



Various Materials Of Carbon Activate For Natural Coagulants To Reduce Chemical Oxygen Demand (COD) (Study Meta-Analysis In Indoesian Industry)

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ABSTRACT

Industrial activities have negative impacts on the environment such as increased pollution due to waste disposal, especially for industrial waste which directly into rivers. An effective treatment that can be carried out by industrial owners is the adsorption of industrial wastewater by coagulants. The purpose of this study was to identify the factors that influence

COD reduction. A meta-analysis study was conducted by the authors by combining 20 national and international studies published and indexed on pages 2, 3, 4, 5, Indonesian Publication Index, in the span of 13 years (2007 - 2020). From the calculation of the average difference in the adsorbent dose and contact time, p values of 0,000 or $p < 0.05$ means that there is a significant influence between the adsorbent dose and contact time on the reduction in COD of industrial waste.

Key word: *Industrial Liquid Waste, Chemical Oxygen Demand, Activated Carbon, Meta-Analysis*

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I. Introduction

The industry is an activity that is able to improve the regional economy. Industrial activities improving the economy of an area and reducing unemployment. In addition, there are also negative impacts on the environment such as increased air pollution, noise, and river pollution if industrial waste is discharged directly without any specific treatment.^{1,2}

Industrial liquid waste discharged directly into the river has pollutant parameters such as BOD, TSS, Turbidity, COD, etc. Chemical Oxygen Demand (COD) is one of the highest level parameters when testing laboratory waste. COD is the need for oxygen in the process of oxidation of organic material in waters that go through chemical processes and cause a decrease in the level of dissolved oxygen in the water. Some factors that influence high levels of COD include the location of industrial establishments close to rivers (waste disposal sites) and the presence of other pollutants in wastewater that is wasted in the water, so that wastewater in the river will accumulate and COD levels are getting greater.^{3,4} However, there are treatments that can be done to reduce the level of COD of industrial waste, such as the manufacture of wastewater treatment plants consisting of water equalization, like the slow-rapid mix, like sedimentation, like aeration, until filtration. While one example of treating small-scale waste is the adsorption method.⁵

Wastewater adsorption is a method of treatment with the help of media such as coagulant, zeolite, or activated carbon. Activated carbon is one of the ingredients to reduce the levels of COD in various industrial wastewater. The basic ingredient of activated carbon is a natural material that is usually available but is not utilized by much general public, for example, bagasse, coconut shell, rice husk, corncob, corn cobs. In addition, there are natural coagulants such as water hyacinth plants, water jasmine plants, cocoa pods, sawdust, and others. In this study, a merger of several studies from journals/theses will be carried out so that variables will be found that affect the reduction in COD levels.^{6,7}

II. Material And Methods

This research uses a meta-analysis method with a quantitative approach. The population in this study were 49 articles, journals, and the thesis which had the theme of reducing COD levels of industrial waste both on a household scale (tofu, paste, laundry, textiles) as well as large-scale industries (Hospitals, and Palm Oil) using activated carbon and natural coagulant. In addition, research has been published nationally and internationally and indexed on the pages of Sinta 2, Sinta 3, Sinta 4, Sinta 5, Garuda Garuda Portal, in a minimum span of 10 years. Then the research sample was taken purposively based on the purpose and certain considerations. Samples from the study were obtained after reviewing 49 articles, journals, and theses that have complete research data (not only listed in the abstract) and have an operational definition referred to by the author. Then obtained 20 studies from the provinces of Aceh, Padang, East Java, Central Java, West Java, NTB, West Kalimantan to India from articles, journals, and theses that fit the specified criteria, from the range of publishing for 13 years (2007 - 2020).

Study Design: Study using the Meta-Analysis method, quantitative approach

Study Location: Search for articles and journals with appropriate themes conducted in Semarang, Central Java, Indonesia (10)

Duration of Study: April - June 2020.



Sample size: 20 Research articles and journals.

Sample size calculation: The research sample was taken using a purposive technique, which means that it was adjusted to certain considerations. After getting 49 articles related to the management of industrial waste using activated carbon & natural coagulants, and tracing the completeness of the data and the suitability of the operational definitions, 20 studies were obtained that fit the criteria.

Subjects & methods of selection: The population of this study are articles and journals with the theme of management of industrial wastewater with adsorption using coagulants and activated carbon of natural materials and have been published nationally and internationally. The researcher then sorts out the journals according to the desired theme. Next to determine the research sample which is traced back to the completeness of the research data and its operational resolution. Then the articles and journals are re-published to read. Articles and journals are indexed by Sinta 2, Sinta 3, Sinta 4, Sinta 5 and the Garuda Dikti Portal

Inclusion criteria:

Research that discusses the theme of industrial liquid processing with activated carbon/ adsorbent from bagasse, coconut shells, corncobs, corn husks, rice husks, cocoa pods, teak sawdust, and water hyacinth.

Research from published articles / national journals and international journals

Research completed in the span of 13 years (between 2007 - 2020)

Exclusion Criteria:

Research that has an operational resolution differs from what the author requested

Research that does not have complete text / only provides abstracts

Research Outside the Asian Region

Statistic analysis

The selected research data were analyzed using the Microsoft Excel EpiYudin software application. Then the data is adjusted based on available categories. COD levels are included in the numerical data scale, so data processing is done on a mean sheet. Furthermore, the name and year of the study were included, the average COD levels of the pre-test and post-test groups, the number of pre-test groups, the number of post-test groups, standard deviations, and the value of the research df. After entering these data, the value of p, I², and the weight of the research will be obtained automatically. If the value of $p < 0.05$, the weighting uses the random-effects model. Conversely, if the value of $p > 0.05$ then weighting uses the fixed effect model.

III. Results

Table 1 shows that I² value is 96.9% and $p = 0.000$, which means that there is a significant influence between the addition of the adsorbent dose with a decrease in the COD content of industrial waste. Weighting each study can use the random-effects model table, because the p-value in the table above is $0.000 < 0.05$. Large research variations will result in small weights, and vice versa. So it can be seen that the DR research has the smallest weight.



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Table 1. Effect of Adsorbent Doses on Reduction of Industrial Liquid Waste COD Levels

Researcher & Year	Results of Each Research			i2	P	Weight	Random Effect Models		
	Average Difference	Min	Max				Average Difference	Min	Max
RY 2010	484.91	84.62	885.2	96.90%	0.000	7	481.431	323.876	638.986
SU 2014	358.75	329.83	387.67			12.9			
UM 2015	198.79	60.93	336.65			11.8			
RL 2016	41.6	3.27	79.93			12.8			
MG 2017	509.6	429.57	589.63			12.5			
ST 2017	2079.42	1573.4	2585.44			5.5			
ABS 2018	424.56	336.67	512.44			12.4			
FV 2018	439.76	274.67	604.85			11.3			
ZL 2019	564.2	413.65	714.75			11.6			
DR 2020	1192.8	214.3	2171.3			2.2			
						100			

In table 2, the I2 value of 99.89% and p 0.000 are obtained, which means that there is a significant influence between the contact time and the decrease in COD content of industrial waste. Weighting each study can use the random-effects model table because the p-value in the table above is 0,000 <0.05. Large research variations will result in small weights, and vice versa. So it can be seen that YS research has the smallest weight.



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Table 2. Effect of Contact Time on Decreasing COD levels of Industrial wastewater

Researcher & Year	Results of Each Research			i2	P	Weight	<i>Random Effect Models</i>		
	Average Difference	Min	Max				Average Difference	Min	Max
STN 2007	23.05	13.98	32.11	99.89 %	0.000	10.3	580.94	363. 5	798.35
RY 2010	588.37	0	975.94			7.8			
YS 2013	7144.16	22.37	14265.9			0.1			
SU 2014	353.47	322.6	384.30			10.3			
DG 2015	319.20	236.8	401.56			10.2			
NUR 2015	326.86	3	487.00			9.8			
RL 2016	41.60	3.27	79.93			10.3			
ST 2017	2079.42	1573.	2585.44			6.6			
ZL 2019	681.20	533.8	828.51			9.8			
DS 2019	544.50	538.6	550.36			10.3			
FCH 2019	727.00	674.1	779.85			10.2			
DR 2020	1989.20	1192.	2785.88			4.3			
		52				100.0			

IV. Discussion

COD is the total oxygen needed by organic substances for the chemical oxidation process. High COD volume results in decreased oxygen levels in the waters, so the number of dead aquatic biota will increase. COD can be found in community wastewater, river water, and industrial wastewater. If industrial wastewater is directly discharged into the waters, it will cause the accumulation of chemicals that are detrimental to society such as causing skin irritation, causing a foul odor that interferes with the human breathing. So that treatment is needed to reduce levels of COD before the waste is discharged into the waters.^{8, 6}



Adsorption of liquid waste using activated carbon and coagulants from natural raw materials can be done to reduce COD levels effectively and efficiently. The raw materials of activated carbon and natural coagulants used in previous studies include coconut shells, rice husks, bagasse, corncobs, corn husk, water hyacinth, sawdust, etc. which have high cellulose. Utilization of these materials into natural coagulants or activated carbon takes into consideration the reasons for their ease of being found in the environment, are inexpensive, and have a low use-value because there is not yet high public awareness to use them. Making activated carbon is done through several stages including removal of water content/dehydration, then carbonization without oxygen, then activation of activated carbon with strong acids/bases. Waste treatment with the addition of coagulants / activated carbon is usually done by the batch method.^{9, 10}

Research with meta-analysis methods can be done by combining research with similar themes a minimum of 2, with a minimum span of 10 years. The purpose of the meta-analysis method research is to get the magnitude of the effects and differences between variables and get the weight of each study.¹¹ Data processing on the meta-analysis method can be done with Microsoft Excel EpiYudin Software by paying attention to the scale of the data. COD content data that will be examined are included in the numerical data category so that the average calculation can be done. After obtaining 49 articles and journals on the theme of liquid waste management using natural coagulants and activated carbon, the authors conducted a journal search. A journal search was conducted to obtain a purposive research sample. So that 20 studies were obtained from journals and articles which had been indexed 2,3,4,5, and the Garuda Eagles Portal. The liquid waste examined in 20 journals and articles included petis industrial waste, textile waste, tofu liquid waste, laundry liquid waste, hospital liquid waste, leather tanning waste.

In the data processing variable adsorbent dose, there are 10 studies combined. After calculating the average difference, an I2 value of 96.9% was obtained and a p-value of 0.000 or $p < 0.05$, which means that there was a significant effect between the addition of an adsorbent dose to a decrease in COD levels of industrial waste. From the results of the study of RY et al, MG et al, RL et al, FV, and ABS et al showed that the greater the level or dose of adsorbent applied to liquid waste, the decrease in COD levels obtained in the posttest group was also higher. Whereas in the studies of SU et al, ZL, ST et al, UM et al proved that the highest reduction in COD levels did not always occur at the highest dose addition. This can occur because of the possibility of saturation of the solution. The adsorbent dose is the amount of material that is added at the time of treatment before measuring COD levels. Determination of adsorbent levels from researchers adjusted to the characteristics of Industrial Waste. The researcher will usually conduct a preliminary test to determine the optimum dosage so that when the actual research is the researcher is sure of the dose range applied to the treatment.^{12, 13} A solution is in a saturated condition if the addition of material to the tested solution does not affect the treatment, so it should be stopped immediately and the optimum dose determined. In the 10 studies combined, we can find the smallest research variation or the research with the biggest weight, namely the SU study, in 2014.¹⁴



Furthermore, there were 12 studies with contact time variables combined. After calculating the difference in mean, I2 value of 99.89% and p-value of 0.000 or $p < 0.05$, which means that there is a significant influence between the length of time of contact with the reduction in COD levels of industrial waste. From the results of STN, DG, RL et al, RY et al, ZL et al, DS, and FCH et al, proving that the longer the adsorbent or activated carbon is contacted with industrial liquid waste, the decrease in COD levels obtained in the posttest group is also higher. In the study of YS et al, the highest decrease in COD occurred not in contact between the waste and the longest adsorbent. Whereas the research of NUR et al proved that COD levels decreased gradually along with the addition of the duration of adsorbent contact with industrial liquid waste. In the SU study, there was a decrease in COD levels along with the length of time of contact, but when the decrease in COD reached the peak so that the solution had saturation. Then the research of DR et al and ST et al showed that COD levels fluctuate when given varying contact times. Contact time is the duration required between the solution / liquid industrial waste to make contact with the material. A solution is in a saturated condition that can occur if the addition of time significantly to the solution being tested does not affect the treatment, so you should immediately calculate the optimum time based on decreasing levels of COD.^{15, 16} YS research in 2013 has the smallest weight, so the variation of research is very large.

V. Conclusion

Based on research conducted by combining 20 data from articles and journals with the theme of industrial wastewater management using natural coagulants and activated carbon, it can be concluded that the variable adsorbent dose and contact time significantly influence the reduction in COD levels of industrial waste, as evidenced by a p-value of 0,000 or $p < 0.05$.



References :

1. Julianto FT, Suparno. Analisis Pengaruh Jumlah Industri Besar dan Upah Minimum Terhadap Pertumbuhan Ekonomi di Kota Surabaya. *J Ekon dan Bisnis*. 2016;1(2):27.
2. Ridwan IR. Dampak Industri Terhadap Lingkungan Dan Sosial. *J Geogr Gea*. 2016;7(2).
3. Lumaela AK, Otok BW, Statistika J, Matematika F, Alam P, Cod K, et al. Pemodelan Chemical Oxygen Demand (COD) Sungai di Surabaya Dengan Metode Mixed Geographically Weighted Regression. *Sains dan Seni Pomits* [Internet]. 2013;2(1):D 100-D105. Available from: http://ejurnal.its.ac.id/index.php/sains_seni/article/viewFile/3204/821
4. Santoso AD. Keragaan Nilai DO , BOD dan COD di Danau Bekas Tambang Batu bara. *J Teknol Lingkung* [Internet]. 2018;19(1):89–96. Available from: https://www.researchgate.net/publication/323146081_Keragaan_Nilai_DO_BOD_dan_COD_di_Danau_Bekas_Tambang_Batubara_Studi_Kasus_pada_Danau_Sangatta_North_PT_KPC_di_Kali_matan_Timur
5. Alimsyah A, Damayanti A. Penggunaan Arang Tempurung Kelapa dan Eceng Gondok untuk Pengolahan Air Limbah Tahu dengan Variasi Konsentrasi. *J Tek ITS* [Internet]. 2013 Mar 1 [cited 2019 Mar 26];2(1):D6–9. Available from: <http://www.ejurnal.its.ac.id/index.php/teknik/article/view/3170>
6. Kusnaedi. Mengolah Air Kotor untuk Air Minum. In: Sepsi N, editor. *I. Jakarta: Penebar Swadaya*; 2010. p. 25–35. Available from: <https://books.google.co.id/books?id=QqqkS4zPILsC&pg=PP6&dq=mengolah+air+kotor+untuk+a+ir+minum&hl=id&sa=X&ved=0ahUKewjB4OaQ6fTIAhVERo8KHfcaBa4Q6AEILTAB#v=onepage&q=mengolah+air+kotor+untuk+air+minum&f=false>
7. Ayub S, Changani F. Adsorption Process for Wastewater Treatment By Using Coconut Shell. *Civil, Struct Environ Infrastruct Eng Res Dev* [Internet]. 2014;4(3):1–8. Available from: <http://lib.itenas.ac.id/kti/wp-content/uploads/2014/03/Anita-Jurnal-Online-20-11-2012.pdf>
8. Sumantri A, Cordova MR. Dampak Limbah Domestik Perumahan Skala Kecil Terhadap Kualitas Air Ekosistem Penerimaannya Dan Dampaknya Terhadap Kesehatan Masyarakat. *J Pengelolaan Sumberd Alam dan Lingkung* [Internet]. 2011;1(2):127–34. Available from: <http://journal.unnes.ac.id/nju/index.php/kemas/article/view/3388>
9. Astuti W, Kurniawan B. Adsorpsi Pb²⁺ Dalam Limbah Cair Artifisial Menggunakan Sistem Adsorpsi Kolom Dengan Bahan Isian Abu Layang Batubara Serbuk dan Granular. *J Bahan Alam Terbarukan*. 2015;4(1):27–33.
10. Laksono EW. Analisis Daya Adsorpsi Suatu Adsorben [Internet]. Pendidikan Kimia FMIPA UNY. Yogyakarta; 2002. Available from: <http://staffnew.uny.ac.id/upload/131569340/pengabdian/analisis.pdf>
11. Anwar R. Meta Analisis. In Bandung: Subbagian Fertilitas Dan Endokrinologi Reproduksi Bagian Obstetri Dan Ginekologi Fakultas Kedokteran UNPAD; 2005. p. 1–19.
12. Coniwanti P, Mertha ID, Eprianie D. Pengaruh Beberapa Jenis Koagulan Terhadap Pengolahan Limbah Cair Industri Tahu Dalam Tinjauannya Terhadap Turbidity, TSS dan COD. *J Tek Kim No 3, Vol 19, Agustus 2013* [Internet]. 2013;19(3):22–30. Available from: <http://jtk.unsri.ac.id/index.php/jtk/article/view/148/147>
13. Sari PD, Puri WA, Hanum D. Delignifikasi Bonggol Jagung Dengan Metode Microwave Alkali. *J Ilmu-Ilmu Pertan “AGRIKA.”* 2018;12(2):164–72.



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Social (IJHES)**

14. Ramadhan A, Sutanto, Iryani A. Penurunan Chemical Oxygen Demand (COD) Limbah Larutan Penyapu Jenuh Antara Dengan Pereaksi Fenton Dan Kaporit. In: Seminar Nasional Riset Pangan, Obat-Obatan dan Lingkungan Untuk Kesehatan. Bogor; 2013.
15. Siregar RD, Zaharah TA, Wahyuni N. Penurunan Kadar COD (Chemical Oxygen Demand) Limbah Cair Industri Kelapa Sawit Menggunakan Arang Aktif Biji Kapuk (Ceiba Petandra). Kim Khatulistiwa [Internet]. 2015;4(2):62–6. Available from: jurnal.untan.ac.id/index.php/jkkmipa/article/download/9724/9495
16. Laura PD, Moersidik SS, Priadi CR. Adsorpsi Dan Regenerasi Karbon Aktif Dalam Pengolahan Air Limbah Industri Farmasi Terhadap Penurunan Kadar Chemical Oxygen Demand (Studi Kasus: Penggunaan Tempurung Kelapa dan Batu Bara sebagai Adsorben dalam Pengolahan Air Limbah PT. Kimia Farma Plant Ja. In Jakarta; 2014.



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