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Analysis of liquid waste in weaving home industry at Nusa Penida, Klungkung, Bali, Indonesia

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ABSTRACT

Introduction: The existence of regulations using clothing made from traditional Balinese fabrics cloth called "endek" has caused the demand for woven fabrics to increase. One of the traditional woven fabric handicrafts starting to be recognized and favored by the public is the Cepuk and Rangrang woven fabric from island of Nusa Penida. Currently, liquid waste from weaving home industry activities has not been processed. The purpose of the study was to measure the quality of liquid waste from the weaving home industry and compare it with the quality standards of liquid waste for businesses and or textile industry activities.

Method: This study was descriptive, conducted in Nusa Penida District, Klungkung Regency. The sample size was 25, taken by purposive sampling from nine craftsmen actively carrying out the production process with repetition three times. Measurement of liquid waste quality was carried out at the Laboratory of Panureksa Denpasar. The parameters examined are mandatory test parameters including physical parameters (temperature, TDS, TSS and color) and chemical parameters (total chromium, total ammonia, BOD_5, COD, sulfide, oil and fat). Data analysis was carried out by comparing the measurement results with the Liquid Waste Quality Standards for Textile Industry Businesses and Activities according to Bali Governor Regulation 16 of 2016.

Result: The results showed an average temperature of 27.48° C, TDS levels of 6,095.20 mg/L, TSS 1,090.76 mg/L and color 2,216.56 TCU scale. The chemical parameters showed average levels of total chromium 2.3912 mg/L, total ammonia 1.6068 mg/L, BOD_5 675.84 mg/L, COD 1,286.72 mg/L, Sulfide 0.2395 mg/L, oil and fat 1,340 mg/L. Based on Bali Governor Regulation No. 16 of 2016, the parameters of temperature, total ammonia, Sulfide, Oil and Fat meet the quality standard requirements. While the parameters of TDS, TSS, color, total chrome, BOD and COD do not meet the quality standard requirements because it exceed the maximum allowable levels.

Conclusion: It is recommended that weaving craftsmen carry out liquid waste treatment before disposal in the environment.

Keywords: liquid waste; home industry weaving.
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INTRODUCTION

The development of the textile industry in Indonesia from year to year shows an increasing development. The textile and apparel industry is one of the pillars of the non-oil and gas processing industry sector. The contribution of the number of workers reached 2.67 percent, the second largest in the processing industry. In 2021, the Gross Domestic Product (GDP) of the textile industry reached 6.3 percent of the non-oil and gas processing industry. The increasing trend of the textile industry in 2016-2017 makes the textile and apparel industry one of the priorities to be developed in the National Industrial Development Master Plan.[1]

In Bali, the development of the textile industry has also increased, especially clothing made from traditional Balinese woven fabric cloth called "endek". Traditional Balinese woven fabric is a creative cultural heritage of the Balinese people that must be preserved and protected and used and empowered as the identity of the Balinese people. The Governor of Bali has issued Decree Letter number 4 of 2021 concerning the Use of Balinese Endek Woven Fabric/ Balinese Traditional Woven Fabric. The circular letter urges all public and private institutions and community organizations to use clothes/clothing made from Balinese endek various activities every Tuesday. The existence of rules using clothing made from traditional Balinese endek, caused the weaving industry to increase. One of the famous traditional woven fabric crafts is the Cepuk and Rangrang woven fabric.

Cepuk and Rangrang woven fabrics are crafts from Nusa Penida. The weaving craft is done from generation to generation on a household scale so that it can increase the community's source of income. Woven fabrics are made simply using non-machine looms, so it takes a long time to complete a piece of cloth. The coloring

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process uses natural dyes. The increase in tourist visits has increased demand for typical Nusa Penida woven fabrics. The demand for more diverse patterns and motifs causes the coloring materials used to be not only natural dyes, but also synthetic coloring.

In addition to producing fabric, the process of making woven fabric also produces liquid waste. The results of the initial survey of the wastewater produced, the waste is concentrated in color after the yarn dyeing process. Color is a qualitative characteristic that can be used to assess the general condition of wastewater. Textile industry waste is generally dominated by the presence of color in wastewater due to the dyeing process. At the time of dyeing and rinsing produces wastewater that is colored according to the dye used.[2]

The batik and textile industry is one of the producers of liquid waste derived from the coloring process. Batik and textile industry waste in addition to having a high dye content, also contains synthetic materials that are difficult to dissolve or not easy to decompose. When the coloring process is complete, cloudy, concentrated liquid waste will be produced and has a color according to the dye used. Waste dyes generated from the textile industry are generally non-biodegradable organic compounds, so they can cause environmental pollution.[3]

Industrial wastewater has become one of the concerns in recent years, especially wastewater from the textile industry. The Regional Government regulates wastewater quality standards for businesses and/or textile industry activities through Bali Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria. The quality standard parameters of textile wastewater must be tested, including Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), total chromium (Cr), total ammonia (NH3-N), sulfide (S), oil and grease.[4]

Liquid waste generated by weaving crafts is currently not managed properly. Liquid waste by the community is disposed of directly in open areas such as moorlands, home yards or small ditches around the house. If this condition is left unchecked, it will cause environmental pollution in the long run. The home weaving industry in Nusa Penida is a supporting factor for the community's economic growth in the island region. The existence of environmental pollution issues will affect the image of the Nusa Penida islands as one of the developing tourist destinations. The purpose of the study was to measure the quality of liquid waste from the weaving home industry in Nusa Penida and compare it with the Liquid Waste Quality Standards for Businesses and or Textile Industry Activities according to Bali Governor Regulation Number 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria.

METHODS

This study was descriptive, conducted in Nusa Penida District, Klungkung Regency, Bali, Indonesia. The population was liquid waste from weaving craftsmen. Research sampling was done by purposive sampling. The size of the study sample was 25, taken from nine craftsmen who were still actively carrying out the production process with a repetition of three times. Wastewater sampling is carried out on wastewater before it is discharged into the environment. Data collection was carried out through measurement of wastewater quality at the Laboratory of Panureksa Denpasar. The parameters examined were physical parameters (temperature, TDS, TSS and color) and physical parameters (total chromium, total ammonia, BOD_5, COD, sulfide, oil and fat). Data analysis was carried out by comparing the results of liquid waste measurements with the Liquid Waste Quality Standards for Businesses and or Textile Industry Activities listed in the Bali Governor Regulation Number 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria.

RESULTS AND DISCUSSION

Characteristics of liquid waste in weaving industry

Cepuk fabric is made simply using non-machine looms, so it takes a long time to complete a piece of cloth. Weaving a cloth with a width of two meters takes about 5 to 30 days, depending on the motif or pattern and the type of coloring used. Generally, the manufacture of fabrics using synthesized dyes takes faster than using natural dyes, the price is cheap and the colors are diverse.

In addition to producing fabric, the process of making Cepuk woven fabric also produces liquid waste. Based on the results of the research, the liquid waste generated by each home industry weaving in Nusa Penida averages 20-30 liters per day. The volume of waste is also based on the size of the fabric orders obtained by weaving craftsmen. The volume of waste produced is relatively small, depending on the fabric orders received by the craftsmen. The liquid waste produced by weaving waste is very concentrated in color according to the color during the dyeing process, including red, orange, yellow and blue.

Dyes during the dyeing process generally do not enter all of them into the yarn used as textile materials. The liquid waste produced contains residual dyes according to the colors used, including red, orange, yellow, blue and black. So liquid waste from the textile industry is easily recognized when discharged directly into the environment. The use of synthesized colors can cause problems in the environment because they are difficult to degrade.[5]

During the coloring process, most weaving craftsmen use synthetic dyes. This compound is only used about 5%, while the remaining 95% will be disposed of as waste. Synthetic dyes are generally quite stable, making it difficult to degrade in nature and harmful to the environment. Its presence in very large concentrations because it can increase COD (Chemical Oxygen Demand).[3]

Liquid waste generated by weaving crafts is currently not managed properly. Liquid waste by the community is disposed of directly in open areas such as home yards or small ditches around the house. Environmental pollution due to waste depends on the characteristics of the waste produced by an industrial business. Waste treatment that is not maximized is due to the lack of waste treatment technology and the side effects of waste treatment, namely the presence of toxic gases such as carbon monoxide, cyanide hydrogen (HCN).[6]

Weaving Industry Liquid Waste Quality

Liquid waste results from activities or industrial processing in the shape of liquid. Its existence is a pollutant that must be treated properly so that it does not exceed the quality standard threshold set by the government. Waste characteristics include physical and chemical characteristics.

Physical parameters

Based on the results of laboratory examinations, the percentage of physical parameters of liquid waste that meet the quality standard requirements according to Bali Governor Regulation Number 16 of 2016 is as follows:

The levels of each wastewater based on physical parameters can be seen in table 1. In the effluent quality standard, the maximum level for a substance to be discharged into the environment is regulated. Based on table 1 and 2, the physical parameters for temperature still meet the threshold, because they have not exceeded the maximum allowable levels. However, the levels exceed the quality standards in the parameters of Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and color.

Temperature

Temperature is an important parameter due to its effects on chemical reactions, reaction rates and water use in daily life. Usually, wastewater has a temperature that tends to be warm towards hot. Good water has the same temperature as the ambient air temperature (26-30° C). Based on the results, the temperature of liquid waste in the weaving home industry ranges from 26.3-31° C (According to the Governor's regulation No. 16 of 2016) the maximum allowed is 38° C, so the temperature is still in accordance with meeting the quality standard requirements.

Total Dissolved Solids (TDS)

Based on the results of the study, the effluent TDS levels were between 1,580-17,400 mg/L and an average of 6,095.20 mg/L (According to the Governor's regulation No. 16 of 2016) the maximum allowed is 2,000 m/L, so the TDS levels do not meet the quality standard requirements. Based on figure 1, all samples (100%) of liquid waste TDS levels do not meet the quality standard requirements. The presence of high concentrations of TDS in water bodies can cause pollution and death of aquatic organisms. High TDS will reduce the ability of water bodies to maintain aquatic ecosystems. TDS analysis is needed to determine the pollution load and to design a biological wastewater treatment system. Therefore, an effort is made to treat the TDS so that the content is obtained in accordance with the quality standards.[3]

Total Suspended Solids (TSS)

Suspended solids (TSS) are suspended materials in a volume of water. It is important to measure TSS levels in waste water, because it can determine the level of water pollution by suspended solids. The content of TSS in large amounts in wastewater will cause turbidity in the water. Precipitation will occur if the wastewater is allowed to stand for a relatively long time. Based on the results, the TSS level of wastewater is between 135-2500 mg/L and an average of 1,090.76 mg/L (According to the Governor's regulation No. 16 of 2016) the maximum allowed is 50 mg/L, so TSS levels do not meet the quality standard requirements. Based on graph 1, all samples (100%) of wastewater TDS levels do not meet the quality standard requirements.

Color

Color is a qualitative characteristic that can be used to assess the general condition of wastewater. Textile industry waste is generally dominated by the presence of color in wastewater due to the dyeing process. At the time of coloring and rinsing produces wastewater that is colored according to the dye used.[2] Based on observations, the color of wastewater is very concentrated, this is supported by the results of the color examination showing a color parameter value of 330-8,870 TCU scale. In the quality standards of the Governor of Bali No. 16 of 2016, there is no

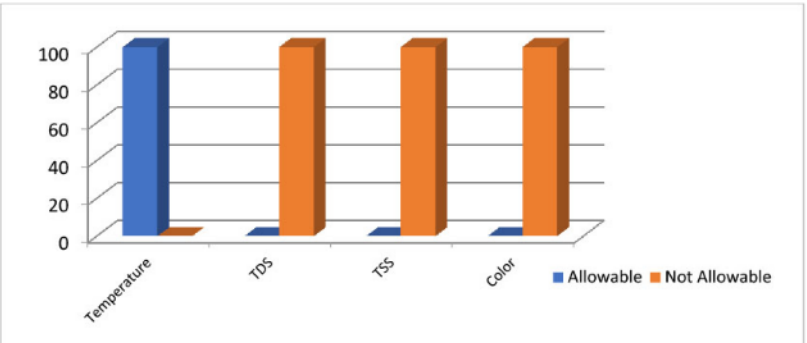

Figure 1. Percentage of Liquid Waste Physics Parameters that Meet Quality Standard Requirements.

Table 1. Liquid Waste Quality Based on Physical Parameters.

No	Parameter	Unit	Results			Standard requirement (Pergub Bali No 16 Tahun 2016)
			Lowest value	Highest value	Average	
1	Temperature	°C	26,3	31,0	27.48	38
2	Total Dissolved Solids (TDS)	mg/l	1.580	17.400	6095.2	2.000
3	Total Suspended Solids (TSS)	mg/l	135	2500	1090.76	50
4	Color	TCU scale	330	8870	2216,56	-

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maximum level listed, but the color of the wastewater is very concentrated colorful, so it does not meet the requirements for discharge into the environment.

Chemical Parameters

Based on the results of laboratory examinations, the percentage of wastewater that meets the quality standard requirements according to Bali Governor Regulation Number 16 of 2016 on chemical parameters can be seen in figure 2.

The levels of each liquid waste based on chemical parameters can be seen in table 2.

Total Chromium (Cr)

The results of this study according to table 2 show that chromium levels in wastewater between 0.35-6.30 mg/L and an average of 2.3912 mg/L. According to the Governor's regulation No. 16 Year 2016) the maximum allowable level is 1 mg/L. Based on graph 2, the percentage of liquid waste samples mostly (68%) chromium levels do not meet the quality standard requirements. Textile industry waste was identified as containing heavy metal chromium (Cr) which is used in large quantities in the textile refinement process. Textile waste that is disposed of without treatment has the potential to cause migration of heavy metal chromium to the surrounding ecosystem. Heavy metal chromium in textile waste can pollute waters and even accumulate in rice fields and plantations, leading to a decrease in public health.[8]

Total Ammonia (NH_3- N)

The results showed total ammonia levels (NH_3- N) in wastewater between 0.15-11.40 mg/L and an average of 1.6068 mg/L. According to the Governor's regulation No. 16 Year 2016) the maximum allowable level is 8.0 mg/L, so ammonia levels (NH_3- N) meet the quality standard requirements. Based on graph 2, all samples meet the requirements for total ammonia levels (NH_3- N). Ammonia (NH_3 -N) levels are highly toxic substances, which can result from the decomposition of organic and organic substances in wastewater.[9]

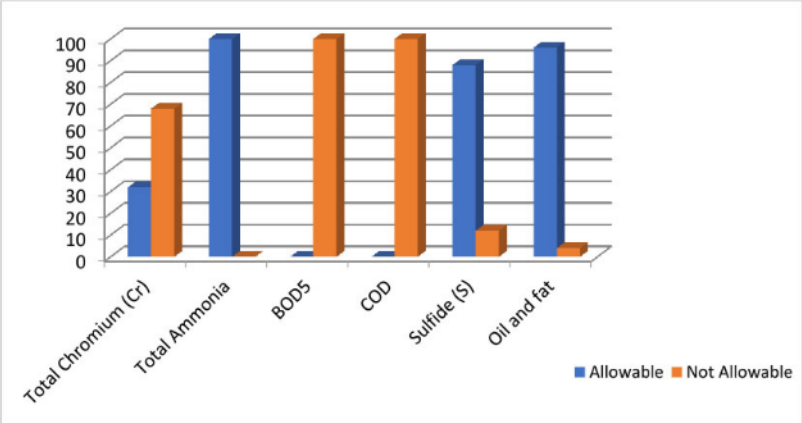

Figure 2. Percentage of liquid waste that meets the requirements Quality Standard on Chemical Parameters.

Biochemical Oxygen Demand (BOD)

Based on the research results, the BOD levels are between 100-1,560 mg/L and an average of 675.84 mg/L. According to the Governor's regulation No. 16 of 2016) the maximum allowable level is 50 mg/L, so the BOD level does not meet the quality standard requirements. Based on graph 2, the percentage of liquid waste samples all (100%) BOD $levels_5$ do not meet the quality standard requirements.

Biochemical Oxygen Demand (BOD) levels are the amount of dissolved oxygen required by bacteria to decompose or oxidize almost all dissolved organic substances and some suspended organic substances in water.[10] The BOD measurement method is used to measure the sample's initial dissolved oxygen content (DOi) immediately after sampling. Furthermore, measuring the dissolved oxygen content in samples that have been incubated for 5 days in dark conditions with a temperature of 20° C or wh is often called DO_5. The BOD value is the difference between DO_i and DO_5, expressed in milligrams of oxygen per liter (mg/L). High BOD levels indicate high organic matter content in wastewater. BOD levels are important to determine the proportion of the amount of biodegradable organic matter and provide an idea of the amount of oxygen that will be used in the decomposition process in a week.[11]

Chemical Oxygen Demand (COD)

Based on the research results, COD levels are between 300-2700 mg/L and an average of 1,286.72 mg/L. According to the Governor's regulation No. 16 of 2016) the maximum allowable level is 150 mg/L, so the COD level of wastewater does not meet the quality standard requirements. Based on graph 2, the percentage of liquid waste samples all (100%) COD levels do not

Table 2. Liquid Waste Quality Based on Chemical Parameters.

No	Parameter	Results				Maximum Allowable Level (Bali province decree number 16 in 2016)
		Unit	Lowest Value	Highest Value	Average	
1	Total Chromium (Cr)	mg/L	0.35	6,30	2.3912	1.0
2	Total Ammonia (NH_3N)	mg/L	0.15	11.40	1.6068	8.0
3	BOD_5	mg/L	100	1.56	675.84	60
4	COD	mg/L	300	2.700	1.286.72	150
5	Sulfide (S)	mg/L	0.09	0.62	0.2395	0.3
6	Oil and fat	mg/L	0.45	2.20	1.340	3.0

meet the quality standard requirements.

Chemical Oxygen Demand (COD) levels are the amount of chemical oxygen needed to break down all organic matter contained in water. COD levels are studied to describe the amount of organic substances dissolved in wastewater.[10] If the concentration of organic matter in wastewater gradually decreases, the COD level will decrease.[12]

Sulfide (S), Oils and fats

The textile industry is one of the industries that produces liquid waste with high Sulfide levels. In certain levels H_2S is toxic to humans, animals and aquatic biota. H_2S compounds can also cause corrosion.[13] Based on the research results, Sulfide levels are between 0.09-0.62 mg/L and an average of 0.2395 mg/L. According to the Governor's regulation No. 16 Year 2016) the maximum allowable level is 50g/L, so the Sulfide level meets the quality standard requirements. Similarly, in oil and fat, the results showed levels between 0.45-2.20 mg/L and an average of 1.340 mg/L, which means that oil and fat levels meet the quality standard requirements.

CONCLUSIONS AND SUGGESTIONS

Physical parameters show an average temperature of 27.48° C, TDS levels of 6095.20 mg/L, TSS of 1090.76 mg/L and color of 2216.56 TCU scale.nThe chemical parameters showed average levels of total chromium 2.3912 mg/L, total ammonia 1.6068 mg/L, BOD 675.84 mg/L, COD 1286.72 mg/L, sulfide 0.2395 mg/L, oil and fat 1.340 mg/L. Temperature, total ammonia, Sulfide, Oil and Fat parameters meet the quality standard requirements according to Bali Governor Regulation No. 16/2016. In the parameters of TDS, TSS, color, total chrome, BOD_5 and COD do not meet the quality standard requirements because the levels exceed the maximum levels allowed according to the Bali Governor's regulation No. 16 of 2016.

Suggestion

For weaving craftsmen it is recommended to carry out wastewater treatment before disposal in the environment, so that parameters that do not meet quality standards can be reduced.

CONFLICT OF INTEREST

All author declares there is no conflict of interest regarding publication of the study.

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AUTHOR CONTRIBUTION

All authors had contributed to manuscript writing and agreed for the final version of the manuscript for publication.

ETHICAL CONSIDERATION

This study has been allowed by the Government of Klungkung Regency with research permit number 503/105/RP/DMPTSP/2022,

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