Development of Hydrotalcite as an Adsorbent to Remove Heavy Metals in Lead and Chromium Solutions

by

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13300

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Chemical Engineering)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Chemical Engineering Programme
Universiti Teknologi PETRONAS
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BACHELOR OF ENGINEERING (Hons)
(CHEMICAL ENGINEERING)

Approved by,

....
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TRONOH, PERAK

January 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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NOR SYAMIMI NABILA BT. MOHAMAD ZU

ABSTRACT

This research work studies on the development of hydrotalcite mixed oxides as an adsorbent for the heavy metal removal application. The main objective of the study is to develop hydrotalcite mixed oxides which can adsorb optimum capacity of heavy metals ions. This is because of the increasing of heavy metals content in water, soil as well as food and also excess exposure to them can lead to damage in organism structure especially human beings and aquatic life. Based on previous researches, characteristics of hydrotalcite mixed oxides which are high surface area, porosity and basicity, are effectives for adsorption process. Hydrotalcite mixed oxides will be synthesized by using co-precipitation method and characterized to identify their composition, pore size, surface area and surface morphology using the equipment such as X-Ray Diffractometer (XRD), BET Surface Area Analyzer and Field Emission Scanning Electron Microscope (FESEM). After characterization, the hydrotalcites mixed oxides prepared will be tested for its efficiency in removing heavy metals such as lead (Pb) and chromium (Cr) ions in aqueous solutions. The concentration of heavy metals left in the sample after adsorption process was measured by using Atomic Absorption Spectrometer (AAS) to identify the percentage of adsorption. Optimum adsorption capacity of heavy metals is expected to be the result for this research.

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This project completion would have been impossible without the contributions and guidance from experts and individuals. Here, I would like to express my gratitude to those who were directly and indirectly involve throughout two semesters of my Final Year Project (FYP) I and II courses.

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ABBREVIATIONS AND NOMENCLATURES

XRD	X-Ray Diffractometer
FESEM	Field Emission Scanning Electron Microscope
AAS	Atomic Absorption Spectrometer
LDH	Layered Double Hydroxide
BET	Brunauer–Emmett–Teller
CTA	Chromotropic Acid
ETSC-OHTC	4-Ethyl Thiosemicarbide Intercalated Organophilic Calcined Hydrotalcite
TEM	Transmission Electron Microscope
CPS	Count per second
HTC	Hydrotalcite Calcined

CHAPTER 1

INTRODUCTION

1.1 Background Of Study

Rapid development of industrial sectors and urbanization in Malaysia lead to an increase in heavy metals content in rivers, lakes, soil and also underground water. According to Moon (2007), heavy metal is a metal element that has high density between 4-5 g/cm^3 which comes from transition elements group that is considered as hazardous and accumulated in human bodies. Examples of heavy metals are zinc, cadmium, copper, manganese, mercury, chromium, iron, arsenic and lead. The source of heavy metals can be from natural processes or manmade since these metals occur in Earth's geological structures. Mining and chemical industries are some of the examples of main manmade source of heavy metals. Figure 1.1 shows one of the rivers that are contaminated by heavy metals in China. China has been suffering chromium and cadmium waste in 2009 due to industrialization (Fang, 2009).

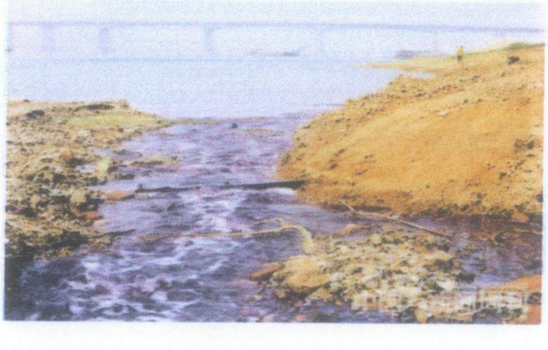


Figure 1.1: Heavy metals contamination in Xiangjiang River, China (Fang, 2009)

Some heavy metals are essential in human body with an appropriate dose. However, if the dose is exceeded, it can lead to damage in organism structure. According to Occupational Safety and Health Administration (OSHA), the effects of excessive exposure of heavy metals to the living organisms and environment are showed in Table 1.1.

Table 1.1: Effects of heavy metals (OSHA, 2013)

Heavy metals	Effects
Copper (Cu)	Nausea, diarrhea, tissue injury, genetic disease, anemia, chronic liver disease
Zinc (Zn)	Increase acidity of water, dizziness, abdominal pain, nausea, hemorrhagic pancreatitis
Cadmium (Cd)	Fever, muscle ache, pneumonitis, irritation, pulmonary edema, kidney failure, fragile bones
Chromium (Cr)	Skin rashes, stomach ulcers, respiratory problems, weakened immune system, liver damage, lung cancer, death, damage gills of fish
Iron (Fe)	Enzyme dysfunction, inflammation, cancer, bacterial growth stimulant, diabetes, nervous system disease, hypertension, kidney failure
Arsenic (As)	Irritation to stomach and intestines, reduce production of red and white blood cells, cancer, infertility, miscarriage, brain damage
Lead (Pb)	Vomiting, diarrhea, coma, convulsion, death
Mercury (Hg)	Insomnia, memory loss, kidney failure, fatality, corrosive to skin, brain damage, paralysis
Manganese (Mn)	Psychiatric illnesses, mental confusion, impaired memory, neurological problems, kidney failure

1.2 Problem Statement

Increasing number of chemical industries give a great impact to the environment since high amount of effluents that contain heavy metals are produced from the chemical process every day. A lot of technologies had been invented for heavy metals treatment and control in order to improve the water resources as well as save human being and environment. For example, the methods that are already used in waste water treatment are lime based technology, ion exchange and through adsorption by using activated carbon as the adsorbent. However, the previous treatments also have some limitations and disadvantages in treating heavy metals from industrial waste. One of the drawbacks is that only certain heavy metals ion can be removed. Besides, some of them require very high operating and maintenance costs. Therefore, the methods are not cost effective to be implemented since there are a lot of infrastructures needed. Some treatment also needs to undergo difficult chemical process to achieve the purification of wastewater. Based on the limitations of previous treatment, an effective method that can overcome heavy metals problem should be discovered more. The investigations on removing heavy metals using other type of adsorbents such as hydrotalcites in Malaysia are limited.

1.3 Objectives and Scope of Study

1. To synthesize and characterize Mg and Ni based hydrotalcites
2. To test the performance of hydrotalcite by removing heavy metals through adsorption process
3. To obtain the optimum adsorption capacity of heavy metals ions using hydrotalcite

This research will be focusing on synthesizing Mg-Ni-Al hydrotalcite. The Mg:Ni:Al hydrotalcite will be prepared with two different molar ratios which are 2:1:1 (magnesium based) and 1:2:1 (nickel based) for optimum performance and will be characterized by using XRD, FESEM and BET Surface Area Analyzer. Both hydrotalcites will be tested for their ability to adsorb heavy metals ions in aqueous Cr and Pb solutions. Agitation times as well as initial and final concentration of metal ions are the important parameters involved throughout this experiment. This study focused on the adsorption of two heavy metals ions which are lead (Pb) and chromium (Cr). The results of the performance test will be analyzed to determine the amount of heavy metals being adsorbed by using AAS. From the data obtained, optimum adsorption of heavy metals ions by hydrotalcites was determined.

CHAPTER 2

LITERATURE REVIEW

2.1 Heavy Metals Problems in Malaysia

Heavy metals contamination around Malaysia is increasing. In Terengganu, it was reported that the concentration of mercury (Hg) and stannum (Sn) are high in rivers than lake waters (Sultan et al., 2011). A few researchers study about the assessment of heavy metals in tilapia fish in Langat River and Engineering Lake in Bangi. It is reported that the contaminations of heavy metals like copper and zinc found are higher in Engineering Lake compared to Langat River (Taweel et al., 2013). According to the results found, the allowable limit for tilapia fish consumption must be five times per week or less to avoid any health effects. According to Zakaria (2008), mercury content in Sungai Damansara, Selangor has exceeded the limit which is 3.9ppb. The acceptable limit for mercury content in water sources is supposed to be only 2.00ppb. Therefore, the water in Sungai Damansara is not safe since mercury can cause brain and kidney damage to human being. A study about heavy metals content in soils and crops at ex-mining land in southern Perak was carried out by Mender (2004). It is found that Chinese radish has high Ni content while Pb and Zn are high in yam bean and cultivated soil respectively. In Bestari Jaya, Selangor, an assessment about heavy metals content in soil and water of ex-mining area showed that Zn content is the highest in water at the sampling station which is 121mg/L compared to Ni, As and Pb. Most of heavy metals studies involves in Selangor due to the developing industries sectors there. Figure 2.1 shows the example of river in Malaysia which has been contaminated by heavy metals.

Figure 2.1: Heavy metals contamination in Malaysia (Leow, 2011)

One of the alternatives used in removing heavy metals is by using post treatment (Naji et al., 2010). This method use high quality limestone, gravel and clay bricks as the medium to adsorb cadmium (Cd), lead (Pb), zinc (Zn), nickel (Ni), copper (Cu) and chromium (Cr). The process repeated by increasing the amount of high quality lime stone to obtain the maximum adsorption of heavy metals. The treatment proves that high quality lime stone is able to adsorb maximum of 90% heavy metals from prepared solution. Besides, an alternative solution to eliminate heavy metals is through adsorption by using agricultural wastes such as rice husk and sawdust (Khan et. al., 2004). Modified rice husk is reported to be effective in removing Cd, Cu and Pb from aqueous solution due to its high adsorption capacity. Rice husk is able to adsorb Cd up to 90%. However, other heavy metals like Ni (II) and Cu (II) cannot be removed completely. Hence, a new method of treatment that can completely remove heavy metals ions should be studied.

2.2 What is Hydrotalcite?

Natural hydrotalcite has a chemical formula of $Mg_6Al_2(CO_3)(OH)_{16}.4(H_2O)$ and can be found in nature in white or colorless with molecular weight of 603.98 g/mol. Synthetic hydrotalcite is anionic clays and also known as layered double hydroxide (LDH) which is similar to brucite, $Mg(OH)_2$ structures. The name of hydrotalcite is referring to its resemblance to talc and its characteristic which has high water content. Synthetic hydrotalcite can be prepared by using co-precipitation method. Co-precipitation is the process of precipitation of more than one substance simultaneously. Through hydrogen bonding, the layers of hydroxides are stacked together. The general formula for hydrotalcite is $[M^{2+}_{1-x}M^{3+}_{x}(OH)_{2x}]^{x+}(A^{n-})_{x/n}.mH_2O$ where M^{2+} is Mg but can also be Ni, Zn and Cu. M^{3+} is aluminium (Al) but may be chromium (Cr), manganese (Mn), cobalt (Co) and ferum (Fe) (Stephenson, 2013). The layer of hydrotalcite consists of a basic layer with positive charges.

Hydrotalcite can be used as additives for polymers, anion exchange, antacids, and catalyst to accelerate reactions, catalyst support, nuclear waste treatment and also sorbents (Stephenson, 2013). The hydrotalcite that undergoes thermal treatment which is also known as calcined hydrotalcite has larger surface area and high porosity (Gutierrez, 2009). Anirudhan et al. (2012) stated that high porosity and surface area of hydrotalcite will increase the capacity of adsorption. According to Yunfeng Xu et al. (2010), hydrotalcite has high anion exchange capacity which is very crucial in adsorption process since it gives more efficiency in removing anionic contaminants. Ocelli et al. (2003) found that hydrotalcite has strong basic properties that can be used for removing sulfur oxides or any acidic air pollutants in atmosphere.

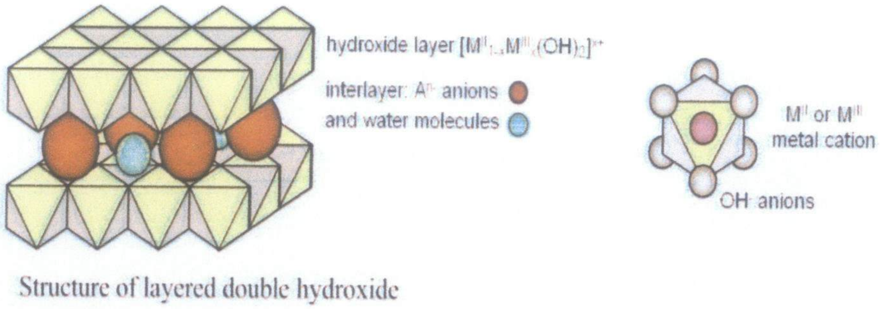


Figure 2.2: Structure of hydrotalcite (Cífková et al., 2013)

2.3 Previous Research about Hydrotalcites as Adsorbents

A lot of studies had been done to study about the application of hydrotalcites as an adsorbent. From the latest research, Chen and Song (2013) carried out a study about removing Cr (VI) and Cu (II) by using chromotropic acid-intercalated Zn-Al hydrotalcite. The hydrotalcite used in the study is prepared by using co-precipitation method. Solution A is prepared with 12 g of 6.03 mol chromotropic acid (CTA) which is dissolved in 50 ml CO_2 free deionized water. 2M of NaOH solution is added to make the pH of solution neutral, 7 and then it is dissolved again in 200 ml of CO_2 free deionized water. After that, the solution is mixed together with 23.8 g of 0.8 mol $Zn(NO_3)_2$.6H2O and 7.5 g of 0.02 mol $Al(NO_3)_3.9H_2O$. For Solution B, 9.6 g of 0.24 mol NaOH is dissolved in 200 ml CO_2 free deionized water to form alkali solution. Both solutions are mixed for 2 minutes with rotor speed of 3000 rpm before being aged at 97°C under N_2 stream for 8 hours. Final product obtained is washed using water and ethanol for five times and dried for 24 hours at 70°C. The result obtained from this study is that the maximum adsorption of Cr (VI) is approximately 782 mg/g while Cu (II) is about 450 mg/g.

Some researchers investigated about the adsorption of Arsenic by using Mg-Al-CO_3 hydrotalcite with a molar ratio of 2.87 (Dwadhal et al., 2011). Hydrotalcite used is also prepared by co-precipitation method. The Arsenic solution used in this experiment is from As_2O_5 powder. In this experiment, the effects of competing ions presence are investigated. As the result, the presence of competing ions like SO_4^{2-}, Cl^-, CO_3^{2-}, NO_3^- and F^- reduces the percentage of Arsenic adsorbed. Calcined hydrotalcite adsorbs arsenic (As) and selenium (Se) more as stated by Yang et al. (2005). From the study about adsorption of As and Se, it is concluded that the higher the hydrotalcite dose, the higher adsorption of Se and As. According to Dawdhal et al. (2011), the presence of competing ions reduces the ability of hydrotalcite to adsorb As. Figure 2.3 shows the adsorption isotherm for As (V) removal experiment with the presence of competing ions.

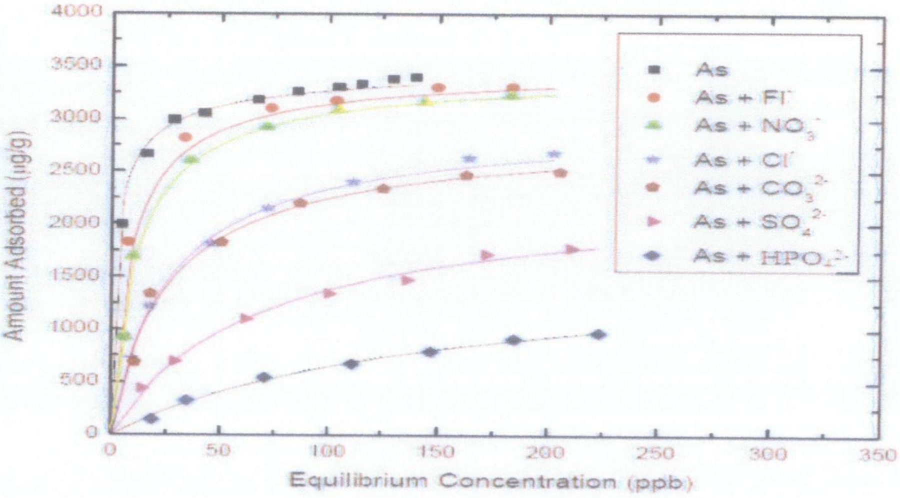


Figure 2.3: Adsorption isotherm for As (V) by hydrotalcite with the presence of competing ions at a fixed initial concentration (Dawdhal et al., 2011)

Apart from that, a research has been carried out to study the ability of Ni-Co-Cr hydrotalcite in adsorbing hydrogen for hydrogen storage purpose. Salam et al. (2013) stated that hydrotalcite with molar ratios of 1:2:1 (cobalt rich) gave significant hydrogen adsorption below 100°C which is suitable for reversible system and also show the major hydrogen adsorption at 180°C compared to hydrotalcite with molar ratio of

2:1:1 (nickel rich). From the research, Ni rich hydrotalcite reached a steady state earlier compared to Co rich hydrotalcite. It is concluded that hydrotalcite is the best solution for hydrogen storage due to good interaction energy of hydrogen molecule (Salam et al., 2013). Anirudhan et al. (2012) has investigated about the adsorption of Cu (II) ions by using 4-ethyl thiosemicarbide intercalated organophilic calcined hydrotalcite (ETSC-OHTC). From the research, it is stated that the adsorbent which is hydrotalcite must have an excellent stability for efficient adsorption. The adsorption of Cu (II) ions is the best at pH of 5.5. Figure 2.4 shows the adsorption graph of Cu(II) by using ETSC-OHTC. The adsorption reached equilibrium after 4 hours with a temperature of 303 K. From the graph, it can be seen that Cu(II) ions are removed almost completely when 3.0 g of adsorbent added in Cu(II) solution.

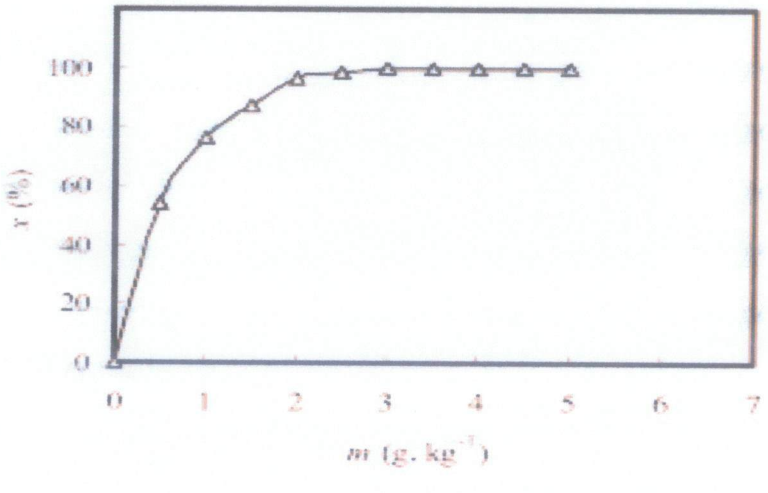


Figure 2.4: Effect of adsorbent dose (m) on the adsorption of Cu(II) using ETSC-OHTC (Anirudhan et al., 2012)

From the previous researches, it is proven that hydrotalcite is effective in adsorption process due to its high surface area, porosity and basic properties. Therefore, from those properties of hydrotalcite and previous researches, this project will focus on achieving an optimum adsorption capacity of heavy metals by using hydrotalcite mixed oxides.

2.4 Characterizations of Hydrotalcites

From previous researches, hydrotalcites are characterized by using XRD, FESEM and BET Surface Area Analyzer. BET Surface Area Analyzer measures the surface area and pore size distribution of hydrotalcites by using gas adsorption and mercury porosimetry. According to Fetter et al. (2000), the surface area for nitrated hydtrotalcites is lower than carbonated hydrotalcite. This is due to the lower anion density in carbonate hydrotalcites that cause more diffusion of N_2. Hydrotalcites involved in their experiment were labeled as hydrotalcite (HT), degasification temperature, degasification time. For example HT 100/2 means hydrotalcite degasified at 100°C for 2 hours. R indicates that the experiment was repeated. N indicates there is no degasification for the second time and Y refers to degasification for the second time. Table 2.1 shows the results of characterization of nitrated hydrotalcite from BET Surface Area Analyzer.

Table 2.1: Surface area from BET Surface Area Analyzer (Fetter et al., 2000)

Sample	Surface area (m^2/g)	Loss of mass (w%)
HT 100/2	3.0 ± 0.1	5.0
HT 100/2 RY	3.0	1.7
HT 100/RN	2.2	-
HT 200/2	4.0 ± 0.6	14.2
HT 200/2 RY	2.7	1.0
HT 200/2 RN	4.2	-
HT 300/2	7.3 ± 1.0	16.0
HT 300/2 RY	13.2	2.0
HT 300/2 RN	7.2	-
HT 300/18	100.0 ± 5.0	28.4

FESEM provides narrow probing beams at low and high electro energy to produce spatial image while minimizing sample charging and damage. Figure 2.5 shows the surface morphology of chromotropic acid-intercalated Zn-Al hydrotalcite from FESEM. Chen and Song (2013) stated that morphology of chromotrpic acid-intercalated Zn-Al hydrotalcite was slightly irregular hexagonal plate-like where the plate size is around 3.5µm.

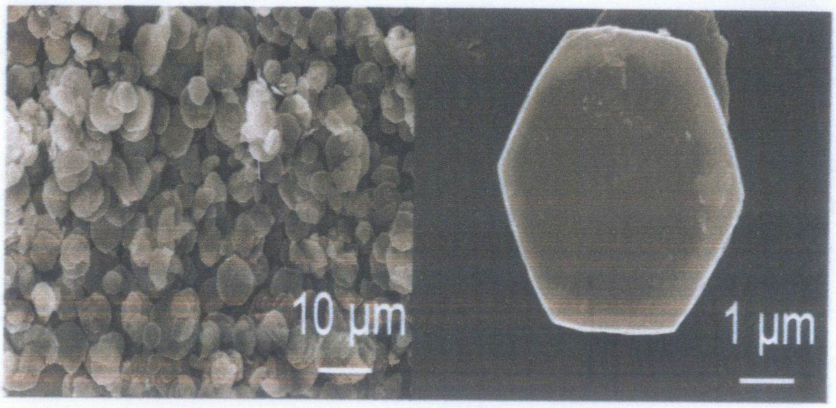


Figure 2.5: FESEM image for chromotrpic acid-intercalated Zn-Al hydrotalcite (Chen and Song, 2013)

In Figure 2.6, FESEM photographs show that HTC has a corn-flake structure while ETSC-OHTC shows a heterogeneous nature. The particles for ETSC-OHTC are aggregated which can enhance the adsorption capacity.

Figure 2.6: FESEM results for HTC (A) and ETSC-OHTC (B) according to Anirudhan et al. (2012)

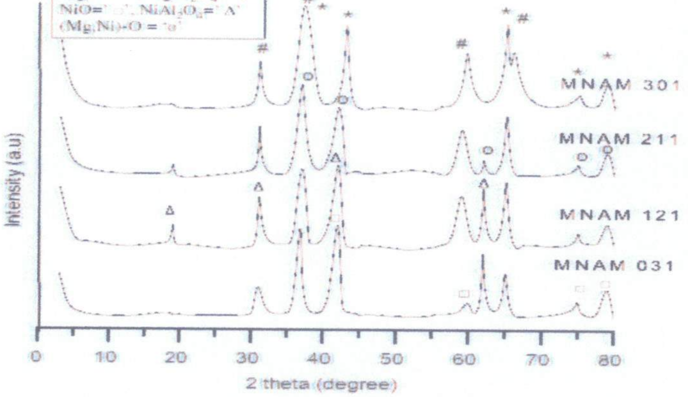


Figure 2.7: XRD pattern of Mg-Ni-Al hydrotalcite with different molar ratios (Salam et al., 2013)

Figure 2.7 shows the result from XRD analysis of different molar ratios of hydrotalcite mixed oxides Mg-Ni-Al which are 3:0:1, 2:1:1, 1:2:1 and 0:3:1. According to Salam et al (2013), this XRD pattern indicates full decomposition of the precursors of synthesized materials at calcination temperature which lead to various oxide derivatives. It proves that the samples analyzed have hydrotalcite structure. Figure 2.8 shows XRD patterns for ETSC-OHTC. The broad peaks reflect that the material is slightly disordered. This is due to the entering of other molecules into the hydrotalcite interlayer space.

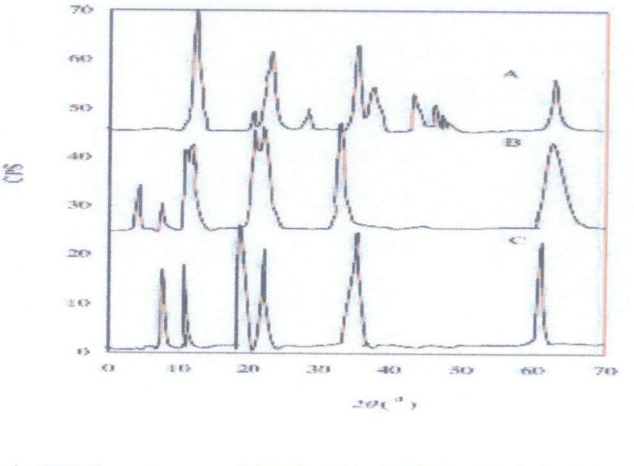


Figure 2.8: XRD patterns of HTC (A), ETSC-OHTC (B) and Cu(II)-ETSC-OHTC (C) (Anirudhan et al., 2012)

Figure 2.9 shows the XRD spectrum of hydrotalcite-like compound that was prepared with the ratio of Mg/Al equals to two. The diffraction patterns proved that the sample has double layered structure (Gutierrez, 2009).

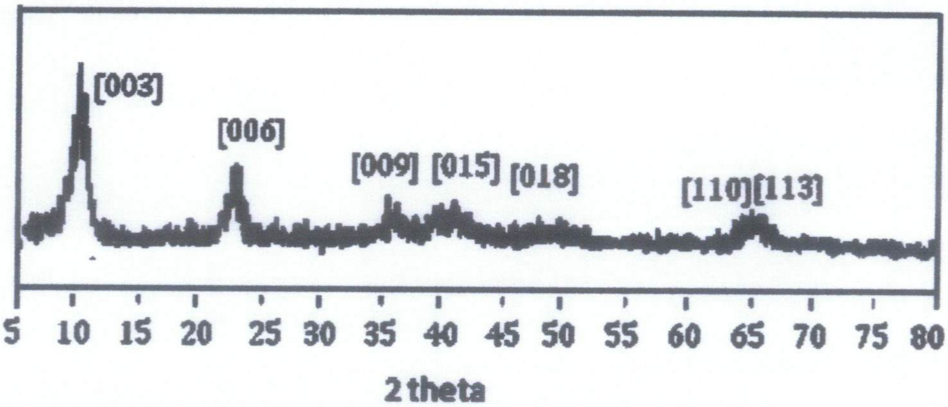


Figure 2.9: XRD spectrum of hydrotalcite like compound (Gutierrez, 2009)

2.5 Principles of Adsorption

Adsorption is a process where ions, molecules or bimolecules of gas, liquid or dissolved solid are attached to the surfaces. Adsorption can be divided into two depending on its adsorbate and adsorbent. Adsorbate is the gas, solute or liquid which is being adsorbed while adsorbent is the liquid or solid which the adsorption occurs. There is physical adsorption (physisorption) where the force of attraction between adsorbate and adsorbent is Van der Waal's forces and also chemical adsorption (chemisorption) which the strength of its force of attraction is almost the same as chemical bonds. The important factors that influence adsorption capacities are:

- The nature of adsorbent and adsorbate
- The surface area of adsorbent
- Operating condition of experiments

The rate of adsorption is directly proportional to the surface area of adsorbents. Large surface area will give high adsorption extend (Walter, 2013). The adsorbents will adsorb large amounts of molecules into pores on their surface. These pores have a large active surface area that helps the adsorption process to occur. Adsorbents can be classified according to the average diameter of their inner pores. The classes of pores size are as the following:

Table 2.2: Classification of adsorbents ("Basic Principal of Adsorption", 2013)

Adsorbents	Average Diameter
Micro porous	2 Å – 20 Å
Meso porous	20 Å - 500 Å
Macro porous	>500 Å

The unit is in Å, angstrom, the unit of length which equals to one billionth of a meter, 10^{-10}m. The common adsorbents used are silica gel, zeolites and activated carbon. Silica gel is used as adsorbent in drying of gases, refrigerants, organic solvents and also for dew point control of natural gas. Silica gel is porous and gives high affinity for water vapors. Removal of odor from gases, sulfur and nitrogen oxides, purification of helium, water purification as well as recovery of solvent vapors commonly use activated carbon as the adsorbents. Activated carbon has very high porosity and surface area that gives high adsorption capacity. Zeolites are applied in carbon dioxide removal from natural gas and also in the drying of process air. Zeolites has strong electrostatic field which results in strong interaction with polar molecules like water for adsorption process.

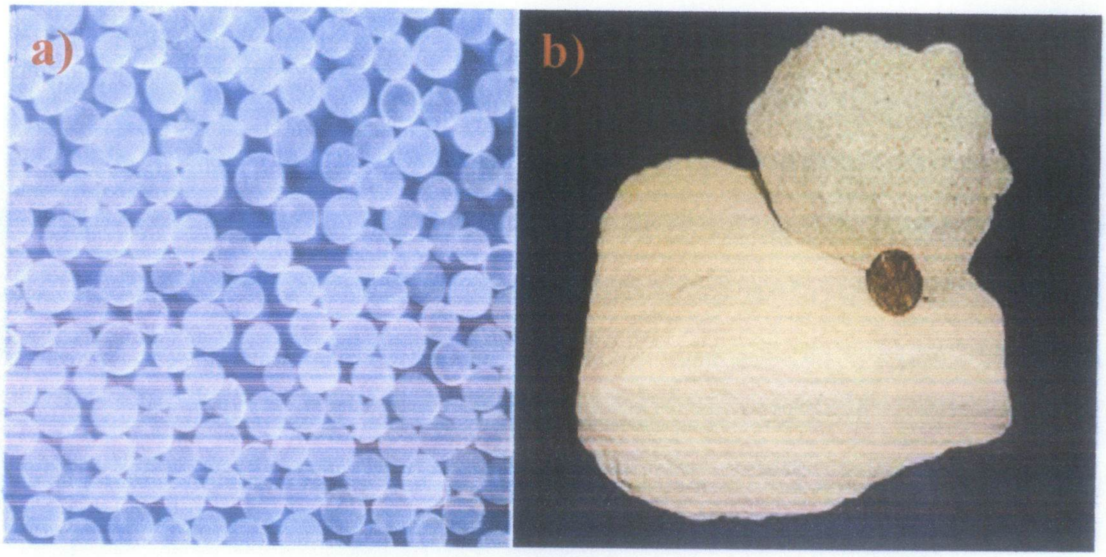


Figure 2.10: (a) Silica gels and (b) zeolites

Figure 2.11: Activated carbon

Adsorption is studied by using graphs which is known as adsorption isotherms. These isotherms are defined as the adsorption capacity. Adsorption isotherm is the function of amount of adsorbate on the adsorbent and the pressure or concentration at a constant temperature. Adsorption isotherms help to classify adsorbents into six different types as below ("Basic Principle of Adsorption", 2013):

- Type I Isotherms
    - This isotherms show the characteristics of micro porous adsorbent. The forces involve in attracting the molecules are Van der Waals forces. Adsorbents included under Type I are silica gel and charcoals.
- Type II Isotherms
    - Type II gives the features for non-porous surfaces, macro-porous adsorbents and also compacted powders. Graphitized carbon and compact powder of silica are examples for Type II isotherm.
- Type III Isotherms
    - Non-porous or macro-porous solids belong to this isotherm. For examples polymers and silica aero gels. The intermolecular forces between adsorbate molecules are stronger than forces between adsorbent and adsorbate.
- Type IV Isotherms
    - This class is most observed for meso-porous adsorbents. The intermolecular forces are the same as forces for type I and II isotherms.
- Type V Isotherm
    - It is similar in nature to type III isotherms but with the different average pore size. The pore size is smaller. Example for this class is the adsorption of organic vapors on meso-porous adsorbents.
- Type VI Isotherm
    - Stepwise adsorption in multilayer exhibited on a macro-porous or non-porous adsorbent. Adsorption for each layer is similar to type II isotherm. For example, the adsorption of argon and krypton on graphitized carbon.

Figure 2.12 below shows the adsorption isotherm diagram for each of isotherm types from Type I to Type VI.

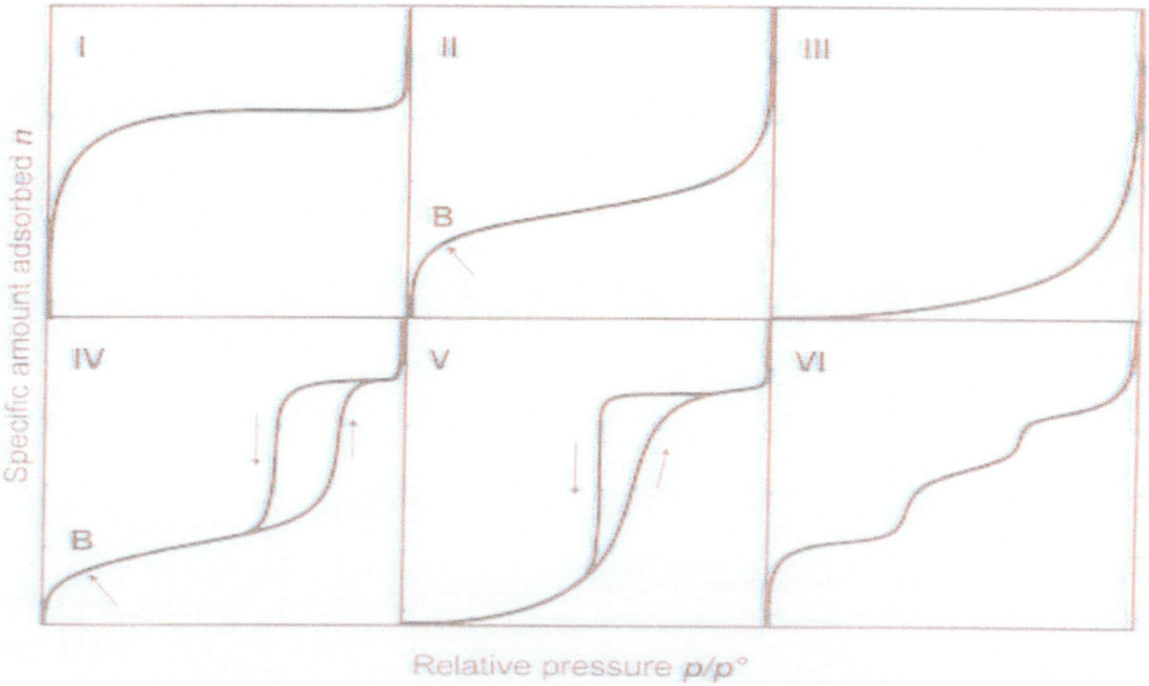


Figure 2.12: Adsorption isotherms diagram (Hoa, 2013)

Table 2.3: Summary of previous researches about hydrotalcite as adsorbent

Author	Year	Descriptions	Application	Conclusion
Yang Chen and Yu Fei Song	2013	- Less than 10% adsorption of Mn(II), Mg(II) and Cd(II) ions in 500min - Less than 20% and 35% removal of Co(II) and Ni(II) respectively - Almost 95% of Cu(II) and 90% of Cr(VI) adsorbed in 600min	- chromotropic acid (CTA) intercalated layered double hydroxide (LDH) - Adsorbent of heavy metals	- Chromotropic acid (CTA) intercalated layered double hydroxide (LDH) shows high ability to adsorb Cr(VI) and Cu(II) ions compared to other heavy metals
M. Abdus Salam, Suriati Sufian and T. Murugesan	2013	- The hydrotalcite shows a porous microstructure with hexagonal plate-like and coral-like - Ternary mixed oxides give more hydrogen adsorption capacities compared to binary mixed oxides - nickel catalyst is added and it gives 3.9wt% adsorption capacity	- Mg-Ni-Al hydrotalcite - As adsorbent for hydrogen storage	- Mixed oxides without magnesium reduces the adsorption of hydrogen and mixed oxides without nickel gives high adsorption capacity
M. Abdus Salam, Suriati Sufian and Ye Lwin	2013	- A study about the hydrogen adsorption on mixed oxides using the density functional theory (DFT) - Use hydrotalcite with different molar ratios of 3:0:1, 2:1:1, 1:2:1 and 0:3:1	- Ni-Co-Cr hydrotalcites - Adsorbent to store hydrogen	- The investigation proves that hydrotalcite is the best solution for hydrogen storage due to good interaction energy of hydrogen molecule

Author	Year	Descriptions	Application	Conclusion
T. S. Anirudhan, S. Jalajamony and S. S. Sreekumari	2012	- Comparing the characteristics of calcined hydrotalcite (HTC), ETSC-OHTC and Cu(II)-ESTC-OHTC - The particles in ETSC-OHTC are aggregated which enhance its adsorption capacity - Almost 100% removal of Cu(II) by using 3.0g/kg ETSC-OHTC	- 4-Ethyl Thiosemicarbazide Intercalated Organophilic Calcined Hydrotalcite (ETSC-OHTC) - Adsorbent of Cu (II) ions	- A new adsorbent, ETSC-OHTC proved its efficiency in removing Cu(II) ions from aqueous system.
Megha Dadwhal, Muhammad Sahimi and Theodore T. Tsotsis	2011	- Research about adsorption of Arsenic (As) presence of competing ions such as fluorides, phosphates, sulfates, carbonates, chlorides and nitrates - Adsorption of As obeys the Sips isotherm for both presence and absence of competing ions - Phosphates ions compete the most with As ions for adsorption on LDH	- Mg-Al-CO_3 LDH - Adsorbent of As ions	- The adsorption capacity of As reduces with the presence of various competing ions
Yunfeng Xu, Jia Zhang, Guangren Qian, Zhong Ren, Zhi Ping Xu, Yueying Wu, Qiang Liu and Shizhang Qiao	2010	- Research on removing Cr(VI) from groundwater by using hydrotalcite-derived - Cr(VI) concentration in the groundwater reduces when time increases	- Mg-Al-CO_3 LDH - Adsorbent of Cr(VI) ions	- Calcined hydrotalcite can remove Cr(VI) effectively in groundwater and gives high quality of treated water

Author	Year	Descriptions	Application	Conclusion
Yonglan Xu and Jia-Qian Jiang	2008	- Research about the technologies used in removing Boron (B) such as treatment with clay materials, hydrotalcites, electrocoagulation, reverse osmosis and ion exchange resin	- Mg/Al LDH, hydrocalumite and etringite - Adsorbent of Boron	- 93.5% of Boron can be removed with LDH dose of 36g/L - After six times regeneration of LDH, removal of Boron is reducing to 40%
N. Gutiérrez, E. Ramos and C. Contreras	2008	- A study about the removing of Cr(VI) from aqueous solution - Maximum removal of Cr(VI) by LDH is 100mg and 125mg for heated LDH	- Mg/Al LDH - Adsorbent of Cr(VI)	- Removing of Cr(VI) improved when LDH undergoes thermal treatment
Li Yang, Zoya Shahrivari, Paul K. T. Liu, Muhammad Sahimi and Theodore T. Tsotsis	2005	- Study on removal of As and Selenium (Se) - Calcined LDH has higher surface area than uncalcined LDH - The adsorbent dose can affect the adsorption isotherm	- Calcined and uncalcined Mg-Al-CO_3 LDH - Adsorbent of As and Se	- As(V) and Se(IV) adsorbed increases when the concentration of LDH increases - The adsorption capacity of As(V) is higher than Se(IV) on both calcined and uncalcined LDH
Maria Teresa Olguin, Pedro Bosch, Dwight Acosta and Silvia Bulbulian	1998	- Study about the sorption of radioactive $^{131}I^-$ by thermally treated hydrotalcites - Sorption capacity of radioactive is 0.24 meq/g which means 7.2% of anion exchange capacity - When the temperature increased for calcining, the sorption increases up to 2.08 meq/g.	- Mg-Al-CO_3 LDH - Sorbent of radioactive $^{131}I^-$	- The sorption of radioactive depends on the calcining temperature

Table 2.3 above shows the summary of literature reviews studied for this project related to the application of hydrotalcites as the adsorbents. There are a lot of researches about hydrotalcite as heavy metals adsorbents done by researchers in other countries compared to Malaysia. For example, Chen and Song (2013) proved that hydrotalcites had capability to remove almost 90% to 95% of heavy metals ions such as Cr and Cu. In Malaysia, there is a study about hydrotalcite as hydrogen adsorbent instead of heavy metals adsorbent by Salam et al. (2013). From the study, it was concluded hydrotalcite can be the best solution in storing hydrogen since it gave high adsorption capacity. Apart from that, the development of new hydrotalcite which is ETSC-OHTC by Anirudhan et al. (2012) also shows the ability of hydrotalcite in removing heavy metals ion since it remove almost completely of Cu ions in aqueous solution.

Dawdhal et al. (2011) and Yang et al. (2005) had studied the removal of As ions by using hydrotalcites. Both researches showed the optimum adsorption capacity of As ions by hydrotalcite and proved that calcined hydrotalcite performed better in adsorption process due to high surface area after calcination at 500°C compared to uncalcined hydrotalcites. The technologies of removing Boron also included the adsorption using hydrotalcite as one of the methods. This study showed that hydrotalcite can be regenerated after being used to remove 93.5% of Boron (Xu and Jiang, 2008). Last but not least, hydrotalcite was also studied in the sorption of radioactive $^{131-}$I which proved that sorption increased when the calcination temperature of hydrotalcite increased.

From the summary of the hydrotalcite related researches, the authors highlight about the high ability of hydrotalcite as adsorbents. Therefore, this project is relevant to prove that hydrotalcite can be applied in treating industrial effluent in Malaysia.

CHAPTER 3

METHODOLOGY

3.1 Procedures

1. Preparation of chemicals, glassware and equipment to be used throughout the project. The list of chemicals and glassware will be required are:

Table 3.1: List of chemicals and glassware

	Items	Unit
GLASSWARE	Burette	2
	Clamp and stand	2
	Hot plate	1
	Stirrer bar	1
	Beaker	4
	Thermometer	1
	Filter funnel	2
	Filter paper	2 boxes
	Big petri dish	3-4
	Mortar and pestle	1
	Vials	20
	Conical flasks	4-5
	Glass rod	2
	Mass balance	1
CHEMICALS	Magnesium Nitrate Hexahydrate	500g
	Nickel Nitrate Hexahydrate	500g
	Aluminium Nitrate Nanohydrate	500g
	Sodium Carbonate Decahydrate	1kg
	Lead (II) nitrate	250g
	Chromium solution	1 L

2. Synthesis of Hydrotalcite mixed oxides compounds
    - Mg-Ni-Al hydrotalcites will be prepared by using co-precipitation method with sodium carbonate as precipitating agent referring to the optimum performance given by the hydrotalcite according to Salam et al. (2013). The reactions involved in the synthesizing are as below:

      $2Mg(NO_3)_2.6H_2O+2Na_2(CO_3).10H_2O \rightarrow Mg_2(OH)_2.CO_3+4NaNO_3+30H_2O+H_2CO_3$ …………………………………………………………… **(1)**

      $2Ni(NO_3)_2.6H_2O+2Na_2(CO_3).10H_2O \rightarrow Ni_2(OH)_2.CO_3+4NaNO_3+30H_2O+H_2CO_3$ …………………………………………………………… **(2)**

      $2Al(NO_3)_3.9H_2O+3Na_2(CO_3).10H_2O \rightarrow 2Al(OH).CO_3+6NaNO_3+46H_2O+H_2CO_3$ …………………………………………………………… **(3)**

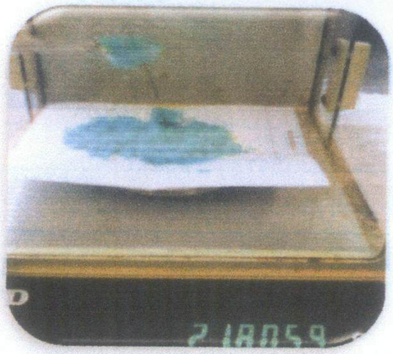
    - Mg-Ni-Al hydrotalcite was prepared with two different molar ratio which were 2:1:1 and 1:2:1 for 50g each
    - Table 3.2 shows the mass of Mg, Ni and Al used to synthesize both ratios of hydrotalcite referring to Salam et al. (2013).

Table 3.2: Mass of Mg, Al and Ni used in synthesizing hydrotalcites

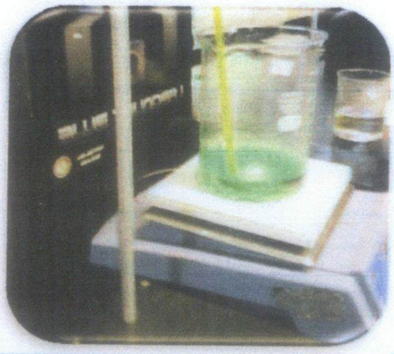
Molar Ratio	Magnesium (g)	Nickel (g)	Aluminium (g)	Sodium Carbonate (g)
Mg-Ni-Al = 2:1:1	21.74	12.33	15.91	48.84
Mg-Ni-Al = 1:2:1	10.56	23.97	15.46	47.47

- The procedure of synthesizing Mg-Ni-Al = 2:1:1 hydrotalcites are as below:

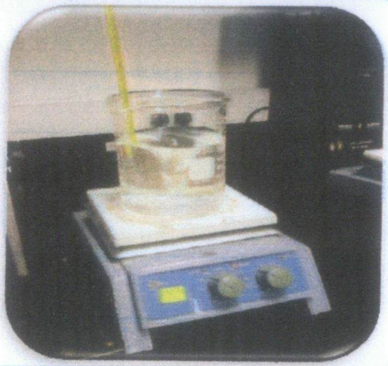
Mg, Ni and Al were weighted according to the mass in Table 3.2



All of the chemicals were dissolved in 113 mL, 56 mL and 170 mL of distilled water respectively and heated at 60 – 70°C while stirring at speed of 3 – 4 rpm until the solutes were completely dissolved and produced clear solution

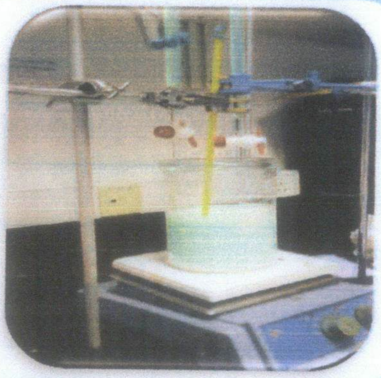


48.84 g sodium carbonate (Na_2CO_3) was dissolved in 341 mL of distilled water and heat at 60 - 70°C while stirring at 3 – 4 rpm of speed until the solution became clear.

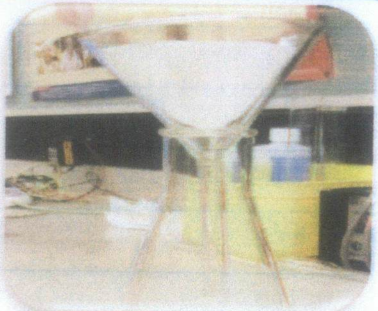


Mg, Ni and Al solutions were mixed altogether in 1 L beaker and stirred for a while using a glass rod.

Na_2CO_3 was titrated with the mixture of mixed oxides for 30 minutes at the speed of 3 – 4 rpm. The temperature during titration was maintained at 55°C

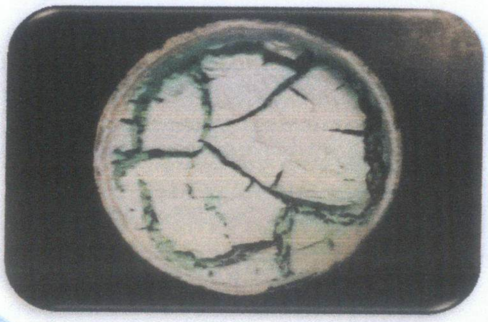


After titration completed, the solution was filtered.



Gel produced after filtration was scrapped by using spatula and kept in a petri dish to be dried in the oven at 110°C for 12 hours.

After 12 hours drying, took out the hydrotalcite from oven and ground it to form powder.



Hydrotalcite was kept in the vials and labeled once the preparation was finished. The procedures were repeated for Mg-Ni-Al = 1:2:1 hydrotalcite.

3. Characterization of hydrotalcites
    - The samples of hydrotalcites obtained from the synthesis were analyzed comparatively by a number of techniques such as XRD, BET Surface Area Analyzer and FESEM to determine its structure, surface area and morphology.

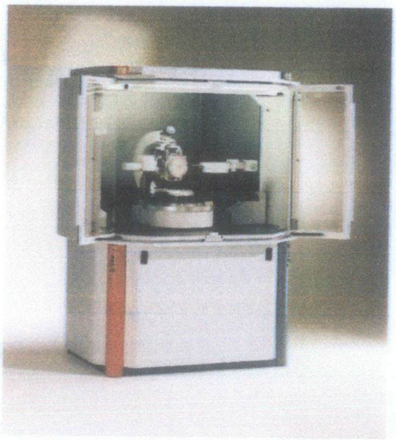


Figure 3.1: XRD

Figure 3.2: BET Surface Area Analyzer

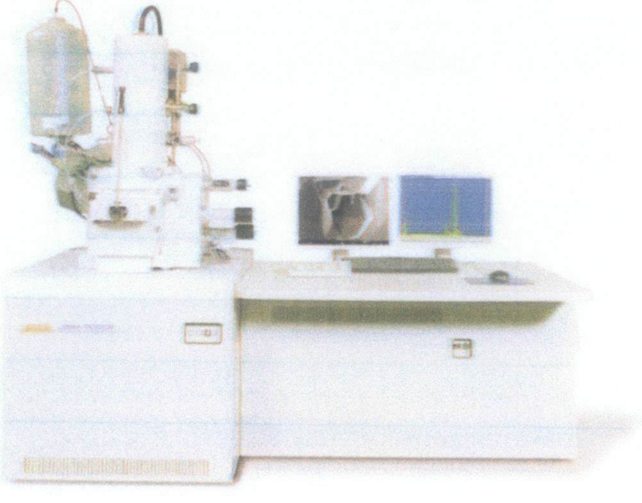


Figure 3.3: FESEM

4. Performance Test

- The performance of hydrotalcites as adsorbents will be tested in aqueous metals solution which were Cr and Pb solutions. The steps for performance test are shown below:

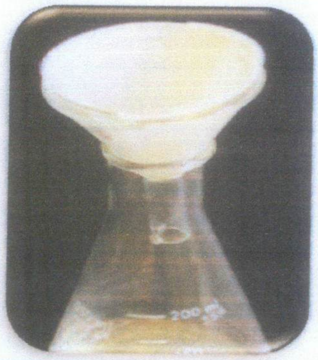
Cr and Pb solutions were prepared. Cr solution was prepared with the concentration of 5 mg/L while Pb was prepared with concentration of 100 mg/L.

The pH of both metals solutions were adjusted by using acetic acid. pH of Cr was adjusted to 3 while Pb was adjusted to be pH of 4 with pH meter.

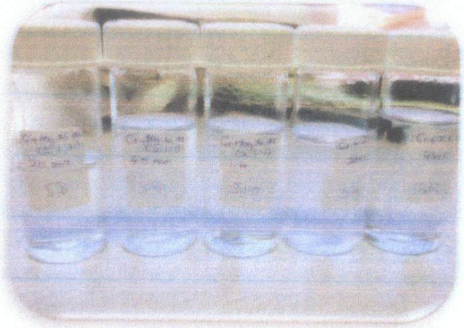
0.3 g of Mg-Ni-Al hydrotalcite with ratio of 2:1:1 was added into 150 mL of Cr solution. 7 samples of Cr solution with hydrotalcite were prepared. The conical flasks were covered with aluminium foil.

All samples were labeled according to agitation times which were 20 min, 40 min, 1 hr, 2 hrs, 4 hrs, 6 hrs and 24 hrs respectively. All samples were kept in water bath shaker at 25°C with speed of 240 rpm for the specified time.

After shaking for the specified time in the water bath shaker, the samples were taken out and filtered using filter paper.



After filtration, the filtrate was kept in vials. The same procedures were repeated by using Mg-Ni-Al hydrotalcite with ratio of 1:2:1 and Pb solutions.



Final concentration of Pb and Cr solutions were analyzed by using AAS. The percentage of adsorption was determined.

3.2 List of Analytical Equipment

The analytical equipment that will be used in characterization and performance test are listed in Table 3.3.

Table 3.3: List of analytical equipment will be used

Equipment	Function
X-Ray Diffractometer (XRD)	To identify crystalline species in the hydrotalcite
Field Emission Scanning Electron Microscope (FESEM)	To study the surface morphology, orientation and composition of hydrotalcites
BET Surface Area Analyzer	To measure the specific surface area of the hydrotalcites
Water Bath Shaker	To provide shaking motion the mixture of hydrotalcite and make-up solutions for adsorption process
Atomic Absorption Spectrometer (AAS)	To measure the concentration of heavy metals ions left in the solution after adsorption process

CHAPTER 4

RESULTS AND DISCUSSION

4.1 XRD Analysis

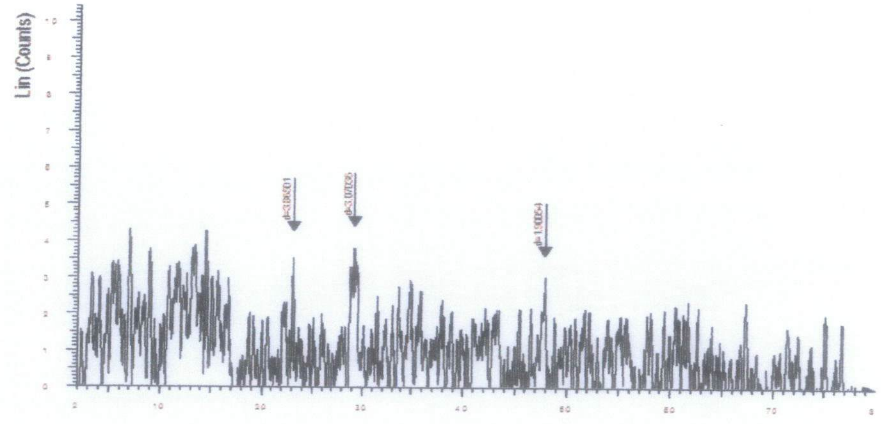


Figure 4.1: XRD of Mg-Ni-Al 1:2:1

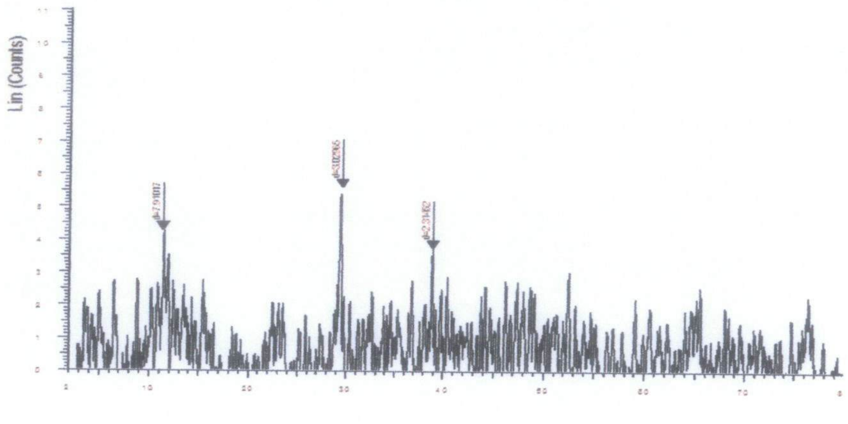


Figure 4.2: XRD for Mg-Ni-Al 2:1:1

From the figures above, both results from XRD analysis show sharp and symmetric peaks at low value of 2-theta. This indicates that the samples analyzed have characteristic of hydrotalcites and it consist of one phase only. XRD analysis of the sample synthesized proves that the formation of hydrotalcite is successful.

4.2 BET Surface Area Analysis

Table 4.1: Surface area of hydrotalcites from BET Surface Area Analyzer

Hydrotalcites	Surface Area (m^2/g)	Pore diameter (nm)	Pore volume (cm^3/g)
Mg:Ni:Al = 2:1:1	325	13.5	1.09
Mg:Ni:Al = 1:2:1	284	13	0.92

After XRD analysis that proves the formation of hydrotalcite, surface area and pore size of hydrotalcite are analyzed. From Table 4.1, it shows that Mg-Ni-Al 2:1:1 has higher surface area which is 325 m^2/g compared to Mg-Ni-Al 1:2:1. According to BET analyzer, both hydrotalcites has large pore size which proves that the optimum adsorption of heavy metals can be achieved. Large pore size indicates that the hydrotalcites have high porosity surface which plays the important roles in adsorbing Cr and Pb ions.

4.3 FESEM Analysis

Figure 4.3 and Figure 4.4 show the images from FESEM analysis. Morphology of Mg-Ni-Al 1:2:1 hydrotalcite in Figure 4.3 shows the sponge-like image due to the overlapping of platelets structure. Platelets structure indicates that the sample has layered structure (Sumeet et al., 2007). Meanwhile, FESEM image shows coral like particles of Mg-Ni-Al 2:1:1 hydrotalcite in Figure 4.4 which means that hydrotalcite is a porous material corresponding to large pore size obtained from BET analysis (Misra and Perrotta, 1992). Besides, coral like morphology indicates that the pH of solution is 10 during the synthesis of hydrotalcite which means it has basic property (Salam et al., 2013).

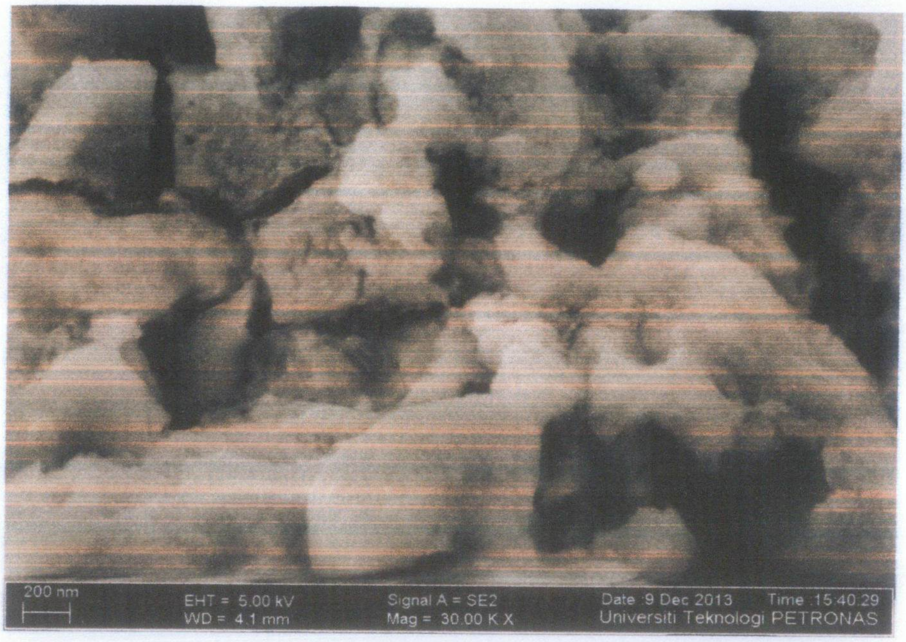


Figure 4.3: Morphology of Mg-Ni-Al = 1:2:1 from FESEM

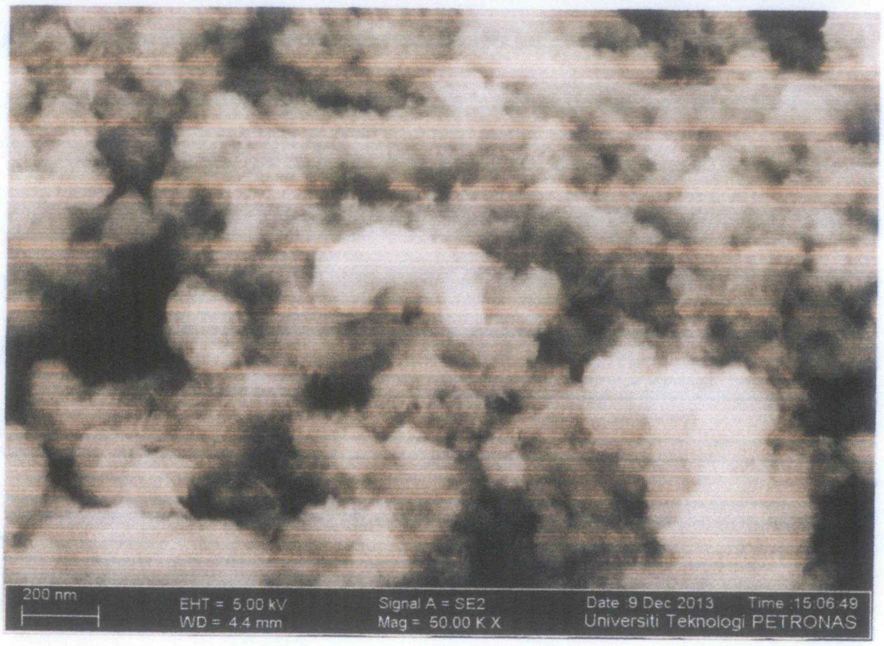


Figure 4.4: Surface of Mg-Ni-Al = 2:1:1 which has coral-like particles from FESEM

4.4 Adsorption of Chromium and Lead Ions

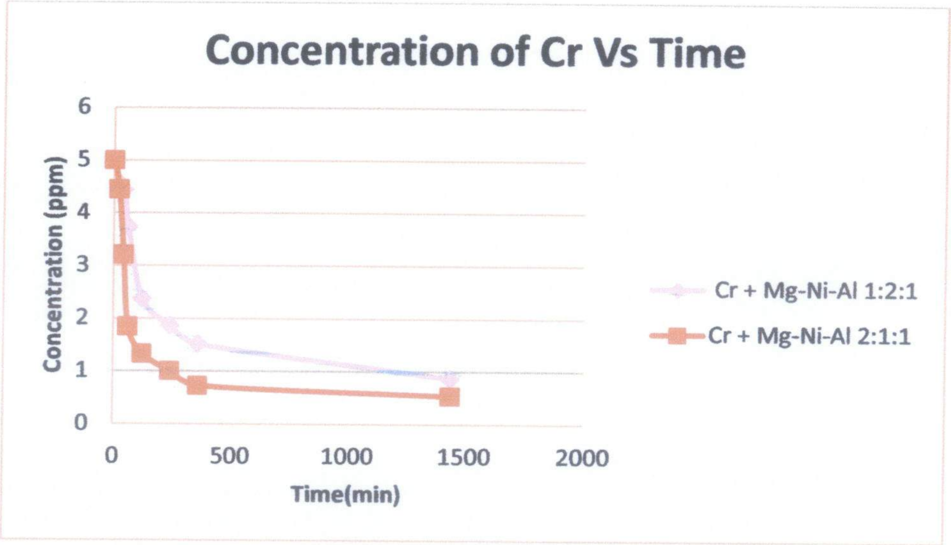


Figure 4.5: Graph for concentration of Cr versus agitation time

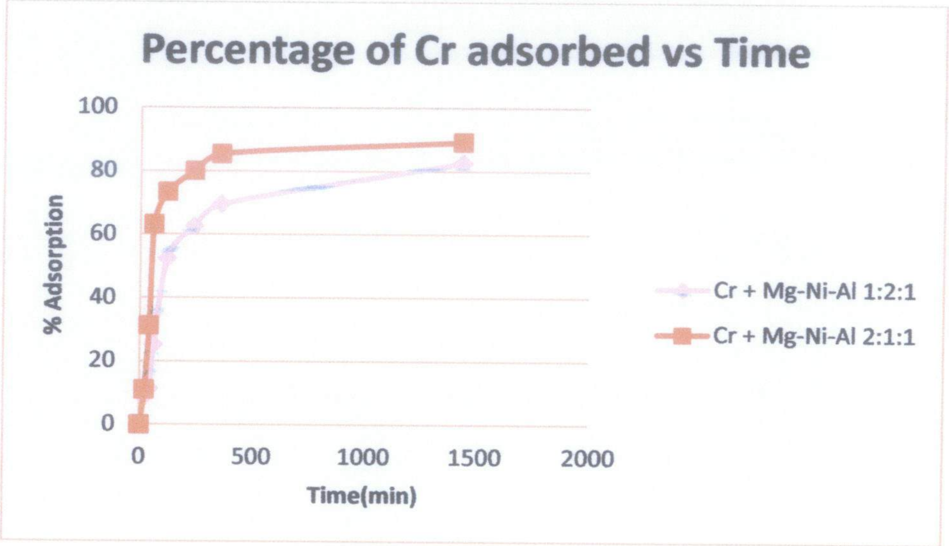


Figure 4.6: Percentage of Cr adsorbed by hydrotalcite

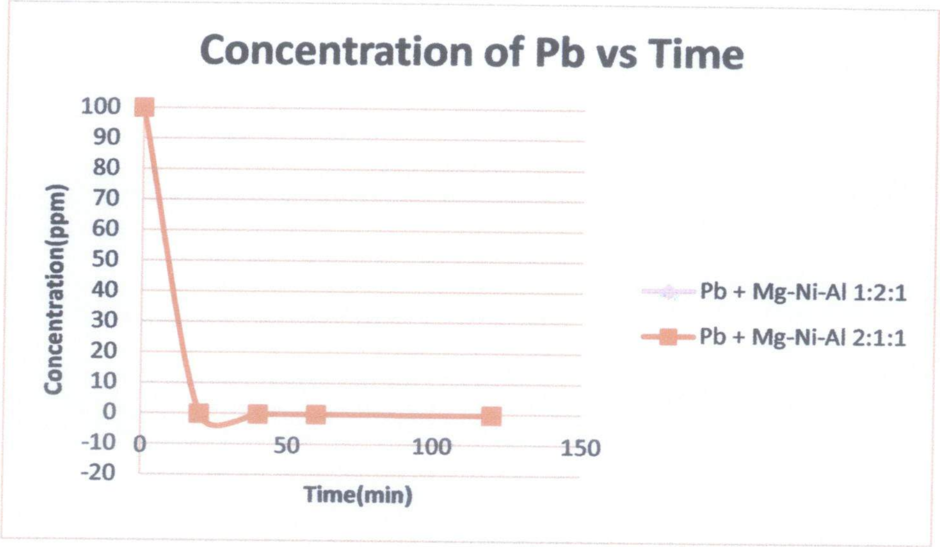


Figure 4.7: Graph for concentration of Pb versus agitation time

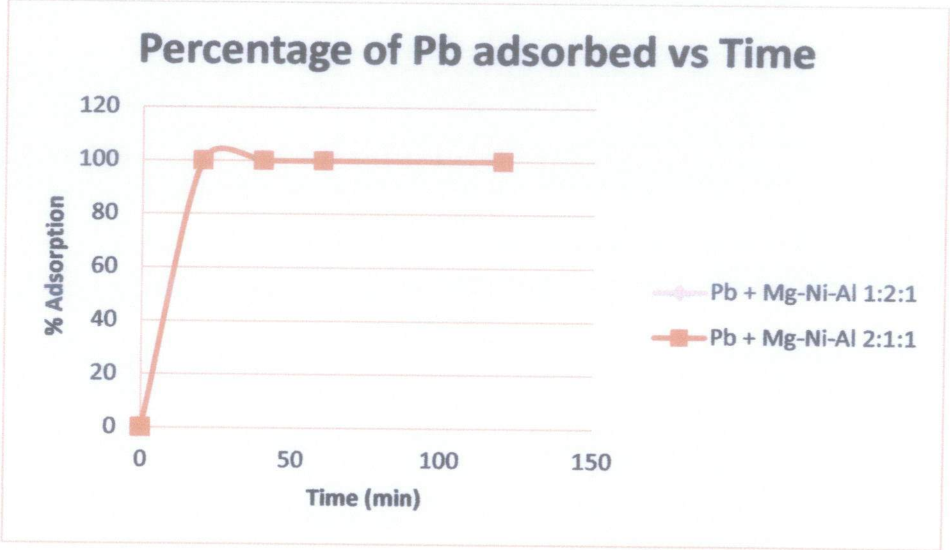


Figure 4.8: Percentage of Pb adsorbed by hydrotalcite

Referring to Figure 4.5, the concentration of Cr solution after adsorption by using Mg-Ni-Al 2:1:1 is lower compared to using Mg-Ni-Al 1:2:1which indicates that more Cr ions are adsorbed. According to the data obtained from AAS, the percentage of adsorption is calculated by using the formula below:

$$\% \, Adsorption = \frac{C_o - C_f}{C_o} \times 100$$

Where C_o = Initial concentration of heavy metals solution (mg/L)

C_f = Final concentration of heavy metals solution (mg/L)

The trends of graphs in Figure 4.6 and Figure 4.8 show the behavior of adsorption isotherm Type I which indicates that hydrotalcites are micro porous materials which attract Cr and Pb ions to the surface by Van der Waals forces. Since hydrotalcites are anionic with layered of hydroxides, high capacity of heavy metals ions can be attracted which lead to high percentage of adsorption. Mg-Ni-Al 2:1:1 hydrotalcite can adsorb 89.2% of Cr while Mg-Ni-Al 1:2:1 adsorbs 82.6% of Cr ions after 24 hours. In Figure 4.7, the final concentration of Pb solution after 20 minutes and onwards shows negative values. These values mean that there is no Pb ions detected in the solution. Thus, it can be concluded that 100% of Pb ions are removed from the solution by both hydrotalcites as can be seen in the graph from Figure 4.8. From the experiment, agitation time also plays an important role in removing optimum capacity of heavy metals ions. The concentration of heavy metals ions decreases inversely with the agitation time, thus increasing the percentage of adsorption.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The application of hydrotalcite as the adsorbent has been widely recognized. However, only a few researches were carried out to investigate about the ability of hydrotalcite in adsorbing heavy metals. This study emphasizes on the removal of heavy metals ions such as lead and chromium from aqueous metal solutions and real water sample from lake and rivers. From this report, hydrotalcite Mg-Ni-Al with molar ratios of 2:1:1 (Mg based) and 1:2:1 (Ni based) were synthesized using co-precipitation method. Both hydrotalcite were characterized by using BET Surface Area Analyzer, FESEM and XRD to analyze its morphology, pore size and hydrotalcite structures. According to the BET results, Mg-Ni-Al hydrotalcite with ratio of 2:1:1 has higher surface area compared to Mg-Ni-Al with 1:2:1 ratio which is 325 m^2/g. From BET result, it can be concluded that Mg based hydrotalcite is able to adsorb high capacity of heavy metals ion compared to Ni based hydrotalcite since it also has high pore size which is 13.5 nm. Furthermore, FESEM images show the surface of Mg-Ni-Al 1:2:1 hydrotalcite with coral like particles as well as porous surface of Mg-Ni-Al 2:1:1.

For the performance test of hydrotalcite, the final concentrations of Cr and Pb solutions after 20 min, 40 min, 1 hr, 2 hrs, 4 hrs, 6 hrs and 24 hrs agitation times were analyzed by using AAS. From the observation during experiment, Cr solution showed color changes after undergoing adsorption process with hydrotalcite. The yellowish color of Cr solution became clear after adding hydrotalcite. This showed that adsorption had taken place in the metal solutions. After adsorption process, hydrotalcite is able to remove 82-89% of Cr and 100% of Pb.

Based on the experiment carried out, hydrotalcites are proven to be one of the alternatives that can be used in heavy metals treatment as hydrotalcites showed effective adsorption capability. According to the characteristics of hydrotalcites which are high porosity, high surface area and high anion exchange, it is recommended to implement the use of hydrotalcites in waste water treatment. The treatment of heavy metals using hydrotalcites is a fast process and cost effectives. It does not require complicated chemical reactions and infrastructures to apply hydrotalcites in treating industrial waste. Therefore, hydrotalcites should be commercialized as heavy metals adsorbents in industry.

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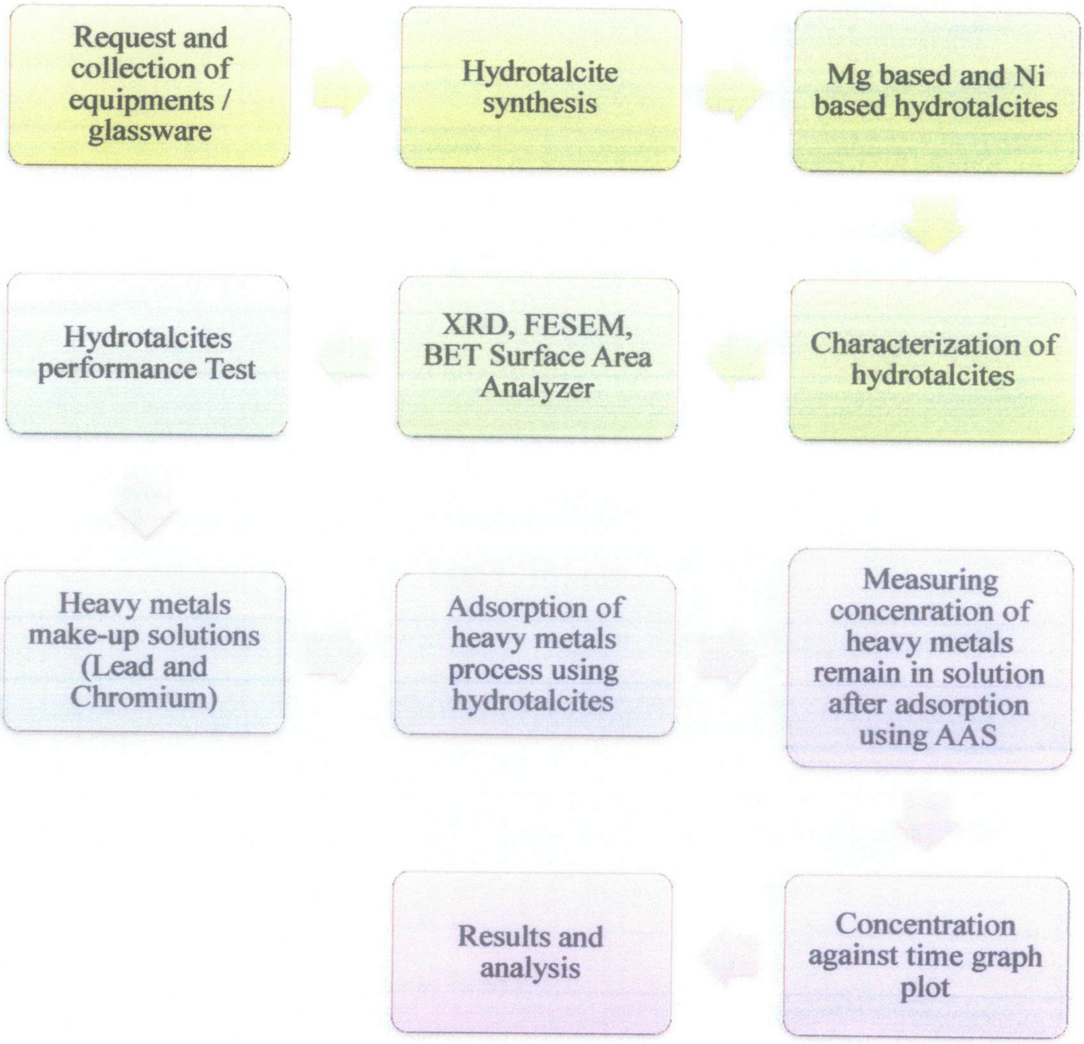
APPENDIX A: Gantt Chart of Research Activities

Activities	WEEKS																													
	FYP (I) MAY 2013															FYP (II) SEPTEMBER 2013														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Confirmation of Project Title	■	■	■	■											SEMESTER BREAK															
Literature Review			■	■	■	■																								
Submission of Extended Proposal Defense							■																							
Proposal Defense								■	■																					
Preparation of chemicals and glassware										■	■	■	■																	
Submission of Interim Draft Report													■																	
Submission of Interim Report														■																
Synthesis and Characterization of Hydrotalcite													■	■		■	■	■	■											
Hydrotalcite Performance Test																■	■	■	■	■	■	■	■	■	■					
Submission of Progress Report																							■							
Pre-SEDEX																										■				
Submission of Draft Report																											■			
Submission of Dissertation (Soft Bound)																												■		
Submission of Technical Paper																												■		
Oral Presentation																													■	
Submission of Dissertation (Hard Bound)																														■

MILESTONES

1) Literature Review and Research Works---------------------------Week 6 FYP (I)
2) Proposal Defense--Week 8 FYP (I)
3) Preparation of chemicals and glassware---------------------------Week 13 FYP (I)
4) Synthesis and Characterization of Hydrotalcite -----------------Week 4 FYP (II)
5) Hydrotalcite Performance Test-------------------------------------Week 10 FYP (II)
6) Report Writing--Week 15 FYP (II)

APPENDIX B: Flow Chart of Research Activities



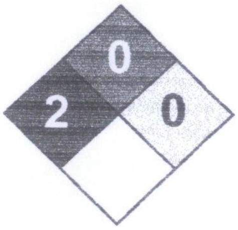
APPENDIX C: Results from AAS Analysis

1. Result for Chromium solution analysis

Agitation Time (min)	C_o (ppm)	C_f (ppm)		Adsorption (%)	
		1:2:1	2:1:1	1:2:1	2:1:1
0	5	5	5	0	0
20	5	4.5706	4.4510	8.6	11.0
40	5	4.4356	3.2086	11.3	31.2
60	5	3.7424	1.8466	25.2	63.1
120	5	2.3743	1.3319	52.5	73.4
240	5	1.8681	1.0098	62.6	80.0
360	5	1.5184	0.7301	69.6	85.4
1440	5	0.8712	0.5399	82.6	89.2

2. Result for Lead solution analysis

Agitation Time (min)	C_o (ppm)	C_f (ppm)		Adsorption (%)	
		1:2:1	2:1:1	1:2:1	2:1:1
0	100	100	100	0	0
20	100	-0.1144	-0.1179	100	100
40	100	-0.1961	-0.1961	100	100
60	100	-0.1961	-0.1981	100	100
120	100	-0.2288	-0.2125	100	100
240	100	-0.2526	-0.2288	100	100
360	100	-0.2779	-0.2533	100	100
1440	100	-0.2953	-0.2615	100	100



Health
Fire
Reactivity
Personal Protection

Material Safety Data Sheet
Aluminum nitrate nonahydrate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Aluminum nitrate nonahydrate

Catalog Codes: SLA1981

CAS#: 7784-27-2

RTECS: BD1050000

TSCA: TSCA 8(b) inventory: Aluminum nitrate nonahydrate

CI#: Not available.

Synonym:

Chemical Name: aluminum nitrate nonahydrate

Chemical Formula: $Al(NO_3)_3 \cdot 9H_2O$

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**
Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

omposition:

Name	CAS #	% by Weight
Aluminum nitrate nonahydrate	7784-27-2	100

xicological Data on Ingredients: Aluminum nitrate nonahydrate: ORAL (LD50): Acute: 3632 mg/kg [Rat]. 3980 mg/kg ouse]. 4280 mg/kg [Rat].

Section 3: Hazards Identification

tential Acute Health Effects:
zardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of in contact (permeator). Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may use respiratory irritation.

tential Chronic Health Effects:
RCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. EVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged posure to the substance can produce target organs damage.

Section 4: First Aid Measures

e Contact:

heck for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 inutes. Cold water may be used. Get medical attention.

kin Contact:
case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contamina lothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medic ttention.

erious Skin Contact:
ash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

halation:
inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical ttention.

erious Inhalation:
vacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If reathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical ttention.

gestion:
o NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious erson. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

erious Ingestion: Not available.

Section 5: Fire and Explosion Data

lammability of the Product: Non-flammable.

uto-Ignition Temperature: Not applicable.

lash Points: Not applicable.

lammable Limits: Not applicable.

roducts of Combustion: Not available.

ire Hazards in Presence of Various Substances: Not applicable.

xplosion Hazards in Presence of Various Substances:
isks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in esence of static discharge: Not available.

re Fighting Media and Instructions: Not applicable.

pecial Remarks on Fire Hazards: Not available.

pecial Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

nall Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

rge Spill:
xidizing material. Stop leak if without risk. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep bstance damp using water spray. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; ke if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. eck TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

recautions:
eep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Do not ingest. Do not reathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ıgested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes.

torage:
eep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents nd combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers.

Section 8: Exposure Controls/Personal Protection

ngineering Controls:
se process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommendec xposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants elow the exposure limit.

ersonal Protection:
plash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

ersonal Protection in Case of a Large Spill:
plash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid halation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this roduct.

xposure Limits:
WA: 2 Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

hysical state and appearance: Solid.

dor: Not available.

aste: Not available.

olecular Weight: 375.13 g/mole

olor: Not available.

H (1% soln/water): Not available.

oiling Point: Decomposition temperature: 135°C (275°F)

elting Point: 73°C (163.4°F)

ritical Temperature: Not available.

pecific Gravity: 1.058 (Water = 1)

apor Pressure: Not applicable.

apor Density: Not available.

olatility: Not available.

dor Threshold: Not available.

ater/Oil Dist. Coeff.: Not available.

nicity (in Water): Not available.

ispersion Properties: See solubility in water.

olubility:

asily soluble in cold water. Soluble in hot water.

Section 10: Stability and Reactivity Data

tability: The product is stable.

stability Temperature: Not available.

onditions of Instability: Not available.

compatibility with various substances: Not available.

orrosivity: Non-corrosive in presence of glass.

pecial Remarks on Reactivity: Not available.

pecial Remarks on Corrosivity: Not available.

olymerization: Will not occur.

Section 11: Toxicological Information

outes of Entry: Eye contact. Inhalation. Ingestion.

xicity to Animals: Acute oral toxicity (LD50): 3632 mg/kg [Rat].

hronic Effects on Humans: Causes damage to the following organs: lungs, mucous membranes.

ther Toxic Effects on Humans:
azardous in case of skin contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

ecial Remarks on Toxicity to Animals: Not available.

ecial Remarks on Chronic Effects on Humans: Not available.

ecial Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

otoxicity: Not available.

D5 and COD: Not available.

oducts of Biodegradation:
ssibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

xicity of the Products of Biodegradation: The products of degradation are more toxic.

ecial Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

aste Disposal:

Section 14: Transport Information

T Classification: CLASS 5.1: Oxidizing material.

ntification: : Aluminum Nitrate UNNA: UN1438 PG: III

pecial Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

ederal and State Regulations: TSCA 8(b) inventory: Aluminum nitrate nonahydrate

ther Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

ther Classifications:

VHMIS (Canada):
LASS C: Oxidizing material. CLASS D-2B: Material causing other toxic effects (TOXIC).

SCL (EEC):
8- Contact with combustible material may cause fire. R36/38- Irritating to eyes and skin.

MIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 0

Reactivity: 0

Personal Protection: E

ational Fire Protection Association (U.S.A.):

Health: 2

Flammability: 0

Reactivity: 0

Specific hazard:

rotective Equipment:
loves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator hen ventilation is inadequate. Splash goggles.

Section 16: Other Information

eferences: Not available.

ther Special Considerations: Not available.

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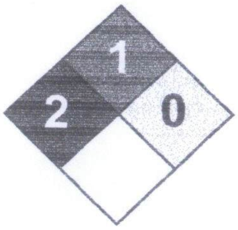
Chemicals & Laboratory Equipment



Health	
Fire	
Reactivity	
Personal Protection	

Material Safety Data Sheet
Chromium MSDS

Section 1: Chemical Product and Company Identification

Product Name: Chromium

Catalog Codes: SLC4711, SLC3709

CAS#: 7440-47-3

RTECS: GB4200000

TSCA: TSCA 8(b) inventory: Chromium

CI#: Not applicable.

Synonym: Chromium metal; Chrome; Chromium Metal Chips 2" and finer

Chemical Name: Chromium

Chemical Formula: Cr

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Chromium	7440-47-3	100

Toxicological Data on Ingredients: Chromium LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of ingestion.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, lungs, liver, upper respiratory tract. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminat clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 580°C (1076°F)

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Moderate fire hazard when it is in the form of a dust (powder) and burns rapidly when heated in flame. Chromium is attacked vigorously by fused potassium chlorate producing vivid incandescence. Pyrophoric chromium unites with nitric oxide with incandescence. Incandescent reaction with nitrogen oxide or sulfur dioxide.

Special Remarks on Explosion Hazards:
Powdered Chromium metal +fused ammonium nitrate may react violently or explosively. Powdered Chromium will explode spontaneously in air.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep awa from incompatibles such as oxidizing agents, acids, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.5 (mg/m3) from ACGIH (TLV) [United States] TWA: 1 (mg/m3) from OSHA (PEL) [United States] TWA: 0.5 (mg/m3) from NIOSH [United States] TWA: 0.5 (mg/m3) [United Kingdom (UK)] TWA: 0.5 (mg/m3) [Canada]Consult local authorities fo acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Metal solid.)

Odor: Odorless.

Taste: Not available.

Molecular Weight: 52 g/mole

Color: Silver-white to Grey.

pH (1% soln/water): Not applicable.

Boiling Point: 2642°C (4787.6°F)

Melting Point: 1900°C (3452°F) +/- !0 deg. C

Critical Temperature: Not available.

Specific Gravity: 7.14 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

spersion Properties: Not available.

olubility:
soluble in cold water, hot water. Soluble in acids (except Nitric), and strong alkalies.

Section 10: Stability and Reactivity Data

ability: The product is stable.

stability Temperature: Not available.

nditions of Instability: Excess heat, incompatible materials

compatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

rrosivity: Not available.

ecial Remarks on Reactivity:
compatible with molten Lithium at 180 deg. C, hydrogen peroxide, hydrochloric acid, sulfuric acid, most caustic alkalies and ali carbonates, potassium chlorate, sulfur dioxide, nitrogen oxide, bromine pentafluoride. It may react violently or ignite wit omine pentafluoride. Chromium is rapidly attacked by fused sodium hydroxide + potassium nitrate. Potentially hazardous compatibility with strong oxidizers.

ecial Remarks on Corrosivity: Not available.

lymerization: Will not occur.

Section 11: Toxicological Information

utes of Entry: Inhalation. Ingestion.

xicity to Animals:
50: Not available. LC50: Not available.

ronic Effects on Humans:
RCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC. y cause damage to the following organs: kidneys, lungs, liver, upper respiratory tract.

her Toxic Effects on Humans:
zardous in case of skin contact (irritant), of inhalation. Slightly hazardous in case of ingestion.

ecial Remarks on Toxicity to Animals: Not available.

ecial Remarks on Chronic Effects on Humans:
y cause cancer based on animal data. There is no evidence that exposure to trivalent chromium causes cancer in man.

ecial Remarks on other Toxic Effects on Humans:
ute Potential Health Effects: May cause skin irritation. Eyes: May cause mechanical eye irritation. Inhalation: May cause ation of the respiratory tract and mucous membranes of the respiratory tract. Ingestion: May cause gastrointestinal tract ation with nausea, vomiting, diarrhea. Chronic Potential Health Effects: Inhalation: The effects of chronic exposure include ation , sneezing, reddness of the throat, bronchospasm, asthma, cough, polyps, chronic inflammation, emphysema, chroni nchitis, pharyngitis, bronchopneumonia, pneumoconoisis. Effects on the nose from chronic chromium exposure include ation, ulceration, and perforation of the nasal septum. Inflammation and ulceration of the larynx may also occur. Ingestion nhalation: Chronic exposure may cause liver and kidney damage.

Section 12: Ecological Information

otoxicity: Not available.

D5 and COD: Not available.

roducts of Biodegradation:
ossibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

oxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

pecial Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

aste Disposal:
aste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

OT Classification: Not a DOT controlled material (United States).

entification: Not applicable.

pecial Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

deral and State Regulations:
onnecticut hazardous material survey.: Chromium Illinois toxic substances disclosure to employee act: Chromium Illinois emical safety act: Chromium New York release reporting list: Chromium Rhode Island RTK hazardous substances: romium Pennsylvania RTK: Chromium Minnesota: Chromium Michigan critical material: Chromium Massachusetts TK: Chromium Massachusetts spill list: Chromium New Jersey: Chromium New Jersey spill list: Chromium Louisiana spill porting: Chromium California Director's List of Hazardous Substances: Chromium TSCA 8(b) inventory: Chromium SARA 3 toxic chemical notification and release reporting: Chromium CERCLA: Hazardous substances.: Chromium: 5000 lbs. 268 kg)

her Regulations:
SHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the ropean Inventory of Existing Commercial Chemical Substances.

her Classifications:

HMIS (Canada): Not controlled under WHMIS (Canada).

CL (EEC):
0- Limited evidence of carcinogenic effect S36/37/39- Wear suitable protective clothing, gloves and eye/face protection.
5- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

IIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 1

Reactivity: 0

Personal Protection: E

tional Fire Protection Association (U.S.A.):

Health: 2

Flammability: 1

Reactivity: 0

Specific hazard:

tective Equipment:
ves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash goggles.

Section 16: Other Information

ferences: Not available.

er Special Considerations: Not available.

eated: 10/10/2005 08:16 PM

st Updated: 05/21/2013 12:00 PM

Material Safety Data Sheet

reation Date 07-Jul-2009 **Revision Date** 07-Jul-2009 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

roduct Name	**Lead(II) nitrate**
at No.	**L61-3, L62-12LC, L62-100, L62-500**
ynonyms	Lead dinitrate; Plumbous nitrate
ecommended Use	Laboratory chemicals

ompany
isher Scientific
ne Reagent Lane
air Lawn, NJ 07410
el: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 703-527-3887

2. HAZARDS IDENTIFICATION

ANGER!

Emergency Overview

xidizer: Contact with combustible/organic material may cause fire. May cause cancer. Suspect cancer hazard. Harmful by inhalation and if swallowed. May cause eye, skin, and respiratory tract irritation . May cause central nervous system ffects. May cause harm to the unborn child. Possible risk of impaired fertility. Danger of cumulative effects. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

ppearance White **Physical State** Solid. **Odor** odorless

arget Organs	Liver, Kidney, Central nervous system (CNS), Blood, Reproductive System

otential Health Effects

cute Effects
rinciple Routes of Exposure

Eyes	May cause irritation.
Skin	May cause irritation. May be harmful in contact with skin.
Inhalation	Harmful by inhalation. May cause irritation of respiratory tract.
Ingestion	Harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.
ronic Effects	May cause cancer. May cause harm to the unborn child. May impair fertility. Danger of cumulative effects. May cause adverse liver effects. May cause adverse kidney effects.

e Section 11 for additional Toxicological information.

Aggravated Medical Conditions	No information available.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Lead nitrate	10099-74-8	99

4. FIRST AID MEASURES

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.
nhalation	Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.
ngestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Notes to Physician	Treat symptomatically.

5. FIRE-FIGHTING MEASURES

lash Point	No information available.
Method	No information available.
Autoignition Temperature	No information available.
Explosion Limits	
Upper	No data available
Lower	No data available
Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available.
Hazardous Combustion Products	No information available.
Sensitivity to mechanical impact	No information available.
Sensitivity to static discharge	No information available.

Specific Hazards Arising from the Chemical
Oxidizer: Contact with combustible/organic material may cause fire. Thermal decomposition can lead to release of irritating gases and apors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective ear

NFPA	Health 2	Flammability 0	Instability 2	Physical hazards OX

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing. Avoid dust formation.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Provide adequate ventilation. Keep combustibles (wood, paper, oil, etc) away from spilled material. Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. HANDLING AND STORAGE

Handling Use only under a chemical fume hood. Wear personal protective equipment. Keep away from clothing and other combustible materials. Avoid dust formation. Do not get in eyes, on skin, or on clothing. Do not breathe dust.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Do not store near combustible materials.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

***NIOSH IDLH:** Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

hysical State	Solid
ppearance	White
dor	odorless
dor Threshold	No information available.
H	3 - 4 20% aq. sol.
apor Pressure	negligible
apor Density	No information available.
iscosity	No information available.
oiling Point/Range	No information available.
elting Point/Range	470°C / 878°F
ecomposition temperature °C	470°C
lash Point	No information available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Evaporation Rate	negligible
Specific Gravity	4.530
Solubility	Soluble in water
log Pow	No data available
Molecular Weight	331.2
Molecular Formula	N2 O6 Pb

10. STABILITY AND REACTIVITY

Stability	Oxidizer: Contact with combustible/organic material may cause fire.
Conditions to Avoid	Avoid dust formation. Incompatible products. Excess heat. Combustible material.
Incompatible Materials	Strong reducing agents, Organic materials, Powdered metals
Hazardous Decomposition Products	Nitrogen oxides (NOx), lead oxides
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions .	None under normal processing..

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information	No acute toxicity information is available for this product

Component Information

rritation	No information available.
Toxicologically Synergistic Products	No information available.

Chronic Toxicity

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	ACGIH	IARC	NTP	OSHA	Mexico
Lead nitrate	Not listed	Group 2A	Not listed	X	Not listed

IARC: (International Agency for Research on Cancer)
IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans

Sensitization	No information available.
Mutagenic Effects	Mutagenic effects have occurred in humans.

Reproductive Effects	Experiments have shown reproductive toxicity effects on laboratory animals.
Developmental Effects	Developmental effects have occurred in experimental animals.
Teratogenicity	Teratogenic effects have occurred in experimental animals..
Other Adverse Effects	The toxicological properties have not been fully investigated.. See actual entry in RTECS for complete information.
Endocrine Disruptor Information	No information available

12. ECOLOGICAL INFORMATION

This product contains a chemical which is listed as a marine pollutant according to DOT

Ecotoxicity
Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Persistence and Degradability	No information available
Bioaccumulation/ Accumulation	No information available
Mobility	No information available

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification

14. TRANSPORT INFORMATION

DOT

UN-No	UN1469
Proper Shipping Name	LEAD NITRATE
Hazard Class	5.1
Subsidiary Hazard Class	6.1
Packing Group	II

TDG

UN-No	UN1469
Proper Shipping Name	LEAD NITRATE

14. TRANSPORT INFORMATION

Hazard Class	5.1
Subsidiary Hazard Class	6.1
Packing Group	II

IATA

UN-No	1469
Proper Shipping Name	LEAD NITRATE
Hazard Class	5.1
Subsidiary Hazard Class	6.1
Packing Group	II

IMDG/IMO

UN-No	1469
Proper Shipping Name	LEAD NITRATE
Hazard Class	5.1
Subsidiary Hazard Class	6.1
Packing Group	II

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Lead nitrate	X	X	-	233-245-9	-		X	X	X	X	KE-21907 X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313
Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Lead nitrate	X	10 lb	-	-

Clean Air Act
Not applicable

OSHA
Not applicable

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Lead nitrate	10 lb	-

California Proposition 65
This product contains the following Proposition 65 chemicals:

Component	CAS-No	California Prop. 65	Prop 65 NSRL
Lead nitrate	10099-74-8	Cancer/Developmental	-

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Lead nitrate	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	Y
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade	No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class
C Oxidizing materials
D1B Toxic materials
D2A Very toxic materials

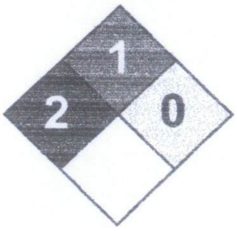
16. OTHER INFORMATION

Prepared By	Regulatory Affairs Thermo Fisher Scientific Tel: (412) 490-8929
Creation Date	07-Jul-2009
Print Date	07-Jul-2009
Revision Summary	"***", and red text indicates revision

Disclaimer
The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

ScienceLab.com
Chemicals & Laboratory Equipment



Health
Fire
Reactivity
Personal Protection

Material Safety Data Sheet
Magnesium nitrate hexahydrate MSDS

Section 1: Chemical Product and Company Identification

roduct Name: Magnesium nitrate hexahydrate

atalog Codes: SLM2878

AS#: 13446-18-9

TECS: OM3750000

SCA: TSCA 8(b) inventory: No products were found.

I#: Not available.

ynonym:

hemical Name: Magnesium Nitrate Hexahydrate

hemical Formula: Mg(NO3)2.6H2O

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

mposition:

Name	CAS #	% by Weight
Magnesium nitrate hexahydrate	13446-18-9	100

xicological Data on Ingredients: Magnesium nitrate hexahydrate: ORAL (LD50): Acute: 5440 mg/kg [Rat].

Section 3: Hazards Identification

tential Acute Health Effects:
zardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant). Prolonged osure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation.

tential Chronic Health Effects:
zardous in case of ingestion, of inhalation. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not ilable. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be ic to blood, kidneys, lungs, gastrointestinal tract. Repeated or prolonged exposure to the substance can produce target ans damage.

Section 4: First Aid Measures

Contact:

eck for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 utes. Cold water may be used. Get medical attention.

n Contact:
ase of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminate hing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical ntion.

ious Skin Contact:
sh with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

alation:
haled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical ntion.

ious Inhalation:
cuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If athing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical ntion.

estion:
NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious son. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

ious Ingestion: Not available.

Section 5: Fire and Explosion Data

nmability of the Product: May be combustible at high temperature.

o-Ignition Temperature: Not available.

sh Points: CLOSED CUP: Higher than 93.3°C (200°F).

nmable Limits: Not available.

ducts of Combustion: Some metallic oxides.

Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of heat.

losion Hazards in Presence of Various Substances:
s of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in ence of static discharge: Not available.

Fighting Media and Instructions:
lizing material. Do not use water jet. Use flooding quantities of water. Avoid contact with organic materials.

cial Remarks on Fire Hazards: Not available.

cial Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

ll Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

ge Spill:
lizing material. Stop leak if without risk. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep stance damp using water spray. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; if needed. Eliminate all ignition sources. Call for assistance on disposal.

Section 7: Handling and Storage

cautions:
ːp away from heat. Keep away from sources of ignition. Keep away from combustible material. Empty containers pose a risk, evaporate the residue under a fume hood. Do not ingest. Do not breathe dust. Wear suitable protective clothing. In e of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show th tainer or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents.

rage:
ːp container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

ineering Controls:
process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended osure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants w the exposure limit.

sonal Protection:
ısh goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

sonal Protection in Case of a Large Spill:
ısh goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid lation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this luct.

osure Limits: Not available.

Section 9: Physical and Chemical Properties

sical state and appearance: Solid. (Hygroscopic)

r: Not available.

te: Not available.

ecular Weight: 256.41 g/mole

or: White.

1% soln/water): Not available.

ing Point: Decomposition temperature: 330°C (626°F)

ing Point: 89°C (192.2°F)

cal Temperature: Not available.

cific Gravity: 1.64 (Water = 1)

or Pressure: Not applicable.

or Density: Not available.

tility: Not available.

r Threshold: Not available.

er/Oil Dist. Coeff.: Not available.

city (in Water): Not available.

ersion Properties: See solubility in water.

bility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

bility: The product is stable.

tability Temperature: Not available.

nditions of Instability: Not available.

ompatibility with various substances: Reactive with reducing agents.

rosivity: Non-corrosive in presence of glass.

ecial Remarks on Reactivity:
trong oxidizer may cause violent combustion of oxidizable materials. Contact with dimethyl formamide, combustible, anic, and oxidizable materials can generate heat, perhaps causing ignition and combustion. Possibly hygroscopic.

ecial Remarks on Corrosivity: Not available.

ymerization: Will not occur.

Section 11: Toxicological Information

utes of Entry: Eye contact. Inhalation. Ingestion.

icity to Animals: Acute oral toxicity (LD50): 5440 mg/kg [Rat].

onic Effects on Humans: May cause damage to the following organs: blood, kidneys, lungs, gastrointestinal tract.

er Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation (lung irritant).

cial Remarks on Toxicity to Animals: Not available.

cial Remarks on Chronic Effects on Humans: Not available.

cial Remarks on other Toxic Effects on Humans:
irritating to mucous memebranes. May affect lungs and central nervous system. Excessive amounts of magnesium cause central nervous system depression, and may also affect the heart. Other Chronic Effects: May cause hemoglobinemia, which is characterized by chocolate-brown colored blood, headache, weakness, dizziness, breath tness, cyanosis, rapid heart rate, unconsciousness and possible death. Repeated exposure may cause kidney damage an stive tract abnormalities. Effects may be delayed.

Section 12: Ecological Information

toxicity: Not available.

)5 and COD: Not available.

ducts of Biodegradation:
sibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

icity of the Products of Biodegradation: The products of degradation are more toxic.

cial Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

te Disposal:

Section 14: Transport Information

T Classification: CLASS 5.1: Oxidizing material.

ntification: : Magnesium nitrate UNNA: UN1474 PG: III

cial Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

leral and State Regulations: No products were found.

er Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

er Classifications:

MIS (Canada): CLASS C: Oxidizing material.

L (EEC):

Contact with combustible material may cause fire. R36/37/38- Irritating to eyes, respiratory system and skin. S17- Keep y from combustible material.

S (U.S.A.):

lealth Hazard: 2

ire Hazard: 1

eactivity: 0

ersonal Protection: E

onal Fire Protection Association (U.S.A.):

lealth: 2

lammability: 1

eactivity: 0

pecific hazard:

ective Equipment:

es. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator n ventilation is inadequate. Splash goggles.

Section 16: Other Information

rences: Not available.

r Special Considerations: Not available.

ted: 10/10/2005 08:39 PM

Updated: 05/21/2013 12:00 PM

Material Safety Data Sheet

Nickel(II) nitrate hexahydrate
MSDS# 16370

Section 1 - Chemical Product and Company Identification

MSDS Name:
Nickel(II) nitrate hexahydrate
Catalog Numbers:
N/1750/50, N/1750/53, N/1800/50, N/1800/60, N/1800NC
Synonyms:
Nickelous nitrate hexahydrate; Nitric acid, nickel(2+) salt, hexahydrate; Nickel dinitrate hexahydrate.
Company Identification:Fisher Scientific UK
Bishop Meadow Road, Loughborough
Leics. LE11 5RG
For information in Europe, call:(01509) 231166
Emergency Number, Europe:
01509 231166

Section 2 - Composition, Information on Ingredients

CAS#: 13478-00-7
Chemical Name: Nickel dinitrate hexahydrate
%: 99
EINECS#: unlisted
Hazard Symbols:
Risk Phrases:

Text for R-phrases: see Section 16
Hazard Symbols:
T O N
Risk Phrases:
49 61 20/22 38 41 42/43 48/23 50/53 68 8

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Harmful by inhalation and if swallowed. Irritating to skin. Risk of serious damage to eyes. May cause sensitization by inhalation and skin contact. Contact with combustible material may cause fire. May cause cancer by inhalation. Toxic : danger of serious damage to health by prolonged exposure through inhalation. May cause harm to the unborn child. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.Possible risk of irreversible effects.

Potential Health Effects

Eye:
May cause severe eye irritation and possible injury.

Skin:
Causes skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material.

Ingestion:
May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause liver and kidney damage.

Inhalation:
Dust is irritating to the respiratory tract. May cause allergic respiratory reaction. May cause methemoglobinemia, cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), convulsions, tachycardia, dyspnea (labored breathing), and death.

Chronic:
Prolonged inhalation may cause respiratory tract inflammation and

lung damage. Prolonged or repeated skin contact may cause sensitization dermatitis and possible destruction and/or ulceration.

May cause respiratory tract cancer. Possible risk of harm to the unborn child.

Section 4 - First Aid Measures

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.

Skin:

Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water.

Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation:

Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Section 5 - Fire Fighting Measures

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Strong oxidizer. Contact with other material may cause fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Substance is nonflammable. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Containers may explode if exposed to fire.

Extinguishing Media:

Use water spray to cool fire-exposed containers. Substance is noncombustible; use agent most appropriate to extinguish surrounding fire. For large fires flood fire with water from a distance. Do NOT use dry chemicals, CO2, Halon or foams.

Section 6 - Accidental Release Measures

General Information:

Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Wear a self contained breathing apparatus and appropriate personal protection. (See Exposure Controls, Personal Protection section). Avoid generating dusty conditions. Remove all sources of ignition. Carefully scoop up and place into appropriate disposal container. Provide ventilation.

Section 7 - Handling and Storage

Handling:

Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. Avoid contact with eyes, skin, and clothing. Wash clothing before reuse. Do not breathe dust or fumes. Use only with adequate ventilation.

Storage:

Do not store near combustible materials. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from reducing agents.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls:

Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

CAS# 13138-45-9:
United Kingdom, WEL - TWA: (nickel, inorganic compounds, soluble): 0.1 mg/m3 TWA (as Ni)
United Kingdom, WEL - STEL: (nickel, inorganic compounds, soluble): 0.3 mg/m3 STEL (as Ni)
United States OSHA: 1 mg/m3 TWA (as Ni) (Nickel soluble compounds).
Belgium - TWA: (nickel soluble compounds): 0.1 mg/m3 VLE (as Ni)
Malaysia: (nickel soluble compounds): 0.1 mg/m3 TWA (inhalable fraction, as Ni)
Netherlands: (nickel soluble compounds): 0.1 mg/m3 MAC (as Ni)
Spain: (nickel soluble compounds): 0.1 mg/m3 VLA-ED (as Ni)
CAS# 13478-00-7:
United Kingdom, WEL - TWA: (nickel, inorganic compounds, soluble): 0.1 mg/m3 TWA (as Ni)
United Kingdom, WEL - STEL: (nickel, inorganic compounds, soluble): 0.3 mg/m3 STEL (as Ni)
United States OSHA: 1 mg/m3 TWA (as Ni) (Nickel soluble compounds).
Belgium - TWA: (nickel soluble compounds): 0.1 mg/m3 VLE (as Ni)
Malaysia: (nickel soluble compounds): 0.1 mg/m3 TWA (inhalable fraction, as Ni)
Netherlands: (nickel soluble compounds): 0.1 mg/m3 MAC (as Ni)
Spain: (nickel soluble compounds): 0.1 mg/m3 VLA-ED (as Ni)

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin:

Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to prevent skin exposure.

Respirators:

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Color: emerald green
Odor: odorless
pH: 4.0 (aqueous sol.)
Vapor Pressure: Negligible
Viscosity: Not available
Boiling Point: 137 deg C (278.60□F)
Freezing/Melting Point: 56.7 deg C (134.06□F)
Autoignition Temperature: Not applicable
Flash Point: Not applicable.
Explosion Limits: Lower:Not available
Explosion Limits: Upper:Not available
Decomposition Temperature:
Solubility in water: Soluble
Specific Gravity/Density: 2.05
Molecular Formula: Ni(NO3)2.6H2O
Molecular Weight: 290.8

Section 10 - Stability and Reactivity

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Dust generation.
Incompatibilities with Other Materials
Strong reducing agents, combustible materials, flammable liquids.
Hazardous Decomposition Products
Nitrogen oxides, irritating and toxic fumes and gases, nickel oxide.
Hazardous Polymerization
Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 13138-45-9: QR7200000
CAS# 13478-00-7: QR7300000
LD50/LC50:
RTECS: Not available.
RTECS: CAS# 13478-00-7: Oral, rat: LD50 = 1620 mg/kg;.
Carcinogenicity:
Nickel dinitrate anhydrous -
California: carcinogen, initial date 5/7/04 (Nickel compounds).
NTP: Known carcinogen (Nickel compounds).
IARC: Group 1 carcinogen (Nickel compounds).
Nickel dinitrate hexahydrate -
California: carcinogen, initial date 5/7/04 (Nickel compounds).
NTP: Known carcinogen (Nickel compounds).
IARC: Group 1 carcinogen
Other:
See actual entry in RTECS for complete information.

Section 12 - Ecological Information

Not available

Section 13 - Disposal Considerations

Products considered hazardous for supply are classified as Special Waste and the disposal of such chemicals is covered by regulations which may vary according to location.
Contact a specialist disposal company or the local authority or advice. Empty containers must be decontaminated before returning for recycling.

Section 14 - Transport Information

IATA

Shipping Name:	NICKEL NITRATE
Hazard Class:	5.1
UN Number:	2725
Packing Group:	III

IMO

Shipping Name:	NICKEL NITRATE
Hazard Class:	5.1
UN Number:	2725
Packing Group:	III

RID/ADR

Shipping Name:	NICKEL NITRATE
Hazard Class:	5.1
UN Number:	2725
Packing Group:	III

Section 15 - Regulatory Information

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: T O N

Risk Phrases:

R 49 May cause cancer by inhalation.
R 61 May cause harm to the unborn child.
R 20/22 Harmful by inhalation and if swallowed.
R 38 Irritating to skin.
R 41 Risk of serious damage to eyes.
R 42/43 May cause sensitization by inhalation and skin contact.
R 48/23 Toxic : danger of serious damage to health by prolonged exposure through inhalation.
R 50/53 Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 68 Possible risk of irreversible effects.
R 8 Contact with combustible material may cause fire.

Safety Phrases:

S 53 Avoid exposure - obtain special instructions before use.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 60 This material and its container must be disposed of as hazardous waste.
S 61 Avoid release to the environment. Refer to special instructions/safety data sheets.

WGK (Water Danger/Protection)

CAS# 13138-45-9: 2
CAS# 13478-00-7: Not available

Canada

CAS# 13138-45-9 is listed on Canada's DSL List

US Federal

TSCA

CAS# 13138-45-9 is listed on the TSCA Inventory.
CAS# 13478-00-7 is not on the TSCA Inventory because it is a hydrate. It is considered to be listed if the CAS number for the anhydrous form in on the

Section 16 - Other Information

Text for R-phrases from Section 2
MSDS Creation Date:
8/06/1998
Revision #5 Date
12/01/2006
Revisions were made in Sections:
2, 3, 9, 11, 14, 15, 16

Fisher Scientific

laterial Safety Data Sheet
odium carbonate decahydrate

ISDS# 21083

Section 1 - Chemical Product and Company Identification

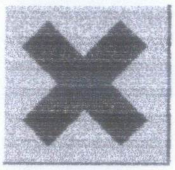
ISDS Name:	Sodium carbonate decahydrate
'atalog lumbers:	AC213500000, AC213500010, AC213500025, AC271070000, AC271070025, S264500, S2653 S265500
ynonyms:	Sal soda; Washing soda.
ompany Identification:	Fisher Scientific One Reagent Lane Fair Lawn, NJ 07410
or information in the US, call:	201-796-7100
mergency Number US:	201-796-7100
HEMTREC Phone Number, US:	800-424-9300

Section 2 - Composition, Information on Ingredients

Phrases:	
S#:	6132-02-1
mical Name:	Sodium carbonate, decahydrate
	>99
ECS#:	unlisted
ard Symbols:	

for R-phrases: see Section 16

Hazard Symbols: XI



Risk Phrases: 36

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

'arning! Contact with skin causes irritation and possible burns, especially if the skin is wet or moist. May cause severe ey ritation and possible injury. May cause severe respiratory and digestive tract irritation with possible burns. Target Organs None.

ɔtential Health Effects

'e:	Contact with eyes may cause severe irritation, and possible eye burns.
:in:	Contact with skin causes irritation and possible burns, especially if the skin is wet or moist.
gestion:	May cause severe gastrointestinal tract irritation with nausea, vomiting and possible burns.
halation:	May cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema.
ıronic:	Prolonged or repeated inhalation may cause nosebleeds, nasal congestion, erosion of the teeth, perforation of th nasal septum, chest pain and bronchitis.

Section 4 - First Aid Measures

'es:	Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately.
	Get medical aid. Flush skin with plenty of water for at least 15 minutes while removing contaminated clothi

ngestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.

nhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear. Do NOT use mouth-to-mouth resuscitation.

Notes to hysician:

Section 5 - Fire Fighting Measures

eneral nformation: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas.

xtinguishing edia: Use agent most appropriate to extinguish fire. Use water spray, dry chemical, carbon dioxide, or appropriate foam.

Autoignition Temperature: Not available.

Flash Point: Not available

Explosion Limits: Lower: Not available

Explosion Limits: Upper: Not available

NFPA Rating: NFPA Rating:

Section 6 - Accidental Release Measures

eneral nformation: Use proper personal protective equipment as indicated in Section 8.

pills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Clean up spills immediately, observing precautions in the Protective Equipment section. Avoid generating dusty conditions. Provide ventilation.

Section 7 - Handling and Storage

andling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Avoid ingestion and inhalation. Wash clothing before reuse.

torage: Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Sodium carbonate anhydrous	none listed	none listed	none listed
Sodium carbonate, decahydrate	none listed	none listed	none listed

SHA Vacated PELs: Sodium carbonate anhydrous: None listed Sodium carbonate, decahydrate: None listed

ngineering Controls:

Good general ventilation should be sufficient to control airborne levels. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.

xposure Limits

ersonal Protective Equipment

yes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face

lothing:	Wear appropriate protective clothing to minimize contact with skin.
espirators:	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Color: colorless, white semi-transparent
Odor: none reported
pH: 11.5 @ 1% solution
Vapor Pressure: Not applicable.
Vapor Density: 9.9
Evaporation Rate: Not applicable.
Viscosity: Not applicable.
Boiling Point: Not applicable.
Freezing/Melting Point: 34 deg C (93.20°F)
Decomposition Temperature: Not available
Solubility in water: Soluble
Specific Gravity/Density: 1.46
Molecular Formula: $Na_2CO_3.10H_2O$
Molecular Weight: 286.1118

Section 10 - Stability and Reactivity

hemical Stability:	Stable at room temperature in closed containers under normal storage and handling conditions. Decomposed by acids with effervescence, evolution of carbon dioxide. Readily effloresces (lose water molecules of hydration) on exposure to air, leaving a powdery coating on the material.
onditions to Avoid:	Dust generation, prolonged exposure to air.
ıcompatibilities with ther Materials	Acids, aluminum.
azardous ecomposition roducts	Carbon monoxide, carbon dioxide, sodium oxide.
azardous olymerization	Has not been reported.

Section 11 - Toxicological Information

TECS#:	CAS# 497-19-8: VZ4050000 CAS# 6132-02-1: None listed
D50/LC50:	RTECS: **CAS# 497-19-8:** Draize test, rabbit, eye: 100 mg/24H Moderate; Draize test, rabbit, eye: 50 mg Severe; Draize test, rabbit, skin: 500 mg/24H Mild; Inhalation, mouse: LC50 = 1200 mg/m3/2H; Inhalation, rat: LC50 = 2300 mg/m3/2H; Oral, mouse: LD50 = 6600 mg/kg; Oral, mouse: LD50 = 6600 mg/kg; Oral, rat: LD50 = 4090 mg/kg; . RTECS: **CAS# 6132-02-1:**.
arcinogenicity:	Sodium carbonate anhydrous - Not listed as a carcinogen by ACGIH, IARC, NTP, or CA Prop 65. Sodium carbonate, decahydrate - Not listed as a carcinogen by ACGIH, IARC, NTP, or CA Prop 65.
ther:	See actual entry in RTECS for complete information.

Section 12 - Ecological Information

Section 13 - Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.

Section 14 - Transport Information

DOT
pping Name: Please contact Fisher Scientific for shipping information
zard Class:
Number:
king Group:
nada TDG
pping Name: Not available
zard Class:
Number:
king Group:

Section 15 - Regulatory Information

uropean/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: XI

Risk Phrases:

R 36 Irritating to eyes.

Safety Phrases:

S 22 Do not breathe dust.

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

WGK (Water Danger/Protection)

CAS# 497-19-8: 1

CAS# 6132-02-1: 1

Canada

CAS# 497-19-8 is listed on Canada's DSL List

Canadian WHMIS Classifications: D1B, E

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

CAS# 497-19-8 is listed on Canada's Ingredient Disclosure List

CAS# 6132-02-1 is not listed on Canada's Ingredient Disclosure List.

Federal

TSCA

CAS# 497-19-8 is listed on the TSCA Inventory.

CAS# 6132-02-1 is not on the TSCA Inventory because it is a hydrate. It is considered to be listed if the CAS number for the anhydrous form in on the Inventory (40CFR720.3(u)(2)).

Section 16 - Other Information

MSDS Creation Date: 7/24/1998
Revision #6 Date 7/20/2009