Pb Ion Removal Using Wood Ash

by

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CERTIFICATION OF APPROVAL

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Approved by,

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TRONOH, PERAK

JULY 2005 SEMESTER

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.

SIRADICK LAM TALENTA

ABSTRACT

Lead (Pb) is a toxic material and can cause grevious health complications in humans. Its removal from the environment is highly desirable and many techniques have been developed for this specific purpose. However, many of these techniques are costly and some materials used are difficult to obtain. Therefore much research has been done in order to find new more cost effective alternatives. This project has the objective of determining whether wood ash is an effective alternative.

The project is carried out in an experimental manner. Wood ash is mixed with a known concentration of lead ions. The amount of lead removed is determined by using the Atomic Absorption Spectrometer. This data is then interpreted to determine the effectiveness of wood ash as a lead ion remover. The experiment is performed with three different concentrations of lead ions; 20, 40 and 60 parts per million (ppm). To see the effect of temperature, the experiments are performed at room temperature, 30, 35, 40 and 45 Degrees Celsius. In all the experiments, all the lead is removed within the first ten minutes of the experiment. It has been determined that the mechanism of lead ion removal is precipitation, hence the fast rate of lead removal.

This experiment has proven that ash is a very efficient lead ion remover, accomplishing this by chemical precipitation. Therefore ash is considered to be a viable alternative for lead ion removal. Further studies should be conducted to determine the optimum operating conditions and also the detailed economics of removing lead using wood ash.

ACKNOWLEDGEMENTS

I wish to take this opportunity to thank Mr. Bawadi bin Abdullah, my helpful supervisor in this project. I also wish to thank all the laboratory technicians whose help I have sought and received throughout the course of conducting the project, especially Mr. Zaaba Yussoff, Mr. Shahar, Mr. Yusoff and Mr. Jamalludin. I thank my parents, Mr. and Mrs. Talenta for providing me with support throughout this project. I wish also to thank all those friends and staff who have contributed to the success of this project.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Lead has a certain toxic and cumulative effect and its discharge into the environment represents serious threat to many life forms. It is a soft malleable element extracted from the ore galena. It has a bluish-white-gray appearance and is commonly found in containers and pipes for liquids, solder, paint, bullets, radiation shielding, lead acid batteries, and antiknock compound used in gasoline.

It is therefore highly desirable to discover means of removing lead contaminants in our environment effectively and safely for the benefit of all. This projects researches on the use of wood ash for the removal of lead ions.

1.2 Problem Statement/Identification

Currently, the methods being employed in the removal of heavy metals is expensive. Wood ash is a viable alternative which is found in abundance and comparatively cheap to other adsorbents such as activated carbon. In this case, rubber wood has been chosen as it is found abundantly here in Malaysia.

1.3 Significance of Project

Many methods have been employed in the removal of heavy metals or in this case lead contaminants. However, many of these methods are expensive (such as activated carbons) or require materials which are not found in abundance. Wood ash however is available readily. The success of this project will make available a new alternative which is easy and cost-efficient.

1.4 Objective and Scope of Study

The objective of the Project is to determine the effectiveness of rubber wood ash as a material for the removal of lead ions through experimental work and processing of the resulting data. The experiment will cover different temperatures and concentrations to examine the corresponding results in terms of the amount of removed lead, and to determine the optimum conditions for lead ion removal.

1.5 Feasibility of the Project within the scope and Time Frame.

The Project has been allocated a certain amount of time to which the Project must be completed. Therefore the scope of this Project is shaped in order to accommodate to the limited time.

CHAPTER 2

LITERATURE REVIEW AND/OR THEORY

2.1 Lead Poisoning

Lead is a cumulative poison and a neurotoxin and can be found to accumulate in the bone marrow, blood, tissue and urine. Lead exposure is especially harmful to children for three reasons – their rapidly developing nervous system is particularly sensitive to the effects of lead; they absorb a greater portion of lead to which they are exposed than adults do; and they are more likely to incur exposure than adults when their surroundings are contaminated with lead. Exposure for a short period of time to high concentrations of lead can cause coma, convulsions and death. Lead poisoning causes mental retardation (memory and concentration problems), blindness, chronic kidney diseases, fatigue, anemia, gastroenteritis, muscular paralysis, behavioral changes, high blood pressure, birth defects, cardiovascular disease, and damage to male reproductive systems and other impairments. Lead poisoning in the United States is found to occur commonly among children living in old and substandard houses built before 1950 who accidentally eat the lead-based paint on woodwork and paint that peels or flakes from walls .

Salvato (1192) says that in 1992, an estimated 27 million households in the United States remained contaminated by lead paint. Later in 1981, over 500,000 children were reported to being screened for lead poisoning and nearly 22,000 (4.4 percent) had lead toxicity. In comparison, 4 years later in 1985, of 785,285 children screened, 11,739 (1.5 percent) had lead toxicity (p.110).

2.2 Lead Levels in Humans

Salvato (1992) says that there is evidence that there is no acceptable level of lead in humans. Even low levels (below 25 µg/dl) may cause brain damage. It is theorized that lead, as well as other toxic pollutants may interfere with calcium flow into neurons, thereby disrupting the learning process in children (p. 113). In 1992, the Centre for Disease Control in the United States guideline for blood-level is 10 µg/dl. Alloway and Ayres (1997) say that the critical concentrations for lead in blood are the EC recommended level of 35 µg/dl (p.215).

The maximum amount of Pb allowed in sewage and industrial effluents is 0.1 mg/L according to the Department of Irrigation and Drainage Sarawak.

2.3 Lead Sources

Lead contamination in the environment comes from various sources besides paint, such as "lead in gasoline discharged with automobile exhaust in urban areas, lead fumes and ashes produced in battery repair and burning lead battery casings, inadequately ventilated indoor firing ranges (where the lead comes from the bullet material), emissions from industrial processes, soft corrosive water standing and flowing in lead pipe, pipe with lead soldered joints, some bronze and brass faucets, chrome plated fixtures, natural or added lead in food and drink, lead in dust and soil, making lead type, handling lead scrap, lead in lead arsenate pesticides, radiator repair, pottery and ceramics manufacture, lead crystal decanters, lead-soldered cans colored newsprint, household dust in urban areas, and lead in some household products" (Salvato, 1992, p. 110).

2.4 Lead Removal

According to Salvato (1992)

> Removal of lead-based paint requires special precautions to protect children, adults, and workers from inhaling dust and fumes. Sanding causes the release of lead-laden dust and, and open-flame burning or torching releases lead fumes. A heat gun is preferred. Precautions include: enclosure of the work area to prevent spread of the dust to other apartments or public areas; protection of furnishings and clothing in the apartments; worker protection, including proper respirator and clothing; complete dust removal and collection, using a vacuum with a high efficiency particle air filter; and proper disposal of the dust and debris. The effectiveness of dust removal and cleanup should be determined by surface sampling (floors, walls, window sills) before and after paint removal. Encapsulating the lead-based paint may be a preferred and acceptable alternative to removal, if accepted by the respective regulatory agency. Easily accessible locations, such as window sills, should be given priority (p.109).

The phasing out of tetraethyl lead from gasoline has introduced a potential and unknown problem associated with manganese compounds used as a replacement for lead, which are emitted at low levels in various forms including the toxic manganese tetroxide. However, a Department of Housing and Urban Development study between 1970 and 1976 in New York City showed a drop in blood-lead levels in children from 30 to 21 μg/100ml of blood. This shows that the removal of lead in gasoline had a significant positive impact on the children's health.

The removal of lead is usually chemical precipitation. Sorption processes including ion exchange and adsorption are an alternative with great potential to treat water and wastewaters containing heavy metals. The high cost of many adsorbents has led to the research into more cost effective adsorbents – most notably by-products and waste from various industries. Some of these materials combine good adsorption capacities and buffering effect, which assure almost complete removal of heavy metals without preliminary correction of the initial pH being necessary.

2.5 Removal Techniques in Industries

Ion Exchange-

In solution, salts separate into positively-charged cations and negatively-charged anions. Deionization can reduce the amounts of these ions. Ion exchange is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that water solutions must be electrically neutral, therefore ions in the resin bed are exchanged with ions of similar charge in the water. As a result of the exchange process, no reduction in ions is obtained. In the case of Pb, operation begins with a fully recharged resin bed, having enough positively charged ions to carry out the cation exchange. Usually a polymer resin bed is composed of millions of medium sand grain size, spherical beads. As water passes through the resin bed, the positively charged ions are released into the water, being substituted or replaced with the soluble Pb in the water (ion exchange). When the resin becomes exhausted of positively charged ions, the bed must be regenerated by passing a strong, usually NaCl (or KCl), solution over the resin bed, displacing the Pb^{2+}ions with $2Na^+$ ions. Typically, Pb ion exchange utilizes a strong acid cation resin bed.

Reverse Osmosis:Process –

Reverse osmosis (RO) is a physical process in which contaminants are removed by applying pressure on the feed water to direct it through a semi-permeable membrane. The process is the "reverse" of natural osmosis (water diffusion from dilute to concentrated through a semi-permeable membrane to equalize ion concentration) as a result of the applied pressure to the concentrated side of the membrane, which overcomes the natural osmotic pressure. RO membranes reject ions based on size and electrical charge. The raw water is typically called feed; the product water is called permeate; and the concentrated reject is called concentrate. Common RO membrane materials include asymmetric cellulose acetate or polyamide thin film composite. Common membrane construction includes spiral wound or hollow fine fiber. Each material and construction method has specific benefits and limitations depending upon the raw water characteristics and pre-treatment. A typical large RO installation includes a high pressure feed pump, parallel 1st and 2nd stage membrane elements (in pressure vessels); valving; and feed, permeate, and concentrate piping. All materials and construction methods require regular maintenance. Factors influencing membrane selection are cost, recovery, rejection, raw water characteristics, and pretreatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance.

Lime Softening -

Lime softening uses a chemical addition followed by an upflow Sludge Chemical Conditioning (SCC) to accomplish coagulation, flocculation, and clarification. Chemical addition includes adding $Ca(OH)_2$ in sufficient quantity to raise the pH while keeping the levels of alkalinity relatively low, to precipitate carbonate hardness. Heavy metals, like Pb, precipitate as $Pb(OH)_2$. In the upflow SCC, coagulation and flocculation (agglomeration of the suspended material, including Pb, into larger particles), and final clarification occur. In the upflow SCC, the clarified water flows up and over the weirs, while the settled particles are removed by pumping or other collection mechanisms (i.e. filtration).

Coagulation and Filtration –

Coagulation and filtration for insoluble Pb uses the conventional chemical and physical treatment processes of chemical addition, rapid mix, coagulation with dry alum, flocculation, and dual media filtration. Chemical coagulation and flocculation consists of adding a chemical coagulant combined with mechanical flocculation to allow fine suspended and some dissolved solids to clump together (floc). $Al_2(SO4)_3$has been proven to be the most effective coagulant for insoluble Pb removal. Filtration consists of final removal by dual media filtering of all floc and suspended solids.

2.6 Atomic Adsorption Spectrometer

Basic Principle of Atomic Absorption Spectrometry

The technique of flame atomic absorption spectroscopy (FAAS) requires a liquid sample to be aspirated, aerosolized, and mixed with combustible gases, such as acetylene and air or acetylene and nitrous oxide. The mixture is ignited in a flame whose temperature ranges from 2100 to 2800 °C.

During combustion, atoms of the element of interest in the sample are reduced to free, unexcited ground state atoms, which absorb light at characteristic wavelengths.

The characteristic wavelengths are element specific and accurate to 0.01-0.1nm. To provide element specific wavelengths, a light beam from a lamp whose cathode is made of the element being determined is passed through the flame. A device such as photon multiplier can detect the amount of reduction of the light intensity due to absorption by the analyte, and this can be directly related to the amount of the element in the sample.

Interferences

Since the concentration of the analyte element is considered to be proportional to the ground state atom population in the flame, any factor that affects the ground state population of the analyte element can be classified as an interference. Factors that may affect the ability of the instrument to read this parameter can also be classified as an interference. The following are the most common interferences:

A) Spectral interferences are due to radiation overlapping that of the light source. The interference radiation may be an emission line of another element or compound, or general background radiation from the flame, solvent, or analytical sample. This usually occurs when using organic solvents, but can also happen when determining sodium with magnesium present, iron with copper or iron with nickel.

B) Formation of compounds that do not dissociate in the flame. The most common example is the formation of calcium and strontium phosphates.

C) Ionization of the analyte reduces the signal. This is commonly happens to barium, calcium, strontium, sodium and potassium.

D) Matrix interferences due to differences between surface tension and viscosity of test solutions and standards.

E) Broadening of a spectral line, which can occur due to a number of factors. The most common linewidth broadening effects are:

1. Doppler effect
This effect arises because atoms will have different components of velocity along the line of observation.

2. Lorentz effect
This effect occurs as a result of the concentration of foreign atoms present in the environment of the emitting or absorbing atoms. The magnitude of the broadening varies with the pressure of the foreign gases and their physical properties.

3. Quenching effect
In a low-pressure spectral source, quenching collision can occur in flames as the result of the presence of foreign gas molecules with vibrational levels very close to the excited state of the resonance line.

4. Self absorption or self-reversal effect

The atoms of the same kind as that emitting radiation will absorb maximum radiation at the centre of the line than at the wings, resulting in the change of shape of the line as well as its intensity. This effect becomes serious if the vapour which is absorbing radiation is considerably cooler than that which is emitting radiation.

2.7 Chemical Precipitation

Precipitation reactions are reactions which result in the formation of an insoluble product. A precipitate is an insoluble solid formed by a reaction in solution. Prediction of formation of precipitates is based on the solubilities of different compounds. There are no rules based on physical properties to guide one in the prediction of the solubility of a compound. However, experimental observations have led to empirical guidelines for ionic compounds. The following table is a summary of solubility guidelines for ionic compounds, organized according to the anion in the compound.

Table 2.0: Solubility guidelines for common ionic compounds in water (Brown, LeMay, Bursten; Chemistry The Central Science)

Soluble Compounds		**Important Exceptions**
Compounds containing	NO_3^-	None
	$C_2H_3O_2^-$	None
	Cl^-	Compounds of Ag^+, Hg^{2+}, and Pb^{2+}
	Br^-	Compounds of Ag^+, Hg^{2+}, and Pb^{2+}
	I^-	Compounds of Ag^+, Hg^{2+}, and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+}, Ba^{2+}, Hg^{2+}, and Pb^{2+}
Insoluble Compounds		**Important Exceptions**
Compounds containing	S^{2-}	Compounds of NH_4^+, the alkali metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+, and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH-	Compounds of the alkalli metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}

CHAPTER 3

METHODOLOGY

Procedure

1. Charcoal is fed to a furnace to be burned at 600°C for 4 hours.
2. The product is crushed using a pestle and mortar and the ash is sieved to obtain an average of 63μm particle size.
3. Lead solutions of 20,40 and 60 ppm are prepared
4. Solution is placed in a beaker, which is then placed in a temperature controlled bath if necessary.
5. This experiment is carried out in a batch manner. 1 gram of wood ash is poured into 300 mL of the respective Pb solution and stirred.
6. The experiment is carried out at ambient temperature, 40 degrees C and 50 degrees C.
7. At every 5 minute interval (10 minutes for 40 and 50 Degrees C), a sample of the solution is taken out, filtered and kept in containers.(Note: Different time intervals are chosen based on practicality of sampling during the experiment)
8. The lead ion concentration is determined using the Atomic Adsorption Spectrometer.

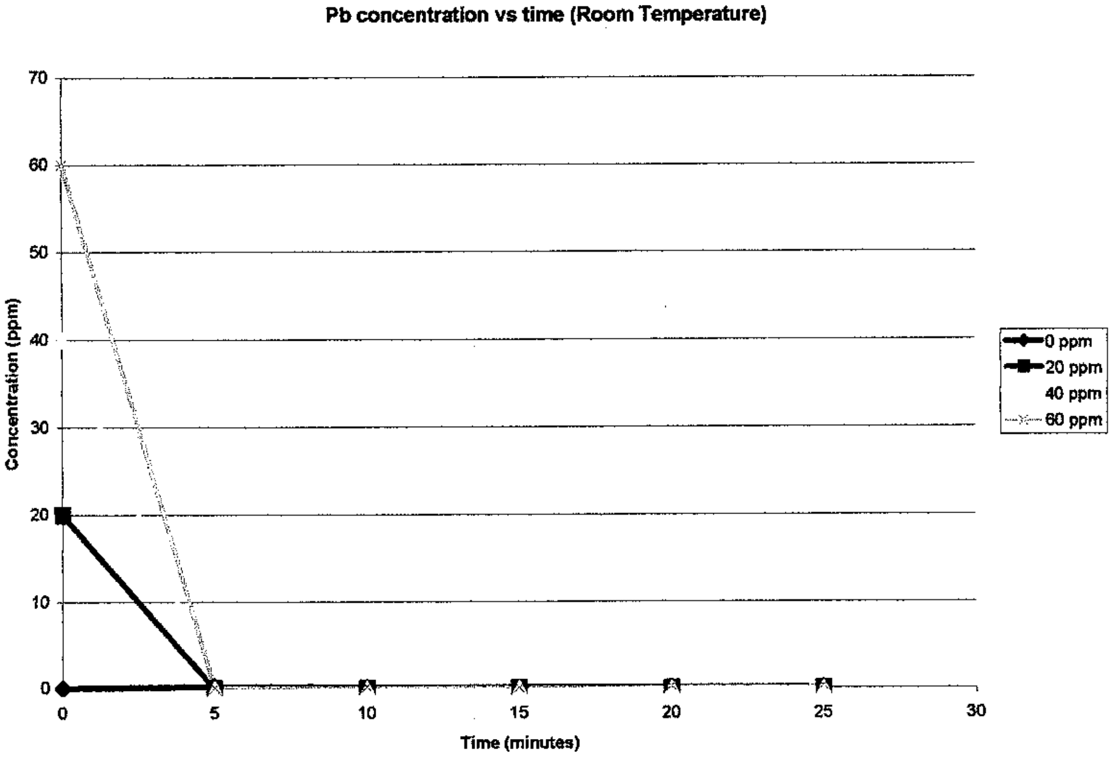
Tools (Equipment)

1. Assortment of beakers, measuring cylinders, Erlenmyer flasks, stirring rods.
2. Atomic Absorption Spectrometer
3. Furnace
4. Oven
5. Electric stirrer

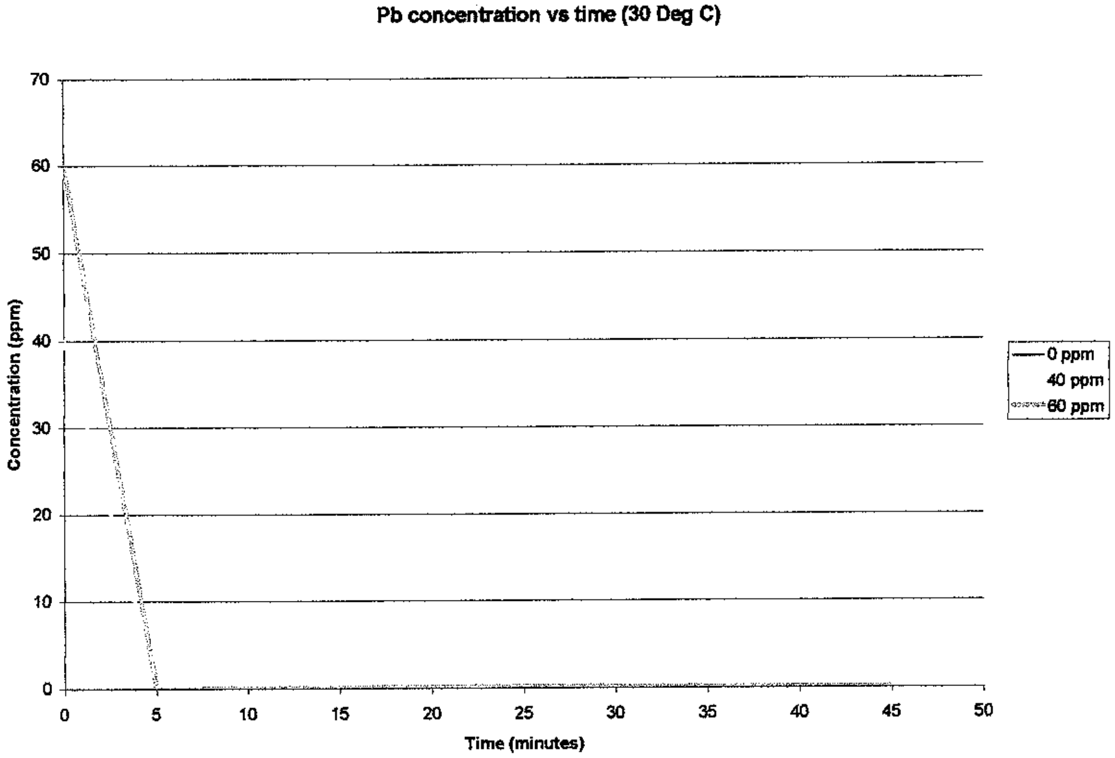
CHAPTER 4

RESULTS AND DISCUSSION

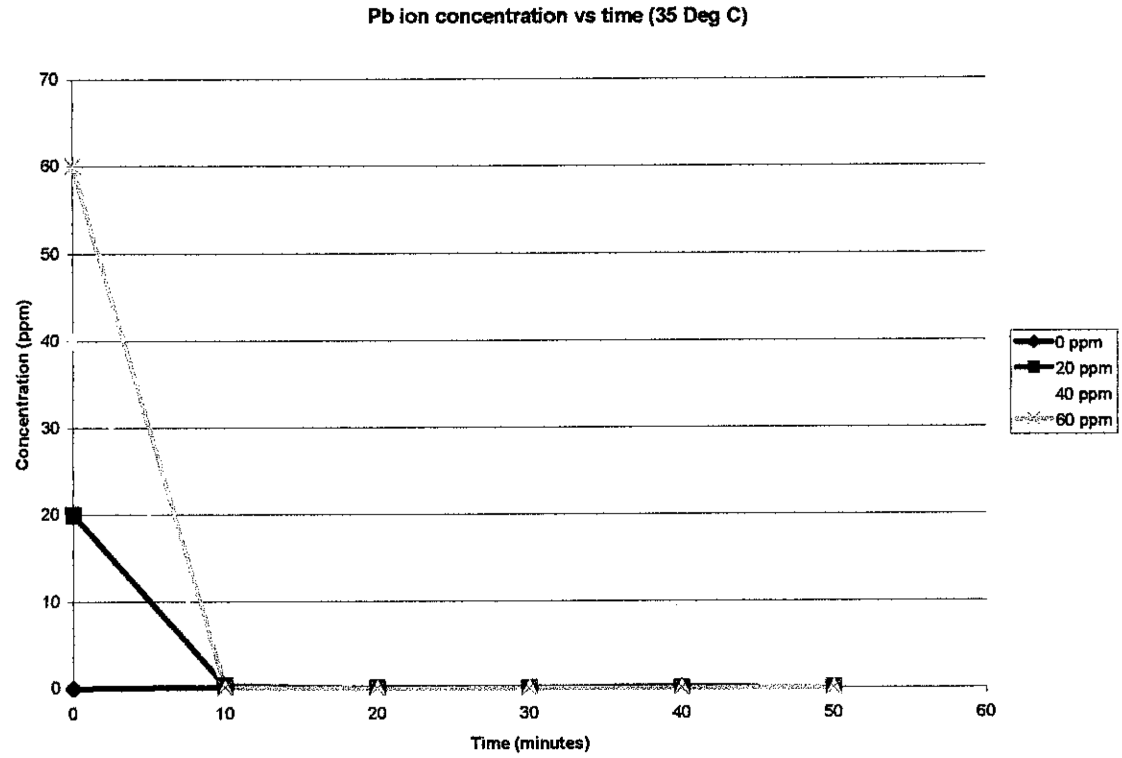
Before proceeding further, it must be mentioned that the negative values of concentration readings in the results are to be taken as zero. The negative values show that there are no more detectable lead ions, and the negative values are actually due to errors in the AAS which are discussed in the Literature Review/Theory Section.



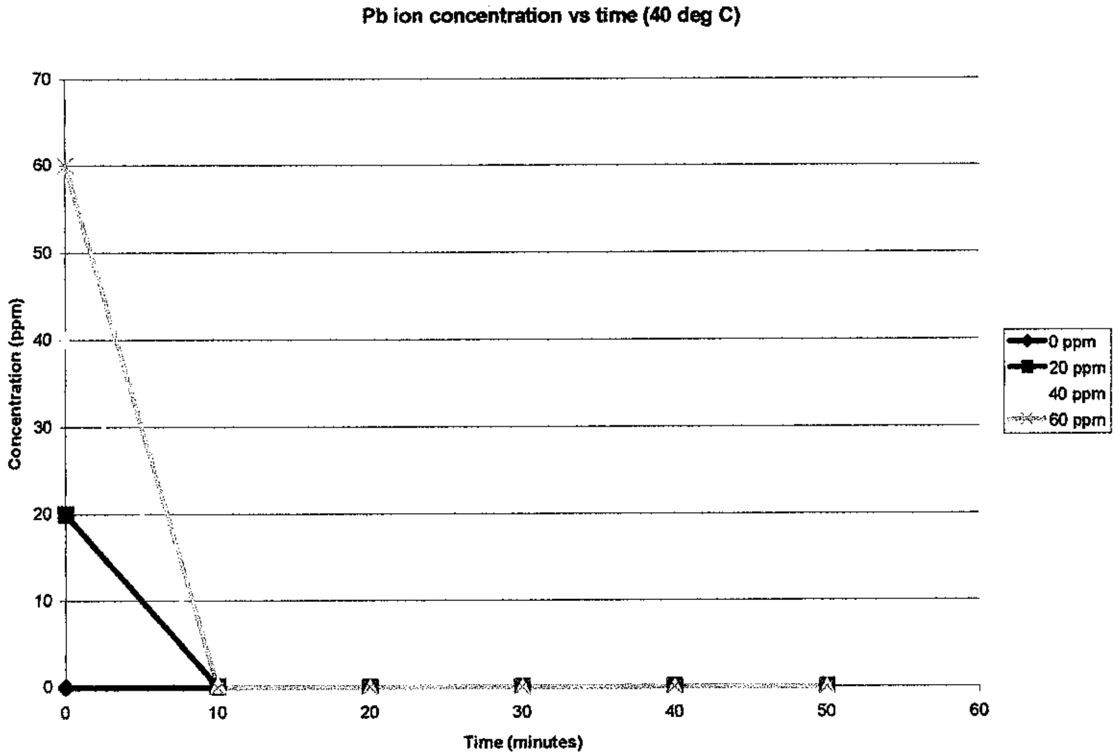
In this graph, it is shown that at room temperature, all the 3 different concentrations of lead ions; 20, 40 and 60 ppm, reach zero concentration at 5 minutes.



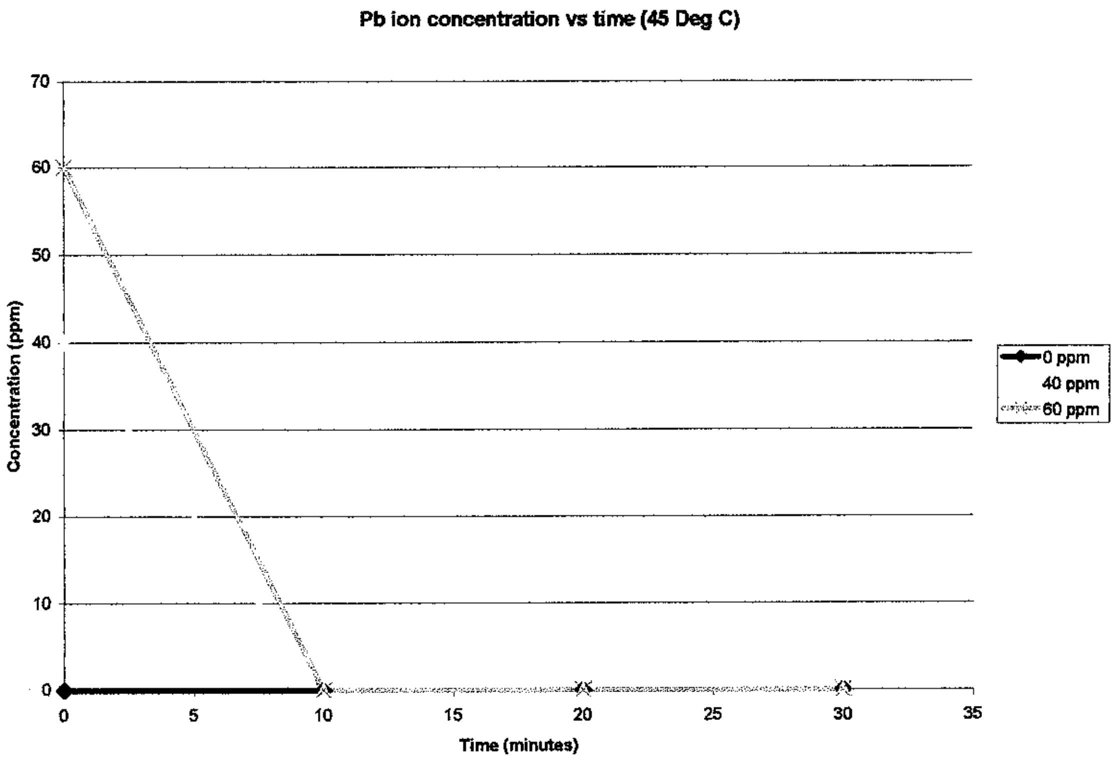
This graph shows that for the concentrations of 40 and 60 ppm, all the lead is removed within the first 5 minutes with the experiment being run at 30 degrees Celcius.



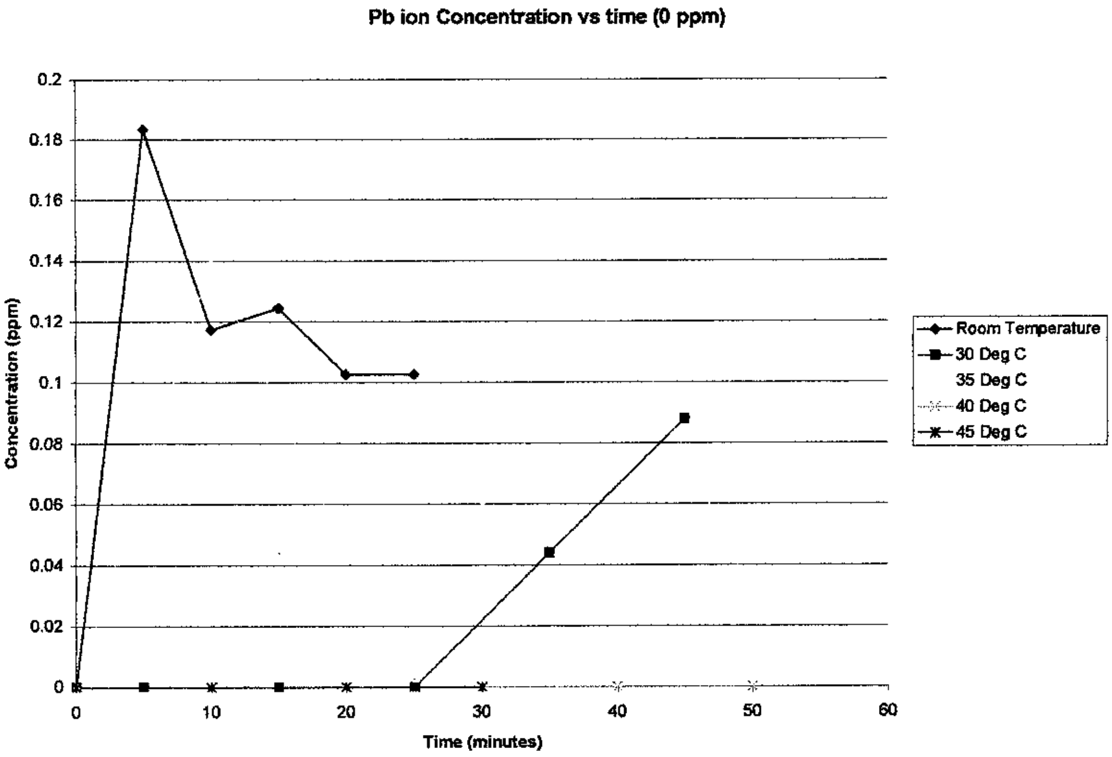
The graph represents the trend of the concentration versus time at 35 degrees Celsius. From here, one can see that for all the concentrations, lead is removed totally at 10 minutes. Based on previous results, lead may have been removed by 5 minutes, however, this cannot be ascertained here as the interval chosen for this experiment is 10 minutes.



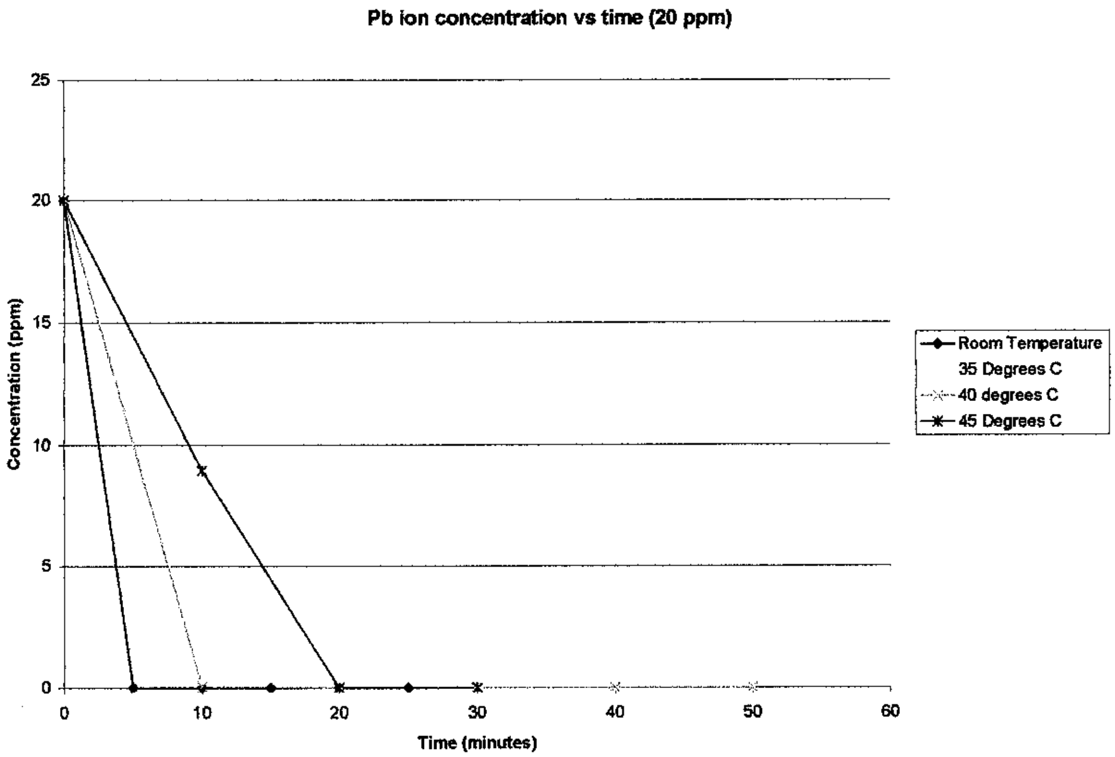
For the experiment run at 40 degrees Celsius all the different solutions achieve zero concentration of lead ions at 10 minutes. As mentioned before, zero concentration may have been achieved earlier, but is not able to be shown since the time interval is different.



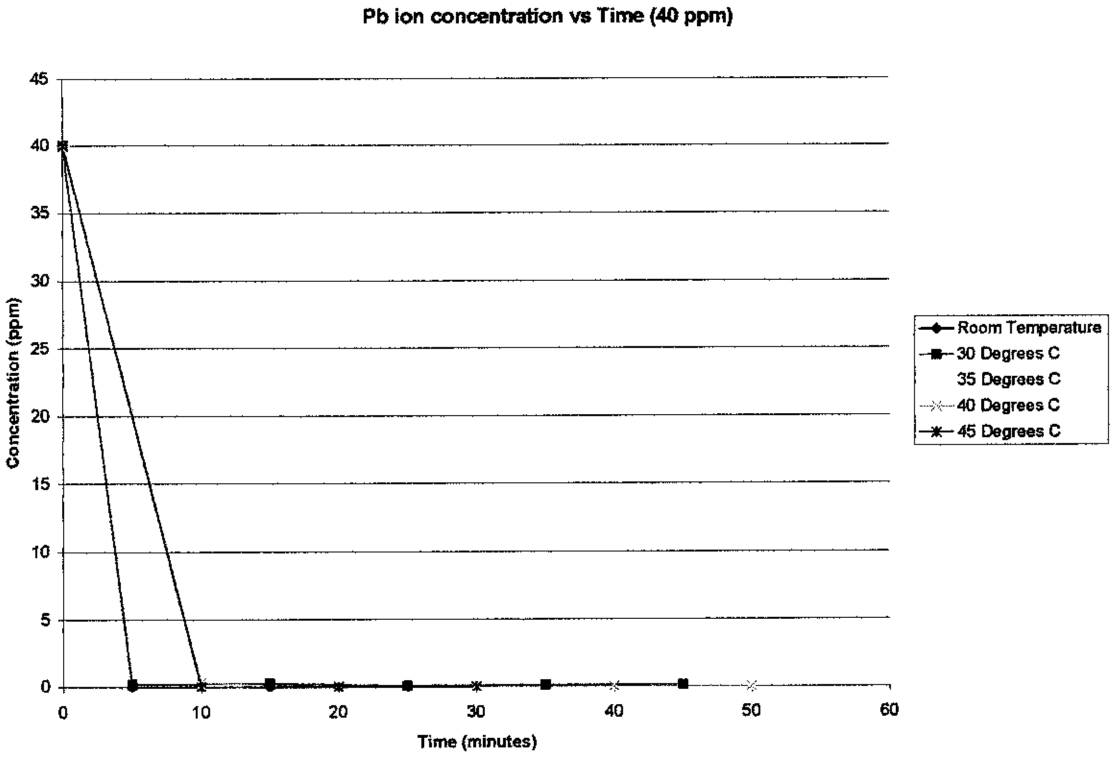
In this graph, all the solutions reach zero concentration of lead ions at 10 minutes.

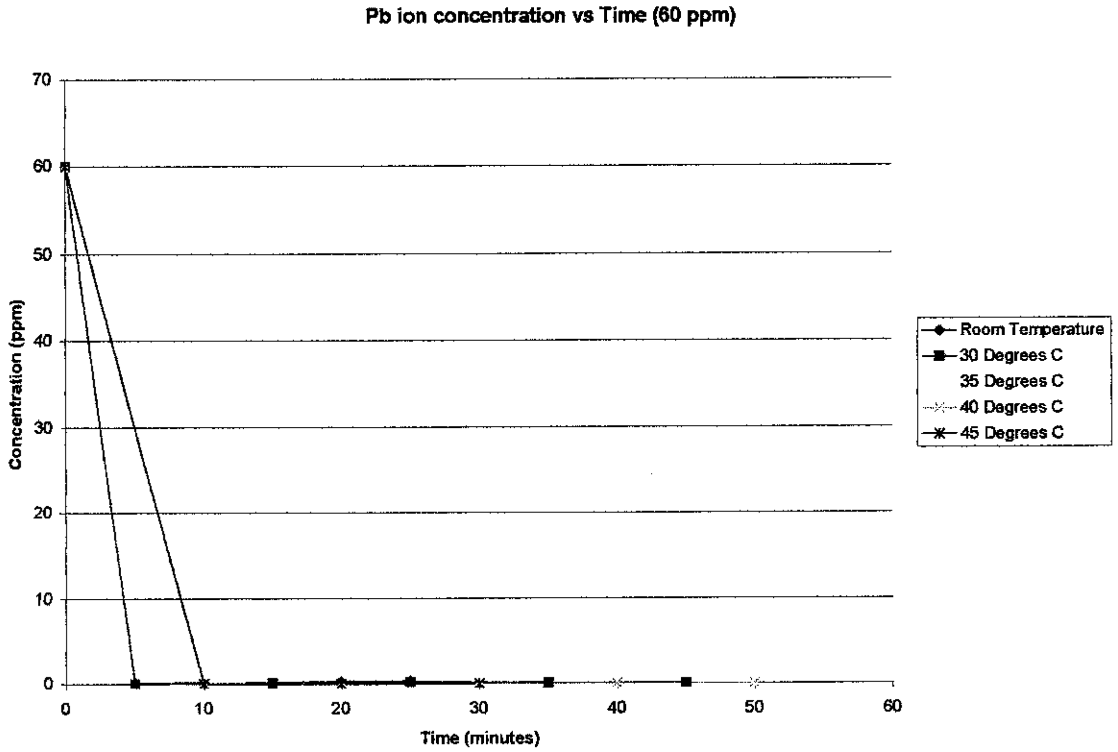


As expected, for the control solution of 0 ppm, the concentration of lead is zero at all times. Though there are some small positive readings, these readings are essentially zero, based on error margin.



The trend shows that at room temperature all the lead ions are removed at 5minutes. As for 35 and 40 Degrees Celsius, all the lead ions are removed at the first ten minutes, and for 45 Degrees Celsius, zero lead ion concentration is reached at 16 minutes. As mentioned earlier, for the 35, 40 and 45 Degrees Celsius experiments, the zero lead ion concentration may have been achieved earlier, but not recorded as the experiments have different time intervals.


Pb ion concentration vs Time (40 ppm)


Pb ion concentration vs Time (60 ppm)

For the graphs of Concentration versus Time for 40ppm and 60ppm solutions, one can see that experiments at all temperature reach zero lead ion concentration by ten minutes except for room temperature and 30 Degrees Celsius. Again, due to the different time intervals chosen, it may be that all the lead ions are removed by the first five minutes.

4.2 Discussion

Theoretically the concentration of lead in the solutions will decrease with the increase in time of the reaction. Also, the reaction rate, will increase with increase in temperature. However, the results have not faithfully followed this trend, due to experimental errors which will be discussed later. Of more importance, the results have shown that wood ash is an efficient material in removing lead.

4.2.1 Results Interpretation

From the general trend of the graphs, it is that many of the reactions reach zero concentration of lead ions very quickly. Many of the reactions show that within the first 5-10 minutes, all lead has been removed, thus proving the efficiency of wood ash in lead removal.

4.2.2 Lead Removal Mechanism

It has been discovered that the reaction is due NOT mainly to adsorption by carbon as is widely thought, instead due mainly to precipitation reaction. This is concluded with reference to 1) The speed at which the lead removal takes place, and 2) The low concentration of carbon in the ash (average carbon content = 2.6585%).

The reactions here happened quickly and in general, precipitation is very fast, almost instantaneous as compared to adsorption. Therefore it is evident that precipitation and not adsorption by carbon which has taken place. To further emphasize this, the carbon content in the wood ash is very low. This is because as the wood is burned in excess oxygen at very high temperature, virtually all the carbon has been oxidized.

Therefore this shows that the major mechanism of ash removal in the solution is not through adsorption by carbon.

4.2.3 Precipitation of Lead Hydroxide

Potassium, which is a major component of wood, is first oxidized in the ashing stage. When the ash is added to the solutions of lead ions, the potassium oxides react with the water to produce potassium hydroxide (evident by the basic pH of the solutions after being added with ash). Other heavy metals such as calcium, silicon and magnesium are also oxidized, however they have lower solubility in water. Potassium hydroxide in turn produce hydroxides when dissolved in water and these in turn will react with the lead ions to produce lead hydroxide, an insoluble salt which precipitates out (K_{sp} for Lead Hydroxide = 2.5×10^{-16}).

$$4K(s) + O_2(g) \rightarrow 2K_2O(s)$$

When dissolved in water, K_2O reacts with water to form hydroxide ions,

$$O^{2-}(aq) + H_2O(l) \rightarrow 2OH^-$$

In turn, the produced hydroxides react with lead ions to produce lead hydroxide,

$$Pb^{2+} + 2OH^- \rightarrow Pb(OH)_2 \quad \text{(solubility: 0.016g/100g water at 20 degrees C)}$$

Table 4.0: Elements found in 16 ash samples taken from northern Wisconsin. (Mark J. Kopecky, N. Larry Meyers, Wally Wasko; Using industrial wood ash as soil amendment)

Element	Range of concentrations	Pounds applied in 10-ton.acre ash application
Calcium (Ca)	22-45%	4400-9200
Magnesium (mg)	1.2-2.2%	240-440
Phosphorus (PsO5 equivalent)	1.1-2.3%	230-460
Potassium (K2O equivalent)	1.3-4.6%	260-910
Aluminium (Al)	0.2-1.1%	42-230
Iron (Fe)	0.1-1.1%	26-210
Manganese (Mn)	0.06-0.3%	12-56
Zinc (Zn)	0.01-0.5%	3-100
Boron (B)	0-210ppm	0-4
Chromium (Cr)	0-14ppm	0-0.03
Copper (Cu)	0-54ppm	0-1.1
Nickel (Ni)	0-7ppm	0-0.1
Cadmium (Cd)	0-22ppm	0-0.4
Cobalt (Co)	0-6ppm	0-0.1
Lead (Pb)	-17ppm	0-0.3

Precipitation is an almost instantaneous reaction, which is why the concentration of lead drops very quickly in all of the solutions. The reaction is a third order reaction and is the rate is temperature dependent.

4.2.4 Quantitative Analysis

From the results, 1 gram of ash is able to remove all the lead ions in all of the lead ion solutions. In the context of this experiment, the maximum amount of lead removed is 18 mg. However, this does not indicate the true maximum limit of lead ion removal by the wood ash. As the removal mechanism is due to precipitation and not through adsorption, one cannot directly link the removal of lead to the amount of ash. The removal of lead is directly linked to the number of OH^- ions present in the solution, being the ion that it reacts with to produce the insoluble compound of lead hydroxide. The amount of hydroxides in the solution is determined as follows

pH of solution (added with wood ash) = 10.2

= - log [H+]

Thus,

$[H+] = \text{antilog}(-10.2) = 6.3 \times 10^{-11}$

We know that

$K_w = [H+][OH-] = 1.0 \times 10^{-14}$

Thus

$[OH-] = 1.6 \times 10^{-4}$ M (moles/litre)

Basis: 300ml of 60 ppm lead solution + 1 gram ash

The amount of lead in this solution is 8.7×10^{-6} moles

The amount of hydroxide ions is 4.8×10^{-5} moles

Each molecule of lead hydroxide requires 2 hydroxide ions, meaning there must the double the number or hydroxide ions than the lead ions in the solution.

Amount of hydroxide ions necessary for complete reaction with free lead ions,

8.7×10^{-6} moles $\times 2 = 1.7 \times 10^{-5}$ moles

Amount of hydroxide ions is more than adequate,

4.8×10^{-5} moles > 1.7×10^{-5} moles

The maximum amount of lead ions able to be adsorbed by the ash in this condition is

4.8×10^{-5} moles ÷ 2 = 2.4×10^{-5} moles

4.2.5 Errors

The major error occurring in this experiment lies in the execution of the experiment. Human error in preparation of the standard solutions of lead ions, variations in the stirring rate, unintentional contamination of samples, possible inaccuracy in readings by machines (stirrers, heaters, AAS) all contribute to a considerable error margin in this experiment.

Preparation of standard solutions

There is possible error during the preparation of the solutions, such as the measurement of liquid volumes, and weight of salts. Unintentional contamination also may have occurred.

Variations in stirring rate.

There has been some considerable error in the stirring rate, especially that of the water bath, as the stirring rate is controlled manually and this gives rise to inaccurate setting of the stirring rate. Furthermore, the water bath did not mix the solutions as well as the normal stirrer since the water bath's stirrer functions more like a shaker than a stirrer. This makes the results somewhat inaccurate, and difficult to be compared since the stirring action is not exactly the same.

Inaccurate heating

The water bath is used to heat the solutions to the desired temperature. The water level in the water bath may not be the same at every usage of the equipment, and possible errors in temperature readings and also heat loss to the surroundings all cause inaccuracies in the experiment.

Contamination of samples and marginal errors in AAS readings.

In the preparation of the samples to be tested by the AAS, contamination may have occurred, for example, by residue in the beakers used to transfer the solutions or in the containers used to store the samples.

The AAS also presents some amount of error due to interferences in its operation which has been discussed in the Discussion section.

As a conclusion, the many errors possible during the conduction of this experiment has led the results to deviate from the expected trend and should be read and interpreted keeping in mind the error margin.

Due to limited time, unsatisfactory results are unable to be duplicated to check for validity.

CHAPTER 5

CONCLUSION

The project is important in determining the effectiveness of wood ash as an adsorbent for lead ions, thus replacing the need for expensive adsorbents such as activated carbon. The experiment has proven that ash is a very good material for the removal of lead ions.

CHAPTER 6

RECOMMENDATION

Further study/analysis should be put into the usage of ash for the removal of lead ions. It is important to establish the optimum operating conditions for the removal of lead ions, thus increasing the effectiveness of the process. Of particular interest, this experiment should be carried out with a different method of preparation of the wood ash. In this experiment, wood is incinerated in a non-vacuum furnace. Therefore further study should include wood burned in a total vacuum furnace, and have the results compared. Also of equal importance, the time interval for sampling of the mixture during the removal process should be reduced to enable the determination of the rate constant and rate of reaction.

CHAPTER 7

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CHAPTER 8
APPENDIX

Results

0 ppm Room Temperature		**20 ppm Room Temperature**		**40ppm Room Temperature**		**60ppm Room Temperature**	
Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)
0	0	0	20	0	40	0	60
5	0.1833	5	0	5	0	5	0.0293
10	0.1173	10	0	10	0	10	0.1026
15	0.1246	15	0	15	0	15	0.088
20	0.1026	20	0	20	0	20	0.2199
25	0.1026	25	0	25	0	25	0.2639

Results

0ppm 30degrees C		**20ppm 30degrees C**		**40ppm 30degrees C**		**60ppm 30degrees C**	
Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)
0	0	0	20	0	40	0	60
5	0	5	8.914	5	0.1906	5	0
15	0	15	6.5536	15	0.2566	15	0.0733
25	0	25	5.8791	25	0.044	25	0.1833
35	0.044	35	2.9616	35	0.132	35	0.088
45	0.088	45	0.5425	45	0.1173	45	0.044

Results

0ppm 35degrees C		**20ppm 35degrees C**		**40ppm 35degrees C**		**60ppm 35degrees C**	
Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)
0	0	0	20	0	40	0	60
10	0.1393	10	0.3542	10	0	10	0.1033
20	0.0443	20	0	20	0	20	0
30	0.059	30	0	30	0	30	0
40	0.1255	40	0	40	0	40	0
50	0.0295	50	0	50	0.0443	50	0

Results

0ppm 40degrees C		**20ppm 40degrees C**		**40ppm 40degrees C**		**60ppm 40degrees C**	
Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)
0	0	0	20	0	40	0	60
10	0	10	0.06	10	0.3	10	0
20	0	20	0	20	0	20	0
30	0	30	0	30	0	30	0
40	0	40	0	40	0	40	0
50	0	50	0	50	0	50	0

Results

0ppm 45degrees C		**20ppm 45degrees C**		**40ppm 45degrees C**		**60ppm 40degrees C**	
Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)	Time (min)	Conc.(ppm)
0	0	0	20	0	40	0	60
10	0	10	8.96	10	0	10	0
20	0	20	0	20	0	20	0
30	0	30	0	30	0	30	0