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PRELIMINARY

**ARTICLES**

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AIP Conference Proceedings

RESEARCH ARTICLE | MAY 08 2023

# Preface: Advancing the Innovation to Recover Our Planet: A Preface of 3rd Borobudur International Symposium on Science and Technology 2021



*AIP Conference Proceedings* 2706, 010001 (2023)
https://doi.org/10.1063/12.0013684

# Preface: Advancing the Innovation to Recover Our Planet: A Preface of 3rd Borobudur International Symposium on Science and Technology 2021

Today, we stand on the edge of industrial revolution that will drastically change the way we live, work, and communicate. This change is unpredictable in terms of scale, scope, and complexity. As a result, we don't know the expectations and risks that may occur in the future. However, wise solutions for this change must be integrated and comprehensive, involving all stakeholders from global to local governments, public and commercial sectors, academia, and civil society. On the other hand, environmental sustainability and welfare must be the main considerations in decision making in this period. For example, intelligent sensors combined with Artificial Intelligence (AI) have demonstrated their ability in production processes, educational technology, and other activity-supporting technologies.

In this current period, smart and science-based solutions are urgently needed to the economic recovery. For the scientific community, research should continue under any conditions. Therefore, the 3rd Borobudur International Symposium is presented to share research experiences and reports on the research progress of each institution.

The main theme of this symposium is "Decade of Action towards Climate Change Issues: Advancing the Innovation to Recover our Planet" as a part of the masterplan of United Nations for sustainable development goals in 2030. This symposium is attended by 442 presenters and 753 attendances from eleven countries include: Indonesia, Maroco, Hungaria, Malaysia, Thailand, Vietnam, UK, Austria, Netherland, South Africa, and Nigeria.

Certainly, this event will not be successful without the support of co-hosts. On behalf of the Committee, we thank the co-hosts:

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18. Universitas Muhammadiyah Purworejo
19. Universitas Pelita Bangsa
20. Universitas Singaperbangsa Karawang
21. Universitas Tidar
22. Universitas Trisakti

Therefore, we present world-class keynote speakers whom able to capture these scientific topics, they are: First, Assoc. Prof. Tony Hadibarata, BSc, MSc, PhD. (Curtin University Malaysia); Second, Assoc. Prof. Olusegun David Samuel, B.Eng., M.Eng., Ph.D. (Federal University of Petroleum Resource-FUPRE Nigeria); Third, Dr. Rachmat Adhi Wibowo M.S. (Austrian Institute of Technology, Austria); Forth, Prof. Michael Hardy (Coventry University, UK); and Prof. Do Ahn Tai (Thai Nguyen University of Economics and Business Administration, Vietnam).

We hope that the articles presented in the 3rd BIS provide new insights for participants and for a wider audience, stimulate new research paths, and open up opportunities for research collaboration between institutions.

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RESEARCH ARTICLE | MAY 08 2023

# Effect of bentonite and carbon active from coconut hush additives for waste water treatment

Havidh Pramadika ; Bayu Satyawira; Samsol; ... et. al



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https://doi.org/10.1063/5.0120316

# Effect of Bentonite and Carbon Active from Coconut Hush Additives for Waste Water Treatment

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**Abstract.** The production of wastewater in the oil and gas operation should be treated to meet the environmental codes. One of the methods to treat the wastewater is by absorption; before determining absorbent effectiveness, the absorbent has also able to improve wastewater property. The absorbents are bentonite and carbon active. Bentonite in the commercial world is a term for clay containing montmorillonite and is classified as dioctahedral. The carbon active material is made from crushed coconut hush. The purpose of this research is to determine the improvement of wastewater properties quality; namely acidity, TDS, and salinity; with different concentration of bentonite and coconut hush. Bentonite and coconut hush were cleaned and then filtered to a certain size. Both absorbents were activated by using acid. The wastewater was mixed with these absorbents for different concentrations. The laboratory result shows a reduction of acidity up to 1,8 pH, total dissolved solids up to 2934 PPM, and salinity of the wastewater up to 13 PPT. The use of bentonite and coconut hush for the wastewater product of petroleum operation would reduce the wastewater contamination content to meet the environmental codes; with the coconut hush performance was comparable to bentonite performance.

## INTRODUCTION

In the oil and gas industry, the wastewater is a common byproduct during field operation. The wastewater needs to be treated in order to eliminate any dangerous substance that pollute the environment. The government has already set regulations on wastewater to be disposed properly, in order to control the environment [1-5]. One method to treat the waste water is by using adsorption process [6-11]. The wastewater is mixed with a certain concentration of absorbent which will absorb any unwanted materials. The absorbent uses in this laboratory study were bentonite and carbon active material. The carbon active material was made from crushed dried coconut hush. Bentonite in the commercial world is a term for clay containing montmorillonite and is classified as dioctahedral. Bentonite is also used in control the mud weight during drilling operation [12-14]. Before studying the effect of absorbents absorption of unwanted material in the wastewater, certain wastewater properties need to be reduced or controlled [6, 8, 9, 13]. In this laboratory study, three wastewater parameters were measured and studied before and after being mixed with absorbents; they are acidity, total dissolve liquid, and salinity. The result showed that the coconut hush gave comparable results in reducing the forementioned parameters.

## METHOD

Figure 1 is the flow chart of the laboratory study. The apparatus and materials were prepared in order to have the best conclusion result during laboratory study. The apparatuses are litmus paper to measure the acidity, TDS meter to measure the total dissolve solid (TDS), and salinity hydrometer to measure the salinity of the wastewater and mixture of wastewater and absorbents.

The absorbent materials, which are bentonite and coconut hush; are also being prepared. They have to be cleaned, dried, and then both are activated by using acid; which is hydrochloride acid HCl. Afterward, the pure wastewater acidity, TDS, and salinity are measured; and these measurements are the base values of these three parameters. The prepared bentonite and coconut hush are each mixed with wastewater with concentration of 0.5, 1.0, 2.0, 2.5, and 3

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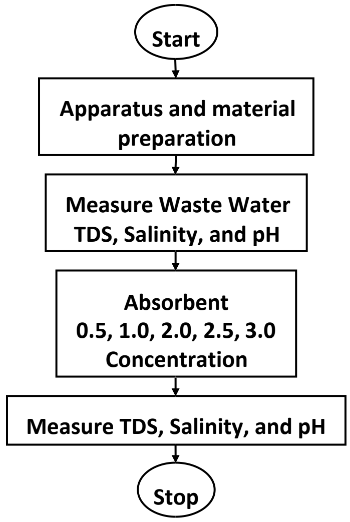


**FIGURE 1**. Flowchart of Laboratory Study

Bentonite is depicted in Figure 2a, and coconut hush is depicted in Figure 2b.


(a) (b)

**FIGURE 2**. (a) Bentonite (b) Coconut Hush

In cleaning up, 250 grams of each absorbent were each mixed with 1 liter of distilled water, and were stirred for 2 hours. Each of the mixtures were allowed to stand for 24 hours. The bentonite and coconut hush suspensions were being filtered and dried. Each of bentonite and coconut hush were grinded and were being sieved by using 200 mesh size for bentonite and using 100 mesh size for coconut hush.

Afterward, the both filtered and cleaned bentonite and coconut hush each were being activated by using 1 Mole HCl. In bentonite activation, 400 ml 1 M HCl was mixed with 200 grams with filtered and cleaned bentonite. The mixture is stirred for 4 hours. Then, the bentonite was cleaned with distilled water, until the water has pH 7 acidity.

Finally, the residual bentonite was dried at 100°C for 4 hours. For carbon active material from coconut hush activation, 400 ml 1 M HCl was mixed also with 200 grams with filtered and cleaned coconut hush, and the mixture is stirred for 1 to 4 hours. Then, the coconut hush was cleaned with 200 to 500 ml distilled water, until the water has pH 7 acidity. The residual of coconut hush was filtered and dried at 50°C for 6 to 24 hours.

The wastewater is prepared to be mixed with clean and dried absorbents. The wastewater is depicted in Figure 3. The wastewater used in this laboratory research is formation water taken from an oil field formation water.

**FIGURE 3**. Wastewater

The wastewater total dissolved solid was measured by using TDS meter, and the unit of TDS is part per million (ppm). The salinity of wastewater was measured by using salinity hydrometer, the unit of salinity is part per thousand (ppt). The acidity was measured by using litmus paper, and the unit is pH.

Each of bentonite absorbent and carbon active absorbent from coconut water were mixed with wastewater sample. The concentration of each of the absorbent mixture with wastewater are 0.5, 1.0, 2.0, 2.5, and 3.0 gram for every cc of waste water. Finally, the total dissolve solid, salinity, and acidity of each of wastewater and absorbent mixtures were being measure.

## RESULT AND DISCUSSION

Table 1 is the summary of the pure wastewater parameter. Initially, before being mixed with any absorbents, the acidity is pH 9, salinity is 5651 ppm, and salinity is 24 ppt. According to Regulation of the Indonesian State Minister for the Environment Number 19 of 2010, the wastewater standards quality for oil and gas exploration and production activities from on-shore facilities, the acidity is pH from 6 to 9, and salinity is 4000 ppm to be disposed properly [1].

**TABLE 1**. Pure Wastewater Parameter

| | **Acidity, pH** | **TDS, ppm** | **Salinity, ppt** |
|---|---|---|---|
| Waste Water | 9 | 5651 | 24 |

The pure wastewater was mixed with the absorbents; bentonite and carbon active made from dried coconut hush. The concentration of the absorbent was selected to be 0.5, 1.0, 2.0, 2.5, and 3.0 gr of absorbents for every 1 cc of waste water. Table 2 is the result of experiments.

The wastewater mixture with absorbent decreased the pH toward neutral pH of 7 for both bentonite and coconut hush absorbents. The pH for mixing wastewater and both absorbents with 3 gr/cc concentration reduced the pH to 7.2. Both absorbents also reduced the total dissolved solid TDS of the mixture up to 2586 ppm, for mixture with 3% coconut hush. Meanwhile the salinity of wastewater mixture with absorbents decreased up to 11 ppt, for mixture with 3% coconut hush.

Figure 4 is the detail graph of pH changing due to bentonite and coconut hush toward waste water. The dot of red color is the acidity of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The acidity instantly reduced to pH of 8.5 when the wastewater was mixed with bentonite and to 8.1 when the wastewater was mixed coconut hush. The higher the concentration, the higher the reduction of pH; the mixture acidity became close to neutral of pH 7. With small concentration of absorbents, the hush water reducing more on pH as compared to bentonite, but at high absorbent concentrations, both absorbents gave wastewater the same acidity number. It is understandable and reasonable phenomena, as both absorbents were activated by using acid of 1 M HCl when preparing both absorbents.

**TABLE 2**. Wastewater and Absorbent Mixture Parameter

| Absorbent | Acidity, pH | | TDS, ppm | | Salinity, ppt | |
|---|---|---|---|---|---|---|
| Concentration, gr/cc | Bentonite | Coconut Hush | Bentonite | Coconut Hush | Bentonite | Coconut Hush |
| 0.5 | 8.5 | 8.1 | 2717 | 3885 | 18 | 24 |
| 1.5 | 8.2 | 7.9 | 2792 | 3520 | 14 | 21 |
| 2 | 7.8 | 7.5 | 2808 | 3175 | 15 | 13 |
| 2.5 | 7.4 | 7.4 | 2835 | 3087 | 15 | 11 |
| 3 | 7.2 | 7.2 | 2720 | 2586 | 15 | 11 |

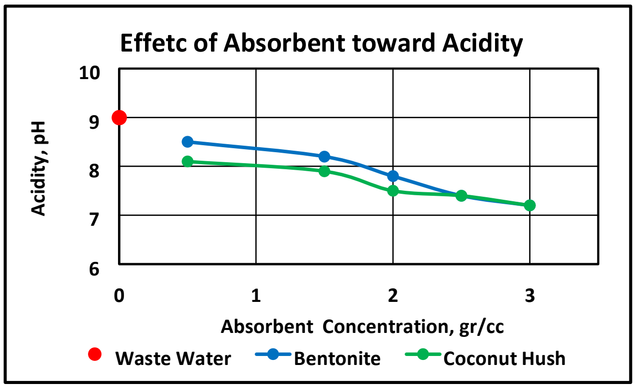


**FIGURE 4**. Effect of Absorbents toward Wastewater Acidity

Figure 5 is the effect of absorbents toward total dissolve solid TDS. The dot of red color is the total dissolve solid of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The TDS of wastewater mixture with bentonite and coconut hush instantaneously decreased significantly, especially with bentonite. However, the increase of bentonite in concentration in the mixture did not have any effect on the mixture's TDS; the TDS averaged 2770 ppm with the increase of bentonite concentration form 0.5 gr/cc to 3 gr/cc. On the other side, coconut hush absorbent reduced the mixture TDS with the increase in coconut hush concentration, furthermore, the mixture TDS decreased surpassed the effect of bentonite on TDS, which is 2586 ppm TDS.

Figure 6 is the effect of absorbents toward total dissolve solid Salinity. The dot of red color is the salinity of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The salinity of wastewater mixture with bentonite and coconut hush decreased along with the increase of absorbents concentration. The decrease in salinity with bentonite as absorbent, did not decrease significantly the mixture salinity along with the increase of bentonite concentration. The mixture salinity with 0.5 gr/cc of bentonite was 18 ppt, while at 3.0 gr/cc, the mixture salinity reached only 15 ppt. Meanwhile, at very low concentration of 0.5% coconut hush in the wastewater mixture, the salinity of wastewater mixture did not change at all as compared to pure wastewater, at which was at 24 ppt. At low coconut hush concentration, the decrease of mixture salinity is insignificant, but at high coconut hush concentration, the mixture salinity became significant. However, at high concentration of coconut hush, the salinity of mixture wastewater did not decrease more, the salinity is at 11 ppt at 3 gr/cc.

The performance of carbon active from coconut hush was the same at high concentration of additives as the bentonite performance on the effect from acidity. At high concentration of 2.5 and 3.5, the acidity from both were the same in reducing pH toward neutral. The performance of coconut hush in TDS reduction was better at the high concentration of additive, as compared to bentonite in the total dissolve solid as bentonite performance, the mixture TDS with coconut hush is lower at 3 gr/cc concentration. The performance of coconut hush in salinity reduction was also better in the high concentration additives as compared to bentonite performance. The salinity was already lower at of 2.5 gr/cc coconut hush.

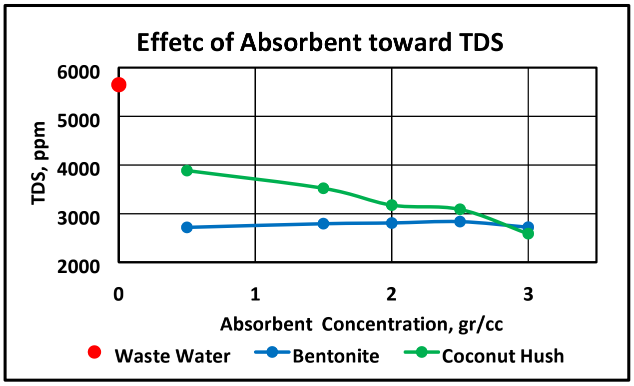


**FIGURE 5**. Effect of Absorbents toward TDS

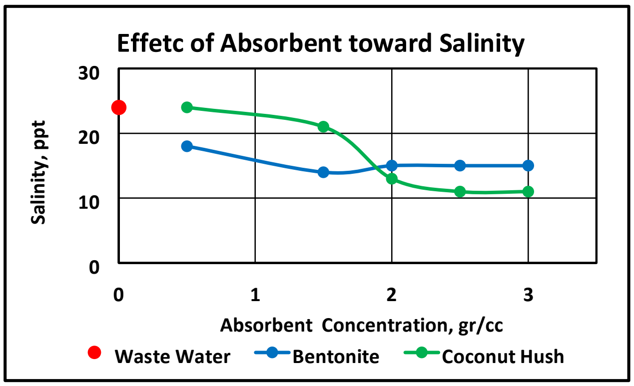


**FIGURE 6**. Effect of Absorbents toward Salinity

## CONCLUSION AND RECOMMENDATION

The pH of acidity in the wastewater due to bentonite and carbon active from coconut hush reduced along with the increase of additives concentration, and the acidity were closed to neutral. The increase of bentonite concentration in the wastewater had no effects on the TDS, while the increase of coconut hush concentration reduced TDS, and with the concentration of coconut hush 3%, the reduction passed the effect of bentonite additive. Above 2 gr/cc, coconut hush additive gave better performance than bentonite additive in salinity reduction of wastewater. Both bentonite and coconut did not reduce salinity further for concentration of above 2 gr/cc. Coconut hush is comparable and better to bentonite in performing reduction of pH, TDS, and Salinity of waste water. It is recommended that the absorption of hydrocarbon emulsion in the waste water should be determined in order to see the best absorbent for waste water sample.

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*by* Havidh Pramadika

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## METHOD

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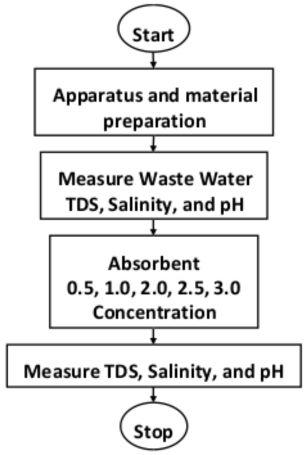


**FIGURE 1**. Flowchart of Laboratory Study

Bentonite is depicted in Figure 2a, and coconut hush is depicted in Figure 2b.


(a) (b)

**FIGURE 2**. (a) Bentonite (b) Coconut Hush

In cleaning up, 250 grams of each absorbent were each mixed with 1 liter of distilled water, and were stirred for 2 hours. Each of the mixtures were allowed to stand for 24 hours. The bentonite and coconut hush suspensions were being filtered and dried. Each of bentonite and coconut hush were grinded and were being sieved by using 200 mesh size for bentonite and using 100 mesh size for coconut hush.

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The wastewater is prepared to be mixed with clean and dried absorbents. The wastewater is depicted in Figure 3. The wastewater used in this laboratory research is formation water taken from an oil field formation water.

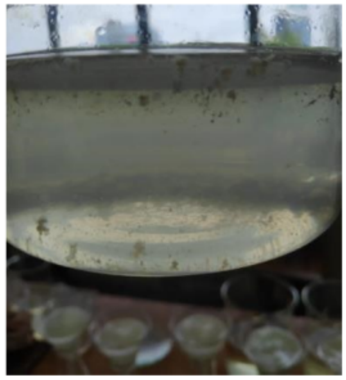

**FIGURE 3**. Wastewater

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Table 1 is the summary of the pure wastewater parameter. Initially, before being mixed with any absorbents, the acidity is pH 9, salinity is 5651 ppm, and salinity is 24 ppt. According to Regulation of the Indonesian State Minister for the Environment Number 19 of 2010, the wastewater standards quality for oil and gas exploration and production activities from on-shore facilities, the acidity is pH from 6 to 9, and salinity is 4000 ppm to be disposed properly [1].

**TABLE 1**. Pure Wastewater Parameter

| | **Acidity, pH** | **TDS, ppm** | **Salinity, ppt** |
|---|---|---|---|
| Waste Water | 9 | 5651 | 24 |

The pure wastewater was mixed with the absorbents; bentonite and carbon active made from dried coconut hush. The concentration of the absorbent was selected to be 0.5, 1.0, 2.0, 2.5, and 3.0 gr of absorbents for every 1 cc of waste water. Table 2 is the result of experiments.

The wastewater mixture with absorbent decreased the pH toward neutral pH of 7 for both bentonite and coconut hush absorbents. The pH for mixing wastewater and both absorbents with 3 gr/cc concentration reduced the pH to 7.2. Both absorbents also reduced the total dissolved solid TDS of the mixture up to 2586 ppm, for mixture with 3% coconut hush. Meanwhile the salinity of wastewater mixture with absorbents decreased up to 11 ppt, for mixture with 3% coconut hush.

Figure 4 is the detail graph of pH changing due to bentonite and coconut hush toward waste water. The dot of red color is the acidity of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The acidity instantly reduced to pH of 8.5 when the wastewater was mixed with bentonite and to 8.1 when the wastewater was mixed coconut hush. The higher the concentration, the higher the reduction of pH; the mixture acidity became close to neutral of pH 7. With small concentration of absorbents, the hush water reducing more on pH as compared to bentonite, but at high absorbent concentrations, both absorbents gave wastewater the same acidity number. It is understandable and reasonable phenomena, as both absorbents were activated by using acid of 1 M HCl when preparing both absorbents.

**TABLE 2.** Wastewater and Absorbent Mixture Parameter

| Absorbent | Acidity, pH | | TDS, ppm | | Salinity, ppt | |
|---|---|---|---|---|---|---|
| Concentration, gr/cc | Bentonite | Coconut Hush | Bentonite | Coconut Hush | Bentonite | Coconut Hush |
| 0.5 | 8.5 | 8.1 | 2717 | 3885 | 18 | 24 |
| 1.5 | 8.2 | 7.9 | 2792 | 3520 | 14 | 21 |
| 2 | 7.8 | 7.5 | 2808 | 3175 | 15 | 13 |
| 2.5 | 7.4 | 7.4 | 2835 | 3087 | 15 | 11 |
| 3 | 7.2 | 7.2 | 2720 | 2586 | 15 | 11 |

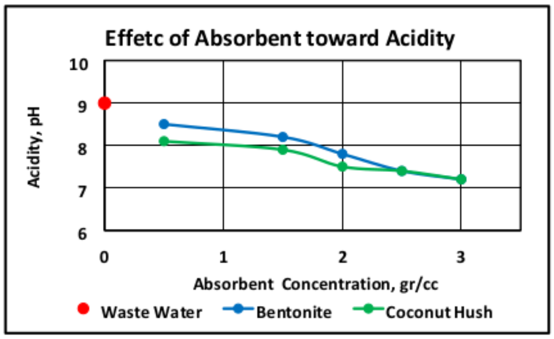


**FIGURE 4**. Effect of Absorbents toward Wastewater Acidity

Figure 5 is the effect of absorbents toward total dissolve solid TDS. The dot of red color is the total dissolve solid of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The TDS of wastewater mixture with bentonite and coconut hush instantaneously decreased significantly, especially with bentonite. However, the increase of bentonite in concentration in the mixture did not have any effect on the mixture's TDS; the TDS averaged 2770 ppm with the increase of bentonite concentration form 0.5 gr/cc to 3 gr/cc. On the other side, coconut hush absorbent reduced the mixture TDS with the increase in coconut hush concentration, furthermore, the mixture TDS decreased surpassed the effect of bentonite on TDS, which is 2586 ppm TDS.

Figure 6 is the effect of absorbents toward total dissolve solid Salinity. The dot of red color is the salinity of pure waste water, the blue color is for the effect of bentonite, and the green color is for coconut hush. The salinity of wastewater mixture with bentonite and coconut hush decreased along with the increase of absorbents concentration. The decrease in salinity with bentonite as absorbent, did not decrease significantly the mixture salinity along with the increase of bentonite concentration. The mixture salinity with 0.5 gr/cc of bentonite was 18 ppt, while at 3.0 gr/cc, the mixture salinity reached only 15 ppt. Meanwhile, at very low concentration of 0.5% coconut hush in the wastewater mixture, the salinity of wastewater mixture did not change at all as compared to pure wastewater, at which was at 24 ppt. At low coconut hush concentration, the decrease of mixture salinity is insignificant, but at high coconut hush concentration, the mixture salinity became significant. However, at high concentration of coconut hush, the salinity of mixture wastewater did not decrease more, the salinity is at 11 ppt at 3 gr/cc.

The performance of carbon active from coconut hush was the same at high concentration of additives as the bentonite performance on the effect from acidity. At high concentration of 2.5 and 3.5, the acidity from both were the same in reducing pH toward neutral. The performance of coconut hush in TDS reduction was better at the high concentration of additive, as compared to bentonite in the total dissolve solid as bentonite performance, the mixture TDS with coconut hush is lower at 3 gr/cc concentration. The performance of coconut hush in salinity reduction was also better in the high concentration additives as compared to bentonite performance. The salinity was already lower at of 2.5 gr/cc coconut hush.

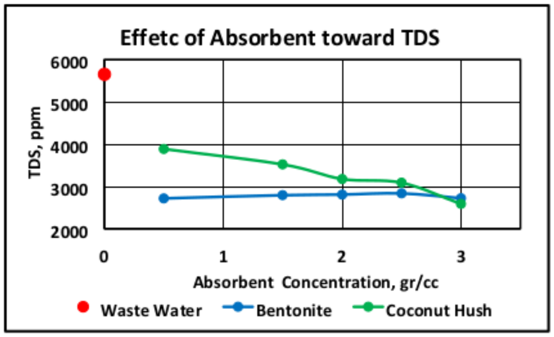


**FIGURE 5**. Effect of Absorbents toward TDS

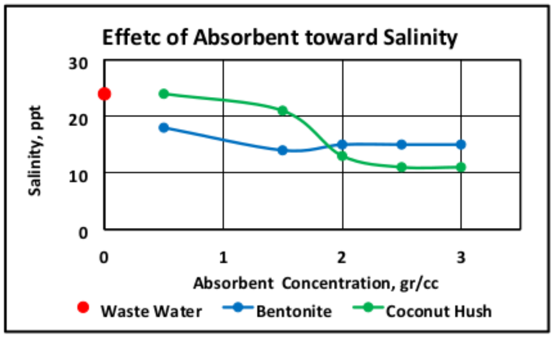


**FIGURE 6**. Effect of Absorbents toward Salinity

## CONCLUSION AND RECOMMENDATION

The pH of acidity in the wastewater due to bentonite and carbon active from coconut hush reduced along with the increase of additives concentration, and the acidity were closed to neutral. The increase of bentonite concentration in the wastewater had no effects on the TDS, while the increase of coconut hush concentration reduced TDS, and with the concentration of coconut hush 3%, the reduction passed the effect of bentonite additive. Above 2 gr/cc, coconut hush additive gave better performance than bentonite additive in salinity reduction of wastewater. Both bentonite and coconut did not reduce salinity further for concentration of above 2 gr/cc. Coconut hush is comparable and better to bentonite in performing reduction of pH, TDS, and Salinity of waste water. It is recommended that the absorption of hydrocarbon emulsion in the waste water should be determined in order to see the best absorbent for waste water sample.

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# Effect of bentonite and carbon active from coconut hush additives for waste water treatment

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