Technium Sustainability

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

Utilization Of Methyl Ester Sulfonate as a Surfactant Raw Material in the Scouring, Bleaching and Dyeing Process of Rayon Fabric

Luciana[1], Riza Rizkiah [2]

[1] Faculty of Engineering, Insan Cendekia Mandiri University, Bandung, Indonesia Jl.Banten No.11 Bandung, 40272
Email: lucianlaksmi697@gmail.com
[2] Faculty of Engineering, Insan Cendekia Mandiri University, Bandung, Indonesia Jl.Banten No.11 Bandung, 40272
Email : rizarizkiah45@gmail.com

ABSTRACT. *The use of surfactants from palm oil as a wetting agent can be applied in the textile wet processes. Used cooking oil that has been through esterification and transesterification processes can be used as a raw material for surfactants. During this process, methyl ester sulfonate has been formed as a surfactant raw material. MES surfactant as an active ingredient in detergents has a detergency ability in water with a high hardness level, has a tolerance property to Ca^{2+} ions, has a low foaming rate, and has good stability to pH. The purpose of this research is to utilize used cooking oil that has been processed through esterification, transesterification, and sulfonation for the surfactant manufacturing process which will later be used for wet textile processes and to determine the optimum concentration of surfactant produced in the cooking and dyeing process of rayon compared to commercial surfactants (teepol). The experiments carried out were the process of making surfactants from methyl esters into sulfonate methyl esters, through the processes of sulfonation, purification and neutralization. Then, testing the wetting time, absorbency of the fabric and testing the resistance of acid, base, and hardness. Then the surfactant product is applied to the cooking and bleaching processes simultaneously, then the dyeing process is continued with the surfactant as a cloth wetting agent in the dyeing process. Then tested the age and evenness of the dyed fabric color. The results showed that MES surfactant has almost the same properties as a teepol, which holds it hard and not resistant to acids and bases. It has a good wetting ability and can reduce surface tension so that the fabric can absorb water in 23,36 seconds. The optimum conditions were achieved in MES surfactant concentrations using 2 ml / L in the scouring bleaching process (simultaneous) and 2 ml / L in the dyeing process. The color saturation is 25.6148 and the color evenness results in a standard deviation of 0.395.*

Keywords: *Used Cooking Oil, Methyl Ester Sulfonate, Bleaching Cooking, Dyeing, Rayon Fabric.*

INTRODUCTION

Cooking oil is a vegetable oil that comes from plants and has been purified and can be consumed as foodstuffs. The Cooking oil is most widely used by the public, industry, and, restaurants. The cooking oil is made from palm oil. As much as 49% of the total demand for cooking oil is household consumption and the rest is for industrial and restaurant needs. Used cooking oil is usually only disposed of in waterways by housewives or small industries. This disposal causes environmental pollution, both in rivers and in the soil, because the oil is not biodegradable by decomposing microorganisms [1].

Waste cooking oil can be harmful to microorganisms and other organisms. The presence of toxic, organic, and volatile compounds such as acrylamide, aldehyde, 4-hydroxymethylfurfural in heated cooking oil (waste oil) has been known to have mutagenic

and carcinogenic activities. Additionally, toxic compounds in the oil can be readily dissolved into the water and absorbed into living cells, eventually killing plants and animals [1].

Another alternative of waste cooking oil utilization is used for MES (methyl ester sulfonate) production.MES is an eco-friendly oleo chemical based anionic surfactant, can be easily synthesized using bio-oil feedstock and can be used for detergent application The advantages of MES are higher detergency at lower doses, stable in hard water, good biodegradability, harmless oral toxicity (2.2-3.8 g/kg weight), low toxicity on animal (low toxicity range) and good skin compatibility [2].

Using surfactants of palm oil as a substance wetting agent in the cooking process of cellulosic fabrics. The surfactant is in the form of MES (methyl ester sulfonate). So in this study will use used cooking oil as the main ingredient in the manufacture of surfactants for the cooking process on rayon fabric. The main process that is carried out starts from the esterification, transesterification, and sulfonation processes so that the oil becomes a surfactant in the form of MES which can become a *wetting agent* as an ingredient in cooking and dyeing in the textile process. Therefore, research will be carried out on used cooking oil (used cooking oil) as a surfactant in the cooking and dyeing process of rayon cloth. The purpose of this experiment is to utilize used cooking oil that has been processed through esterification, transesterification, and sulfonation for the process of making surfactants to be used for wet textile processes and to determine the optimum concentration of surfactant results made from used cooking oil in the cooking and dyeing process of rayon cloth compared to commercial surfactants (teepol).

LITERATURE REVIEW

1. Used Cooking Oil

Used cooking oil is the remaining cooking oil from household waste and culinary scraps that are used repeatedly. Judging from its chemical composition, used cooking oil contains carcinogenic compounds, and the compounds tend to be very susceptible to oxidation, causing a rancid odor when stored for a long time [3]. This is due to the breaking of the triglyceride bonds into glycerol and free fatty acids (FFA) or saturated fatty acids. Used cooking oil is also very popular with aflatoxin fungi that cause liver disease. The physical properties of used cooking oil are yellowish-brown, smell rancid and there is sedimentation. Meanwhile, the chemical properties of used cooking oil are easily hydrolyzed, which converts the oil into free fatty acids and glycerol. The oxidation process occurs when a certain amount of oxygen is in contact with oil. The hydrogenation process aims to grow double bonds from the carbon chains of fatty acids in the oil [4].

2. Methyl Ester sulfonate (MES) surfactant

Surfactant or Surface Active Agent is a surface-active substance that is on the surface of the water, interface, water, and air which has a unique characteristic, which tends to be centered on the interface so that it can reduce or increase surface tension[5]. Surfactants consist of a hydrophobic (water-loving) group called ahead and a hydrophilic (water-hating) group called a tail which is a long chain of carbon atoms. Methyl ester sulfonate (MES) is an anionic surfactant derived from natural oils. Polymers are large molecules composed of many repeated units that increase viscosity as a mobility control[6]. MES surfactants are the products of washing and cleaning (washing and cleaning products), also called anionic surfactant as a detergent active ingredient that has high detergency properties with high hardness (hard water). MES production process by reacting methyl ester with sulfonating agents, for example the reagent used sulfuric acid (H2SO4) [7].

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

3. Rayon Fiber

Rayon fiber is a type of artificial fiber whose raw material comes from nature, namely from wood with high cellulose content so that its properties are almost the same as cellulose fibers [8]. The chemical properties of rayon are the same as cellulose fibers, rayon is not acid-resistant and dilutes alkaline resistant, rayon is resistant to organic solvents, so it can be dry washed. Rayon is not mildew resistant, but rather resistant to sunlight. Besides, rayon is resistant to high temperatures, but it is easily burned by flames [9]. Rayon is easily wrinkled in use or creases after washing it needs to be an anti-wrinkle and anti-dragging process, rayon with high wet modulus is more stable in washing equivalent to cotton, can be mercerized, anti-wrinkle and anti-shrink like cotton. Rayon fibers in the market consist of Viscose Rayon, Acetate Rayon, Couproammonium Rayon. All types of general rayon are very comfortable to use because of their high moisture absorption of up to 13%. Rayon fiber is widely used for women's clothing, women's socks, and underwear[10].

4. Reactive Dyes

Reactive dyes are the most widely used dyes in the textile industry [11][12]. This dye can react with cellulose or protein fibers, has a small molecular weight, dissolves in water, and covalently bonds with the fiber so that the reactive dye results provide good color resistance properties to washing and sweating [13]. It has a bright color, complete color variations, and does not withstand oxidizing agents containing chlorine[14] .

In use, reactive dyes can be classified into 2 groups, namely cold reactive dyes and hot reactive dyes [15]. Both of them are distinguished from the molecular structure contained and the immersion process, both the temperature used and the auxiliary substances used in the dyeing process. The process of dyeing reactive dyes consists of 3 stages, the first stage the dye is adsorbed on the fiber surface, the second the dye diffuses from the fiber surface into the fiber, and the third is the fixation process, namely the reaction between the dye and the fiber. The reaction that occurs between the dye and the fiber: D-Cl + Cellulose - OH D-O- Cellulose + HCl $\longrightarrow$

HCl + NaOH $\longrightarrow$ NaCl + H_2O

Hydrolysis with water:

D-Cl + H_2O $\longrightarrow$ D-OH + HCl

Reactive dyes react with fibers and form covalent bonds so that the dyes become part of the fibers (Isminingsih et al. 1979).

METHODOLOGY

A.Material

The material used is rayon, a reactive dye. The substance used is the MES surfactant from used cooking oil

B. Research Methods

The experiments carried out were the process of making surfactants from methyl esters into sulfonate methyl esters, through the processes of sulfonation, purification and neutralization. Then, testing the wetting time, absorbency of the fabric and testing the resistance of acid, base, and hardness.

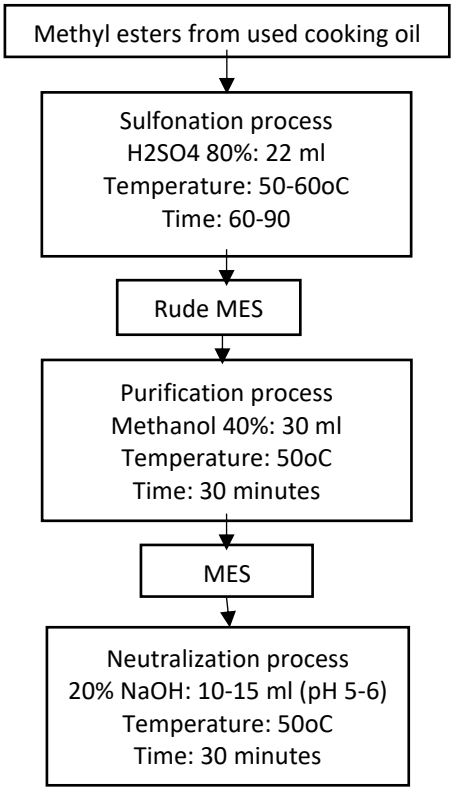
Then the surfactant product is applied to the scouring and bleaching processes simultaneously, then the dyeing process is continued with the surfactant as a cloth wetting

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

agent in the dyeing process. Then tested the age and evenness of the dyed fabric color. Evaluation of research results includes:

1. Testing the wetting time using the AATCC TM 17-2005 test method.
2. Testing the absorption capacity using the SNI 0279-2013 test method.
3. Testing the resistance of acids, bases, and hardness using the SNI 0279 test method.
4. The weight reduction test uses the SNI 8100-2015 test method.
5. Testing of age and evenness of color using the SNI-ISO-JO2-2010 test method.

1. Flow chart of surfactant manufacture

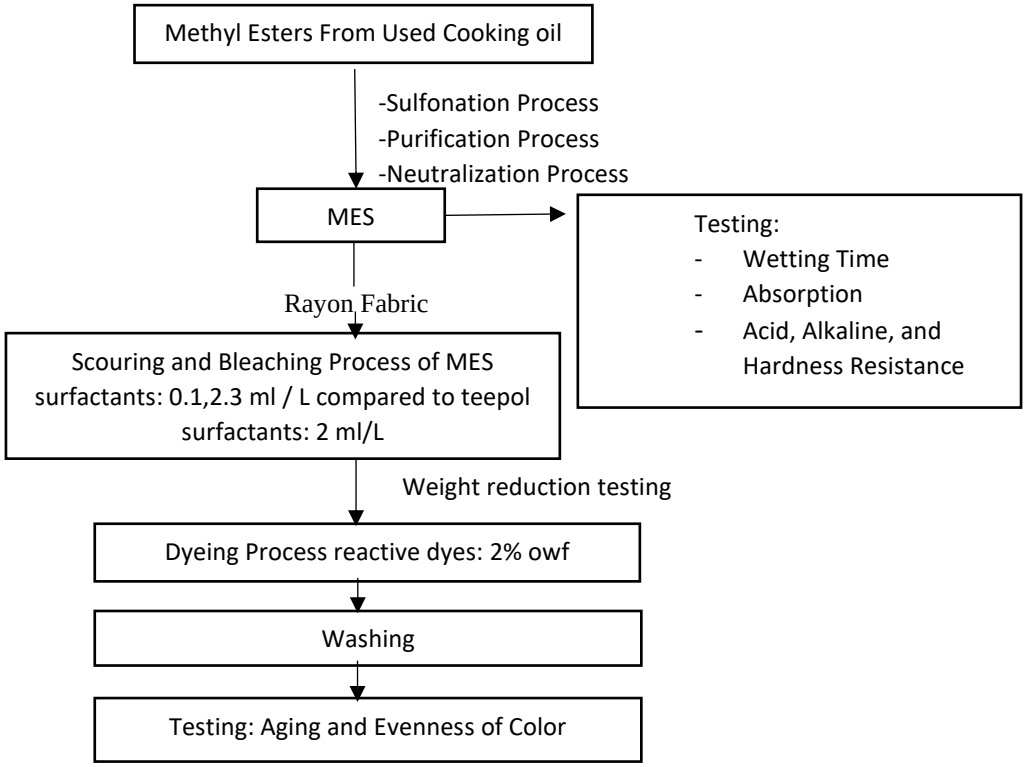


2.1 Flow chart of surfactant manufacture

Technium Sustainability

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

2. Research flow Chart



2.2 Research Flow Chart

RESEARCH RESULTS AND DISCUSSION.

1 . Testing of wetting time

Testing of wetting time was carried out to determine the ability of the surfactant to reduce the surface tension of the fabric so that the fabric could absorb water in a relatively fast time. The calculation starts when the cloth to be tested is stored above the surface of the water which already contains a certain concentration of surfactant, then the calculation is stopped when the cloth sinks or reaches the bottom. The results of the cloth wetting time process are shown in Figure 2.

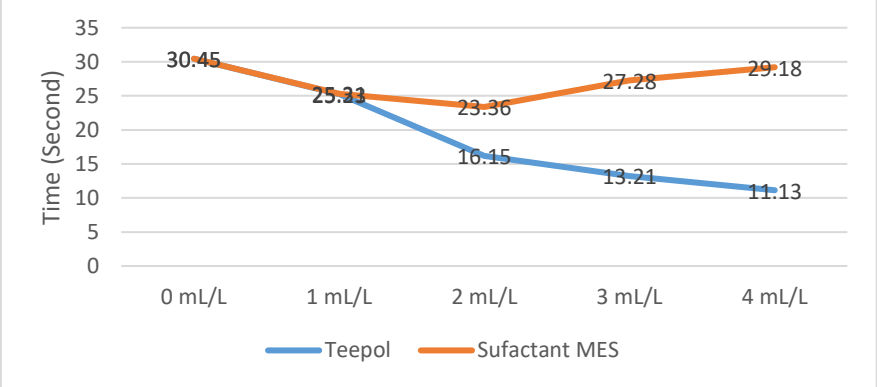


Figure 2 Graph of the relationship between concentration and wetting time

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

The graph above shows the ratio of wetting time between MES surfactant and teepol, the higher the teepol concentration the faster the wetting occurs. At a concentration of 1 ml/l the wetting time was 25.23 seconds and at a high concentration of 4 ml/l had the fastest wetting time of 11.13 seconds. Whereas in MES surfactants the higher the concentration has a longer wetting time. The fastest wetting time at a concentration of 2 ml/l was about 23.36 seconds and at a concentration of 3 ml/l and 4 ml/l the wetting time increased at 27.28 seconds and 29.18 seconds.

2. Fabric absorbency results

Absorption capacity shows how much water can be absorbed by the fabric with the help of surfactants as surface-active agents that help reduce surface tension on the fabric. Rayon cloth is a cellulose cloth that easily absorbs water with an MR (*Moisture Regain*) value of 11-14% higher than cotton which is only 7-8.5% so that the absorbency of the fabric has a high value. Results absorption fabric can be seen in Figure 3 below:

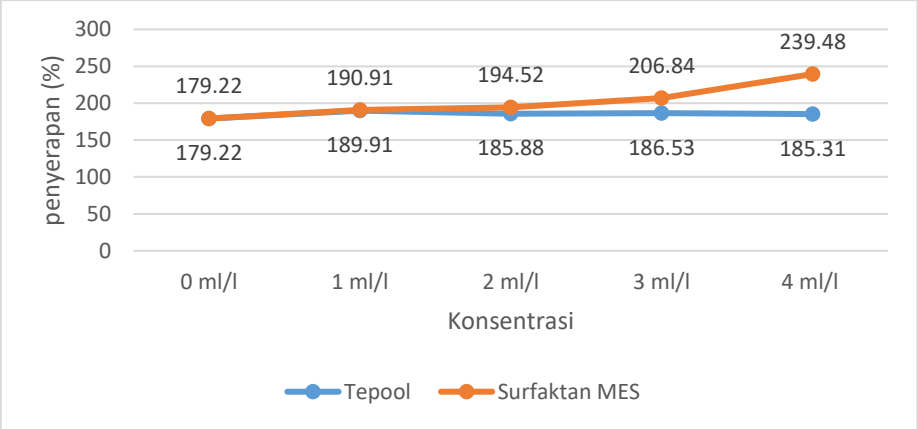


Figure 3. Graph of the Relationship between Surfactant Concentration and Fabric Absorption.

The results show that the absorption value of rayon cloth has high absorption, almost three times the initial weight. This happened to teepol and MES surfactants. For teepol, the most absorption was at a concentration of 2 ml / l which was 189.91% but this value was almost the same as the other concentrations, whereas in MES surfactants the higher the concentration, the higher the absorption in the fabric at a high concentration of 4 ml / l the percentage reduction weight reached 239.48% and was the highest absorption in the testing process.

However, MES surfactants have another factor in fabric absorption, namely the weight gain due to the presence of micelles. The hydrophobic part will move in the oil phase on the fabric so that there is an additional weight that occurs in the rayon cloth. This is the same as the factor in the wetting time process where the more surfactant concentration the more micelles are formed, these micelles will stick to the fabric and will become a fabric weight factor due to the aggregate caused by these micelles. When the surfactant concentration is high and has reached the point of decreasing surface stress, the micelles formed will aggregate and can affect the fabric including the wet process of textiles.

Technium Sustainability
Vol. 2, No. 2, pp.23-31 (2022)
ISSN: 2810-2991
www.techniumscience.com

3. Results in acid-base and hardness resistance.

Based on the results of testing the resilience of acid -base and hardness obtained the data as follows :

Table 3. Acid-Base Resitance and Hardness Test

No.	Resistance	Surfactant	Teepol
1	Acid	Not Acid Resistant	Not Acid Resistant
2	Base	Not Base Resistant	Not Alkaline Resistant
3	Hard	Hold it hard	Hold it hard

The test showed the same value for resistance to acid-base and hard water where teepol and MES surfactant from used cooking oil were neither alkaline nor acid resistant, but both were resistant to hard water. In the alkaline test, the surfactants were salted and in the acid resistance test, the oil was separated. However, in the hardness resistance test, the solution is not cloudy, and it is the same as a solution that has the same concentration without the addition of hard water. So for the conditions of 20˚DH, 30˚DH and 40˚DH the surfactants are still resistant to hardness.

4.Weight reduction after simultaneous processing

In the weight reduction process in terms of the results after the simultaneous process, especially in the cooking process, MES surfactants have a role in reducing surface stress and binding the oil on the rayon cloth, this oil can affect the dyeing process so that it can be removed/dissolved by the MES surfactant, loss oil on the fabric is seen from the weight reduction results on the rayon cloth. The results of the reduction can be seen in Figure 4 below.

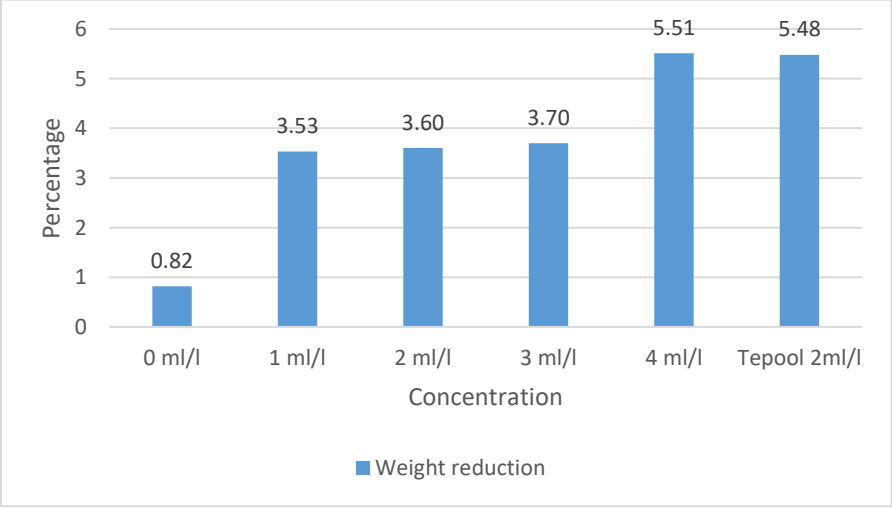


Figure 4 Graph of Weight Reduction on Simultaneously Processed Rayon Fabric

The results showed that the higher the concentration, the more oil/impurities that were lost/dissolved by MES surfactant, the highest concentration in 4 ml / l MES surfactant, namely 5.51%, was the same as the results with the use of 2 ml / l teepol at 5.48%. Surfactants that form micelles will affect the weight reduction results, however, according to Arief Wibi Sana

(2017), The temperature can accelerate the reaction by expanding the energy distribution and increasing the number of molecules that have higher kinetic energy than their activation energy. In these conditions, the greater the chance for a collision to occur, thereby accelerating the reaction of MES decomposition. Temperature plays a role in accelerating the MES decomposition reaction so that the more concentration the more collisions occur which can accelerate the decomposition reaction of the MES surfactant so that it can decompose the micelles that have been formed and can make the surfactant work effectively in reducing surface tension and binding and removing dirt/oil. present on the fabric giving a good weight loss value.

Color preservation and Evenness

MES and teepol surfactants are used in the dyeing process which functions to see how old the color and evenness of color results due to a decrease in surface tension on the rayon fabric so that the dye can enter the rayon fiber. The results show that the highest aging is in the simultaneous concentration variation at 1 ml / l and immersion at 0 ml / l but this results in the standard deviation or the highest color evenness value so that the dyeing results are striped and uneven. When viewed from all the commercial surfactants or teepol the best results with high aging, namely at 25.0872 and good flatness at 0.1555 compared to other results. For the results carried out with the use of surfactants the best results were at a simultaneous process concentration of 2 ml / l and the immersion process of 2 ml / l. These results are almost the same as the results of teepol with a color aging of 25.6148 and the results of color evenness with a standard deviation of 0.3953.

CONCLUSION

1. Used cooking oil can be used as a surfactant in the textile process as a wetting agent in the form of MES (methyl ester sulfonate).
2. MES surfactant has almost the same properties as teepol which is hardness resistant and acid and alkaline resistant. It has the good wetting ability and can reduce surface tension so that the fabric can absorb water in 23.36 seconds
3. The optimum concentration of MES surfactant is at the use of 2 ml / l in the scouring and bleaching process (simultaneously) and 2 ml / l in the dyeing process.
4. The color setting is 25.6148 and the results of the color evenness with a standard deviation of 0.395
5. The higher the MES surfactant concentration in the simultaneous cooking and bleaching process of rayon cloth, the effect on the weight reduction value

SUGGESTION

Further research is needed in the process of making methyl esters using other reactants (sodium bisulfite).

REFERENCES

[1] K. N. M. Zahri, A. Zulkharnain, S. Sabri, C. Gomez-fuentes, and S. A. Ahmad, “Research trends of biodegradation of cooking oil in Antarctica from 2001 to 2021: A bibliometric analysis based on the scopus database,” *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, pp. 1–15, 2021, doi: 10.3390/ijerph18042050.

[2] R. L. Permadani, M. Ibadurrohman, and Slamet, “Utilization of waste cooking oil as raw material for synthesis of Methyl Ester Sulfonates (MES) surfactant,” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 105, no. 1, 2018, doi: 10.1088/1755-1315/105/1/012036.

[3] L. Syahrida Dian Ardhany, “河南省文物考古研究院 1 河南省文物局南水北调文物

保护办公室 2 （1、2.,” *J. Surya Med.*, vol. 3, no. 2, pp. 62–68, 2018, doi: 10.16143/j.cnki.1001-9928.2018.01.002.

[4] A. K. Singh and R. Chandra, “Pollutants released from the pulp paper industry: Aquatic toxicity and their health hazards,” *Aquat. Toxicol.*, vol. 211, pp. 202–216, Jun. 2019, doi: 10.1016/J.AQUATOX.2019.04.007.

[5] S. B. Awad and N. F. Awad, “The Role of Surfactants in Ultrasonic Cleaning: Nanoparticle Removal and Other Challenging Applications,” *Surfactants Precis. Clean.*, pp. 227–271, Jan. 2022, doi: 10.1016/B978-0-12-822216-4.00007-0.

[6] A. D. K. Wibowo, L. A. Yoshi, A. S. Handayani, and Joelianingsih, “Synthesis of polymeric surfactant from palm oil methyl ester for enhanced oil recovery application,” *Colloid Polym. Sci.*, vol. 299, no. 1, pp. 81–92, 2021, doi: 10.1007/s00396-020-04767-5.

[7] H. Tulathammakit and K. Boonyarach, “Synthesis of methyl ester sulphonate surfactant from palm oil methyl ester by using UV or ozone as an initiator,” *Chem. Eng. Trans.*, vol. 39, no. Special Issue, pp. 421–426, 2014, doi: 10.3303/CET1439071.

[8] I. R. Comnea-Stancu, K. Wieland, G. Ramer, A. Schwaighofer, and B. Lendl, “On the Identification of Rayon/Viscose as a Major Fraction of Microplastics in the Marine Environment: Discrimination between Natural and Manmade Cellulosic Fibers Using Fourier Transform Infrared Spectroscopy,” *Appl. Spectrosc.*, vol. 71, no. 5, pp. 939–950, 2017, doi: 10.1177/0003702816660725.

[9] L. Lau and J. Fan, “Laundry performance of fabrics and garments,” *Eng. Appar. Fabr. Garments*, pp. 339–360, Jan. 2009, doi: 10.1533/9781845696443.339.

[10] S. Jaiswal, G. Kumar Gupta, K. Panchal, Mandeep, and P. Shukla, “Synthetic Organic Compounds From Paper Industry Wastes: Integrated Biotechnological Interventions,” *Front. Bioeng. Biotechnol.*, vol. 8, no. January, pp. 1–13, 2021, doi: 10.3389/fbioe.2020.592939.

[11] K. Haggag, M. M. El-Molla, and Z. M. Mahmoued, “Dyeing of cotton fabrics using reactive dyes by microwave irradiation technique,” *Indian J. Fibre Text. Res.*, vol. 39, no. 4, pp. 406–410, 2014.

[12] F. Fu, Q. Wang, and B. Tang, “Effective degradation of C.I. Acid Red 73 by advanced Fenton process,” *J. Hazard. Mater.*, vol. 174, no. 1–3, pp. 17–22, Feb. 2010, doi: 10.1016/J.JHAZMAT.2009.09.009.

[13] P. Pal, “Industry-Specific Water Treatment: Case Studies,” *Ind. Water Treat. Process Technol.*, pp. 243–511, Jan. 2017, doi: 10.1016/B978-0-12-810391-3.00006-0.

[14] K. R. Dasarathan and N. Sah, “Acid and Reactive dyes for Sericin treated polyester fabric,” no. January, 2021.

[15] A. Khatri and R. A. Jhatial, *ADVANCES IN REACTIVE DYEING*, no. February. 2021.