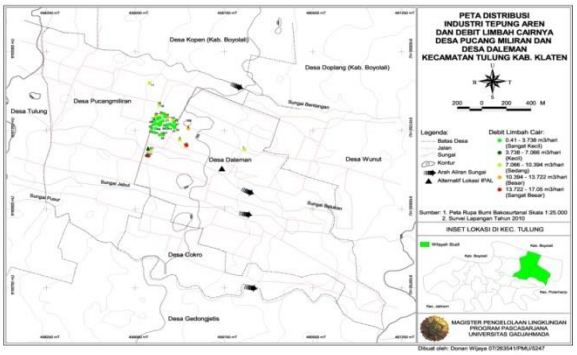

Figure 1 Map of Palm Flour Industry Figure 2 Map of Distribution and Liquid DistributionWaste Discharge

Belukan River is high enough to contaminate, and this river is a branch of the longitudinal Jebul River and into the sub-system of Bengawan Solo Watershade. In the other way, palm flour wastewater has an opportunity to contaminate ground water, especially at the dry season when river infiltrate to the land.

From the land use map, there are industrial areas in the residential, due to industrial scale is categorized as home industry. The residential area surrounded by agricultural area, allow give a positive or negative impact on agricultural production. Firdajanti and Handajani (2005) mentions that wastewater of palm flour production process has a positive value, because currently most of the wastewater is sometimes used for watering and fertilize rice plants, which is a major commodity in the area around the Daleman Village. The usage of this wastewater is traditionally done in considering that the contains of nutrients are useful for plants. But it is requires a more in-depth research, whether it is true that wastewater can increase the yields.

Discharge Wastewater for WWTP Planning

A large number of home industries palm flour Daleman Village and its surrounding areas are about fifty two industry, requires an integrated handling of wastewaters to be more efficient. In the WWTP planning, the daily discharge of industry is importan to be analyzed. From the results of volume measurements and the calculation of the number of units in each industry, most industries (30 industries) only have one tub unit, while the rest have more than 2 units of the tub. The total number of whole tub is 119 units with an average volume is about 1.32 m3, and the total volume of wastewater generated in the entire area of 68.52 m3. From the measurements above, it can be calculated the total daily discharge of the entire industry amounted to 216.06 m3/day, or about 0.0025 m3/second. Total discharge is to be used as reference in calculating the amount of units in a wastewater treatment plant (WWTP).

DISCUSSION

Environmental Degradation

Metals and some other parameters such as oil and biological parameters are not only found in wastewater from the palm flour production process only, but also found in clean water from wells in industrial area (Mr. Mudhlori's well). It is believed that has a strong correlation, which is wastewater contamination is not only from the treatment of production process, but also from clean water (wells) used. Clean water (wells) with bad quality because some parameters exceed the allowed standar quality because of the contamination from palm flour industry in the Daleman Village. It indicate the interdependence of quality between the clean water and wastewater.

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The concentrations of wastewater can be ascertained contain the organic material, starchs or fibers in the form of dissolved or suspended particles. The high content of organic matter depends on the efficiency of the separation process from the water extract (Firdajanti and Handajani, 2005). When the wastewater is dumped into the environment without prior treatment, the wastewater will change its color into blackish brown and smelly. This changes due to the occurrence of decomposition of organic matter in the septic condition and the rate of oxygen in the water puddle to zero. The wastewater can seep into the well and flow into water bodies (rivers) around the place. As a result, the wells and rivers will decrease its quality and are not eligible to be used as a source of clean water.

Thus, in order to prevent the environmental pollution and the reciprocal contaminated phenomenon, there is a need to treat wastewater of palm flour industry before discharged into water bodies, the purpose are to decrease its suspended solids concentrations, metals and organic materials that potentially contaminated the environments. Clean water (wells) are not only used for the production of palm flour industry only, but also for consumption and daily needs. It should to have a prior treatment, so the potential health disorders as a result of bad quality water could soon be prevented.

The Design Calculations Wastewater Treatment Plant (WWTP)

The amount wastewater discharge generated about 0,0025 m3/day or 216.06 m3/second over this time and without treatment prior before it is dumped into water bodies, are potentially contaminate the environment. In certain conditions, the wastewater can be infiltrated into the ground so that not only pollute the river water only, but also groundwater. Based on the results of laboratory tests on wastewater from palm flour industrial, and with a variety of technical and social considerations, the wastewater treatment unit selected are aeration and sedimentation tanks. Aeration system with cascade aeration which is tiered waterfall model has an efficiency of manufacturing costs, low maintenance, and requires no special treatment. Sedimentation tanks for the selected shape is rectangular. The selection of the sedimentation tanks is based on the technical ease of manufacture, low maintenance, and high velocity sedimentation.

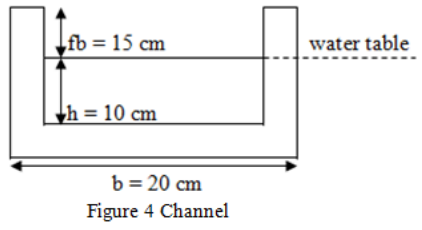

Figure 4 Channel

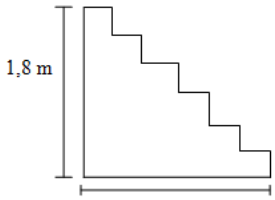

Figure 5 Cascade Aeration

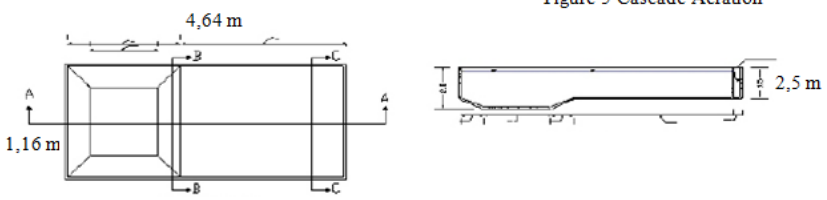

Figure 6 Rectangular Sedimentation

Environmental Management Strategy (SPL)

In preventing the potential negative impacts resulting from human activity, especially from palm flour industry Daleman Village, Klaten, need systematic and integrated steps. In this study, environmental management is made to be more concentrated on the impact of

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wastewater, so the selected treatment unit is wastewater treatment plants (WWTP). The design of WWTP that has been presented is an alternative technical solutions, and it is needs to be correlated to the other aspects approaches for environmental management strategies. Environmental management strategies is important because it contains good advices on the technical level, social, and bureaucratic. The environmental management strategy are as follows:

1. Government: Local Government Klaten, Central Java Provincial Government and central government through the Ministry of Environment needs to educate the public to be able to jointly conduct environmental management, regulatory instruments related to dumping waste in environmental media; seize the initiative for communities to build wastewater treatment plant and solid waste processing unit; mediate the society in which partners can utilize the waste from the production process of solid waste in particular palm flour; facilitating planning financing wastewater treatment plant that has been planned through the mechanism to be more easily realized softloan society; conduct surveillance andenvironmental monitoring activities in the area Daleman palm flour industry and its surrounding villages;
2. Educational institutions (Universities): Universities and colleges in the region of Central Java and Yogyakarta with the government to educate the public to carry out clean production in industrial activity palm flour through community empowerment programs; assist the technical planning of wastewater treatment plants with the right technology approach to make it more applicable and effective; allocate research funding and establish cooperation with foreign institutions to conduct applied research on aspects that are considered critical as the handling of waste;
3. Society: building a collective commitment to environmental management with an alternative solution in constructing of wastewater treatment plants; improving the sanitation system in stages to improve ground water quality conditions (wells); increasing hygienity by implementing cleaner production program to improve product quality; perform waste management liquid, solid, until the domestic waste;
4. The other stakeholders; private companies around the study sites (PT. TirtaInvestama as the producer of Aqua) can build a partnership with the community through activities Corporate Social responsibility and community development programs that focused on environmental management.

CONCLUSION

The From this study obtained the following results:

a. Some parameters of wastewater generated palm flour industries at Daleman Village, Klaten, exceeded the quality standard of The Environmental Minister's Regulation KEP-51/MENLH/10/1995, is the parameter Total Disolved Solid (TDS), Total Suspended Solid (TSS), Degree of acidity (pH), chrome, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Oil.
b. The position of the largest industries is in the settlements on the border between the Daleman Village and Pucangmiliran Village. The number of the largest industries is in Daleman Village. The nearest river from that villages are Bentangan River and Belukan river. From that two rivers, Bentangan Rivers is more crittical to the waste contaminated because most numerous industries nearby. Based on digital distance measurement using Geographic Information System (GIS), the nearest industry to the Belukan River is 10.5 m, while to Bentangan River is 228.5 m.
c. There are 54 palm flour industries with a total discharge of wastewater is about 216.06 m3/day.

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d. Environmental management strategy with the technical approach through the design of wastewater treatment plant (WWTP), with the units used are six levels cascade aeration with a length and height of 1,8 m and rectangular sedimentation with a length of 4,64 m, width 1,16 m, and height 2,5 m.

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