Journal of Chemical Process and Material Technology
http://publikasiilmiah.unwahas.ac.id Ratnani et.al., vol(1), 27-36, 2022

WASTEWATER TREATMENT BAKERY USING ACTIVE CARBON OF WATER HYACINT AND BOILER WASTE

Rita Dwi Ratnani[1]*, Afilina Yunas Ariyaningrum[1], Farikha Maharani[1]
[1]Department of Chemical Engineering, Faculty of Engineering, Wahid Hasyim University, Semarang
Corresponding Author:ritadwiratnani@unwahas.ac.id

ABSTRACT
Bakery industry wastewater usually comes from the washing process of production equipment and generally contains organic compounds, oils, fats, and surfactants. Efforts are needed to overcome these problems so that contamination due to bakery waste can be handled. This study aims to determine the ability of water hyacinth activated carbon and boiler waste activated carbon in improving the quality of wastewater through the adsorption process so that it is expected to be in accordance with the wastewater quality standards set by the Central Java Regional Government. The variables used are activated carbon mass, time, and temperature of the adsorption process. The results showed a change in color and odor, from greenish to clear, and a reduction in fishy odor in the wastewater. A decrease in COD value and an increase in pH also occurred, with the best results being obtained using activated carbon from boiler waste at a mass weight of 20 g, a time of 90 minutes, and a temperature of 45 °C. The best results are obtained by combining activated carbon from water hyacinth and boiler waste at a mass ratio of 1:19 g, a time of 120 minutes, and a temperature of 35 °C.
Keywords: Bakery Industry Wastewater, Adsorption, Activated Carbon, Color, COD, pH

INTRODUCTION

The bakery industry is a place that produces and sells foods made from flour and baked in the oven such as bread, cookies, cakes, pastries and pies. Processed products from the bakery industry are very popular so that the development of the bakery industry is very fast. This development causes positive impacts on the community's economy and a negative impact on the environment, namely by increasing the amount of waste water produced. In bakery industry, wastewater generally comes from the washing process of raw materials, auxiliary materials and production equipment. Wastewater from this process generally contains organic compounds, oils, fats, and surfactants (Malik et al. 2016). The waste water pollutant of the bakery industry comes from the remnants of the dough flour, the dye used and the spread of the baking sheet, while the surfactant comes from the soap used to wash the production equipment.

Most of the bakery industry dispose of their waste water without being treated first and do not think about the impact that will occur. Meanwhile, the wastewater produced usually does not meet the Quality Standards for the Biscuit and Bread Industry Wastewater (Bakery) Perda of Central Java Province Number 5 of 2012 including the COD (Chemical Oxygen Demend) and pH values as shown in table 1 below.

Table 1 Wastewater Quality Standard for Biscuit and Bread Industry (Bakery)

No	Parameter	Maximum rate (mg/L)	Maximum pollution load (kg/ton)
1	BOD	85	0.51
2	COD	175	1.05
3	TSS	85	0.51
4	pH	6-9	
5	Debit	6 m3/ton product	

Source: Central Java Provincial Regulation Number 5 of 2012

COD value is a measure of water pollution by organic substances that can naturally be oxidized and result in reduced oxygen dissolved in water. The concentration of COD in the water must match the quality standards that have been determined so as not to pollute the environment. One way that can be used to treat wastewater to comply with quality standards is by adsorption. Adsorption is the event of adsorption of a substance on the surface of a solid. In the adsorption process, there are 3 stages: the first is the transfer of the adsorbate molecules to the adsorbent film layer, the second is the diffusion of the adsorbate through the adsorbent film layer, and the third is the attachment of the adsorbate to the adsorbent surface (Wardhani, 2013).

Activated carbon is one of the adsorbents that can be used. Activated carbon is a porous solid containing 85-95% carbon, produced from materials containing carbon by heating at high temperatures (Isna et al, 2011). Activated carbon functions as an absorbent for several types of substances contained in a liquid or gas, this is because activated carbon has pores that can adsorb so that it can be used as an adsorbent in the adsorption process. The activated carbon used in this research is water hyacinth activated carbon and boiler waste activated carbon. Water hyacinth plant contains 17.2% crude protein, 15-18% fiber and 16-20% ash which consists of several components such as; potassium, calcium, carbon, sulfur and manganese. Water hyacinth activated carbon itself has the ability to absorb organic compounds and inorganic compounds (Sangkota et al, 2017). Charcoal from the rest of the boiler combustion includes organic material so that it can be used as activated carbon and can be used as an adsorbent, in addition to adding to the use value of boiler combustion waste (Ratnani et al, 2018). This research was conducted to determine the ability of water hyacinth activated carbon and boiler waste activated carbon in improving the quality of bakery industry wastewater, especially to improve the value of COD (Chemical Oxygen Demand), pH, color and odor.

METHODOLOGY

Materials

Materials used are bakery industry liquid waste, water hyacinth activated carbon, boiler waste activated carbon, aquadest, H2SO4, K2Cr2O7, HgSO4, Ag2SO4, Ferroin indicator and ferrous ammonium sulfate (FAS) solution.

Variable Assignment

The variables used in this study are the dependent variable and the independent variable. The dependent variables used are activated carbon type, volume of waste used and stirring speed of sample. The activated carbon used is water hyacinth activated carbon and boiler waste activated carbon with a sample volume of 200 ml and a stirring speed of 1 mot. The independent variables used are mass of activated carbon, stirring time and stirring temperature. The mass of activated carbon used is 5 g, 10 g, 15 g, 20 g and 25 g. Stirring time 30 minutes, 60 minutes, 90 minutes, 120 minutes and 150 minutes. Stirring temperature 25°C, 35°C, 45°C, 55°C and 65°C.

Analisis

In this study, analysis of COD, pH, color and odor was carried out. Analysis of color and odor is carried out organoleptically.

Procedures

The activated carbon that used in the adsorption process is blended to reduce the size which is then sieved using a 100 mesh size screening. The adsorption process was carried out by mixing 100 mesh size activated carbon into 200 ml of the wastewater sample which had been diluted 10 times. Magnetic stirrer with a speed of 1 mot for a predetermined time. Filtered using filter paper which is then analyzed. Color and odor analysis was carried out organoleptically, pH using a pH meter and COD value could be analyzed using the open reflux method which could then be calculated using the following formula.

$$KOK\,(mg/L\,O_2) = \frac{(A-B)(N)(8000)}{mLContoh-Uji}$$

Dimana :

- A is the volume of FAS solution required for the blanko, ml
- B is the volume of FAS solution required for the sample, ml
- B is the normality of FAS solution

RESULTS AND DISCUSSION

Bakery Industry Wastewater Treatment Using Activated Carbon With Color and Odor Parameters

Figure 1. Wastewater adsorption results

Figure 1 show that the bakery industry wastewater after the adsorption process experienced a color change from greenish to clear and the fishy odor in the wastewater was reduced. This shows that activated carbon has a good role in the waste treatment process. In addition, the function of activated carbon itself is to absorb several types of substances contained in a liquid or gas because it has pores, where the larger the surface area of the activated carbon pores, the greater the absorption capacity of activated carbon and can absorb substances. organic matter in wastewater so as to reduce the odor and color present in wastewater (Idrus et al, 2013).

The Ability of Boiler Waste Activated Carbon to Improve COD and pH in Bakery Industry Wastewater

Effect of Boiler Waste Activated Carbon Mass

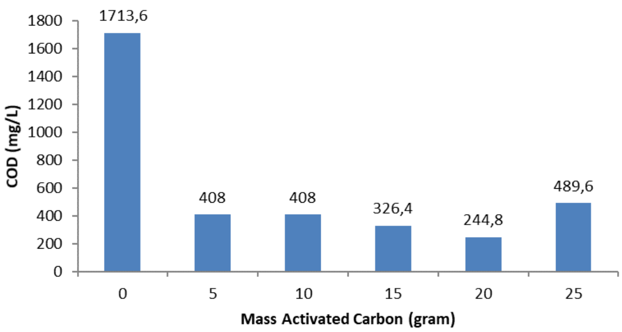

Figure 2. Effect of activated carbon mass on COD

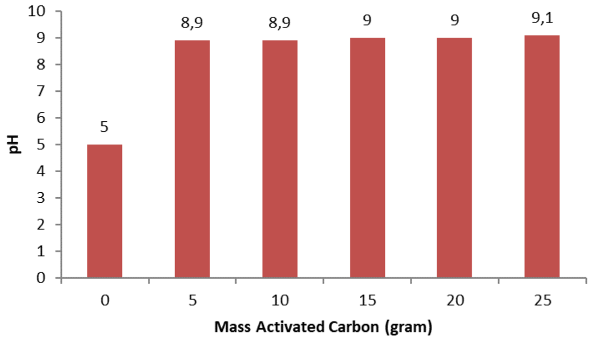

Figure 3. Effect of activated carbon mass on the pH value

Laras, et al (2015) reported that the mass of activated carbon is one of the things that can affect the adsorption results. The results of the effect of the mass of activated carbon in this study can be seen in Figure 2. Figure 3 that the addition of activated carbon affects the decrease in COD and increase in pH values. At a mass of 20 grams is the optimum mass because at that mass the COD value decreases and at a mass of 25 grams the COD value rises again, this increase occurs because too much activated carbon is given so that the activated carbon rubs together and causes the interaction of activated carbon and waste to be less effective (Setyawati et al, 2015). The increase in pH is due to the absorption of hydrogen ions (H^+) by activated carbon, so that the more activated carbon is added, the pH will increase (Laras et al., 2015).

Effect of Adsorption Time on COD

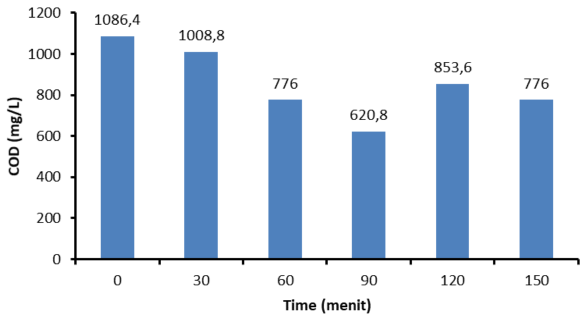

Figure 4. Effect of contact time on COD

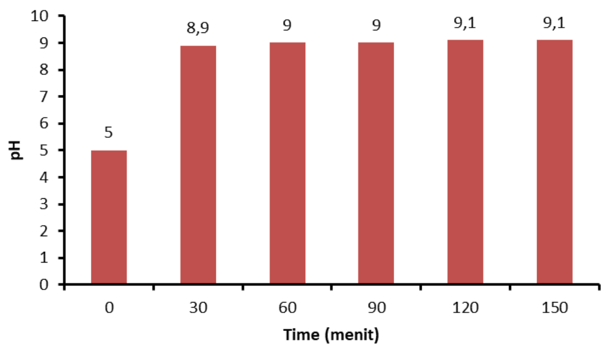

Figure 5. Effect of contact time on pH

Time is one of the things that affect the adsorption process. Figure 4, the optimum time occurred at 90 minutes because at 120 minutes the COD content increased. As stated by Setyawati et al, (2015) the increase in COD was due to the adsorbent having reached the saturation point in the adsorption process, so that the absorption process decreased after the optimum time was reached. In addition, the longer the contact time between activated carbon and waste, the pH also increases (Hatina et al, 2020). The low pH show in figure 5, of the wastewater prior to the adsorption process indicates that microbial activation has occurred which can decompose organic materials into acids.

Effect of Adsorption Temperature

Wirawan, et al (2015) increasing the adsorption temperature can cause the adsorption rate to increase, resulting in a large number of adsorbed substances so as to reduce COD.

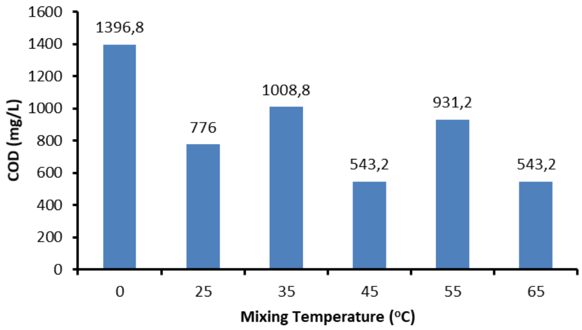

Figure 6. Effect of temperature on COD

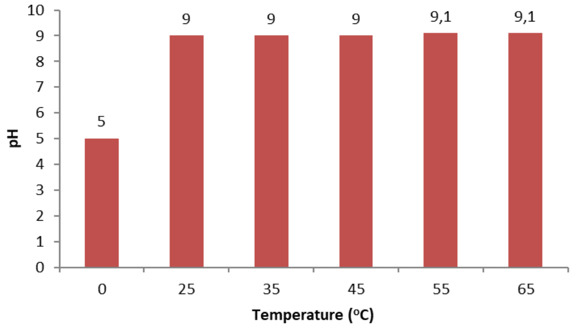

Figure 7. Effect of temperature on the pH value

It can be seen in Figure 6, with increasing stirring temperature, the cod value decreases and increases. This is because the increase in COD value is probably caused by desorption. Desorption occurs when the maximum adsorption process occurs, the surface of the adsorbent is saturated or no longer able to absorb the adsorbate and equilibrium occurs (Purnamasari, 2016). Meanwhile, in Figure 7, it can be seen that increasing the stirring temperature and pH will affect the adsorption capacity. This is because the increase in temperature and pH causes the pores of the activated carbon to become larger so that the adsorption capacity also becomes larger (Priatni et al, 2020).

Combination Activated Carbon Ability to Reduce COD and Increase pH Value in Bakery Industry Wastewater

The comparison of activated carbon used, namely activated carbon from boiler waste, is more than activated carbon from water hyacinth with the optimum mass of activated carbon from boiler waste as a reference.

Effect of Combination Activated Carbon Mass Comparison

The optimum mass of combined activated carbon can be seen in Figure 8. Mass of combined activated carbon can reduce COD in bakery industry waste in mass ratio (1:19). COD decreased the most so that it was in accordance with the wastewater quality standard. Mass comparisons, COD have increased this is due to the water content in the activated carbon.

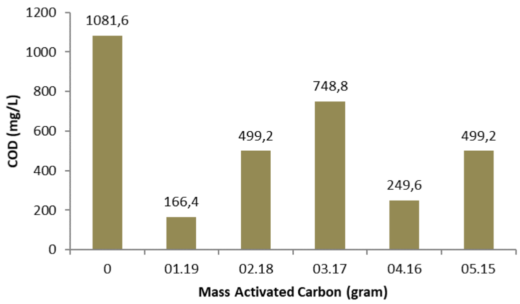

Figure 8. Effect of mass combination of activated carbon on COD

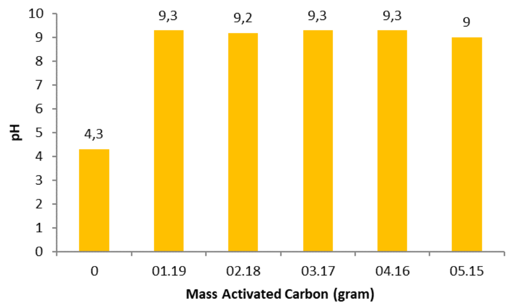

Figure 9. Effect of mass combination of activated carbon on the pH value

The water content of the activated carbon of boiler waste is lower than that of activated carbon of water hyacinth, so that the absorption of activated carbon of boiler waste is higher than that of activated carbon of water hyacinth (Tudjuka et al, 2017). Seeing the results of the decrease in pH in Figure 7, the mass of activated carbon is very influential where the wastewater before adsorption and after adsorption has a significant increase

Effect of Adsorption Time on COD

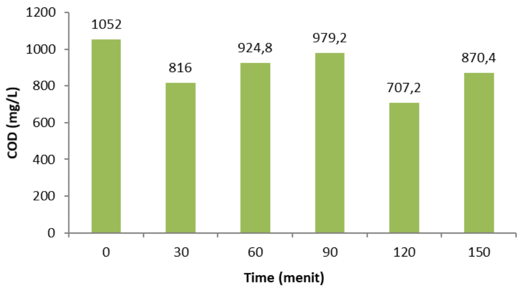

Figure 10. Effect of contact time on COD

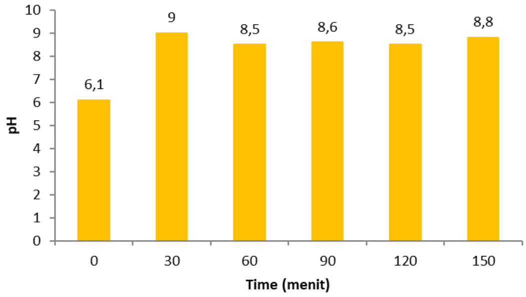

Figure 11. Effect of contact time on pH value

To determine the optimal time in this study, the mass of combined activated carbon (1:19) was used. Figure 10 that the optimum time to reduce COD occurs at 120 minutes, at that time the COD become 707 mg/L where before adsorption the COD are 1052 mg/L. In addition to lowering COD , the adsorption time can also increase the pH value as shown in the Figure 11. This shows that the contact time of activated carbon has an effect on the adsorption process where the longer the stirring time, the longer the organic matter in the liquid waste will pass through the pores of the activated carbon, so that more organic matter in the waste is absorbed (Wirosoedarmo et al., 2016).

Effect of Adsorption Temperature

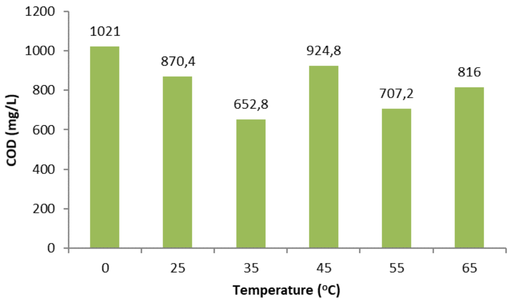

Figure 12. Effect of temperature on COD

Looking at the Figure 12 that temperature can reduce COD and increase pH values. Optimum temperature to reduce COD is at a temperature of 35 °C, even though at that temperature the COD are still far from the wastewater quality standard. As stated by Wirawan, et al (2015) that an increase in the adsorption temperature can accelerate the rate of absorption in the adsorption process, so that an increase in temperature can cause a lot of organic matter content to be absorbed. If it reaches the optimum temperature, desorption will occur where desorption occurs if the adsorption process is maximal, desorption also occurs due to the high temperature used so that many substances are released and cause the COD level to rise again. In addition, the high adsorption temperature can also increase the pH value because many ions are absorbed and the pH value increases as shown in the Figure 12**.**

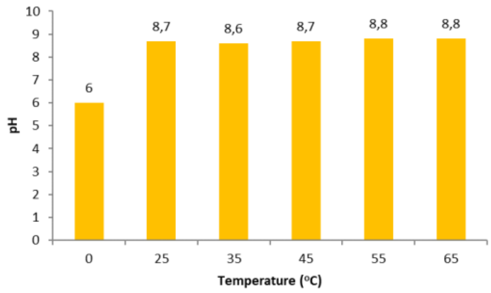

Figure 13. Effect of temperature on the pH value

CONCLUSION

Based on the research that has been done, it can be concluded that activated carbon of water hyacinth and activated carbon of boiler waste can be used to improve the quality of the bakery industry wastewater, especially on the parameters of color, odor, COD, and pH values. In addition, the mass of activated carbon, contact time and temperature used in the adsorption process are very influential in decreasing COD and increasing pH values.

DAFTAR PUSTAKA

Hatina, S., Komala, R., & Wahyudi, R. (2020). Pemanfaatan HCL dan CaCl2 Sebagai Zat Aktivator Dalam Pengolahan limbah Industri Tahu . *Volume 5, Nomor 1, Januari – Juni 2020* .

Idrus, R., Lapanporo, B. P., & Putra, Y. S. (2013). Pengaruh Suhu Aktivasi Terhadap Kualitas karbon Aktif Berbahan Dasar Tempurung Kelapa. *PRISMA FISIKA, Vol. I, No. 1 (2013) ISSN : 2337-8204* , 50-55.

Isna, S., Mayang, A., & Hetty, A. K. (2011). Analisa Variasi Waktu dan Kecepatan Pengaduk Pada Proses Adsorpsi Limbah Logam Berat Dengan Arang Aktif. *Volume 12 No. 1, Juli 2011* .

Laras, N. S., Yuliani, & Fitrihidajati, H. (2015). Pemanfaatan Arang Aktif Limbah Kulit Kacang Kedelai. *ISSN: 2252-3979* .

Malik, R. A., Vistanty, H., & Sartamtono. (2016). Pengolahan air limbah industri bakery menggunkan sistem stripper-lumpur aktif. *Jurnal Teknologi Pencegahan Pencemaran Industri 7 (2) (2016) 89-98* .

Peraturan Daerah Provinsi Jawa Tengah Nomer 5 Tahun 2012 Tentang Baku Mutu Air Limbah.

Priatni, A., Murti, R. S., & Rahmawati, D. (2020). Adsorpsi limbah penyamakan krom dengan adsorben karbon. *Vol. 36 No. 1 Juni 2020: 25-34* .

Purnamasari, I. W. (2016). Adsorpsi-Desorpsi Monologam dan Multilogam Ion Ni(II), Cd(II), dan Cu(II) Oleh Material Biomassa Alga Nitzschia sp yang Dimodifikasi Dengan Pelapisan Silika-Magnetit (Fe3O4). *fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Lampung* .

Ratnani, R. D., Purbacaraka, F. H., & Hartati, I. (2018). Actived Carbon From teak Wood, Jackfruit Wood, and Mangowood Pyrolysis Process. *Journal of Physics: Conf. Series 1217 (2019) 012055* .

Sangkota, V. D., Supriadi, & Said, I. (2017). Pengaruh Aktivasi Kimia Arang Tanaman Enceng Gondok. *ISSN 2302-6030 (p), 2477-5185 (e)* .

Setyawati, H., Rakhman, N. A., & Anggorowati, D. A. (2015). Penerapan Penggunaan Arang Aktif Sebagai Adsorben Untuk Proses Adsorpsi Limbah Cair Di Sentra Industri Tahu Kota Malang. *Nomor 26 Volume XIII Juli – Desember 2015: 67 - 78* .

Tudjuka, M. D., Walanda, D. K., & Hamzah, B. (2017). Arang Enceng Gondok (Eichornia crassipes) Sebagai Adsorben Fenol Pada Limbah PLTU Palu. *ISSN 2302-6030 (p), 2477-5185 (e)* .

Whardani, E., Dirgawati, M., & Alvina, I. F. (2013). Kombinasi Proses Presipitasi dan Adsorpsi Karbon Aktif Dalam Pengolahan Air Limbah Industri Penyamakan Kulit. *Lingkungan Tropis, vol. 7, no. 1, Maret 2013: 39-52* .

Wirawan, W., Leanon, R., & Masyithah, Z. (2015). Pengaruh Suhu Adsorpsi dan Jumlah Penambahan karbon Aktif Terhadap Kecerahan Surfaktan Decyl Poligikosida Dari D-Glukosa Dan Dekanol. *Jurnal Teknik Kimia USU, Vol. 4, No. 3 (September 2015)* .

Wirosoedarmo, R., Haji, A. T., & Hidayati, E. A. (2016). Pengaruh Konsentrasi Dan Waktu Kontak Pada Pengolahan Limbah. *Jurnal Sumberdaya Alam dan Lingkungan* .