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Community Empowerment Through Appropriate Technology: Wastewater Treatment Plant (WWTP) Program in Home-Made Batik Industry at Ngawi, Indonesia

Winarko[1], Bambang HS[2], Sri Utami[3], and Sari Luthfiyah[4]

[1]Department of Environmental Health, Health Polytechnic Minister of Health of Surabaya,
[2]Department of Dental Health, Health Polytechnic Minister of Health of Surabaya, bambanghadi_sugito@poltekkesdepkes-sby.ac.id
[3] Center for Excellence in Science and Technology-Community Empowerment, Poltekkes Kemenkes Surabaya; Indonesia,
[4]Department of Technology of Electro-medic, Health Polytechnic Minister of Health of Surabaya, sarilut@poltekkesdepkes-sby.ac.id

Corresponding author: Sari Luthfiyah (e-mail: sarilut@poltekkesdepkes-sby.ac.id)

ABSTRACT The increasing number of companies and the number of batik productions in the Ngawi region is directly proportional to the amount of wastewater produced and thus poses a burden on the environment as the overflow of wastewater is absorbed from the production process. The results of the laboratory analyses showed that the values for TSS, color, COD, BOD, total ammonia, oil, and grease exceeded the quality standards. Prevention of pollution from wastewater is done through community empowerment. Community empowerment aims to realize the development of Appropriate Technology for Wastewater Treatment Plants (WWTP) and the prevention of Wastewater Pollution to the Environment Around Small and Medium Enterprises (UKM) Griya Batik Widi Nugraha, Ngawi Regency. The benefit of community empowerment is to provide experience for other Batik Wastewater Treatment Plant (WWTP) development programs. Community empowerment at UKM Griya Batik Widi Nugraha Ngawi uses methods of document collection, site surveys, preparation of processing systems, training, and demonstrations. The target group of community empowerment activities at Griya Batik Widi Nugraha Ngawi are the owner of Griya Batik Widi Nugraha Ngawi, batik workers at Griya Batik Widi Nugraha Ngaw, workers in the dyeing and washing process, administrators of Ngawi Batik Association and construction workers. Results of Community Empowerment of UKM Griya Batik Widi Nugraha Workers and Surroundings Together with the academic community of Poltekkes Kemenkes Surabaya, appropriate technology was built for a wastewater treatment plant (WWTP) with a capacity of 1,464.5 liters per day, which is still safe for UKM Griya Batik Widi Nugraha Ngawi Regency. The stages of wastewater treatment are pre-treatment, secondary treatment, tertiary treatment, and storage of the final product. The results of the functional tests based on effluent samples from the final treatment showed that the treatment plant was able to reduce the levels of TSS, color, COD, BOD, total ammonia, oil, and grease that exceeded the quality standard to meet the quality requirements as per the Minister of Environment and Forestry Regulation No. P.16/MENLAHK /SETJEN/KUM.1/2019. These results provide benefits for UKM Griya Batik Widi Nugraha to prevent pollution and can use treated water as a source of fish pond water and watering the garden. It is recommended that community empowerment can be continued by other SMEs that have the potential to dispose of wastewater from production activities and pollute the environment through the use of appropriate technology (TTG) research results by lecturers or students so that they do not stop as intakes.

INDEX TERMS Community Empowerment, WWTP, UKM, Griya Batik Widi Nugraha Ngawi

I. INTRODUCTION

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The Ngawi regency is one of the regions in the province of East Java, located in the westernmost part and bordering the province of Central Java. One of the mainstays of the Ngawi region is batik production, which is growing rapidly. Factors that promote the development of the batik industry include labor, government, community support, product quality, and production volume, which encourage people to preserve their culture[1]. In addition, the development of batik with certain attractive features will stimulate market demand and ultimately the Based on the local wealth of Ngawi, there are several features that can be taken away, namely rice, bamboo, Fort Van Den Bosch or better known as Benteng Pendem and Trinil, which describe old people found in Ngawi.

The development of batik MSME in Ngawi Regency is getting bigger, this can be seen in the data in 2011 there were 9 business installations, then developed into 11 business installations in 20012, 16 business installations in 2013, and 19 business installations Nurul Istiqomah et al (2020). The batik producers are still working traditionally in the production and so far, they are learning only self-taught, which means that the quality assurance of the products produced is not yet good in terms of quantity and quality of the products[2][3][4]. The labor used comes from the local area, especially housewives, who are sometimes still busy with their domestic affairs, so the results and the time has given cannot be controlled for orders in large quantities[5]. Batik According to Nurul Istiqomah et al. (2020), Ngawi district is currently beginning to implement strategies and innovation system, which includes strengthening the batik industry cluster. Batik is one of the cultural achievements of the Indonesian nation, as defined by the United Nations Educational, Scientific, and Cultural Organisation. United Nations Educational, Scientific and Cultural Organisation (UNESCO) term. Accordingly, each region is encouraged to develop batik in line with local wisdom and the unique culture of that region[1].

The growing number of enterprises and the number of batik productions in the Ngawi region are in direct proportion to the amount of wastewater produced, and thus pose a burden on the environment as they collect wastewater from the production process [4]. One of the effluents comes from the Batik Widi Nugraha Small and Medium Enterprises (UKM) plant located at Jalan Wahid Hasyim number 3 Karangsari Ngawi.

The Wastewater Treatment Plant for Batik Widi Nugraha's business is only in the form of a settling tank and is absorbed into the ground so that it can pollute the environment. This condition makes UKM Batik Widi Nugraha Ngawi not want to be one of the batik producers that has an impact on environmental pollution and wants to be a pilot in handling wastewater for batik business installations in Ngawi through appropriate technology in the form of Wastewater Treatment Plants by utilizing the processing results as a water source. fish pond and garden watering.

The results of sampling and checking the quality of the original wastewater before treatment are shown in TABLE 1.

TABLE 1

Results of analysis of wastewater samples before and after treatment at Griya ABtik Widi Nugraha, Ngawi Regency in 2021

No	Parameter	Unit	Quality standards	Results Inspection	Description
1	pH	-	6 - 9	7,8	Meets the standards
2	T S S	mg/L	50	690	Exceeded standards
3	Wanna	UnitPtCo	200	544,25	Exceeded standards
4	C O D	mg/L O2	150	1.068,00	Exceeded standards
5	BOD	Mg/L)2	60	418,00	Exceeded standards
6	Sulfida (Sbg H2S)	Mg/L H2S	0,3	0,04	Meets the standards
7	Amonia Total	mg/NH3N	8	57,14	Exceeded standards
8	Total Khromium	Mg/L Cr	1	0,26	Meets the standards
9	Oil and Fat	mg/L	3	494,00	Exceeded standards
10	Phenol	mg/L	0,5	0,00	Meets the standards
11	Timbal	mg/L Pb	(-)	0,00	Meets the standards

Note: Permen LHK Standard No. P1d/MENLHK/SETJEN/KUM1/4/2019 For the Textile Industry

Based on the background and desire of Griya Batik Widi Nugraha UKM, Ngawi Regency, as one of the batik companies in Ngawi, it is interesting to receive Appropriate Technology Support (TTS) to treat wastewater through Community Empowerment Activities in the form of WWTP construction support [6][4]. Community empowerment through the use of appropriate technologies in the construction of wastewater treatment plants in the domestic batik industry in Ngawi aims to develop appropriate technologies for wastewater treatment plants and prevent pollution of the environment from wastewater in the UKM Griya Batik Widi Nugraha Ngawi region.

Other WWTPs constructed in the last 3 years are: 1) 2019 community service through the construction of wastewater

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treatment plants in SMPN 26 Surabaya, 2) 2020 construction of wastewater treatment plants in SDN Kandangan 1 Surabaya City and 3) 2021 construction of a community wastewater treatment plant for riverside communities in Jambangan, Surabaya City.

II. METHOD AND IMPLEMENTATION

A. METHOD

Community empowerment at UKM Griya Batik Widi Nugraha Ngawi is done through methods of document collection, field surveys, preparation of processing systems, training, and demonstrations [9][8][10]. The target group of the community empowerment activities at Griya Batik Widi Nugraha Ngawi are the owner of Griya Batik Widi Nugraha Ngawi, the workers of the dyeing and washing process, the administrators of Ngawi Batik Association and the construction workers[3][1].

The materials prepared for the appropriate technology in the form of a batik treatment plant in Griya Batik Widi Nugraha, Ngawi Regency are a steel frame as a base for the upper treatment plant, water tanks with a capacity of 650 litres, 300 litres, 250 litres, bioballs, aerators, PVC pipes and accessories, gravel, silica sand, activated carbon, stirring motors, alum (coagulant) and chlorine tablets, bricks, sand, cement, drums and gunny sacks, and equipment for sampling wastewater.

The activity steps start with the first step "Preparation for construction of WWTP",: 1) preliminary survey, 2) design planning based on the results of the preliminary surveys, 3) technical calculation of the WWTP capacity[10], 4) coordination of the enabling support teams, 5) construction of the Griya Batik WWTP[3][8]. The second step "Installation of WWTP in Griya Batik Widi Nugraha, Ngawi Regency" consists of[11][12]: 1) Establishment of the wastewater treatment plant in Griya Batik Widi Nugraha, Ngawi Regency, and 6) Laying the foundations for the installation of the wastewater treatment plant: 1) arrangement of the wastewater treatment plant on the compartment platform[9], 2) installation of the wastewater treatment plant at the site, 3) installation of the aerator and adsorbent 1 in the aeration tank[7], 4) filling of the bioballs in the decomposition tank and filtration tank, 5) installation of the settling tank, 6) installation of two adsorbent tanks, 7) installation of the filtration tank, 8) installation of the yield tank as final preparation[9], 9) Installation of the agitator motor in the coagulation process, 10) Installation of the coagulant tank, 11) Installation of the flocculants, 12) Installation of the chlorinators in the oxidation bath, 14) Installation of the piping and pumps[9], 15) Preparation of the sludge drying bath, 16) Installation of the sludge pump and its piping, 17) Installation of the filling pump of the aeration tank, 18) Completion of the installation circuit of the wastewater treatment. 19) Test run of the wastewater treatment plant, 20) Test run of the wastewater treatment plant maintenance, 21) Acclimatisation of the wastewater treatment plant and 22) Sampling before and after the treatment process [13]. The third step is to hand over the results of the community empowerment through mentoring activities for the construction of the Griya Batik Widi Nugraha Ngawi wastewater treatment plant"[14].

DESIGN OF THE BATIK WASTEWATER TREATMENT SYSTEM FLOW.

The results of the literature study and preliminary survey at the Griya Batik Widi Nugraha UKM site, Ngawi Regency, are still with the flow as shown in FIGURE 1. the following

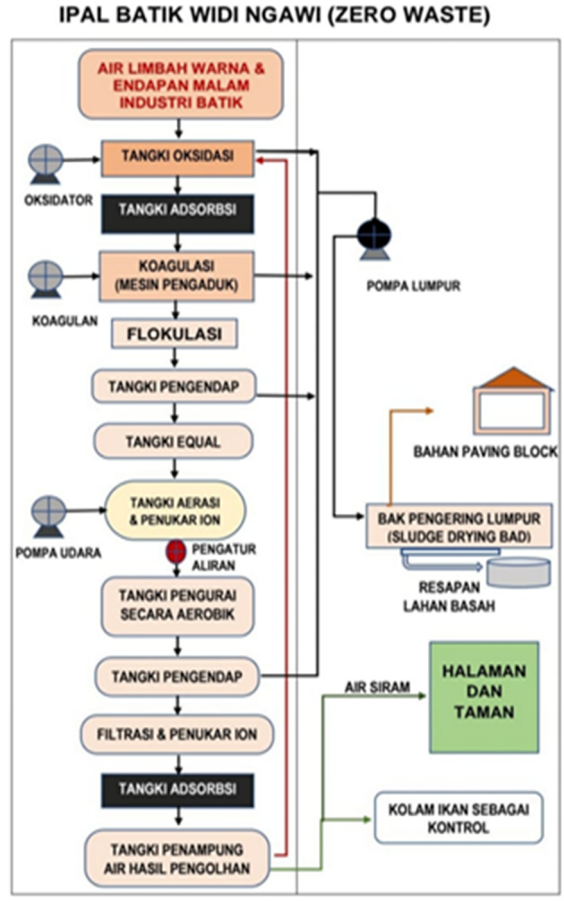
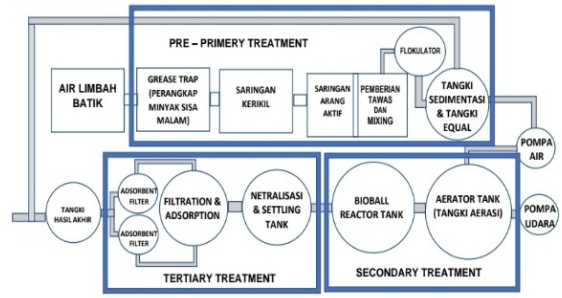


FIGURE 1. Flow of the Griya Batik Widi Nugraha Ngawi wastewater treatment system

FIGURE 2. Detailed landscape of the system according to the stages of the treatment process.



The treatment flow is then mapped in a detailed landscape according to the treatment stages[4][7]. The treatment flow is then mapped in a detailed landscape according to the treatment

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stages, as shown in FIGURE 2. It shows that the wastewater treatment system at Griya Batik Widi Nugraha goes through the stages of pre-treatment, secondary treatment and tertiary treatment.

The process of each stage consists of several processes, namely[13]:

1. Initial and first stages of processing (pre-treatment):
   a. Oil separator made of wax that does not form solids.[15]
   b. Oxidation process with free chlorine material
   c. Activated carbon filter as adsorbent
   d. Addition of alum and stirring with a mixer (coagulation process)
   e. Floculator trough for flocculation for easy deposition
   f. Sedimentation (deposition)[8]
2. Second treatment stage (secondary treatment)[16]:
   a. Aeration process in the aeration tank is automatic[7]
   b. Aerobic degradation process using bio ball media
3. Third treatment stage (tertiary treatment)[17]:
   a.Neutralisation with Ca(OH)2 and sedimentation of the fish fin model.
   b.Filtration and adsorption to remove suspended solids and heavy metals[4][15].
   c. Activated carbon filter to remove dissolved gases and odors.
4. the last tank serves as a reservoir for pond water and plant

Since 500 litres of batik wastewater are produced daily, the average wastewater volume per hour is 20.8 litres/hour 21 litres/hour or 350 ml/minute [19]. With a retention time of 8 hours for the aerobic process, the capacity of the treatment plant is 8 hours x 21 litres/hour = 168 litres.

The capacity of the WWTP in the second treatment stage (secondary treatment) to the third treatment (tertiary treatment) is designed with a capacity of 1,464.5 litres from the design capacity [16][10]: 1) aeration tank of 1,000 liters, 2) degradation tank of 212.5 litres (0.85 pro sites bioball X 250 litres), 3) 200 litres settling tank, 4) 52 liters sand filter (26% X 200 litres) according to Fraser (1973), 5) activated carbon tank neglected.

Based on the capacity of 1,464.5 litres designed in the second and third processing stages, it is still safe for Griya Batik Widi Nugraha UKM, Ngawi Regency, to expand its production to a maximum volume of 1,464.5 litres of wastewater per day or increase it by 2.5 times [19][1]. Detailed design by processing stage based on the treatment plant design of 1,464.5 litres, then detailed in the form of prospective drawings as shown in FIGURE 3. This prospective representation is to facilitate the team to realize the empowerment of the community through the construction of Batik wastewater treatment plants [14][2][2].

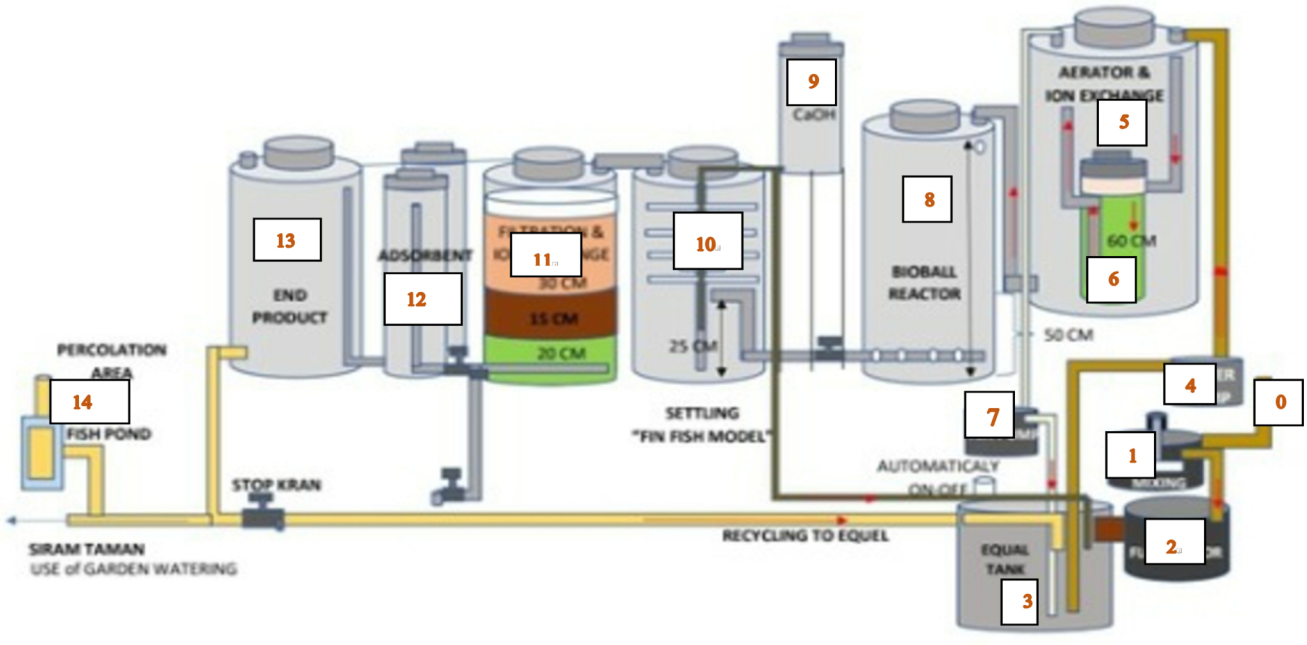

FIGURE 3. Prospective image of the Griya Batik Widi Nugraha Ngawi UKM wastewater treatment plant. Description : 0 : Waste Water From Grease Trap; 1 : Coagulation tank & Stirrer; 2 : Floculator Tank; 3 : Equel tank; 4 : Water Pump; 5 : Aeration Tank; 6 : Zeolit Tank; 7 : Aerator Mechine; 8 : Biobal Reactor Tank: 9 : CaOH Liquit tank; 10 : Settling Tank; 11 : Rapid Sand Filter Tank; 12 : Carbon Active Filter; 13 : End Product Tank; 14 : Lagoon

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B. IMPLEMENTATION

Implementation of Community Empowerment Through WWTP Construction Activities [10][15]:

1. EXPLANATION OF THE IMPORTANCE OF WASTEWATER TREATMENT AND WWTP PERFORMANCE SYSTEM [20][19]

Community empowerment through assistance in making WWTP for Batik SMEs as a form of concern for the Health Polytechnic Ministry of Health Surabaya in carrying out the Tri Dharma of Higher Education while at the same time realizing the Center for Institutional Excellence in the form of community empowerment activities [21][2]. This activity is a form of fostering the importance of protecting the environment so that it still meets environmental quality standards [22][23].

Explanatory material to the public is related to the impact of wastewater from the production process in the form of heavy metal content[2] that can affect the nervous system due to metal accumulation in the body that enters through the right and or drinks contaminated with heavy metals originating from wastewater, so the color aesthetically interferes with the beauty of the environment[17][4][1]. The presence of water and the presence of wax in the coloring process can cause blockage of the soil pores so that the absorption system is disrupted and can cause flooding[16][9]. The working community at Griya Batik Widi Nugraha and the owners who receive this assistance are shown in FIGURE 4 below.

FIGURE 4. Griya Batik Widi Nugraha Ngawi workers who receive assistance in WWTP development activities

2. PROCUREMENT OF TREATMENT PLANT MATERIALS FOR GRIYA BATIK WIDI NUGRAHA NGAWI.

The WWTP materials are shown in FIGURES 5 for the different stages of the proposed process [18]and consist of tanks for the aeration process, tanks for the aerobic degradation process, settling tanks, filtration tanks, and tanks for storage of the final product for the pond filling and irrigation systems[11][24].

FIGURE 5. Materials for making WWTP

Tank profiles are prepared for the same tank, aeration tank, bio ball reactor, settling tank, filtration tank and final product.

3. THE PROCESS OF WORKING ON MATERIALS AS PREPARATION FOR THE OVERALL ASSEMBLY OF THE WWTP[14][1]

FIGURE 6. Materials The process of painting each part of the WWTP

FIGURE 6. shown about the process of working on materials as preparation for the overall assembly of the wwtp.

4. MAKING WWTP COMPONENT ACCESSORIES

FIGURE 7. Accessories of Cross Sedimentation Tank (Croos)

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Fiber is made for fish fin model sedimentation tank accessories and is installed in settling tanks as FIGURE 7.

FIGURE 8. Color Remover Holder Accessories

FIGURE 8 shows the color removal holder accessory set up to make the work getting easier.

FIGURE 9. Making WWTP Compounds and Accessories

FIGURE 9 illustrates the pipe as an activated charcoal filter and then the black pints

5. WWTP MEDIA WASH

FIGURE 10. Washing of Bio ball, Zeolid Sand and Quartz Sand

FIGURE 10 shows the equipment for washing Bio ball, Zeolid Sand and Quartz Sand. Washing silica sand as filtration material to make it free from dust.

6. INSTALLATION OF WWTP PLATFORM FOR SECONDARY AND TERTIARY TREATMENT[2]

FIGURE 11. Installation of WWTP Platform

FIGURE 11 illustrates the fabrication of the treatment tank in stell form and installation on top of the batik wastewater tank.

7. WWTP COMPONENT ASSEMBLY

FIGURE 12. All WWTP Components Assembled

FIGURE 12 shows the tank profile to be assembled set up on a completed steel base.

8. CONNECTION SETTINGS BETWEEN TANKS[22]

FIGURE 13. Connection Settings and Wastewater Discharge from WWTP all Components Assembled

FIGURE 13 shows the pipe connections from the settling basin to the final water storage tank to the final water storage tank.

9. DETERMINATION OF COAGULANT DOSAGE THROUGH JAR-TES[20]

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Figure 14. Determination of Coagulant Dosage through Jar-Test

FIGURE 14 illustrates the process of determining the coagulant dosage through field testing with the jart test method.

10. SLUDGE DRYING BAD

Figure 15 Sludge Drying Bad

FIGURE 15. illustrates the sludge from each tank entering the sludge dewatering bad to separate the sludge from the water coming from cleaning all the tanks.

III. RESULT

Function Test of the Effectiveness of the Griya Batik Widi Nugraha WWTP, Ngawi Regency

1. PHYSICAL CONDITION OF THE SAMPLE WATER BEFORE AND AFTER THE PROCESS[23][1]

The results of the performance of the Griya Batik Widi Nugraha WWTP will be evaluated on several component parts and processes as well as the final results used as a source of pond water filler and watering plants. Some of the points sampled include [17][12]:

a. Wastewater samples before the first treatment stage (FIGURE 16a) [18]
b. Samples after the first processing (FIGURE 16b) of the process [24]:
   1. Oxidation of addition of hypochlorite
   2. Adsorption process
   3. Coagulation process
   4. 4. Flocculation process
   5. Sedimentation process, and collects in the equal tank
c. Sample of water from sludge drying bath (FIGURE 16c)
d. Samples from the whole process were taken from the faucet after the final product holding tank (FIGURE 16d).

The results of processing from each part have visible changes in color and turbidity so that the level of removal (separation) of solids and color from the preliminary stage to the final stage of processing can be seen [17][1].

The results of the examination of wastewater samples before and after processing using the Griya Batik Widi Nugraha WWTP [19][12], Ngawi Regency which was built through Community Empowerment activities physically have shown results [22][20][25]. The following are the results of a laboratory examination by the ITS Environmental Engineering Laboratory, Surabaya, dated February 10, 2021, for the attached textile wastewater, as shown in TABLE 2.

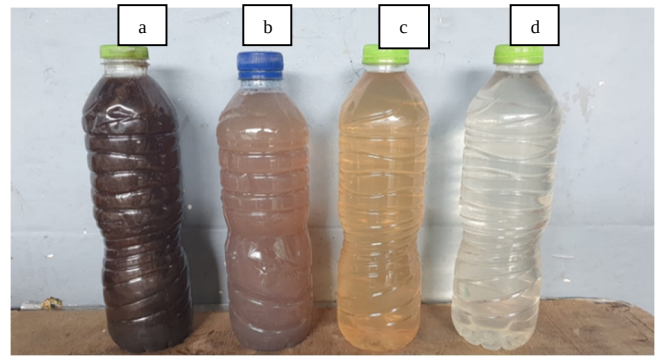

FIGURE 16. Physical Condition of Sample Water Before and After Treatment

FIGURE 16. shows the results of processing from each section which shows the changes in colour and turbidity so that it can be seen the level of removal (separation) of solids and colour from the preliminary stage to the final stage of processing.

The performance of the WWTP UKM Griya Batik Widi Nugraha, Ngawi Regency as a result of assistance by the Health Polytechnic of the Ministry of Health Surabaya through "Community Empowerment" the results have met the quality standards based on attachment II of the Indonesian Environmental Regulation Number: P.16/MENLAHK/SETJEN/KUM.1/2019 for the textile industry[5].

Sampling and laboratory examination as an effort to evaluate the performance of WWTP through field inspections and sampling for inspection of all parameters that are the requirements of quality standards are met, as shown in TABLE 2. It can be seen that the performance of the treatment plant reduces the parameters TSS, colour, COD, BOD, total ammonium, and oil and grease in a range of 1,424% - 5,750%. The final effluent result after commissioning of the WWTP was able to reduce several parameters that previously exceeded the quality standard. The total suspended solids (TSS) content was previously 690 mg/litre and could be reduced to 12 mg/litre while the quality standard is maximum 50 mg/litre. This result can prevent siltation if the wastewater is discharged into the river without treatment.

The colour as one of the measured parameters is 544.25 PtCo units, while the maximum allowable limit is 200 PtCo units. The results of the treatment show that the parameter colour has decreased to 28.20 PtCo units, so that the ethically very questionable colour pollution can be prevented. The COD and BOD parameters, which indicate contamination with organic matter, can also lead to a reduction in the oxygen content of the water, so that all aquatic life that needs oxygen in the water can die. The COD parameter of the effluent of 1,068 mg/litre has exceeded the limit value as the maximum

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TABLE 2
Results of Examination of Wastewater Samples of UKM Griya Batik Widi Nugraha Ngawi Regency in 2021 Before and After Processing

No	Parameter	Unit	Quality standards	Before WWTP	After WWTP	Description
1	pH	-	6 – 9	7,8	6,8	-
2	T S S	mg/L	50	690	12,00	Down by 5.750%
3	Wanna	UnitPtCo	200	544,25	28,20	Down by 5.750%
4	C O D	mg/L O2	150	1.068,00	75,00	Down by 5.750%
5	BOD	Mg/L)2	60	418,00	28,00	Down by 5.750%
6	Sulfida (H2S)	Mg/L H2S	0,3	0,04	0,00	-
7	Amonia Total	mg/NH3N	8	57,14	1,06	Down by 5.750%
8	Total Khromium	Mg/L Cr	1	0,26	0,02	-
9	Oil and fat	mg/L	3	494,00	2,00	Down by 5.750%
10	Phenol	mg/L	0,5	0,00	0,00	Fixed
11	Timbal	mg/L Pb	(-)	0,00	-	Fixed

value is 150 mg/litre. The Batik wastewater treatment plant is able to reduce the COD value to 75 mg/litre so that it meets the requirements and does not become a burden on the environment. Similarly, the previous BOD value was 418 mg/litre, while the maximum value was only 60 mg/litre. The treatment results of the Batik treatment plant have reduced the BOD value to 28 mg/litre, so it is not a burden on the environment.

The previous total ammonium value of 57.14 mg/litre exceeded the prescribed maximum value of 8 mg/litre. The results showed that the total ammonium value was now only 1.06 mg/litre, so that an odour nuisance due to ammonium could be avoided. Similarly, the oil and fat content before reprocessing was 494 mg/litre, while the maximum value was only 3 mg/litre. After treatment in the Batik wastewater treatment plant, the oil and fat content is only 2 mg/litre. Thus, the contamination by oils and fats that can inhibit the oxygen dissolution in the water can be prevented.

The results of developing a suitable technology in the form of a batik treatment plant in Graha Batik Widi Nugraha are very useful as they can prevent pollution and the treated effluent can be used as filling material for fish ponds and for watering the garden in the dry season.

The weakness of this Batik sewage treatment plant is that it requires technical calculations, so a technical assistant is needed to size each part of the component and special staff is needed to operate and maintain the treatment plant.

IV. CONCLUSION

The aim of this community empowerment is to develop appropriate technology for WWTP and prevent pollution from wastewater in the vicinity of UKM Griya Batik Widi Nugraha, Ngawi. The benefit of community empowerment is to gain has managed to realize a suitable technology in the form of a batik wastewater treatment plant (WWTP) capable of preventing environmental pollution. The wastewater treated in the WWTP meets the requirements for textile wastewater quality standards as specified in Annex II of the Regulation of experience for other batik wastewater treatment plant (WWTP) development programmes. Community Empowerment in Griya Batik Widi Nugraha, Ngawi, the Minister of Environment and Forestry of the Republic of Indonesia No. P.16/MENLAHK/SETJEN/KUM.1/2019.

It is recommended that in the future, the empowered communities can be used to implement appropriate technologies (TTS) in the form of batik wastewater treatment plants (IPAL) for other batik SMEs in Ngawi, Indonesia.

Acknowledgment: We would like to thank the Director of Poltekkes Kemenkes Surabaya for his support and the community around the Griya Batik Widi Nugraha UKM, Ngawi Regency for contributed to these activities.

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