Medical Laboratory Technology Journal
10(1), 2024, 18-27
Received 2023-11-09; Revised 2023-09-12; Accepted 2024-20-01
Available online at : http://ejurnal-analiskesehatan.web.id

Analyze of Parameter Values of Sasirangan Home Industry Wastewater at Hot and Cold Dyeing

Noraida, *Abdul Khair

Environmental Health Poltekkes Kemenkes Banjarmasin, Mistar Cokrokusumo Street 1a Banjarbaru, Indonesia.*Email: ulunkhair@gmail.com
DOI: 10.31964/mltj.v10i1.555

Abstract: The sasirangan fabric home industry produces wastewater through the hot and cold dyeing process. It is necessary to know the coloring process and wastewater parameter values to design good wastewater treatment. The purpose of the study was to compare the wastewater parameter values including pH, NH3-N, BOD5, COD, TSS, Oil/Fat, Color, Phenol, Temperature, H2S and Crom Total from Sasirangan Home Industry Wastewater at Hot and Cold Dyeing. This type of research is comparative research with static group comparison design. The sample is a portion of wastewater from home industries from in the province of South Kalimantan Indonesia, namely Banjarmasin City, Banjarbaru City, and Banjar Regency. The sampling technique used accidental sampling with a total of 20 samples consisting of 10 samples of the hot dyeing process and 10 samples of the cold dyeing process. Parameters that do not meet the standards in the hot dyeing process are pH, BOD5, COD, TSS, color, and phenol, while in the cold dyeing process are BOD5, COD, TSS, and color. Statistically, there is a significant difference in the parameter values of pH, TSS, color, phenol, and temperature in sasirangan cloth home industry wastewater between the two processes. The results of the research can be used for planning wastewater treatment for the Sasirangan home industry.
Keywords: Dyeing; home ındustry; hot and cold; sasirangan.

INTRODUCTION

Cancer is one of the NCDs. Cancer in Indonesia is the highest NCD after coronary heart disease. One of the triggers for cancer is synthetic dyes, which in certain levels can be toxic and carcinogenic. (Adriani & Zarwinda, 2019).

Dyes are divided into natural and synthetic dyes. Synthetic dyes are easy to produce, have different colors, and have fastness properties, so they are more widely used than natural dyes (Khehra et al. 2006). Synthetic dyes, apart from being easy to obtain raw materials, the coloring process is also easier and faster (Nugraha & Rakhmatiara, 2020; Rosyida & Achadi, 2014). Synthetic dyes are classified into different groups based on their chemical structure (e.g. azo, anthraquinone, sulfur, phthalocyanine, and triarylmethane) and according to the way they are applied (e.g. reactive, direct, disperse, basic dyes) (Popli and Patel 2015). Ecosystems can be polluted by textile industry waste because the waste is dumped into the surrounding environment without special processing first and does not meet quality standards that are safe for the environment (Andriani, 2017; Paramnesi & Reza, 2020; Zammi et al., 2018). River water polluted by the disposal of textile dye waste can inhibit the life of biota that lives along the river flow. (Zammi et al., 2018). Apart from polluting river water, textile dye wastewater can also pollute people's dug wells (Rizza, 2013)

The textile industry in Indonesia grew rapidly starting in 2018 compared to the food and beverage industry, chemical industry, automotive industry, and electronics

Corresponding Author: Abdul Khair
Environmental Health Poltekkes Kemenkes Banjarmasin, Mistar Cokrokusumo Street 1a Banjarbaru, Indonesia.
Email: ulunkhair@gmail.com

industry (Pratiwi, 2020). However, this condition can cause other problems, these industries produce liquid waste in the form of synthetic dyes, suspended solids, heavy metals, and other chemical components that can pollute the surrounding environment (Subagyo, 2021).

The Banjar tribe is an indigenous population living in South Kalimantan, Indonesia that has certain characteristics. One of the characteristics of the Banjar tribe is the use of cloth clothing with colorful patterns and distinctive designs called sasirangan cloth. Initially, sasirangan cloth was used by the nobles of the Banjar kingdom. But nowadays, the popularity of sasirangan fabric has increased and made it a local industrial commodity typical of South Kalimantan (Andriana, 2018).

Currently, the sasirangan industry can be said to be a mainstay industry, the sasirangan industry has been designated as one of the ten leading commodities/products/business types of South Kalimantan (Putra, 2011). Sasirangan cloth is produced by home industries, on the one hand, the sasirangan cottage industry has improved the community's economy, but on the other hand, the wastewater produced has not been managed properly (Andriana, 2018).

Based on preliminary studies conducted by researchers, it is known that the distribution of sasirangan home industries in South Kalimantan is mainly in Banjarmasin City, Banjarbaru City, and Banjar Regency. According to Nasruddin et al., 2018 the majority of sasirangan industry business managers (80%) use synthetic dyes. The types of chemicals used in dyeing sasirangan fabric include Na2SO4, SLS, caustic soda, indhanthren dye (especially for hot dyeing), indigosol dye (hot dyeing), naphthol dye (especially for cold dyeing), frozen/frosi dye (cold dyeing), the most widely sasirangan industry for used Indhanthren dye and naphthol dye (Nasruddin et al., 2018).

Indhanthren dye has physical characteristics such as blue needles with a metallic luster or very fine blue powder, insoluble in water (must first be reduced to an alkaline metal salt solution), resistant to light and heat, but sensitive to chlorine, poor affinity, cannot color. cellulose fiber directly (Nasruddin et al., 2018). Indhanthren dyes used for sasirangan cloth include Yellow FG, Gold Yellow, Brown, Gray, Violet, Black, Red, Green B, RSN, Blue KR (Nasruddin et al., 2018).

Naphthol dye has the characteristics of being colorless and insoluble in water (caustic soda is needed), it is an adjective dye (needs another substance to produce color), the color produced depends on the type of naphtol salt at the time of coupling, during the intermediate time the naphthol fabric material is sensitive to air, light, droplets of other liquids, chemical vapors, so it must be dry when coupling is carried out (Nasruddin et al., 2018). Naphthol dyes used for sasirangan fabric include Naphthol AS G, Naphthol AS LB, Naphthol AS, Naphthol ASD, Naphthol AS BS, Naphthol AS, Naphthol AS BR, Yellow, Orange GC, Red GG, Red B, Violet B, Blue B, Blue BB, Black B, TRO (Nasruddin et al., 2018).

Previous research regarding the parameters of sasirangan wastewater has been carried out, namely on the color of wastewater (Arifin et al., 2017), BOD and COD levels of sasirangan waste (Ilmannafian et al., 2022), sulfide levels, BOD, COD, total phenols, TSS, oil and fat, NH3N, chrome, cadmium, pH of sasirangan waste (Nasrullah et al, 2018).

However, there is still limited research analyzing the parameter values of sasirangan fabric wastewater related to the hot/cold dyeing process carried out due to differences in the types of dyes such as Indhanthren dye (specifically for hot dyeing) and naphthol color (specifically for cold dyeing). So this research aims to compare the parameter values of Sasirangan household industrial wastewater in hot and cold dyeing.

MATERIALS AND METHODS

This type of research is comparative research, which compares parameter values in sasirangan home industry wastewater between the hot dyeing process and the cold dyeing process. The research sites were sasirangan home industries located in the province of South Kalimantan Indonesia, namely Banjarmasin City, Banjarbaru City, and Banjar Regency. The study population was all home industry wastewater from the hot dyeing process and the cold dyeing process. While the sample is a portion of home industry wastewater from the hot dyeing process and the cold dyeing process.

The sampling technique uses accidental sampling with a total of 20 samples consisting of 10 samples of the hot coloring process and 10 samples of the cold coloring process. Measurement of pH and temperature parameters is carried out directly in the field. Sample treatment for delivery to the Banjarbaru Standardization and Industrial Services Center (BSPJI) laboratory is for examination of TSS, color, and BOD parameters put in a cool box, for examination of crom parameters preserved with the addition of nitric acid, and for examination of oil/fat, ammonia, COD, and phenol parameters preserved with the addition of sulfuric acid.

pH examination using Lovibond pH meter with SNI method, NH_3-N using Shimadzu UV-1900 Spectrophotometer with SNI method, BOD5 using Horiba DO Meter with Winkler Titrimetric method, COD using Horiba Spectrophotometer with SNI method, TSS using oven and anaitic balance with SNI method, Oil/Fat using oven and analytical balance with Gravimetric method, Color using Hach Spectrophotometer with Spectrophotometric method, Phenol using Shimadzu UV-1900 Spectrophotometer with Spectrophotometric method, Temperature using Lovibond Digital Thermometer, H_2S using Pyrex Burette with Titrimetric method, and Total Chrom using SSA GBC Avanta with SNI method.

The data obtained were then analyzed descriptively and analytically. T-test was conducted to compare the value of sasirangan home industry wastewater parameters between the hot dyeing process and the cold dyeing process according to the results of the data distribution test.

Approval for this study was obtained from Ethics Comission of Politeknik Kesehatan Kemenkes Banjarmasin No.208/KEPK-PKB/2023.

RESULTS AND DISCUSSION

Wastewater treatment design must begin with understanding the processes that occur in the industry that generates the wastewater. Furthermore, sampling and parameter checks are carried out and compared with applicable regulations. Currently, regulations related to Wastewater Quality Standards for Textile Industry Businesses and/or Activities are listed in the appendix of the Minister of Environment and Forestry Regulation No.P.16/MenLHK/Setjen/Kum.1/4/2019.

It is known that there are 2 coloring processes carried out in the sasirangan fabric home industry, namely the hot coloring process and the cold coloring process. The results of sampling and examination of 11 parameters in the hot dyeing process are shown in Table 1.

Table 1. Descriptive Analysis of Hot Dyeing Process Parameters

Parameters	Unit	Min	Max	Mean	SD	Standar*
pH	-	11.28	13.18	12.35	0.53	6 to 9
NH_3-N	mg/L	1.075	3.400	1.956	0.79	8.00
BOD_5	mg/L	420	1650	903.8	424.5	60
COD	mg/L	1146.1	4249.4	2307.3	1074.7	150
TSS	mg/L	101	820	385.9	305.6	50
Oil/Fat	mg/L	0.9	3.2	1.8	0.89	3.0
Color	Pt-Co	1290	3900	2704.5	827.6	200
Phenol	mg/L	1.000	3.800	1.995	1.089	0.50
Temperature	^0C	32.8	38.3	35.4	1.9	+ 2 water temp
H_2S	mg/L	0.0009	0.0009	0.0009	0.000	0.30
Crom Total	mg/L	0.014	0.019	0.015	0.003	1.00

*Regulation of Minister of EF No.P.16/MenLHK/Setjen/Kum.1/4/2019

Table 1 is the result of descriptive data processing of 11 parameters from sasirangan cloth home industry wastewater in Banjarmasin City, Banjarbaru City, and Banjar Regency with the hot dyeing process. The table shows that in the hot dyeing process of the sasirangan fabric home industry there are 6 parameters that do not meet the textile industry wastewater quality standards listed in the Minister of Environment and Forestry Regulation No.P.16/MenLHK/Setjen/Kum.1/4/2019 namely pH, BOD5, COD, TSS, color, and phenol.

The results of sampling and examination of 11 parameters in the cold dyeing process are shown in Table 2.

Table 2. Descriptive Analysis of Cold Dyeing Process Parameters

Parameters	Unit	Min	Max	Mean	SD	Standar*
pH	-	4.27	9.70	6.95	2.02	6 to 9
NH_3-N	mg/L	1.127	5.680	2.169	1.32	8.00
BOD_5	mg/L	186	840	512.7	236.3	60
COD	mg/L	421.9	2360.1	1289.4	699.8	150
TSS	mg/L	208	2041	1008.4	643.2	50
Oil/Fat	mg/L	0.9	3.2	2.1	0.94	3.0
Color	Pt-Co	166	1355	674.6	459.9	200
Phenol	mg/L	0.012	0.650	0.239	0.211	0.50
Temperature	^0C	29.2	32.0	30.6	0.9	+ 2 water temp
H_2S	mg/L	0.0009	0.0009	0.0009	0.000	0.30
Crom Total	mg/L	0.014	0.018	0.014	0.001	1.00

* Regulation of Minister of EF No.P.16/MenLHK/Setjen/Kum.1/4/2019

Table 2 is the result of descriptive data processing of 11 parameters from sasirangan cloth home industry wastewater in Banjarmasin City, Banjarbaru City, and Banjar Regency with the cold dyeing process. The table shows that in the cold dyeing process of the sasirangan fabric home industry there are 4 parameters that do not meet the textile industry wastewater quality standards listed in the Minister of Environment and Forestry Regulation No.P.16/MenLHK/Setjen/Kum.1/4/2019 namely BOD5, COD, TSS, and color.

To determine whether there is a difference in the average value of 11 parameters that have been examined in the laboratory, the appropriate comparison test is carried out. The results of the comparison test can be seen in Table 3.

Table 3. Comparison Test of Hot and Cold Dyeing Process Parameters

Parameters	Distribution	Comparison Results	
		Compare Test	P value
pH	Normal	Paired T-Test	0.000*
NH_3-N	Not Normal	Wilcoxon Test	1.000
BOD_5	Not Normal	Wilcoxon Test	0.074
COD	Not Normal	Wilcoxon Test	0.114
TSS	Not Normal	Wilcoxon Test	0.037*
Oil/Fat	Not Normal	Wilcoxon Test	0.192
Color	Normal	Paired T-Test	0.000*
Phenol	Normal	Paired T-Test	0.017*
Temperature	Normal	Paired T-Test	0.001*
Crom Total	Not Normal	Wilcoxon Test	0.655

* There is a difference at 0.05

Table 3 shows that 5 parameters are statistically significantly different at an error level (alpha) of 0.05, namely pH, TSS, color, phenol, and temperature. The parameters NH_3-N, BOD5, COD, oil, and total chrome were not statistically different.

In the process stages of the textile industry, including the sasirangan industry, the main problem is the coloring and finishing stages. These processes require various chemicals and dyes which are generally organic compounds with complex structures. Wastewater from these stages becomes a problem in its disposal (Savin & Butnaru, 2008).

The average pH value in the hot dyeing process is 12.25 (Tabel 1) and in the cold dyeing process is 6.95 (Table 2). Regulation of Minister of Environment and Forestry is that the standard pH of textile industry wastewater is between 6 to 9. This means that the pH of sasirangan industry wastewater in the hot dyeing process has exceeded the standard while the pH of sasirangan industry wastewater in cold dyeing does not exceed the standard. These pH values correspond to the results of textile wastewater characterization for ten years in Bangladesh which ranged from 3.9 to 14 (Dey & Islam, 2015). Statistical results show differences in pH in the two dyeing processes (Table 3), the pH of cold dyeing is lower than hot dyeing, the cold dyeing process uses naphthol dye which requires caustic soda and Turkish Red Oil (TRO). The use of caustic soda chemicals that are alkaline and highly caustic. is intended so that the dye can be perfectly attached to the fibers of the sasirangan fabric while TRO is used as a wetting agent for sasirangan fabrics that will be dyed (Nasrullah et al., 2018). Wastewater with a pH that does not meet the standards that are discharged carelessly into the river will have an impact on the life of biota living in the river (Osibanjo et al., 2011). In addition, the pH of wastewater is one of the parameters that affect wastewater treatment (Mandal, 2014).

The content NH3-N in the hot dyeing process of the sasirangan industry wastewater was 1.956 mg/L (Tabel 1) and in the cold dyeing process was 2.169 (Tabel 2). Regulation of Minister of Environment and Forestry is that the standard NH3-N in textile wastewater is 8 mg/L. This means that the ammonia content in the hot dyeing process and cold dyeing process does not exceed the standard. The low ammonia content is an indication of the absence of odor generated in the sasirangan industry wastewater. Other research shows similar results in Sasirangan wastewater has NH3N levels of 1,879 mg/L (Nasrullah et al., 2018).

In the hot coloring process of sasirangan industrial wastewater, the average Biological Oxygen Demand (BOD) value is 903.8 mg/L (Table 1) and in the cold coloring process is 512.7 mg/L (Table 2). Regulation of Minister of Environment and Forestry is that the BOD standard for textile industry wastewater is 60 mg/L. This means that the BOD value in both the hot dyeing process and the cold dyeing process has exceeded the specified standard. Other research shows lower results that Sasirangan wastewater has BOD levels of 59,12 mg/L (Nasrullah et al., 2018). High BOD values indicate high oxygen demand for microorganisms to decompose biodegradable organic matter. If these biodegradable materials are in large quantities, they can be harmful to water body (Rono, 2017). The higher the BOD value in river water, the worse the water quality and will reduce the value of Dissolved Oxygen (DO) because of the large number of microorganisms in the water. Furthermore, fish and other organisms cannot survive (Rahman et al., 2012).

Chemical Oxygen Demand (COD) is one of the important indicators of textile wastewater quality. COD is the amount of chemical compounds need for oxygen to decompose organic matter. In the hot dyeing process of sasirangan industrial wastewater, the COD value is 2307.3 mg/L (Tabel 1) while in the cold dyeing process it is 1289.4 mg/L (Tabel 2). Regulation of Minister of Environment and Forestry is that COD value for textile wastewater is 150 mg/L. This means that the COD value in sasirangan wastewater both in the hot dyeing process and the cold dyeing process has exceeded the specified standard. Other research shows lower results that Sasirangan wastewater has COD levels of 348,9 mg/L (Nasrullah et al., 2018)The high COD value of river water is an indication of the poor quality of the river water. The development of aquatic biota becomes unsuitable in conditions of higher COD values (Naubi et al., 2016).

The parameter that is also used as an indikatör in textile waste is Total Suspended Solid (TSS). TSS is a solid suspended in water in the form of organic and inorganic materials that can be filtered with millipore paper with 0.45 micrometer pores. The TSS value in the hot coloring process of the sasirangan industry wastewater was 385.9 mg/L (Tabel 1) while in the cold coloring process it was 1008.4 mg/L (Tabel 2). Regulation of Minister of Environment and Forestry is that TSS value is only 50 mg/L. Therefore, this shows that both the TSS value in the hot dyeing process and in the cold dyeing process have exceeded the specified standard. The high TSS concentration will affect the BOD and COD values in the water body (Jingsheng et al., 2006). There is a significant difference in the TSS values in the two dyeing processes, the TSS for hot dyeing is smaller than the TSS value for cold dyeing, this is possibly due to hot dyeing, the substances carried are easily dissolved, thereby reducing the amount of suspended solids.

Oil/fat is also one of the parameters regulated in textile waste. The average value of oil/fat in the hot dyeing process is 1.8 mg/L (Tabel 1) and in the cold dyeing process is 2.1 mg/L (Tabel 2). These values are still below the set standards Regulation of the Minister of Environment and Forestry. Other research shows lower results in Sasirangan wastewater with levels oil/fat of 0,4 mg/L (Nasrullah et al., 2018). The content of oil and grease in textile wastewater is not clearly detectable in other research (Bisschops & Spanjers, 2003).

The main parameter that characterizes the wastewater of the home-based sasirangan industry is the color parameter. The average value of water color in the hot dyeing process was 2704.5 Pt-Co (Tabel 1) and in the cold dyeing process was 674.6

Pt-Co (Tabel 2). These values have exceeded the set standard Regulation of Minister of Environment and Forestry of 200 Pt-Co. Other research shows lower results in Sasirangan wastewater with a color content of 107.93 Pt-Co (Nasrullah et al., 2018). Statistically, there was a difference in the mean water color values between the two dyeing processes (Tabel 3).

Hot dyeing gets a higher color value than wet dyeing. Indhanthren dye used in hot dyeing belongs to the anthraquinone group which is one of the main groups of colored pollutants which is very resistant to degradation due to the presence of melted aromatic rings, which helps the dye stay colored longer (Hassaan, M.A. et al, 2017). Anthraquinone dyes are dyes that are insoluble in water due to the presence of chromophoric groups formed by C=O and C=C conjugation (Choudhary, Roy, A.K., 2018).

Naphthol dyes are used in cold dyeing. Naphtol dye is a textile dye that is used for dyeing quickly compared to natural dyes and other synthetic dyes, such as indigosol and remasol (Lorenza S., 2022). 2-Naphthol is a colorless (or sometimes yellow) fluorescent crystalline solid with the formula C10H7OH (Nair GP, 2011). 2-naphthol is also called β-hydroxynaphthalene and belongs to polycyclic aromatic hydrocarbons with stable chemical structure and strong biological toxicity (Wang, X.; Chen, Q., 2017; Vo, N et al, 2020). The biotoxic effect of 2-naphthol is to reduce glutathione in lung cells, making people more susceptible to lung cancer (Zang, S. Et al., 2010).

Discharge of dyes into water streams based on dye classification ranges from 2% for basic dyes, to 50% for reactive dyes; from the initial dye concentration (Babu, B. R et al., 2007). Reactive dyes which are synthetic dyes include azo dyes and anthraquinones (Khehra, M. S. et al., 2005). The complex structure of this dye makes it very toxic and resistant to degradation (Mohammad, S. G. et al., 2012; Deng, D. et al., 2008). Naphthol dyes used in cold dyeing belong to the azo dye group and Indhanthren dyes used in hot dyeing belong to the anthraquinone group (Khehra, M. S. et al., 2005).

The phenol content in the hot coloring process of sasirangan industrial wastewater amounted to an average phenol value of 1.995 mg/L (Tabel 1) and in the cold coloring process amounted to 0.239 mg/L (Tabel 2). The phenol content in the hot coloring process exceeds standard Regulation of Minister of Environment and Forestry of 0.50 mg/L. Phenol is a toxic compound that can cause environmental problems if disposed of carelessly (Ozbelge et al., 2002). There is a statistical difference in the phenol value in the two dyeing processes (Table 3), hot dyeing has a higher penol value compared to cold dyeing. Indhanthren dye used in hot dyeing belongs to the anthraquinone group. Anthraquinone compounds are one of the secondary metabolite compounds belonging to the group of phenolic quinones which in their biosynthesis come from phenol derivatives (Ariningsih, et al., 2003).

The average temperature value in the hot process is known to be 35.4 degrees Celsius (Tabel 1) while in the cold process it is 30.6 degrees Celsius (Tabel 2). This temperature condition is still in accordance with the temperature of wastewater from the textile industry in Bangladesh, which is between 25-65 degrees Celsius (Dey & Islam, 2015). Statistically there is a difference in the average temperature value in the two dyeing processes, because the technique used for dyeing dyes uses hot and cold conditions.

Wastewater from the sasirangan industry is odorless. This is indicated by the average value of H2S both in the hot dyeing process and in the cold dyeing process is the same at 0.0009 mg/L (Tabel 1&2). These values have not exceeded the Regulation of Minister of Environment and Forestry H2S standard of 0.3 mg/L.

The limitation of the research is that data was not collected on the types of dyes used in the Sasirangan home industry in the hot dyeing and cold dyeing processes. The research discussion is based on a literature data approach which states the many types of dyes used in the hot dyeing and cold dyeing processes in the Sasirangan home industry, South Kalimantan.

CONCLUSION

Parameters that do not meet applicable standards in hot dyeing process wastewater are pH, BOD_5, COD, TSS, color, and phenol, while in the cold dyeing process are BOD_5, COD, TSS, and color. Statistically there is a significant difference in the parameter values of pH, TSS, color, phenol, and temperature in sasirangan fabric home industry wastewater between the hot dyeing and cold dyeing processes. The results of this research with data on differences in wastewater parameter values can be used to plan better wastewater treatment for the sasirangan cloth household industry.

ACKNOWLEDGEMENT

The authors would like to thank all parties involved, especially Poltekkes Kemenkes Banjarmasin, for funding and facilitating this research.

REFERENCES

Adriani, A., & Zarwinda, I. (2019). Pendidikan Untuk Masyarakat Tentang Bahaya Pewarna Melalui Publikasi Hasil Analisis Kualitatif Pewarna Sintetis Dalam Saus. Jurnal Serambi Ilmu, 20(2), 217–237.

Andriana, Y. F. (2018). Pergeseran Fungsi dan Makna Simbolis Kain Sasirangan. Jurnal Rupa, 3(2), 77–92.

Andriani, R. (2017). Toksisitas Limbah Cair Industri Batik Terhadap Morfologi Sisik Ikan Nila Gift (Oreochomis nilotocus). Jurnal SainHealth, 1(2), 83–91.

Arifin, A., Karlina, A., & Khair, A. (2017). The Effect of Chitosan Dosage Againts Liquid Waste Water Color on Oriens Handicraft Sasirangan Home Industry, Landasan Ulin. Journal of Health Science and Prevention, 1(2), 58–67.

Ariningsih, I., Solichatun, dan Anggarwulan, E., (2003), Pertumbuhan Kalus dan ProduksiAntrakuinon Mengkudu (Morinda citrifolia L.) pada Media Murashige-Skoog (MS) dengan Penambahan Ion Ca2+ dan Cu2+, J. Biof, 1: 39-43.

Babu, B. R., Parande, A. K., Raghu, S. & Kumar, P. T. (2007). Textile technology cotton textile processing: waste generation and effluent treatment. J. Cotton Sci. 11, 141–153.

Bisschops, I., & Spanjers, H. (2003). Literature Review on Textile Wastewater Characterisation. Environmental Technology, 24(11), 1399–1411.

Carmen Z, Daniela S (2012) Textile organic dyes—characteristics, polluting effects and separation/elimination procedures from industrial effluents—a critical overview. Organic Pollutants Ten Years after the Stockholm Convention—Environmental and Analytical Update, pp 55–86

Choudhary, Roy, A.K. (2018). Eco-friendly dyes and dyeing. Adv. Mater. Technol. Environ. Appl. 2(1), 145–176

Deng, D., Guo, J., Zeng, G. & Sun, G. (2008). Decolorization of anthraquinone, triphenylmethane and azo dyes by a new isolated Bacillus cereus strain DC11.

Int. Biodeterior. Biodegrad. 62, 263–269. https://doi.org/10.1016/j.ibiod.2008.01.017.
Dey, S., & Islam, A. (2015). A Review on Textile Wastewater Characterization in Bangladesh. Resources and Environment, 5(1), 15–44.
Hassaan, M.A., Nemr, A.El. (2017). Health and environmental impacts of dyes: Mini review. Am. J. Environ. Sci. Eng. 1(3), 64–67. https://doi.org/10.11648/j.ajese.20170103.11.
Ilmannafian, A. G., Darmawan, M. I., & Kiptiah, M. (2022). Pengaruh Fitoremediasi dengan Kombinasi Tanaman pada Kadar BOD dan COD Limbah Sasirangan. Jurnal Teknologi Agro-Industri, 9(1), 72-80.
Jingsheng, C., Tao, Y., & Ongley, E. (2006). Influence of High Levels of Total Suspended Solids on Measurement of COD and BOD in the Yellow River, China. Environmental Monitoring and Assessment, 116, 321–334.
Khehra MS, Saini HS, Sharma DK, Chadha BS, Chimni SS (2006) Biodegradation of azo dye C.I. Acid red 88 by an anoxic–aerobic sequential bioreactor. Dyes Pigments 70:1–7
Khehra, M. S., Saini, H. S., Sharma, D. K., Chadha, B. S. & Chimni, S. S. (2005). Comparative studies on the potential of consortium and constituent pure bacterial isolates to decolorize azo dyes. Water Res. 39(20), 5135–5141. https://doi.org/10.1016/j.watres.2005.09.033.
Lorenza S. (2022). Karakteristik limbah cair industri batik dengan pewarna naphtol di Yogyakarta. Program Studi Teknik Lingkungan Fakultas Teknik Sipil dan Perencanaan Universitas Islam Indonesia
Mandal, H. K. (2014). Influence of Wastewater pH on Turbidity. Int. J. Environ. Res. Dev, 4(2), 105–114.
Mohammad, S. G., Mohammad, K. Y., Mansur, B. I. & Rakesh, K. (2012). Synthesis and characterisation of colorants derived from 1, 4-diamino anthraquinone polyamides. Adv. Chem. Eng. Sci. 2(2), 300–308. https://doi.org/10.4236/aces.2012.22035.
Nair, G. P. (2011). Methods and machinery for the dyeing process. In Handbook of Textile and Industrial Dyeing: Principles, Processes and Types of Dyes (Vol. 1). https://doi.org/10.1533/9780857093974.1.245
Nasruddin, Isnasyauqiah, Nurandin D, Halang B. Normelani E, Kumalawati R, Syaharuddin, Aristin NF, Riadi S. (2018). *Identifikasi Potensi Limbah Cair Zat Pewarna Sasirangan terhadap Pencemaran di Kota Banjarmasin.* Lembaga Penelitian dan Pengabdian Kepada Masyarakat (LPPM) Universitas Lambung Mangkurat dengan Badan Dinas Lingkungan Hidup Kota Banjarmasin.
Naubi, I., Zardari, N. H., Shirazi, S. M., Ibrahim, N. F. B., & Baloo, L. (2016). Effectiveness of Water Quality İndex for Monitoring Malaysian River Water Quality. Polish Journal of Environmental Studies, 25(1), 1-9.
Nugraha, J., & Rakhmatiara, E. Y. (2020). Pemanfaatan Daun Rami Sebagai Bahan Zat Warna Alam dan Fungsionalisasinya Pada Pencelupan Kain Kapas dan Sutera. Arena Tekstil, 35(1), 29–38.
Osibanjo, O., Daso, A. P., & Gbadebo, A. M. (2011). The Impact of Industries on Surface Water Quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. African Journal of Biotechnology, 10(4), 696–702.
Ozbelge, T. A., Ozbelge, O. H., & Başkaya, S. Z. (2002). Removal of Phenolic Compounds from Rubber–Textile Wastewaters by Physico-Chemical Methods. Chemical Engineering and Processing: Process Intensification, 41(8), 719–730.

Paramnesi, P. A., & Reza, A. I. (2020). Dampak Pencemaran Limbah Batik Berdasarkan Nilai Kompensasi Ekonomi di Hulu dan Hilir Sungai Asem Binatur. Kajen: Jurnal Penelitian dan Pengembangan Pembangunan, 4(01), 58–72.

Popli S, Patel UD (2015) Destruction of azo dyes by anaerobic–aerobic sequential biological treatment: a review. Int J Environ Sci Technol 12:405–420

Pratiwi, D. R. (2020). Analisis Daya Saing Industri Tekstil dan Produk Tekstil (TPT) Indonesia di Pasar ASEAN. Jurnal Budget: Isu dan Masalah Keuangan Negara, 5(2), 44-66.

Putra, M. R. A. (2011). Analisis Peranan Industri Kain Sasirangan Terhadap Perekonomian Kota Banjarmasin dan Strategi Pengembangannya (Periode 2005-2009). Theses. IPB University.

Rahman, A., Islam, M., Hossain, M. Z., & Ahsan, M. A. (2012). Study of the Seasonal Variations in Turag River Water Quality Parameters. African Journal of Pure and Applied Chemistry, 6(10), 144–148.

Rizza, R. (2013). Hubungan Antara Kondisi Fisik Sumur Gali Dengan Kadar Nitrit Air Sumur Gali di Sekitar Sungai Tempat Pembuangan Limbah Cair Batik. Unnes Journal of Public Health, 2(3), 1-10.

Rono, A. K. (2017). Evaluation of TSS, BOD5, and TP in Sewage Effluent Receiving Sambul River. Journal of Pollution Effects & Control, 5(2), 1–5.

Rosyida, A., & Achadi, D. (2014). Pemanfaatan Daun Jati Muda Untuk Pewarnaan Kain Kapas Pada Suhu Kamar. Arena Tekstil, 29(2).

Savin, I.-I., & Butnaru, R. (2008). Wastewater Characteristics in Textile Finishing Mills. Environmental Engineering & Management Journal (EEMJ), 7(6), 859-864.

Sekomo CB, Rousseau DPL, Saleh SA, Lens PNL (2012) Heavy metal removal in duckweed and algae ponds as a polishing step for textile wastewater treatment. Ecol Eng 44:102–110

Shah MP, Patel KA, Nair SS, Darji A (2013) Optimization of environmental parameters on microbial degradation of reactive black dye. J Bioremed Biodegrad 4:10–15

Subagyo, P. K. (2021). Pengaruh Zat Pewarna Sıntetıs Terhadap Pewarnaan Kaın Batık. Folio, 2(2), 40-48.

Tambunan, P. M. (2018). Studi Pengaruh pH dan Kesadahan Terhadap Pertumbuhan Ikan Mas Koi (Crypinus Carpio) Dengan Media Pertumbuhan Air Sungai Tuntungan. Jurnal Saintika, 18(1), 8–11.

Vo, N.; Huynh, N.; Le, M.; Vo, K.; Vo, D. (2020). Fabrication of Ag-photodeposited TiO_2/cordierite honeycomb monolith photoreactors for 2-naphthol degradation. J. Chem. Technol. Biotechnol. 95, 2628–2637.

Wang, X.; Chen, Q. (2017). Influencing factors of 2-naphthol degradation in water by biofilm-electrode method. Chem. J. Chin. Univ, 38, 855–859.

Yaseen DA, Scholz M (2016) Shallow pond systems planted with *Lemna minor* treating azo dyes. Ecol Eng 94:295–305

Yaseen, D.A., Scholz, M. (2019). Textile dye wastewater characteristics and constituents of synthetic effluents: a critical review. *Int. J. Environ. Sci. Technol.* 16, 1193–1226. https://doi.org/10.1007/s13762-018-2130-z

Zammi, M., Rahmawati, A., & Nirwana, R. R. (2018). Analisis Dampak Limbah Buangan Limbah Pabrik Batik di Sungai Simbangkulon Kab. Pekalongan. Walisongo Journal of Chemistry, 1(1), 1–5.

Zang, S.; Lian, B.; Wang, J.; Yang, Y. (2010). Biodegradation of 2-naphthol and its metabolites by coupling Aspergillus niger with Bacillus subtilis. J. Environ. Sci, 22, 669–674.