

# Hydrotalcite Mg/Al-NO<sub>3</sub> from Sea Water as Adsorbent of Cu<sup>2+</sup> and Cr<sup>6+</sup> Metals

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**Abstract-** Seawater is a renewable natural resource that is easy to get for use in various purposes. Seawater has many mineral deposits, one of which is MgCl<sub>2</sub>. This research aims to synthesize Mg/Al-NO<sub>3</sub> hydrotalcite-like with Mg raw material from seawater, characterization and test the adsorption capacity to Cu<sup>2+</sup> and Cr<sup>6+</sup> metals. Mg/Al hydrotalcite-like synthesis with NO<sub>3</sub> interlayer was performed on a 2: 1, 2,5: 1, 3: 1-mole ratio with pH 10 for 1 hour coprecipitated. Characterization of Mg/Al-NO<sub>3</sub> Hydrotalcite-like using Atomic absorption spectrophotometry (AAS), X-Ray Diffraction (XRD), XRF (X-ray fluorescence spectrometry), Surface Area Analyzer (SAA). The hydrotalcite-like adsorption power application was tested against Cu<sup>2+</sup> and Cr<sup>6+</sup> metals. The results showed that Mg/Al-NO<sub>3</sub> Hydrotalcite-Like formed at d003, d006, and d110 were 8,55, respectively; 3,86; and 1,51 Å according to the ICDD Hidrotalsit Mg/Al-NO<sub>3</sub> standard, and the area covered by SAA was 132,081 m<sup>2</sup>/g, with compositions tested by XRF on Mg(OH)<sub>2</sub> and Al(OH)<sub>3</sub>, were 11,5 g/ml and 20,3 g/ml, respectively. Hidrotalsit Mg/Al-NO<sub>3</sub> adsorption Cu<sup>2+</sup> occurred of 3,63 mg/g at 30 min contact time and Cr<sup>6+</sup> metal of of 0,75 mg/g at contact 60 minutes.

**Keywords:** adsorbent, synthesis, hydrotalcite, seawater

## I. INTRODUCTION

Seawater is a renewable resource that is easily available for use in various purposes. Indonesia is an archipelagic country surrounded by the sea with an area of waters reaching two-thirds of the land area, which is one of the factors that support seawater to be utilized in the field of scientific research. Seawater has a lot of mineral content, besides salt, there are also chemicals such as MgCl<sub>2</sub>. hydrotalcite from magnesium originating from the artificial sea which contains the main compounds NaCl, Na<sub>2</sub>SO<sub>4</sub>, MgCl<sub>2</sub>, and CaCl<sub>2</sub> [6].

Mineral Hydrotalcite is a double-layered hydroxide that has a negatively charged layer with cations on the interlayer[4]. Anionic clays such as hydrotalcite are less abundant in nature than cationic clays, but anionic clays are easily synthesized. The hydroxide layer has a brucite-like structure and is known as the double hydroxides layer [2] with a general formula [M<sup>2+</sup><sub>1-x</sub>M<sup>3+</sup><sub>x</sub>(OH)<sub>2</sub>]<sup>x+</sup> [A<sub>n-b</sub>/n].mH<sub>2</sub>O, where M<sup>2+</sup> and M<sup>3+</sup> is metal pollution such as copper (Cu<sup>2+</sup>) in an aquatic environment that can pose a danger to health in humans, animals and plants. If the

copper metal content in the aquatic ecosystem exceeds the maximum concentration limit, a metal bioaccumulation process can occur in living things. Cu metals in the form of metalloproteins can show reduced oxidation activity, from Cu<sup>2+</sup> to Cu<sup>+</sup> which can change the structure and function of proteins in living organisms. When Cu enters and accumulates in the human body in high concentrations it can be toxic and result in damage to the liver and kidneys through strong bonds with metallothionein residues [16].

Adsorption is the most effective method for reducing heavy metal pollutants. Adsorbent material has been widely developed in minimizing heavy metal contamination in the water is hydrotalcite. Hydrotalcite has a memory effect (can be regenerated) [12] and has low toxicity. This study utilizes magnesium from Tidung Island sea water as a raw material for making hydrotalcite Mg/Al-NO<sub>3</sub> with NO<sub>3</sub> interlayer. Magnesium from seawater was then added by Al (NO<sub>3</sub>)<sub>3</sub>.9H<sub>2</sub>O, by comparing variations in the mol ratio of Mg and Al using the coprecipitation method and its application used as an adsorbent of metal ions Cu<sup>2+</sup> and Cr<sup>6+</sup>. The purpose of this study was to determine the characteristics of hydrotalcite Mg / Al-NO<sub>3</sub> using SAA, XRD and XRF and determine the adsorption capacity of metal ions Cu<sup>2+</sup> and Cr<sup>6+</sup> by Hydrotalcite Mg /Al-NO<sub>3</sub>.

## II. MATERIALS AND METHODS

### A. Materials

The material used in this study is sea water from Tidung Island Beach which was taken on, Al(NO<sub>3</sub>)<sub>3</sub>.9H<sub>2</sub>O(p.a), Na<sub>2</sub>NO<sub>3</sub>(p.a), NaHCO<sub>3</sub> (p.a), Na<sub>2</sub>CO<sub>3</sub>Aquadest, NaOH, Cr<sup>6+</sup> logam (p.a), CuSO<sub>4</sub>(p.a), HNO<sub>3</sub>(p.a), APDC (Ammonium Pyrrolidine Dithiocarbamate) (p.a), MIBK (Methyl Isobutyl Keton)(p.a), Na<sub>2</sub>SO<sub>4</sub>(p.a), AgNO<sub>3</sub>(p.a), gas N<sub>2</sub>, HCl (p.a), dan NaOH (p.a).

### B. Instrumentation

The tools used in this research are Whatman no.2 filter paper, thermometer, hot plate, Erlenmeyer, centrifuge, a set of glassware, stirrer, stirrer, oven, pH meter, desiccator, volumetric pipette, drop pipette, three-foot flask, AAS Shimadzu instrument AA-7000, SAA Autosorb-1, and Shimadzu XRD-600 X-Ray diffractometer.

### C. Procedure

Analysis of  $Mg^{2+}$  and  $Ca^{2+}$  in seawater with AAS. Seawater is filtered using filter paper on the water pump with water volume 1 L. The filtered sample water is placed in a 1 L measuring cup, set the pH of the sample with 1N  $HNO_3$  as much as 20 drops or with 1 N  $NaOH$  up to pH 3. Then the sample is concentrated by heating using hot plate until the volume becomes 500 ml. Then poured into Erlenmeyer and cooled to  $30^\circ C$ . The sample was added 5 ml APDC, then homogenized. Added MIBK (Methyl Isobutyl Ketone), shaken for 30 seconds and allowed to stand until two layers formed, the water phase was removed and the organic phase was collected into the test tube. If foam or emulsion is formed  $Na_2SO_4$  is added. Then the filtrate was tested using AAS. Impurity of  $Ca^{2+}$  from Sea Water [6]. 100 mL of sea water is added with a solution of 0.001 M  $Na_2CO_3$  and 0.002 M  $NaHCO_3$ , stirred for one hour at  $70^\circ C$ . Ca content analyzed by AAS.

- Synthesis of Hydrotalcite Mg / Al- $NO_3$  from Seawater [5]

A total of 250 mL of a mixture of 0.1 M  $NaNO_3$  and 1 M  $NaOH$  was added slowly to a reactor containing 50 ml of a mixture of Al ( $NO_3$ )  $3.9H_2O$ , and a magnesium solution of seawater, with variations in the Mg /Al 2 mole ratio : 1; 2.5: 1; and 3: 1 to pH 10. The solution is stirred for 1 hour at  $70^\circ C$ , left for 12 hours then washed using distilled water until free of chloride, white solids are dried using an oven at  $60^\circ C$  for 6 hours.

- Characterization of Mg / Al- $NO_3$  Hydrotalcite

*The hydrotalcite crystal structure was characterized using Xray diffractometer (XRD) and scanned every 0.020 / second with an angle range of  $2\theta = 100$ . Determination of the surface area of the material was analyzed using the Surface Analyzer Area (SAA) and the composition of the hydrotalcite sample was analyzed using X-Ray Fluorescence Spectrometry (XRF).*

- Determination of  $Cu^{2+}$  metal adsorption capacity with time variations.

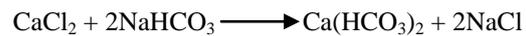
A total of 0.1 g of Mg /Al- $NO_3$  hydrotalcite was put into a beaker glass containing 20 ml of a solution of  $Cu^{2+}$  metal ion concentration of 20 mg / L with a variation of time 0, 15, 30, 45, and 60 minutes at optimum pH 5 which was regulated by addition of 0.05 M  $NaOH$  and 0.05 M  $HCl$ , then stirred at a speed of 200 rpm at  $25^\circ C$  for 1 hour. The solution was filtered with filter paper and added 1 drop of concentrated  $HNO_3$  solution, then analyzed using AAS. The same procedure is also performed on  $Cr^{6+}$  metals.

## III. RESULTS AND DISCUSSION

### A. Analysis $Mg^{2+}$ and $Ca^{2+}$ in Sea Water

Testing of the levels of  $Mg^{2+}$  and  $Ca^{2+}$  found in Tidung Island seawater was carried out in two ways, namely treatment-free test results obtained at 1.481% and 0.129%. While the levels of  $Mg^{2+}$  and  $Ca^{2+}$  with

treatment and treatment using additional  $Na_2CO_3$  or  $NaHCO_3$  solution to reduce  $Ca^{2+}$  levels - each level of  $Mg^{2+}$  and  $Ca^{2+}$  was obtained at 0.905% and 0.098%.  $Ca^{2+}$  ions have a large influence as impurities in the synthesis of hydrotalcite, because calcium can form bicarbonate salts, and settles as white deposits similar to Mg deposits, so that before the synthesis it is necessary to remove  $Ca^{2+}$  ions. The  $Ca^{2+}$  ion in this study can be reduced by adding a mixture of  $Na_2CO_3$  and  $NaHCO_3$  to sea water [6]. The solution of sodium bicarbonate derived from a mixture of sodium carbonate ( $Na_2CO_3$ ) and sodium bicarbonate ( $NaHCO_3$ ) will react with  $CaCl_2$  to form bicarbonate salts with the reaction equation as below.



The decrease in  $Ca^{2+}$  levels in this study was 0.031% and  $Mg^{2+}$  of 0.576%. The results of this study are different from the research which states that sedimentation in this way can precipitate 3% of  $Mg^{2+}$  and 96% ions of  $Ca^{2+}$  from total metal ions in sea water [6]. This can be caused because in this study using pure seawater, while sea water used in the study is a mixture of dolomite seawater, so that the calcium content can be deposited 96% [6].

- Synthesis of Hydrotalcite Mg / Al- $NO_3^-$  [1]

Mg/Al- $NO_3$  hydrotalcite was synthesized by coprecipitation method with  $NO_3^-$  interlayer. hydrotalcite synthesized by comparison of variations in the mg ratio of sea water and Al 2: 1; 2.5: 1; and 3: 1. The  $Ca^{2+}$  content in seawater is kept to a minimum, this is to avoid the formation of impurities when the synthesis takes place. The pH of the solution is maintained at pH so that  $Al^{3+}$  ions do not form deposits of  $Al(OH)_3$ . Conversely, if the pH of the solution is less than pH 10, there will be precipitation of compounds other than hydrotalcite Mg/Al- $NO_3$ .

The stability of hydrotalcite Mg / Al- $NO_3$  is influenced by the size of the constituent cation radius, so that the structure of Mg / Al- $NO_3$  becomes unstable if the cation radius  $M_2$  is  $> 0.06$  nm. The results of empirical calculation of hydrotalcite Mg/Al- $NO_3$  from seawater are  $[Mg_{0.691}Al_{0.31}(OH)_2(NO_3)_{0.31.0.5}(H_2O)]$ . This is in accordance with the results of calculations obtained [11], with hydrotalcite Mg / Al- $NO_3$  synthesized from pure compounds namely  $[Mg_{0.686}Al_{0.313}(OH)_2(NO_3)_{0.31.0.848}(H_2O)]$ . Empirical calculations show no significant difference in the ratio of Mg /Al and nitrate anions between hydrotalcite Mg / Al- $NO_3$  from pure compounds with hydrotalcite Mg/Al- $NO_3$  from seawater.

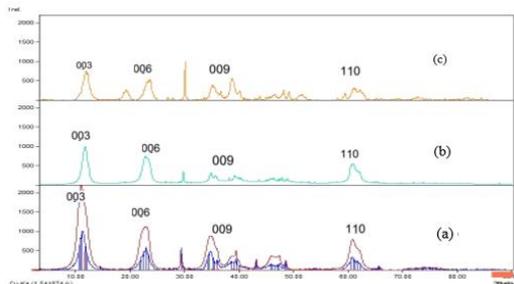
### B. Characterization Test of Mg / Al- $NO_3$ Hydrotalcite Using X-Ray Diffractometer (XRD)

Synthesis of hydrotalcite Mg/Al- $NO_3$  was characterized using X-ray Diffractometer (XRD). This

analysis aims to identify that the main compounds synthesized are Hydrotalcite Mg / Al-NO<sub>3</sub>.

Three peaks in the Hydrotalcite Mg /Al-NO<sub>3</sub> sample with a comparison of the mole variation in this study had different d-spacing. The d-spacing includes d<sub>003</sub> peaks namely Mg (OH)<sub>2</sub>, d<sub>006</sub> peaks namely Al(OH)<sub>3</sub>, and peak d110 namely NO<sub>3</sub>. Mole variation of 2: 1 Hydrotalcite Mg/Al-NO<sub>3</sub> has three peaks of d-spacing, respectively 8.30; 3.80; and 1.50. Molecular variation of 2: 1, Hydrotalcite Mg/Al-NO<sub>3</sub> has three spikes d-spacing 003, 006, and 110 which are not the same as Mg/Al hydrotalcite-like ICDD standard in Figure 1. A mole of variation 2.5: 1 has three d-spacing peaks respectively 8.55; 3.86; and 1.51 Å, wherein moles variation 2.5: 1 has the same d-spacing as the standard ICDD Mg / Al hydrotalcite-like. 3: 1-mole variation has three shoots of d-spacing respectively 8.22; 3.97; and 1.50 Å where in moles of 3: 1 d-spacing is not the same as Mg / Al hydrotalcite-like ICDD standard.

Figure 1. Difraktogram of Mg/AlNO<sub>3</sub> hydrotalcite from sea water (a) Mg / Al NO<sub>3</sub> hydrotalcite 2: 1 (b) Mg / Al NO<sub>3</sub> hydrotalcite 2.5: 1 (c) Mg / Al NO<sub>3</sub>



hydrotalcite-like 3 : 1

Table 1. Value of reflection of the field synthesized by Hydrotalcite Mg / Al-NO<sub>3</sub> from seawater

Value of reflections the field	Mg/Al hydrotalcite standard ICDD (Å)	Hidrotalsit Mg/Al-NO <sub>3</sub> 2:1 (Å)	Hidrotalsit Mg/Al-NO <sub>3</sub> 2,5:1 (Å)	Hidrotalsit Mg/Al-NO <sub>3</sub> 3:1 (Å)
d <sub>003</sub>	8,59	8,30	8,55	8,22
d <sub>006</sub>	3,79	3,80	3,86	3,97
d <sub>110</sub>	1,52	1,50	1,51	1,50

Hydrotalcite Mg/Al-NO<sub>3</sub> has three main peaks which are special features of a layered structure on Hydrotalcite Mg/Al-NO<sub>3</sub> namely 003, 006, and 110 [3]. The special three-peak d-spacing value in the sample is a comparison of mole variation and d-price Standard spacing is shown in Table 1. Table 1 shows the d-spacing of Hydrotalcite Mg/Al-NO<sub>3</sub> by the ICDD standard in the ratio of mole variations to 2.5: 1. This identified that Hydrotalcite Mg/Al-NO<sub>3</sub> was formed at a ratio of 2.5: 1.

The results of the study for Mg/Al hydrotalcite-like with the NO<sub>3</sub> interlayer have d<sub>003</sub> of 9.03. Hydrotalcite Mg /Al-NO<sub>3</sub> from seawater in this study had d<sub>003</sub> of 8.55 [10]. The low intensity of d<sup>003</sup> formed can be made possible due to the presence of remaining calcium ions, and precursors in sea water that might react, thus inhibiting the formation of hydrotalcite-like, which results in very low crystallization of Hydrotalcite Mg/Al-NO<sub>3</sub> [3]. The synthesis process shows that metal hydroxide compounds have been formed, these metal hydroxide compounds are Mg(OH)<sub>2</sub> and Al(OH)<sub>3</sub> compounds which have peaks of 2θ in a row around 19° and 20°. The possibility of Al (OH)<sub>3</sub> settles first because it has a smaller solubility value compared to Mg(OH)<sub>2</sub> or Ca(OH)<sub>2</sub> which is supported by XRF results data which shows the composition of the content of Hydrotalcite Mg/Al-NO<sub>3</sub> constituents [1].

The cause of the emergence of unwanted new peaks in the Hydrotalcite Mg / Al-NO<sub>3</sub> sample is also influenced by the presence of mother liquid when left for 24 hours [4]. Hydrotalcite Mg/Al-NO<sub>3</sub> which was left for a long time in water produced a higher crystallization rate compared to hydrotalcite Mg / Al-NO<sub>3</sub> which was left in the mother liquor [9]. This condition is possible to be influenced because in a solution that is left to stand for 24 hours, the mother liquor is still left so that it causes the development of fine particles blocked by larger particles.

C. Analyzed the Content Contained in the Sample with a Ratio of 2.5: 1 Using XRF

Table 2. The results of the analysis of levels of Mg (OH)<sub>2</sub> and Al(OH)<sub>3</sub> using XRF

Concentrations (g/ml)	Mg(OH) <sub>2</sub>	Al(OH) <sub>3</sub>
	11.5 g/ml	20.3 g/ml

Table 2 shows that in the synthesized sample Hydrotalcite Mg/Al-NO<sub>3</sub> contained the main components of reducing Hydrotalcite Mg/Al-NO<sub>3</sub> namely Mg(OH)<sub>2</sub> and Al (OH)<sub>3</sub> in the amount of 11.5 g / ml and 20.3 g / ml, so that the mole ratio of Mg / Al ratio is obtained. The component of Al(OH)<sub>3</sub> in this study has the largest amount, compared with the results of a study which states that the main component of the largest constituent is Mg (OH)<sub>2</sub> of

20 g / m [7]. It can be assumed that the deposition of the hydrotalcite Mg/Al-NO<sub>3</sub> phase that occurs is imperfect.

D. Surface Area Analyzer (SAA)

To determine the surface area, Hydrotalcite Mg/Al-NO<sub>3</sub> was analyzed by Surface Area Analyzer (SAA) by the BET method (Brunauer, Ermet, and Teller). The results of the analysis can be seen in Table 3.

**Table 3.** Data on the Results of Surface Analysis of Hydrotalcite Mg /Al-NO<sub>3</sub>

No	Ratio Mg:Al	Parameters	
		Surface Area <i>m<sup>2</sup>/g</i>	Radius Å
1	2:1	85,557	1,1255
2	2.5:1	132,081	9,884
3	3:1	283,504	7,6553

The results of the analysis in Table 3 show that the specific surface area of Hydrotalcite Mg/Al-NO<sub>3</sub> for a ratio of 2: 1 is 85.557 m<sup>2</sup>/g. The ratio of 2.5: 1 has a surface area of 132.081 m<sup>2</sup>/g, and for a ratio of 3: 1 it has a surface area of 283.504 m<sup>2</sup>/g. This significant difference allows for the presence of other impurities found in the synthesis of Hydrotalcite Mg/Al-NO<sub>3</sub>. Hydrotalcite Mg/Al-NO<sub>3</sub> with a mole ratio of 2.36: 1 and using the BET method has a surface area of 186.8 m<sup>2</sup>/g [13]. Mg/Al-NO<sub>3</sub> hydrotalcite from seawater can be classified as mesopore, because it has a radius of 10-100 Å, and has a surface area of 40-240 m<sup>2</sup>/g, wherein that area are other microcrystalline regions, such as Al (OH)<sub>3</sub> and Mg (OH)<sub>2</sub> [15]. The similarity of surface area hydrotalcite-like data from seawater in this study is in the variation ratio of 2.5: 1 with the results of previous studies namely at ratio 2.36: 1. Identify that hydrotalcite-like Mg /Al-NO<sub>3</sub> is formed [13].

E. Determination of Hydrotalcite Mg / Al-NO<sub>3</sub> adsorption capacity with time variation

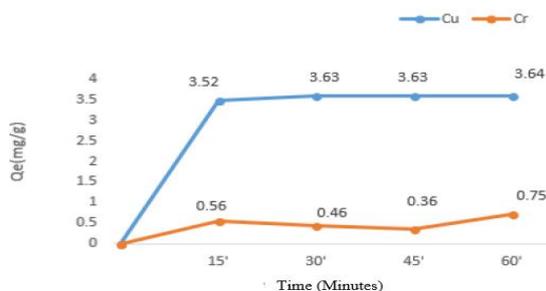


Figure 2. The adsorption capacity of Mg/Al-NO<sub>3</sub> hydrotalcite with time comparison

Based on Figure 2 it is known that the adsorption capacity occurs very quickly in the 30 minutes for Cu<sup>2+</sup> metal ions. This is indicated by the reduction in

the amount of Cu<sup>2+</sup> metal ions absorbed by the surface of Hydrotalcite Mg/Al-NO<sub>3</sub> and has reached the equilibrium point because there is no change until 60 minutes. Whereas Cr<sup>6+</sup> metal ions were adsorbed very fast at 60 minutes but at 45 minutes there was a slowdown of Cr<sup>6+</sup> metal ion adsorption, because the surface-active side of hydrotalcite Mg/Al-NO<sub>3</sub> had not experienced saturation point during precipitation reaction[10]. This is supported by the results of adsorption efficiency which can be seen in Figure 3.

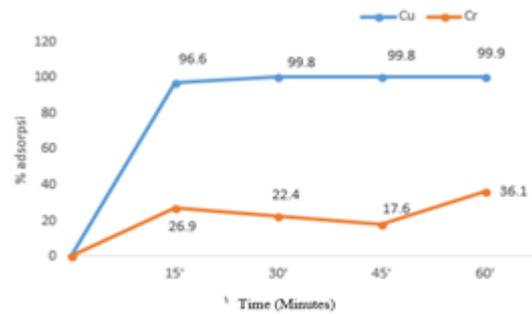


Figure 3. per cent adsorption of Cu<sup>2+</sup> and Cr<sup>6+</sup> by Mg /Al-NO<sub>3</sub> with time variations

Figure 3 shows that the maximum per cent adsorption for Cu<sup>2+</sup> of 99.9% occurs at 30 minutes contact time which is indicated by the achievement of an equilibrium point. Whereas in Cr<sup>6+</sup> there was a fluctuation in per cent adsorption from contact time of 15 minutes to 60 minutes. This is due to the process of adsorption and desorption. The longer the contact time of adsorption, the higher the surface adsorption ability of Hydrotalcite to Cu<sup>2+</sup> metal ions and Cr<sup>6+</sup> metal ions which is characterized by a reduction in the concentration of Cu<sup>2+</sup> and Cr<sup>6+</sup> metals [8].

IV. CONCLUSION

The optimum mole ratio for synthesizing Hydrotalcite Mg / Al-NO<sub>3</sub> from seawater is at a mol ratio of 2.5: 1 at pH 10 with a temperature of 700C within 1 hour. The characteristic Hydrotalcite Mg/Al-NO<sub>3</sub> from seawater has a surface area of 132,081 m<sup>2</sup>/g, according to the surface area of hydrotalcite previous studies amounted to 40-240 m<sup>2</sup>/g and has a pore radius of 10-100Å in the ratio 2.5: 1.

Hydrotalcite Mg /Al-NO<sub>3</sub> with a variation of 2.5: 1 has d-spacing 8.55; 3.86; and 1.51 Å, d-spacing is in accordance with the ICDD hydrotalcite-like standard, which shows that Hydrotalcite Mg / Al-NO<sub>3</sub> has been formed. Hydrotalcite Mg/Al-NO<sub>3</sub> has an adsorption capacity for Cu<sup>2+</sup> metal is 3.56 mg / g for contact time of 30 minutes at 3.63 mg / g and for Cr<sup>6+</sup> metal is 0.021 mg / g for contact time 60 minutes of 0.75 mg / g.

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**REFERENCES**

- [1] Astuti. 2012. Sintesis Mg-Al Diklorfenak Hidrotalsit melalui Reaksi penukaran Ion. *Jurnal Sains dan Terapan Kimia*. vol. 5(3)
- [2] Cavani, F., Trifiro, F., and Vaccari, A., 1991, Hydrotalcite-Type Anionic Clays Preparation, Properties and Applications, *Catalysis Today*, 11, 173-301.
- [3] Herald E, Wijarnako D, Nugrohoningtyas K, Dinala B. 2006. Studi Pengaruh Perbedaan Ratio Mol antara Mg/Al dalam Sintesis Mg/Al Hydrotalcite-like. *Journal AlChem*. vol. 2 (2): 54-59.
- [4] Herald E, Nugrahaningtyas D K, & Heriyanto H. 2017. Calcination on Ca-Mg-Al Hydrotalcite From Brine Water and Its Characterization. *Jurnal Ilmu-Ilmu*. vol 13 (13) :205-216.
- [5] Kameda T, Yoshioka T, Uchida M, & Okuwaki A. 2000. Synthesis of Hydrotalcite using Magnesium from Seawater and Dolomite. *Molecular Crystals and Liquid Crystals Journal*. vol. 341 :407-412.
- [6] Kameda T, Yoshioka T, Uchida M, & Okuwaki A. 2002. Synthesis of hydrotalcite from seawater and its application to phosphorus removal. *Phosphorus, Sulfur and Silicon and Related Elements Journal*. vol. 177 :1503-1506.
- [7] Klopogge J, Hickey L, & Frost R. 2004. FT-Raman and FT-IR Spectroscopic Study of Synthetic Mg/Zn/Al-Hydrotalcites. *Journal of Raman Spectroscopy*. vol. 35 :967-974.
- [8] Kovanda F, Jindova E, Dousova B, Kolousek D, Plestil J, & Sedlokova Z. 2009. Layer Double Hydroxides Intercalated with Organic Anions and their Application In Preparation of LDH/Polimer Nano composites. *Acta Geodyn Journal*. vol. 6 :111-119.
- [9] Kurniawati P, Wiyantoko B, Kurniawan A, & Esti T. 2013. Kinetic study of Cr ( VI ) Adsorption on Hydrotalcite Mg / Al with Molar Ratio 2 : 1. *Journal AlChamy*. vol. 13 :11-21.
- [10] Liang X, Zang Y, & Xu Y. 2013. Sorption of metal cations on layered double hydroxides. *Physicochemical and Engineering Aspects Journal*. 1-29.
- [11] Puspita Sari, F. 2017. Sintesis, Karakterisasi Nanopartikel Magnetit, Mg/Al NO<sub>3</sub> -Hidrotalsit dan Komposit Magnetit-Hidrotalsit. *Journal Chem*. vol.3 :44-49.
- [12] Roto R, Indah Rosma D, & Kuncaka A. 2015. Zn-Al-EDTA Hydrotalcite as Adsorbent for Pb(II) Ion Pollutant in The Environment. *J.Chem*.vol. 22 :226-232.
- [13] Yang JF Z Z. 2008. Use of spray technique to prepare Ni/Al layered double hydroxides. *J. Alloys Compd*. vol. 473 :458-461.
- [14] Zhao R, Yin C, Zhao H, & Liu C. 2003. Synthesis, Characterization, and Application of Hydrotalcites in Hydrodesulfurization of FCC Gasoline. *Fuel Processing Technology Journal*. vol. 81 :201-209.
- [15] Kusumaningtyas M. 2012. Sintesis, Karakterisasi dan Penentuan Kapasitas Penetralkan Asam Mg/Al Hydrotalcite dari Brine Water sebagai Sediaan Antasida. *Journal AlChem*. vol. 14 (12) : 18-20
- [16] Palar, H., 1994, "Pencemaran dan Toksikologi Logam Berat", Rineka Cipta, Jakarta.