STUDY OF OYSTER SHELLS IN THE REMOVAL OF LEAD FROM SYNTHETIC WASTEWATER

PHITTAYOUTH PRATOOMRATH

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Thesis
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STUDY OF OYSTER SHELL IN THE REMOVAL OF LEAD FORM SYNTHETIC WASTEWATER

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ABSTRACT

The objective of this study was to evaluate efficiency of lead removal from synthetic wastewater using burnt oyster shells at 950 ^{o}C for 5 hours as compared to unburnt oyster shells. The oyster shell samples were sieved to pass through a 100 mesh sieve before an adsorbtion experiment according to the ASTM standard procedure. The applied rate of oyster shells was 0.25, 0.50, 1.00, and 2.00 percent at six different pH values (5.63, 7.00, 8.00, 9.00, 10.00 and 11.00) of true wastewater from the chemistry laboratory at Faculty of Science, Burapha University.

The results showed that the burnt oyster shells had greater lead adsorbtion capacity than the unburnt oyster shells at pH levels 8.00 and lower and the similar at pH levels 9.00 and higher. This is probably due to the chemical composition of the oyster shells transformed from $CaCO_3$ to CaO, which may increase reactivity of surfaces of the oyster shell. The pH increase of solution greatly increased lead removal efficiency. The results from true wastewater of the chemistry laboratory at Faculty of Science, Burapha University founded that the burnt oyster shells had greater heavy metal sorption capacity than did the unburnt oyster shells at all rates.

KEY WORDS: OYSTER SHELL / SYNTHETIC WASTEWATER

55 pages

การศึกษาการใช้เปลือกหอยนางรมในการดูดซับตะกั่วออกจากน้ำเสียสังเคราะห์
STUDY OF OYSTER SHELL IN THE REMOVAL OF LEAD FORM SYNTHETIC WASTEWATER

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บทคัดย่อ

การศึกษาในครั้งนี้มีจุดประสงค์ที่จะทราบถึงประสิทธิภาพการดูดซับตะกั่วในน้ำเสียสังเคราะห์โดยเปรียบเทียบประสิทธิภาพระหว่างเปลือกหอยนางรมที่ทำการเผาที่ 950 องศาเซลเซียส นาน 5 ชั่วโมง และเปลือกหอยนางรมที่ไม่ทำการเผา บดละเอียด ร่อนผ่านตะแกรงขนาด 100 เมช (ตามมาตรฐาน ASTM) ที่ปริมาณการใช้ 4 ระดับ ได้แก่ ร้อยละ 0.25 0.50 1.00 และ 2.00 ตามลำดับ ที่ระดับ พีเอช 6 ระดับ (pH 5.63 7.00 8.00 9.00 10.00 และ 11.00) และน้ำเสียจริงจากห้องปฏิบัติการเคมี คณะวิทยาศาสตร์ มหาวิทยาลัยบูรพา

จากการศึกษาพบว่าเปลือกหอยนางรมที่ทำการเผามีประสิทธิภาพในการดูดซับตะกั่วออกจากน้ำเสียสังเคราะห์ดีกว่าเปลือกหอยนางรมที่ไม่ทำการเผาที่พีเอช 8.00 ลงมา และมีประสิทธิภาพใกล้เคียงกันที่พีเอช 9.00 ขึ้นไป ซึ่งอาจมาจากการเปลี่ยนแปลงโครงสร้างของเปลือกหอยจากแคลเซียมคาร์บอเนต (CaCO3) เป็น แคลเซียมออกไซด์ (CaO) กับพื้นที่ผิวที่เพิ่มขึ้นของเปลือกหอยนางรม ระดับพีเอชที่สูงขึ้นของสารละลายทำให้ประสิทธิภาพในการดูดซับสูงขึ้นตามไปด้วย จากการศึกษากับน้ำเสียจริงจากห้องปฏิบัติการเคมี คณะวิทยาศาสตร์ มหาวิทยาลัยบูรพา พบว่าเปลือกหอยที่ทำการเผามีประสิทธิภาพในการดูดซับโลหะหนักดีกว่าเปลือกหอยนางรมที่ไม่ทำการเผาทุกระดับ

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CHAPTER I

INTRODUCTION

1.1 The importance and problems of research

Contaminations of heavy metals in the environment are likely to increase, especially into the natural water. Contamination of lead in natural water was another reason for the degradation of water sources, which consequently causing diseases and other public health problems. Lead mostly emitted from industrial plants, intended or unintended. With the accumulation of lead to a certain level the accumulated metal could be harmful.

Disposal of wastewater that was contaminated with lead used to make precipitated by the addition of chemicals such as lime as calcium carbonate ($CaCO_3$) or sodium hydroxide (NaOH) into the wastewater to react with lead dissolved in water, the sediment was separated from the water. Generally the precipitation lead hydroxide format with addition of lime or caustic soda (Harison, 1981), but this method be wasteful chemicals and expensive.

The wastewater treated by waste materials was alternative to the resource value. The area Tumbol Suensuk and Tambol Ang-sila, Amphoe Muang, Changwat Chonburi was one area that has culture oysters and processing plant with a production of oyster. The oyster shells waste was large amount. It can be seen from the shells of the people to leave their homes in their own communities and around the vacant area. Shells that trouble community portal for the social and environmental such as emit stinking cause the annoyance and risk of disease-carrying flies. Because the shells stack was the source food of the flies. The use of oyster shell, now exist a little quantities when compared with all the shells. The shell to aid in the treat of waste water was the alternative use of waste materials.

The researcher lives in shore Gulf of Thailand area which there was culture oyster greatly and processing in an oyster shell waste was large amount. Thus the researcher then had interest study of oyster shells in the removal of lead form synthetic wastewater. Efficiency for removal of lead using oyster shells because of it had component with $CaCO_3$ and to reduce social and environmental problems resulting from oyster shells. It also adds value and waste materials to benefit as well. Thus the researchers chose to use oyster shells in to doing of this research.

1.2 The importance of this research

1.2.1 The application of knowledge in oyster shells the use of value creation and value.

1.2.2 The knowledge management about water pollution caused by lead contamination.

1.2.3 The search for methods and techniques for the value of oyster shell to reduce or eradicate lead in wastewater.

1.3 Objectives of research

1.3.1. Study the feasibility of using oyster shells as well as to reduce the lead content in synthetic wastewater by comparing the efficiency between the burnt oyster shells and unburnt oyster shells.

1.4 Definitions of research

1.3.1 **Shell oyster** mean oyster shell stack abandoned last 6 – 12 months of Tumbol Seansuk and Tambol Ang-sila Amphoe Muang, Changwat Chonburi.

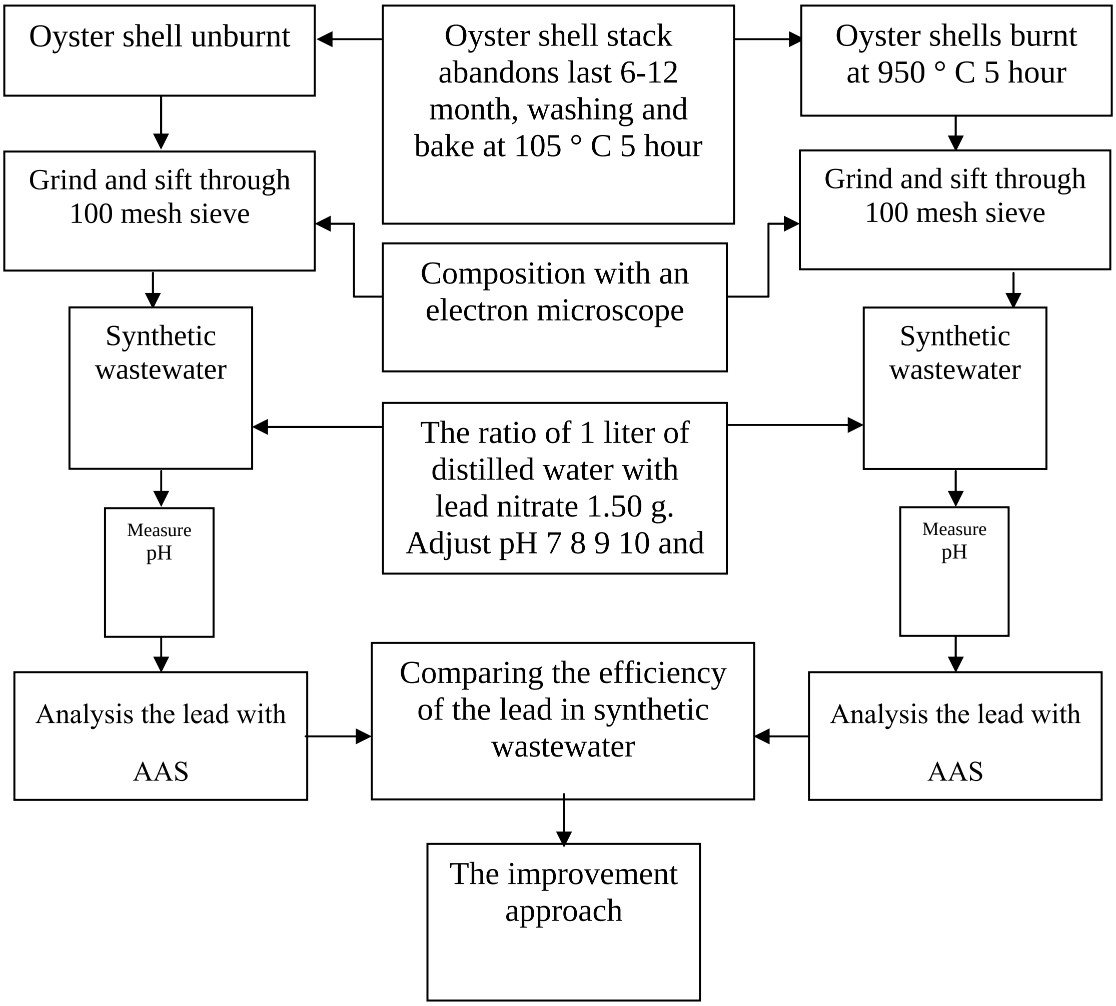
1.3.2 **Lead metal** mean the elements in column IV A of the periodic table, atomic weight 207.19, melting point 327.4°C, boiling point 1725°C and density 11.4 g/ml.

1.3.3 **Synthetic wastewater** mean the solution of lead nitrate 1.50 g in 1,000 ml of distilled water equal to 0.15 %.

1.3.4 **Shell lime burnt** mean the burnt oyster shell at 950°C for 5 hour, being ground grind and sifted through 100 mesh sieve (standard ASTM).

1.3.5 **Shell lime** mean the unburnt oyster shell, being ground grind and sifted through 100 mesh sieve (standard ASTM).

1.5 Conceptual framework



1.6 Benefits expected from research

1.6.1 Know about the feasibility of using throwing-away oyster shells for the removal of lead in synthetic wastewater, or using waste to rid another harmful waste.

1.6.2 Know about determine the effectiveness between oysters shells which burnt and unburnt for the removal of lead in synthetic wastewater.

CHAPTER II
LITERATURE REVIEW

This research aimed to study the feasibility of using oyster shells as a material to absorb lead from synthetic wastewater. Oyster shells was to be used as an absorbent such as structure is a thin layer of porous calcium carbonate was main component (1). Oyster shells was a waste, low economic value and used to advantage in small quantities. This research focuses on the oyster shell as a material to absorb lead from synthetic wastewater to be basic data used in true wastewater.

2.1 Heavy metals

Heavy metal mean to metal with a specific gravity ranging from 5 up, atomic number between 23 to 92 within column 4-7 of table of the elements, 68 elements of the periodic table has a solid state. (except mercury is liquid at room temperature), physical properties and thermal conductivity, very shiny, reflective, induction phase is a thin sheet. The chemistry is the oxidation of several heavy metals can combine with other substances is complex, multiple stable than the metal, especially when combined with organic compounds, metal compounds. (Organometallic compound) which is toxic and can be transferred into an organism,through the food chain. The toxicity of heavy metals of various kinds, could be lethal, accumulation in the human body, may result in disability or death.

2.1.1 Lead an IVA elements in the periodic table, atomic weight 207.19, melting point 327.4 °C, boiling point 1,725 °C, density 11.4 g/ml. Lead is used in such industries pollution problems to the people by increasing the amount of lead residues accumulate in the environment is in the air, soil water, plants and animals which have an impact on public health. Both the plants and animals used as food are often contaminated with lead from the industry. When lead is absorbed into the body through the blood system. Then be stored in the liver, kidney and bone, some of lead is excreted with feces and bile. Lead can inhibition of erythropoiesis of the bone marrow, causing anemia and on collector efficiency and reduced renal function and cause kidney failure. It also found that lead to the destruction of brain cells and nerves, the cause of the brain such as seizures, paralysis, mania, hallucinations, dizziness, abdominal pain, severe fatigue, loss of consciousness, uncertainty and death (2).

2.1.2 The toxicity of lead can into the environment caused by natural process and human action, most of the various industrial and combustion engines, can enter to body through 3way, he respiratory system, the gastrointestinal tract, the lead contamination in drinking water and food and skin from exposure. (show figure 2.1) When lead enters the body it binds to red blood cells. In addition to the soft tissues such as liver, kidney, heart and lungs, 90% of the lead entering the body be stored in bones. Lead is unabsorbed excreted with feces, absorb the excretion of urine from feces, 76 % 16% and 8% of the hair and nails.

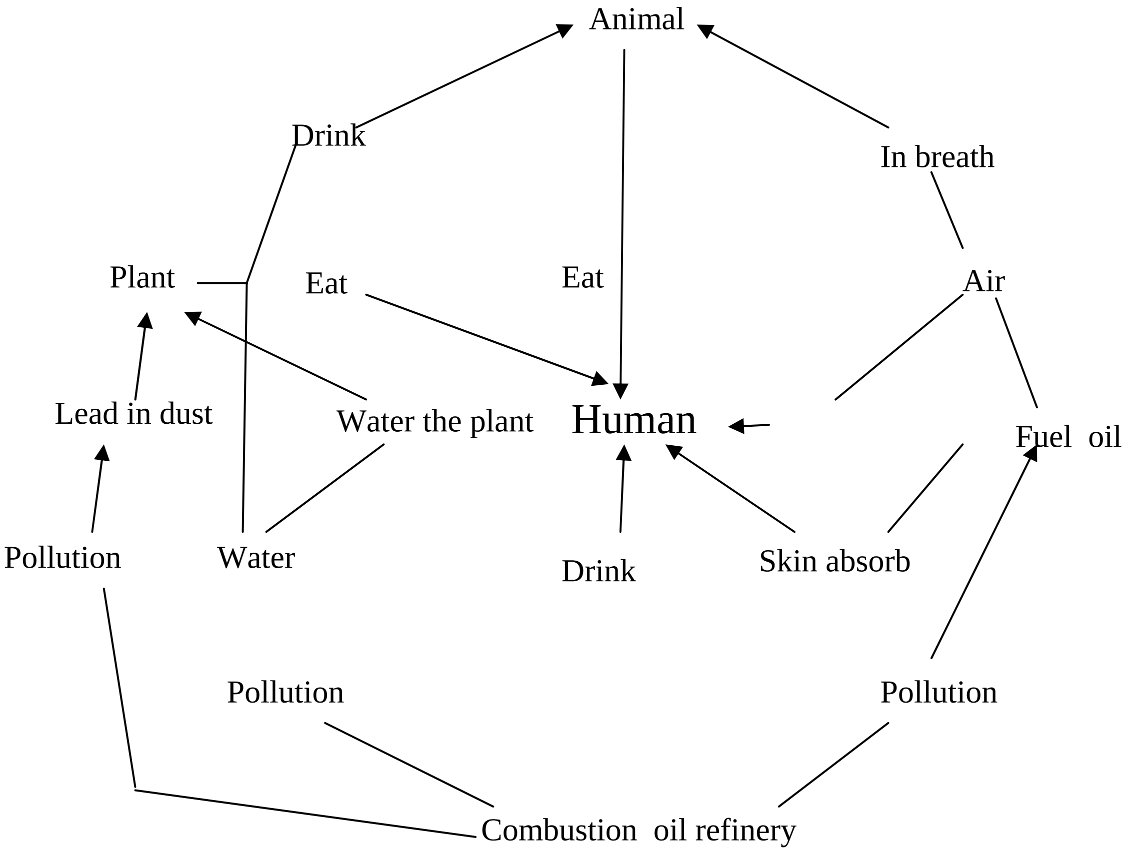


Figure 2.1 Entrance into body of lead (2).

The toxicity of lead is divided into 2 types: toxicity these acute and chronic both inorganic and organic lead.

1) Acute poisoning is rare in patients with eating or breathing in lead dust, lead enters the body in large quantities. Most of the neurotic as irritability, insomnia, anxiety, confusion and alienation of murky issues due to brain damage. It has a sweet taste in the mouth, similar to the metal in the mouth parched with thirst, severe stomach pain around the navel, anorexia, nausea, vomiting, constipation, urine can't output, blood are destroyed, blood pressure decreased, cold, headache, insomnia, muscle fatigue, hand and foot cramps, body senses an abnormal kidney damage may die within a day or two.

2) Chronic toxicity. These patients have been lead by little, gradually accumulate in the body are dizziness, fatigue, constipation, anorexia, depression, restless boredom sometimes headache, vomiting and abdominal cramps, anemia, pale as I do not feel sexual. The period the lead content of teeth. There is a line (Lead Line) which is a neurological syndrome that was associated with paralysis of the muscles of the hand and wrist, ankle, foot drop (Wrist Drop - Foot Drop).

Heavy metals such as mercury, cadmium, arsenic, lead, and some of the heavy metals that are toxic, persistent and will not change over time, then can also accumulate in the human body and water. Therefore, it is necessary to eliminate these heavy metals from waste water or sediment to prevent the spread of water to cycle through the food chain. USEPA has determined that 13 species of toxic metals removal from wastewater, including Beryllium, cadmium, chromium, copper, nickel, lead, zinc, silver, arsenic, mercury, antimony, selenium, and thallium (2).

2.2 Factors that affect absorbing metal

2.2.1 Kinetic of system while there is absorbing happens the molecules of destroied will depart water going to cling on a substance absorbs. Most of molecules will catching within a hole of a substance absorbs and have a little handle that outside skin, ventilating molecules from water goes to a substance absorbs can happen until equilibrium then stop at equilibriums point, condensed intensity of molecule water will be a little because most of molecules moves to catching on a substance absorbs, equilibrium of sucking sticks the skin of substance absorbs be beneficial important property which use in capability specification of the system absorbs such as make to know the system can eradicate the organic substance very much, etc, however still have important factor be kinetic of system be speed of absorbing that is when know how much is absorbing will can happen still must know the speed of absorbing for know how much is absorbing will can happen within the time be in a kinetic of system then helps to fix the time dams up water (or the time touches) of substance equal to size specification of substance bucket absorbs the speed and the capability in absorbing depend on all factor as follows.

2.2.1.1 The confusion, the speed in absorbing might depend on Film Diffusion or depend on Pore Diffusion which depend upon the confusion of the system if water has low confusion water film which surround a substance absorbs will have the very thick (because disturbed) and an obstacle for movement of molecules enter a substance absorb make Film Diffusion be formed fix the speed of absorbing on the other hand if water has hi confusion the water might not collect until is thick film cause the molecules can move to change water film enter seek a substance can absorb fast more than the movement goes inside a hole this cause Pore Diffusion will formed fix the speed of absorbing, that's why the speed in sucking sticks the skin of a substance absorbs then stay with Pore Diffusion because substance system absorbs often have hi confusion.

2.2.1.2 Size and surface area of adsorbent. Physical property important of substance absorbs be the size and skin area. Size of a substance absorbs to are influential build the speed of sucking sticks negative, the rate absorbs to mate turned around part with the size of a substance absorbs area skin part of a substance absorbs that have the relation directly with the capability in absorbing (Adsorptive Capacity) that be a substance absorbs that have skin area more than should sucked molecule more than a substance absorb that have skin area less.

2.2.1.3 The water solubility of the compound is adsorbed on the surface of the adsorbent, (Adsorbate Sdubilitty) when there was absorbing happens the molecules to pulled depart from water and go to cling on solid skin, substance that can dissolve the water (ionize) should have the power has trusted with water closely then difficult substance builds absorbing substance doesn't dissolve the water or can dissolve a little often can cling on substance skin absorbs well, however standard above no come true always because of a substance that can dissolve water a little various kinds cling substance skin can absorb difficult but absorbing might can happen easy with a substance at dissolve water well, that's why then might can't deliver a speech extremely there is the relation certainly in quantity manner between the ability in a substance absorbs and ability to dissolve in water.

2.2.1.4 Size of Adsorbate the size of a substance or molecular lies absorbing happen well most when there is small-sized substance more than a little hole (just enough go inside a hole) because of the gravity between a substance and a substance will absorb to are valuable most the molecular small-sized sucked go inside a hole before from that time the molecular large-sized more than sucked enter.

2.2.1.5 pH because of pH influential build destruction is the ion and water dissolution of a substance differ thus then affect build absorbing with besides ion hydrogen by oneself is the ion at can cling the skin well.

2.2.1.6 Temperature be influential build the speed and the capability in absorbing that is to say the speed increases to follow the temperature up and down follow the reduction in the temperature but capability in absorbing is will valuable is down at hi temperature and will valuable increase at low temperature because of absorbing is the reaction like model Exothermic .

2.2.2 Type of adsorbent a substance that is influential suck the molecular come to stick the skin call that adsorbent, divide get 3 a kind as follows (3).

2.2.2.1 Inorganic such as kind all clay, magnesium oxide, ashes lignite bone (Bone Char) and activated silica. There is surface area about 50-200 a square meter per gram, be defective can catch the molecular or Colloids applying less then have to limit.

2.2.2.2 Activated Carbon be a substance sucks to stick the skin better a substance the inorganic a kind is other because of there is the surface area about 600 - 1,000 square meter per gram. Activated carbon has that to used and deteriorate already can induce do state returning (Regeneration) and come back use new get but be defective, be state returning of carbon must burn at hi temperature make consume many expensive don't break even and must have some part carbon loses because of become dust and it did not work.

2.2.2.3 Organic synthetic substance at has charge on the surface can suck catch with other material at have charge opposite cause sticking to has next for example a substance exchanges kind special ion synthetic for eradicate the organic substance differs call that Macroporous Resin or Adsorbent Resin such as Styrene Divinylbenzene (SDVB) Resin and Phenol - Formaldehyde (PF) Resin etc. There is surface area about 300 - 500 square meter per gram, which lower of activated carbon but there is the merit more can regeneration has easy and cheap such as, salt for Thailand the suitability in using sucks to stick more activated carbon, when, consider the limitation in regeneration (3).

2.3 How to remove heavy metals

Heavy metals in wastewater are many kinds. Some metals are highly toxic and harmful to living things, such as cadmium, mercury, nickel, lead, therefore, must control quantity of heavy metals from high volume to harmful levels. How to get rid of the heavy metals are many ways.

2.3.1 Adsorption, the adsorption of heavy metals by the media to come to the surface of the medium. The media used include activated carbon be expensive. Activated Carbon has sucked surface rate variation which back to the square of the diameter of a molecule of the toxin. Increased concentration of pollutants in the waste, decreased with increasing molecular weight of the pollutant variation with the square of contact time between molecules of impurities with activated carbon content and increasing with pH decreases. Activated carbon when used some time, porosity of the activated carbon are clogged with toxic molecules. Eliminate need for regeneration in the adsorption of or replaced (4).

2.3.2 Oxidation – Reduction in case of the removal of pollutants dissolved in water but cannot be used to precipitate may be used oxidation - reduction that changes toxic to non toxic. The oxidation - reduction such as addition of chemicals may be an oxidizing agent (Oxidant) or a reducing agent (Reductant) either to the oxidation - reduction and pollutants. The reaction of a substance is non toxic or less toxic. The chemicals used are as follows.

(1) Oxidizing agent, including ozone, oxygen, chlorine form, potassium permanganate and hydrogen peroxide.

(2) Reducing substances, including sulfate, iron sulfide and sulfur dioxide.

2.3.3 Ion Exchange process. Can eliminate the positive ion (Cation) and negatively charged ions (Anion) from wastewater. The ion exchange material is divided into two types such as Zeolite and Ion Exchange Resin, ion exchange resin, which is very popular because of its higher performance. Wastewater will flow through tanks containing ion exchange resin. Cation ions in wastewater to be exchanged with hydrogen ions (H^+) or sodium ions (Na^+) of resin ion exchange such as strong acid resin and weak acid cation resin. Anion ions in wastewater will be exchanged with the hydroxide ion (OH^-). Resins all kinds used some time to be effective lower. However, kinds of resin can be regeneration more differently (5).

2.3.4 Chemical precipitation mean chemical precipitation of solution is changed in such a solution is a substance to insoluble in water be sediment by chemicals addition. This method be different from consolidation of sediment, (Coagulation), be addition of chemicals to material as well as a smaller silt sized sediment in reaction to a chemical precipitate. Process of sedimentation be 3 phases: 1) The assemble particles. 2) The growth of crystals. 3) The formation of a solid. The solution can have stable in saturation a little over and when the size of the maximum saturation (Super Saturation) or when any particles reaction solution be precipitate formed, will follow the steps.

(1) Aggregate particles. (Nucleation) the reaction between the particles ions or molecules of solvent in the water together to a critical point (Critical Cluster) then the nucleus is as follows.

X + X X2

X2 + X X3

Xj-1 + X Xj (Critical Cluster)

Nucleation Xj + X Xj +1

The formation of solid deposits are formed on the nuclei or small particles, formed by a cluster of molecules. The particles (Nuclei) of ions be a process that uses energy for structure of nuclei in solution. The energy of each substance is different. The external factors may be involved such as the effect of various ions dissolved in the mixture.

(2) The growth of the crystal (Crystal) after the incorporation of particles of atomic ions on the surface area of nucleus, the crystal (Crystal) is formed by the following equation.

Xj +1 + X Crystal Growth

(3) Agglomeration and Ripening of Solid) after the formation of crystals, it will grow in size until they are solid in the initial period. Crystalline solid formed was not stable enough to be completely solid. However, over time crystal structure changes form more stable. The changes with time as we call Aging Process. Changes in particle size from small to large will happen by itself according to the dynamics of heat (Thermodynamics) of a substance, can accelerate these changes with addition the power such as agitation it (6,7).

Because of the heavy metals found in wastewater and the problem is usually in the form of the solution. It is impossible to treat the wastewater by sedimentation or filtration alone. The removal of heavy metals to cause a fall over precipitate solid. The reaction of the positive and negative ions as well as a solid precipitate insoluble in water before. Then the solids together in a cluster or not. To be separated from water by sedimentation and filtration. Therefore, it is seen that the removal of heavy metals generally have a precipitate with coagulation and with the precipitate and filter heavy metals such as zinc, copper, lead, cadmium, etc. The only problem with the wastewater and the low pH due to heavy metals are soluble at lower pH to increase the pH to make solubility heavy metal reduction in water, and precipitation, so the addition of alkali such as sodium hydroxide or lime based chemicals to the water until the pH is increased to a reasonable level. The precipitated crystals with heavy metal ions in the hydroxide (OH^-) of the resulting crystalline solid assemble to flocculation with the coagulation processes. Separate flocculation with precipitated tank. Amount of lime or soda ash, rough calculation may be used the chemical equation for the reaction of the sludge. However removal of heavy metals should be tested in the laboratory to determine the optimal pH and concentration of chemicals for the removal of heavy metals by the Titration Curve of wastewater resulting from the addition of alkali and Jar Test to determine the pH and the addition of suitable chemical precipitation with hydroxide crystals in it. Heavy metals may be precipitated crystals in combination with other negatively charged ions such as sulfide ($S2^-$) and metal sulfides. Solubility in water is less than the metal hydroxide is used in Na_2S or NaHS reacts with heavy metals. The precipitated crystals precipitated crystals of the disadvantages of heavy metals with the sulfide. Sediments is small and very small. The precipitation is unlikely. Also reacted to the precipitated crystals, toxic gases, heavy metals with lime or soda ash is a popular rather than by the use of lime is the most popular, use lime to precipitate the heavy metals or crystals are larger than the sodium hydroxide (5).

2.3.5 Removal of heavy metals by precipitation with hydroxide, carbonate and sulfide in the treatment of wastewater contaminated with heavy metals by chemical precipitation is a commonly used alternative. The important thing for heavy metal removal by precipitation method is to study the ability in the precipitation of each metal for best resulting precipitate and keep out. The removal of heavy metals by chemical precipitation that chemicals that can be precipitated as the hydroxide, sulfide and carbonate, chemical that is commonly used is hydroxide. The mechanism of reaction of each a positive charge of the metal with OH^- S^{2-} and CO_3^{2-} respectively, resulting in the incorporation of the metal hydroxide, metal sulfides and metal carbonates as follows.

$$M^{2+} + 2OH^- \quad M(OH)_2$$

$$M^{2+} + S^{2-}MS$$

$$M^{2+} + CO_3$$

$$2 - MCO_3$$

Hydroxide in solution, this is the most popular methods. This process will result in change pH, the most of heavy metals are precipitated between pH 8.50 to 9.50, metal hydroxide in the sludge will be dissolved in any pH or cannot sediment completely. Metal hydroxide precipitated in colloidal form so that the addition of a coagulant such as alum and iron for reduce the charge and the particles can touch each be a solid. Although pH value does not matter sulfide and carbonate, sediments of the two methods will be harder than the hydroxide but either way it still is not popular. Because of the sulfide is toxicity if sediment sulfide touch acid be hydrogen sulfide gas. The sludge is difficult to get rid and cost of buying the chemicals is expensive than hydroxide methods by carbonate costs about 4-8 times and sulfide methods costs higher than about 10-20 times. The sedimentation profile of these three methods are as follows.

2.3.5.1 Hydroxide Precipitation. Water-soluble heavy metal ions are converted into the metal hydroxide is insoluble in water (Metals-Hydroxide), by the addition of chemicals to cause precipitation (alkali-precipitating agent) by the chemical reaction and the following.

- Sodium hydroxide (Caustic soda; NaOH)

$$M^{2+} + 2NaOH \; M(OH)_2 \, (s) + 2Na^{+}$$

- Lime (Hydrate Lime; Ca $(OH)_2$)

$$M^{2+} + Ca(OH)_2 \; M(OH)_{2(s)} + Ca^{2+}$$

- Magnesium hydroxide (Magnesium Hydroxide; Mg $(OH)_2$).

$$M^{2+} + Mg(OH)_2 \; M(OH)_{2(s)} + Mg^{2+}$$

The mechanism of precipitation using hydroxide the performance is pH of the water, chemicals precipitate used and the solubility of the precipitated metal. The advantages precipitation of heavy metals by hydroxide is easy, widely used and inexpensive. It can reduce some kind substances in water such as soap and the fluoride etc. The disadvantage be hydroxide have low performance in the removal of some metals such as lead, manganese and silver, etc., While some metals for the reduction - oxidation before precipitation, such as Chromium +6 to Chromium +3 like selenium +6 to selenium +4 and arsenic +3 to +5.

Advantages and disadvantages of precipitation by hydroxide.

Advantages - Control only pH in optimum range.
- It is generally accepted and used in the industry.
- A step in the process is not complicated.
- A low cost.

Disadvantages - Sediments are likely to be dissolved when the pH changes.

- In the precipitation wastewater with many metals it is not performing well because each type of metal has to precipitation different optimal pH.
- The chemical compound complex was negative effect to precipitation by hydroxide.
- Chromium +6 cannot get rid of it this methods.
- Cyanide is a disturbance in the precipitation of heavy metals.
- Precipitation of hydroxide in water can be separated difficult because the structure of soft sediment.
- Hydroxide cannot be precipitated at lower than pH 6.

2.3.5.2 Sulfide Precipitation. Precipitation of heavy metals by sulfide, mechanism as well precipitated by hydroxide. It is changing the heavy metals in solution form as insoluble by the addition of chemicals to precipitate for example.

- Sodium sulfide; Na_2S.
- Sodium hydrosulfide; NaHS.
- Ferrous sulfide; FeS.
- Calcium sulfide; CaS.

Sulfide precipitation is useful to use as an alternative to metal cannot precipitation by hydroxide because the sulfide (S^{2-}, HS^-) is highly effective in the precipitation of metals and the pH does not affect performance much. Sulfide precipitation is often used with lead, copper, chromium+6, zinc, cadmium, mercury and nickel. The precipitation reaction in the normal pH (7.00 to 9.00) sulfide combines with the metal become to the heavy metal-sulfide and the reaction of the precipitation of nickel sulfide is shown in equation.

$$Na_2S + Ni_2 + NiS(s) + 2Na^+$$

Advantages and disadvantages of sulfide precipitation.

Advantages - Can effectively remove heavy metals even with low pH (2-3).

- The time of sedimentation rates are low because of high reactivity.

- Metal removal can be modified to use again.

- The sediment of sulfide is heavier weight than and can be separated from water than sediment of hydroxide precipitate.

- The sulfide leaching at pH 5 is lower than precipitate of hydroxide in a 3-times.

- The sediment of sulfide has hi density than sediment of hydroxyl.

Disadvantages - Be hydrogen-sulfide gas which is toxic.

- The residual sulfide in the treated water.

- Have a musty smell.

- A high cost than precipitate of hydroxide.

2.3.5.3 Carbonate Precipitation the solution of heavy metals can be precipitated directly with various compounds carbonate such as.

- Soda ash (sodium carbonate; Na_2CO_3).
- Sodium bicarbonate; $Na(HCO_3)$
- Calcium carbonate; $CaCO_3$

Carbonate precipitation sediment, heavy metals can be effectively used as an alternative to the precipitation of hydroxide. Carbonate precipitation in the ability to depend on the constants in the precipitation of metals, carbonate and pH in water typically, the solubility of metal carbonates. It is between the high solubility of metal hydroxide with metal sulfides the relationship of carbon and heavy metals. How to carbonate precipitation is effective in removing cadmium, lead and nickel hydroxide precipitation over the site and sediment to be processed for reuse as well. In addition, the precipitation in the hydroxide does not cause gas, however, sometimes the absence of carbon dioxide gas to precipitate the way carbonate precipitation in this process. The metal is precipitated in the form of the metal carbonate, (Metalscarbonate) and high metal hydroxide (metals hydroxide) in the removal of sediment that must be covered to prevent leaching of sediment and sludge.

1) Calcium carbonate precipitation, limestone is usually in the form of high calcium ($CaCO_3$) and dolomite ($CaCO_3MgCO_3$) both of these take the

form of powdered lime. It is mainly used in high calcium precipitation because the reaction rate is higher than. The disadvantages of the method is the precipitation at pH 5.0 to 7.0 so popular used calcium carbonate with lime. The calcium carbonate is the primary treatment of wastewater to adjust the pH 6, then the lime in the treatment of heavy metal to be next.

2) Sodium carbonate precipitation (Na_2CO_3) commercially known as soda ash and it for low pH and buffer of wastewater. Soda ash precipitation reaction rate is relatively low compared to the hydroxide in the reactor used in the precipitation must be large enough to take a deposition for about 45 minutes but the advantages of using soda ash the sediment is less than the hydroxide precipitation in the example.

Advantages and disadvantages of carbonate precipitation.

Advantages - The carbonate compound used in the precipitation can be transported easily.

- Sodium carbonate can increase buffer in water and have sediments around a little.

- Heavy metals can be precipitated at low pH.

- Precipitation of metal-carbonate can be separated easily from water than metal-hydroxide in water.

Disadvantages - It is longer time of precipitation because reaction rate is low.

- Carbonate is contaminate in the solution is simple and easy as carbon dioxide.

- Sometimes calcium carbonate does not reaction with heavy metals.

- Calcium carbonate is precipitated at range pH 5-7 only.

- Chromium +6 reduction process prior to carbonate precipitation.

2.3.6 Electrodialysis are devices that use electricity within a membrane filter 2 kind both anionic and cationic membranes. Which allows same charge to flow through it but molecules of water will flow through it more difficult to extract heavy metals, such as separation of heavy metals from electroplating wastewater, separated from the liquid film (8).

2.3.7 Filtration compression filtering water and trapping the wastewater with high pressure through the filter material.Solids cannot escape the trap filter, Filter is a various such as a multi-channel filtering with the filter (microfiltration), filter has a very fine filter (Ultrafiltration) and filtered by means of osmotic water filtration systems are used to separate the suspended solids economic value.

2.3.8 Drying of the wastewater may dry by sunlight or direct heat to evaporation of water from the remaining solids such as drying the sludge to dry by the sunlight.

2.3.9 Distiliation was isolated by extraction with different boiling point degrees of combination.

2.3.10 Centrifuge based on the principle of centrifugal force. Wastewater is being thrown by a very high speed. Solids high specific gravity will be thrown out around with the method is suitable for wastewater with high concentrations of suspended solids.

2.3.11 Solvent extraction of the extractant which is insoluble in water but soluble substances in wastewater. Then extract containing the soluble extract was removed such as distillation etc, as this method may be a solution in wastewater reuse.

2.4 Oysters

Oysters or mussels Takrom another limpet is a highly nutritious it is well known because the meat is delicious can be eaten fresh or a variety of different types. The parties to the trade. The current yield is not sufficient for the consumption of people in the country. It tends to grow in the coming decade. The price of oysters or shellfish, especially oysters were Taokrm cost more than other types of shellfish. In foreign countries such as Japan, America and France. Oyster farming is an industry using several methods. Natural oyster farming in order to consume the food in the two categories.

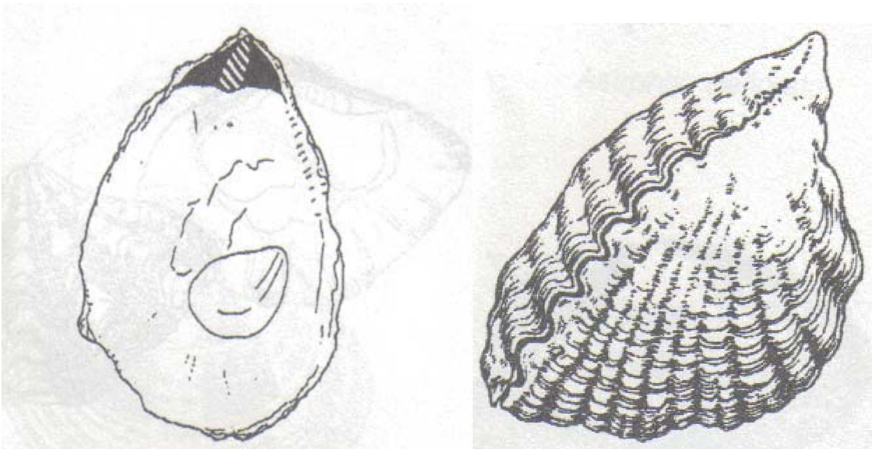
A. Most species, including clams, oysters and white Taokrm jaw. And black mussels Taokrm jaw.

B. Small oyster species. Oysters or clams, or oral penetration or shell diminishes the minister said.

The oyster shells were consumed almost entirely by the nature of culture. Most of the traditional culture. Oyster farming, which has more than 50 years, has produced about 5,000 tons per year, found the coast of Thailand, Chonburi, Rayong,Chanthaburi Province, eastern provinces, including Bangkok, where most of the small farming oysters. Part of the Gulf of Thailand, Pattani and Songkhla, Surat Thani and Chumphon province of Narathiwat with both species and varieties of oysters. For oyster farming on the West Coast and southern provinces of Ranong and Phang Nga. Most of the white mussel Takrom jaw and black mussels Takrom jaw.

2.4.1 Biology of the Oyster

Oysters are bivalves that are found along the coast. The islands were under rocks or tree roots, there are many species from low salinity to high salinity. Oysters are placed in the taxonomy (9).



(A) (B)

Figure 2.2 Offers a variety of oyster. The economic importance(9).

(A) Oyster offers. *Crassostrea*

(B) Oyster offers. *Saccostrea*

Phylum Mollusca
  Class Bivalvia or Pelecypoda
    Subclass Pteriomorphia
      Order Anisomyaria
        Suborder Ostreoida
          Family Ostraeidae
            Genus *Saccostrea*

2.4.1.1 General characteristics of the shells in my cabinet sup (Saccostrea cucullata).

1) The outer shell. Oysters are bivalves that live on the island. Two shell sizes are not equal. The shell has a wavy, uneven appearance diminishes. The shell is left attached to a solid object. The large shell that resembles a cup. The other side is flat, smooth and smaller. The scales along the edge of the shell. The two shells connected by a hinge. The appearance of the shell is fixed, although the same type. The residential area. The object of the islands were like a snail shell to grow on the hard floor as he looks ready.

2) The general nature within the shell. The shell is part of the body shell, which consists of a thin sheet of tissue covering both sides. The plan called for it. Meat Man title (mantle) is a sheet of thin radiating lines extend to the oral and labial palp, which is used in the identification of the oyster. Characterized by the arrangement of the tentacles. Meat on the plate with two pairs of gills, man never acts to filter food from water, and the testicle and respiratory function and helps in the excretion of waste from the body. Flex the muscles of the body shell is included on the various organs, including blood, nervous system, digestive system, reproductive system (10).

Oyster and clam shell-hinged Takrom thick and no teeth in its subscript no water and no fiber. The shell of a single muscle feed by filtering tiny plants and animals with water are both in the sea and brackish water. Naturally found in rocks in the water column at the root of the tree or materials that are in the flood. The lid is welded to one side the cover is attached to the pouch material is deeper than the cover both cover the same size shells found in nature is also jam this material has been distorted by the island.

2.5 Related Research

From the collection of research related to the treatment of wastewater containing heavy metals by chemical precipitation as follows.

2.5.1 Bin L. et al. (11) studied the kinetics of the precipitation of cadmium hydroxide in citrate (salt of citric acid) and without citrate in water. The experimental design using a continuous stirred tank. Using the initial concentration of cadmium in the range 2.0 to 4.0 x 10-4 M and the model name “A population balance model” to calculate the rate of nucleation and growth of the particles. The results showed that when there non citrate particles of cadmium hydroxide in the birth and growth than citrate in the water.

2.5.2 Macchi G. et al. (12) studied the removal of lead from battery manufacturing plant using sediment of iron (Fe^{3+}). It is caused by the sediment. Neutralization with sodium hydroxide and wastewater with sulfuric acid of the plant battery itself. Therefore, this study is useful as a waste utilized in the treatment of wastewater containing lead. The removal efficiency was csimilar to the treatment with hydroxide method. In the plant wastewater with a lead concentration of lead be 10 ppm. In the process of precipitation add sediment of iron at ratio Fe/Pb was 0.5, pH of 9.0 - 9.5. It takes an hour to settle, the concentrations of lead have dropped below 0.2 ppm.

2.5.3 Gomez C. et al. (13) studied the removal of cobalt ($Co2^{+}$) in water with sodium hydrate MA ($NaBH_4$) in this study found that The amount of Hillsboro High Drive (BH^{-4}) at the end of the reaction with BH^{-4} / H_20 affect the removal of cobalt to be effective because Hillsboro Heights Drive will be directly related. pH and alkaline community. The mechanism of cobalt removal. In the drive-in. Will react with water to form the hydroxyl site (OH) also were careful not to have too much oxygen dissolved in water. By avoiding the stirring speed. This will precipitate the cobalt, the reaction with oxygen. The precipitate of cobalt can be oxidized and easily.

2.5.4 Tunay O, Kabdali N (14) studied the treatment of heavy metals in the form of complexes.to settle a hydroxyl site. This study aims to evaluate the mechanisms of bonding that takes place to ensure that it can describe the removal of heavy metals in the complexes in this experiment, the heavy metals are cadmium, copper and nickel composition of organic complexes as well. the metal with acid and EDTA NTA and New York City. Calcium is associated with bonding. The results showed that at high pH. The precipitation of heavy metals are formed from organic complexes that bind to heavy metals, calcium is bound to cause the metal to metal it will catch up with the hydroxyl sites. In a metal hydroxide. Which the sediment can be removed from the water.

2.5.5 Dario M, et al. (15) studied the precipitation of lead sulphate and carbonate in the water by using water with a lead 10 mg/l of sulfate in the range 10-2 M p. pH between 3.9 to 11.3 for carbonate in the form of inorganic compounds. The concentration of 1.5 x 10-2 M concentration of lead was reduced to less than 0.1 mg/L in the study of equilibrium and chemical reaction model MINTEQA2 was used to determine when the sediment was analyzed by X-ray diffraction analysis revealed that the sediments of the metal lead, the three types of anglesite ($PbSO_{4\ (s)}$) cerussite ($PbCO_{3\ (s)}$) and hydrocerussite ($Pb_3\ (CO_3)_2\ (OH)_{2(s)}$).

2.5.6 AI Zouboulis et al. (16) conducted experiments in the laboratory. The removal of metal Chromium +6 ions in water by using a powder aparts which is a mineral containing iron sulfide was found that aparts can act as a reducing agent it can reduce Chromium +6 to Chromium +3 ions which can be eliminated by means of precipitation to the chemical.

2.5.7 Ronald S S, et al. (17) studied how different types of metals in the leachate by means of physics and chemistry. The results showed that the leachate will be the amount of iron and manganese reduction, wastewater aeration process. The other metals can be eliminated by adjusting the pH in the range 9-11.

2.5.8 Macchi G, et al. (18) studied the precipitation of lead in battery manufacturing wastewater by carbonate precipitation. The results showed that the amount of lead remaining in water after precipitation and filtration through a 0.45

micron filter size is less than 0.2 mg/L was precipitated in the pH range 9-10 and concentration. of approximately 1.5 x 10-4 M carbonate precipitation process to occur and to take all 24 hours of sediment settling occurs in the form of hydrocerussite ($Pb_3 (CO_3)_2 (OH)_2$).

2.5.9 Wei Chu. (19) studied the elimination of lead in water by using alum sludge. At pH 11.6 the lead precipitate can most effectively lead to the precipitation with alum sludge and alkaline substances in the water is high lead hydroxide. The maximum efficiency is 96-99%.

2.5.10 Yowwanoot S. (20) studied the optimal conditions and effective in the precipitation of chromium from wastewater dyeing. Using various types of chemicals. Magnesium oxide. Sodium carbonate and lime with water and sediment, three types of polymers in anionic polymerization of cationic and the polymer is fully charged and were precipitated by the use of chemicals in all three of the near the same is 98 percent to 100 percent.

2.5.11 Kanitta T. (21) studied the removal of heavy metals in waste water from the analysis of COD crystals precipitated by means of this chemical. There are three steps in the process is to explore and gather information through interviews. The experiment chemical precipitation of heavy metals and analysis of the cost of wastewater treatment. Analysis of wastewater COD before treatment laboratory and 10 of the different metals, mercury, chromium and iron averaged below the 1341.20 288.45 924.10 and 153.18 ppm, respectively, for the partial purification of chemical substances 4 is a chemical combination of sodium chloride Sodium hydroxide and sodium hydroxide and sodium sulfide Sodium hydroxide and sodium hydrogen sulfide sodium thiosulfate and sodium hydroxide. The metals, mercury, chromium and iron in water is equal to 0.001 0.01 to 0.50 and 1.32 milligrams per liter. The metal removal efficiency of 99.96 and 99.80 percent, 100, 100, respectively.

2.5.12 Pakakrag N. (22) have suggested treatment of the waste by means of chemical precipitation using high tensile strength. The co-precipitated calcium carbonate it was found that the optimum conditions for treatment with Jar test was used for stirring up 5 minutes, stirring slowly for 10 minutes and the pH value of 5.12 was found to reduce the COD is 80.51 percent of the chromium was 64.51 percent arsenic 85.59. Mercury was 91.31 percent and 13.19 percent, which was precipitated suspended solids results were found. The treated wastewater from the waste water within the standard of the industry Except for arsenic.

2.5.13 Wirasinee P. (23) conducted an experiment to precipitate heavy metals in many types of hazardous waste from the laboratory of the University of Amsterdam 3 Department of Chemistry Laboratory. Department of Pharmaceutical Chemistry the Department of Environmental Engineering by chemical precipitation using high tensile strength of $Ca(OH)_2$ and NaOH was found that at pH 12, which was most effective in the removal of NaOH is more effective. Heavy metals from laboratory chemicals and operating environment of $Ca(OH)_2$ is effective in the removal. Heavy metals from the Chemistry results were as follows; a chemistry laboratory is capable of removing Hg, Mn, Pb, Zn, Ca and Cd were 99.99, 98.44, 99.57, 98.90, 62.5 and 22.56 respectively, laboratory of Pharmaceutical Chemistry eliminate Hg, Mn and Zn were 99.99 98.61and 91.02 as. The operating room environment to eliminate Cd, Fe and Hg were 99.98, 99.90 99.95 percent, respectively.

2.5.14 Sirisopa N. (24) study to determine the optimum pH for the precipitation of heavy metal species. Wastewater collected from the lab. General Chemistry Laboratory. Chemicals used in the precipitation of the three types of sodium hydroxide. High calcium hydroxide and sodium hydrogen sulfide by settling them. In the form of metal hydroxide and metal sulfide in the study. Divided into four types of waste water, wastewater treatment from among the cations of a wastewater treatment for the cations among the two wastewater treatment for all three cations and water analysis. And salt mixture, the study found that each execution less than 20 liters of water is acidic. The concentrations ranged from 0-943 mg/l. The sediment as well as in metal hydroxide, using calcium hydroxide in solution. The water has a pH of 11 however, the strength of the Hg^{2+} ion is left to the effluent standards.

2.5.15 Sutindhorn M. (25) studied the contamination levels of heavy metals in the analysis of waste water from the laboratory environment, and compares the effectiveness of the treatment of heavy metal contamination in water with a chemical group, the hydroxyl sites. The carbonate and silicate in wastewater analysis DO BOD COD NH_3-N and NO^{3-}N concentration was studied. Heavy metals found heavy metals from wastewater for mercury, cadmium, chromium, iron, manganese and magnesium be 0.034, 49.989, 50.471, 52.63, 61.23, and 58.66 mg/l respectively, after the heavy metals removal by chemical precipitation of Na_2CO_3 Ca(OH) and Na_2SiO_3 precipitated mass of 10 g/L of wastewater from laboratory chemical analysis. Through adjusting the pH with sodium hydroxide and calcium carbonate to pH 9.0, the removal of various heavy metals, which are 98-99 percent more than the standard features of the waste water discharge of plant except in the case of mercury, it is still too high standard.

CHAPTER III

MATERIAL AND METHODS

This research is the experimental for study to reduction of lead from synthetic wastewater with lime shells from burnt oyster shells at 950 ° C for 5 hours experience compare with unburnt oyster shells, being ground grind and sifted through 100 mesh sieve (standard ASTM).

3.1 Materials

3.1.1 Adsorbent.

3.1.1.1 Preparation of adsorbent from oyster shells stack abandons last 6 - 12 months, Tumbol Seansuk and Tambol Ang-sila Amphoe Muang, Changwat Chonburi.

1) Bring wash clean and air dry.

2) Bake to chase the moistness at 105 ^{o}C for 5 hours.

3) Preparation burnt oyster shells at 950 °C for 5 hours, abandon keep coldly, being ground grind and sifted through 100 mesh.

4) Preparation unburnt oyster shells, being ground grind and sifted through 100 mesh.

5) Keep in utensils that is free from moistness for next step test.

3.1.2 Synthetic wastewater.

3.1.2.1 Preparation of synthetic wastewater 0.15 % from lead nitrate ($Pb(NO_3)_2$ in polyethylene plastic tanks size 1,000 liter installed water pump for circulate and pH was measured.

3.1.2.2 Measured synthetic wastewater 80 liter in polyethylene plastic tanks size100 liter, 6 tanks installed water pump for circulate.

3.1.2.3 Adjust the pH of synthetic wastewater in polyethylene plastic tanks size100 liter to 7.00, 8.00, 9.00, 10.00, and 11.00 respectively by sodium hydroxide solution 1 N. and sulfuric acid solution 1 N.

3.1.2.4 Sampling of the wastewater tank in order to analyze the initial lead.

3.1.3 Chemicals and equipment

3.1.3.1) Oyster shells burnt at 950 °C for 5 hours and unburnt being ground grind and sift through 100 mesh.

3.1.3.2 Distilled water.

3.1.3.3 Sodium hydroxide (NaOH) for pH adjustment.

3.1.3.4 Sulfuric acid (H_2SO_4) for pH adjustment.

3.1.3.5 Electric weighing balances 4 positions.

3.1.3.6 pH meter.

3.1.3.7 Glass equipment.

3.1.3.8 Jar Test Apparatus.

3.1.3.9 Atomic Absorption Spectrophotometer; AAS.

3.1.3.10 Electron microscope.

3.2 Methods of analysis

3.2.1 Preparation adsorbents lead form burnt oyster shells at 950 °C for 5 hours and unburnt being ground grind and sift through 100 mesh. (Fallow 3.1.1)

3.2.2 Preparation synthetic wastewater (fallow 3.1.2) quantity 80 liter in polyethylene plastic tanks size100 liter, 6 tanks of pH5.63 (not adjusted pH) 7.00, 8.00, 9.00, 10.00, and 11.00 respectively by sodium hydroxide solution 1 N and sulfuric acid solution 1 N.

3.2.3 Measured 500 ml. of synthetic wastewater into 4 beakers size 1,000 ml. and installed with Jar-test apparatus.

3.2.4 Weigh the unburnt oyster shell was grind and sifted through 100 mesh quantity 1.25, 2.50, 5.00, and 10.00 g equal to 0.25, 0.50, 1.00, and 2.00 % quantity of synthetic wastewater respectively, put into 4 beakers

3.2.5 Adjust the paddle of Jar-test apparatus speed to 100 cycles/min for 2 minutes, and then adjust the speed to 30 cycles/min for 10 min to achieve flocculation, according to principle of jar test.

3.2.6 Stand abandon 15 minute for precipitated.

3.2.7 Separation clear solution of precipitated to measure pH with pH meter.

3.2.8 Quantity 300 ml of clears solution into the clear plastic polyethylene and add 5 ml. of nitric acid for analysis concentration of lead on the rest.

3.2.9 The experiment was repeated 3 times for average.

3.2.10 Fallow 3.2.4 to 3.2.10 by vary synthetic wastewater was adjusting pH 7.00, 8.00, 9.00, 10.00, and 11.00 respectively.

3.2.11 Fallow 3.2.4 to 3.2.10 with true wastewater.

3.2.12 Change adsorbent to burnt oyster shells at 950 °C for 5 hours and then tested fallow 3.2.4 to 3.2.10.

3.2.13 Analysis of the concentration of lead by Atomic Absorption Spectrophotometer: AAS.

3.2.14 The composition of the adsorbent with an electron microscope

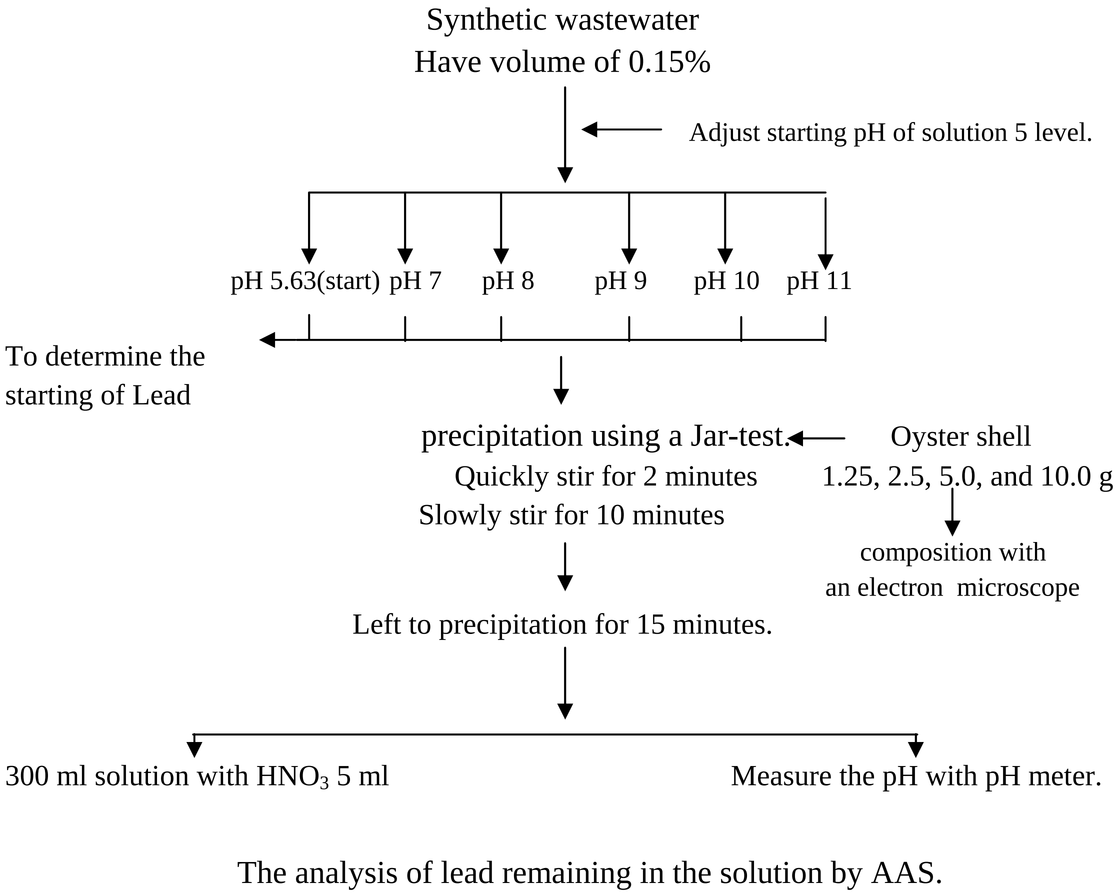


Figure 3.1 How to test the precipitation of lead in synthetic wastewater.

Remark ; Repeat 3 times for each pH an average.

In this work the place of trial, Chemistry laboratory, Faculty of Science Burapha University, Amphoe Muang, Changwat Chonburi.

3.3 Analysis of the data

Information before the precipitation of lead and chemical precipitation with the burnt oyster shells burnt at 950 °C and unburnt oyster shells were analyzed. The studies of sediment in the pH of synthetic wastewater by the method used to analyze the data.

3.4.1 The percentage of reduction of lead content in synthetic wastewater.

$$\text{The precipitation efficiency (\%)} = \frac{\text{before the precipitation of lead - lead after settling x 100.}}{\text{Lead before settling}}$$

3.4.2 Performance comparison efficiency between the burnt oyster shells and unburnt oyster shells.

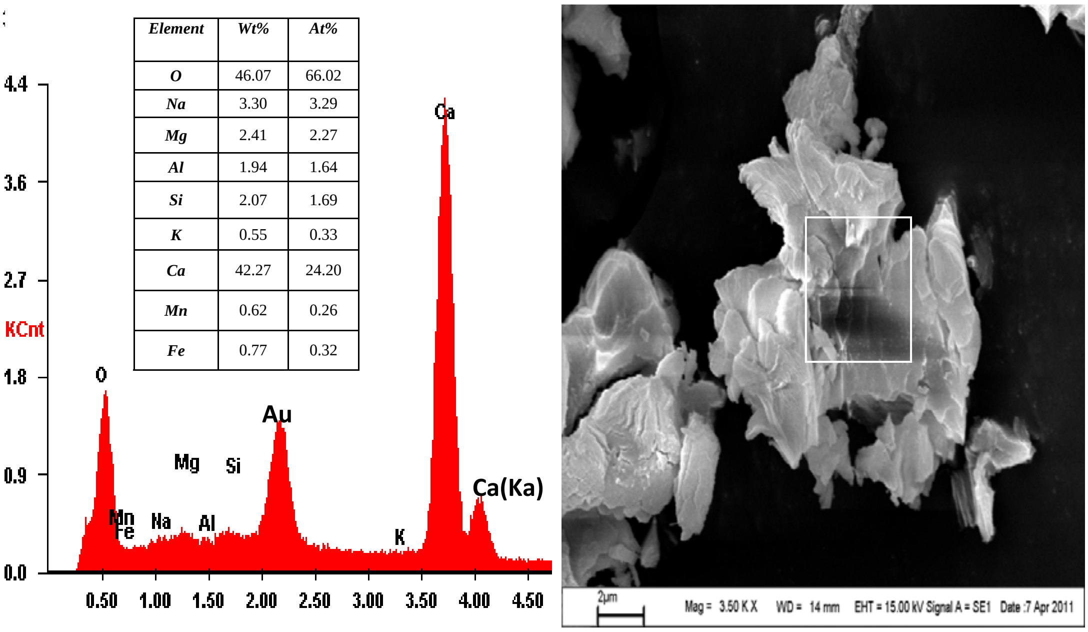
CHAPTER IV

RESULTS AND DISCUSSION

This experimental were study the feasibility of using oyster shells as well as to reduce the lead content in wastewater by comparing the adsorbtion efficiency between the burnt oyster shells at 950 °C for 5 hours and oyster shells unburnt, grinded and sifted through 100 mesh sieve (standard ASTM).

4.1 The components of the oyster shell

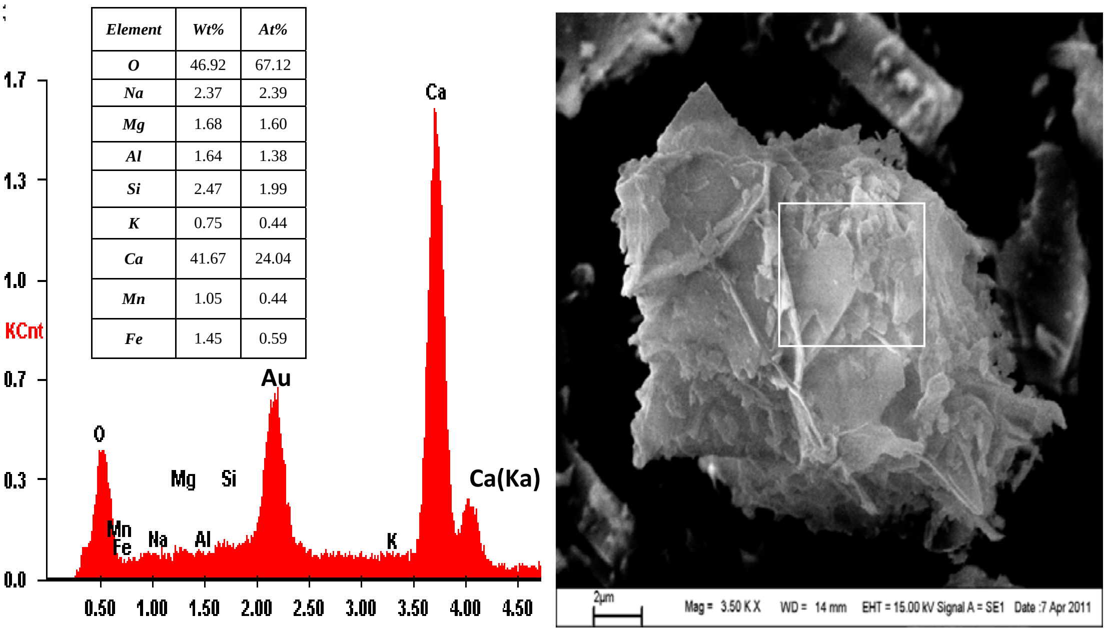
Analysis of the components of burnt oyster shells at 950 °C for 5 hours and unburnt oyster shells, grinded and sifted through 100 mesh sieve (standard ASTM). The result were as an important component is calcium (Ca) 42.27 and 41.67 percent by weight and the other component such as sodium (Na), magnesium (Mg), aluminum (Al) aluminum silicon (Si), potassium (K), manganese (Mn) and iron (Fe) in small quantities. (See in figure 4.1-4.2)



Element	Wt%	At%
O	46.07	66.02
Na	3.30	3.29
Mg	2.41	2.27
Al	1.94	1.64
Si	2.07	1.69
K	0.55	0.33
Ca	42.27	24.20
Mn	0.62	0.26
Fe	0.77	0.32

(A) (B)

Figure 4.1 Show the elemental composition of burnt oyster shells at 950 °C (A) and surface from electron microscope magnification of 3,500 X (B).



Element	Wt%	At%
O	46.92	67.12
Na	2.37	2.39
Mg	1.68	1.60
Al	1.64	1.38
Si	2.47	1.99
K	0.75	0.44
Ca	41.67	24.04
Mn	1.05	0.44
Fe	1.45	0.59

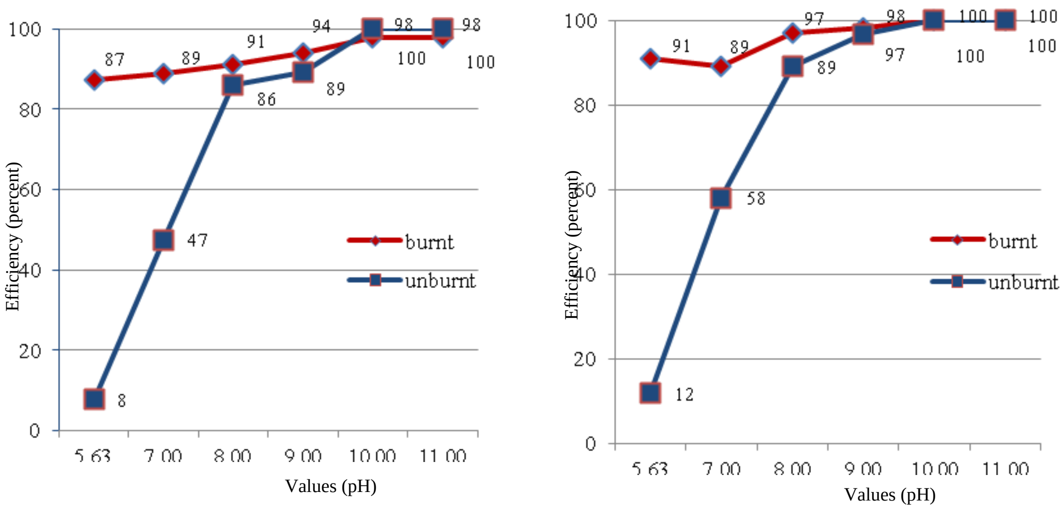
(A) (B)

Figure 4.2 Show the elemental composition of unburnt oyster shells (A) and surface of from electron microscope magnification of 3,500 X (B).

4.2 Comparing the efficiency

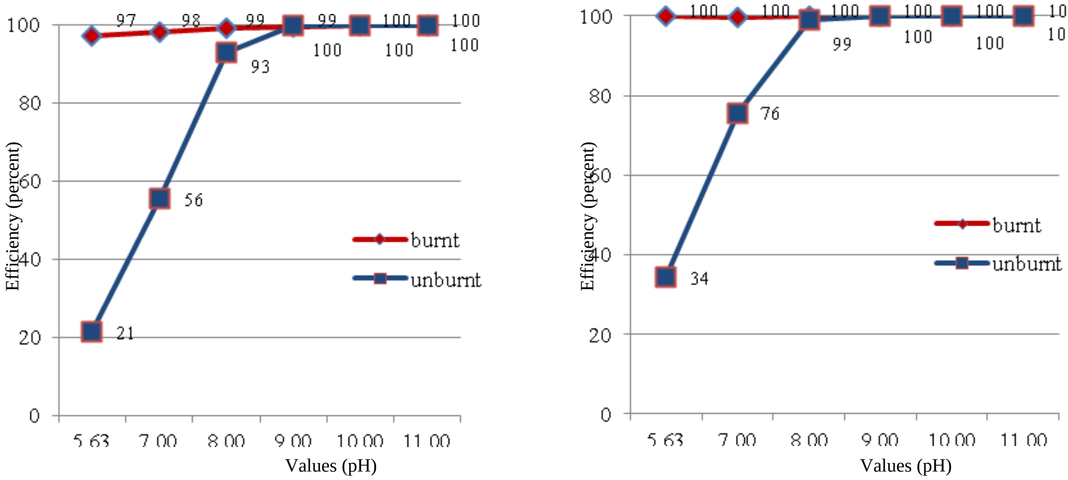
The results of Pb removal efficiency of burnt and unburnt oyster shell tested by Jar-test were shown below.

4.2.1 Pb removal efficiency of oyster shell in the ratio of 0.25, 0.50, 1.00, and 2.00 percent.



A: 1.25 g. or 0.25 percent.

B: 2.50 g. or 0.50 percent.



C: 5.00 g. or 1.00 percent.

D: 10.00 g. or 2.00 percent.

Figure 4.3 Show the adsorbtion efficiency of the lead in synthetic wastewater have volume of 0.25, 0.50, 1.00, and 2.00 percent.

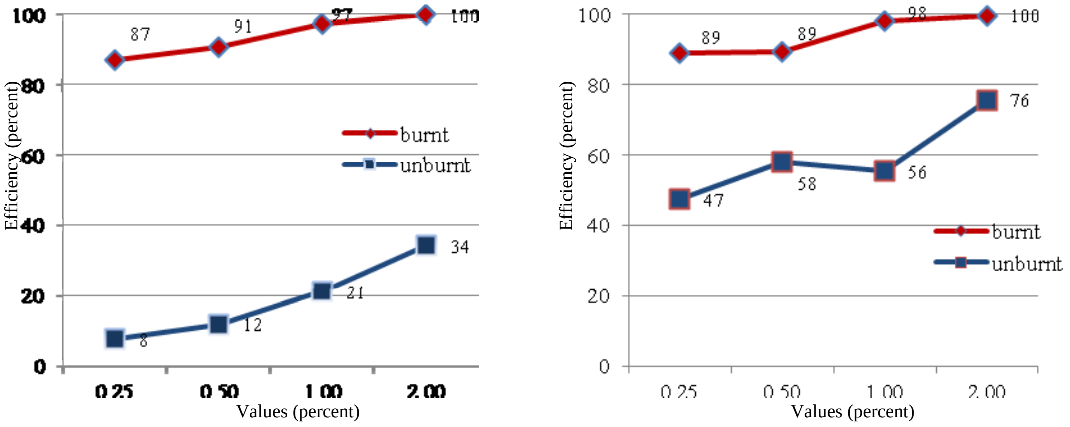
The removal efficiency percentage of 0.25 percent burnt oyster shell application at pH 5.63, 7.00, 8.00, 9.00, 10.00 and 11.00 were 87.33, 88.99, 91.01, 94.07, 97.86, and 97.96 percent, respectively. For the unburnt oyster shells, it was 7.67, 47.45, 86.01, 89.36, 99.95, and 99.94 percent, respectively (Figure 4.3 A).

The removal efficiency percentage of 0.50 percent burnt oyster shell application at six different pH values were 90.90, 89.31, 97.16, 98.12, 99.94, and 99.94 percent, respectively. For the unburnt oyster shells, it was 11.82, 58.05, 89.13, 96.76, 99.95, and 99.95 percent, respectively (Figure 4.3 B).

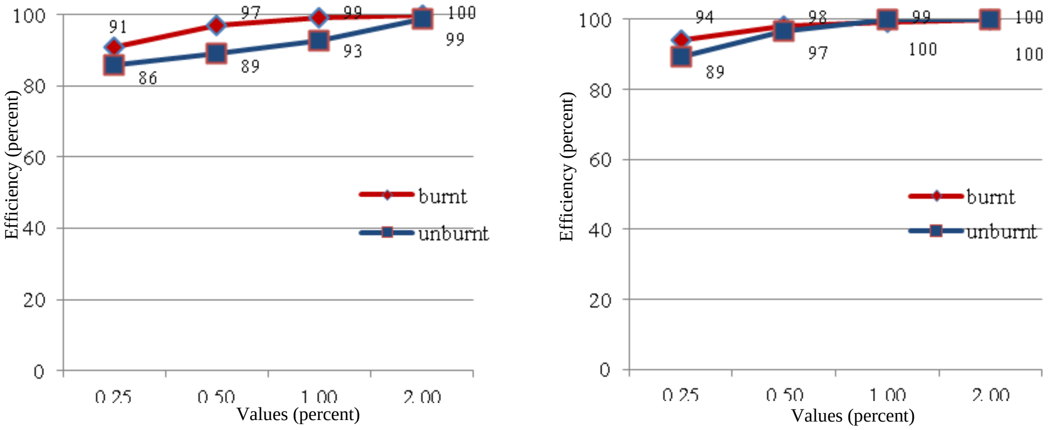
The removal efficiency percentage of 1.00 percent burnt oyster shell application at six different pH values were 97.28, 98.15, 99.16, 99.38, 99.97, and 99.96 percent, respectively. For the unburnt oyster shells, it was 21.22, 55.53, 92.86, 99.95, 99.98, and 99.97 percent, respectively (Figure 4.3 C).

The removal efficiency percentage of 2.00 percent burnt oyster shell application at six different pH values were 99.96, 99.68, 99.90, 99.94, 99.99, and 99.98 percent, respectively. For the unburnt oyster shells, it was 34.32, 75.67, 98.97, 99.98. 99.98, and 99.98 percent respectively (Figure 4.3 D).

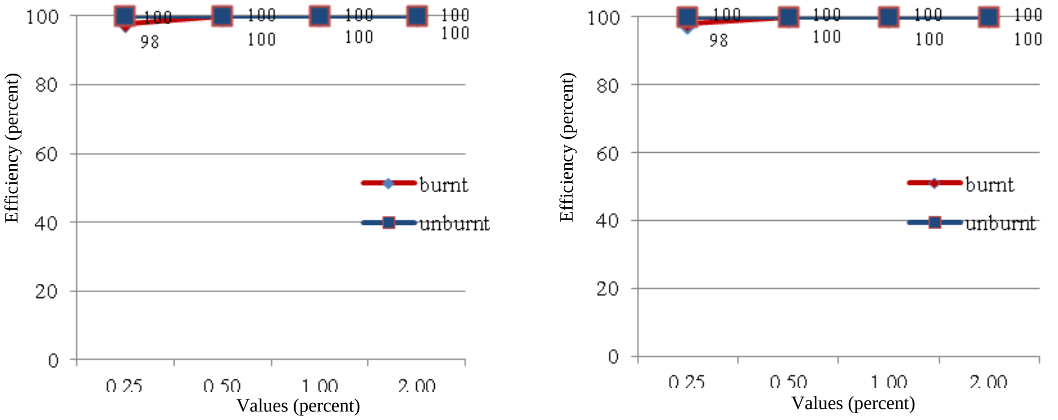
4.2.2 Pb removal efficiency at pH 5.63, 7.00, 8.00, 9.00, 10.00, and 11.00.



A: At pH 5.63 B: At pH 7.0



C: At pH 8.0 D: At pH 9.0



E: At pH 10.0 F: At pH 11.0

Figure 4.4 Show the adsorbtion efficiency of the lead in synthetic wastewater at pH 5.63, 7.00, 8.00, 9.00, 10.00, and 11.00.

Pb removal efficiency at pH 5.63 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 87.33, 90.90, 97.28, and 99.96 percent respectively, while the results of unburnt oyster shell application was 7.67, 11.82, 21.12, and 34.32 percent, respectively (Figure 4.4 A).

Pb removal efficiency at pH 7.00 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 88.99, 89.31, 98.15, and 99.68 percent respectively, while the results of unburnt oyster shell application was 47.45, 58.05, 55.53, and 75.67 percent, respectively (Figure 4.4 B).

Pb removal efficiency at pH 8.00 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 91.01, 97.16, 99.16, and 99.90 percent respectively, while the results of unburnt oyster shell application was 86.01 89.13 92.86 and 98.97 percent, respectively (Figure 4.4 C).

Pb removal efficiency at pH 9.00 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 94.07, 98.12, 99.38, and 99.94 percent respectively, while the results of unburnt oyster shell application was 89.36, 96.76, 99.95, and 99.98 percent, respectively (Figure 4.4 D).

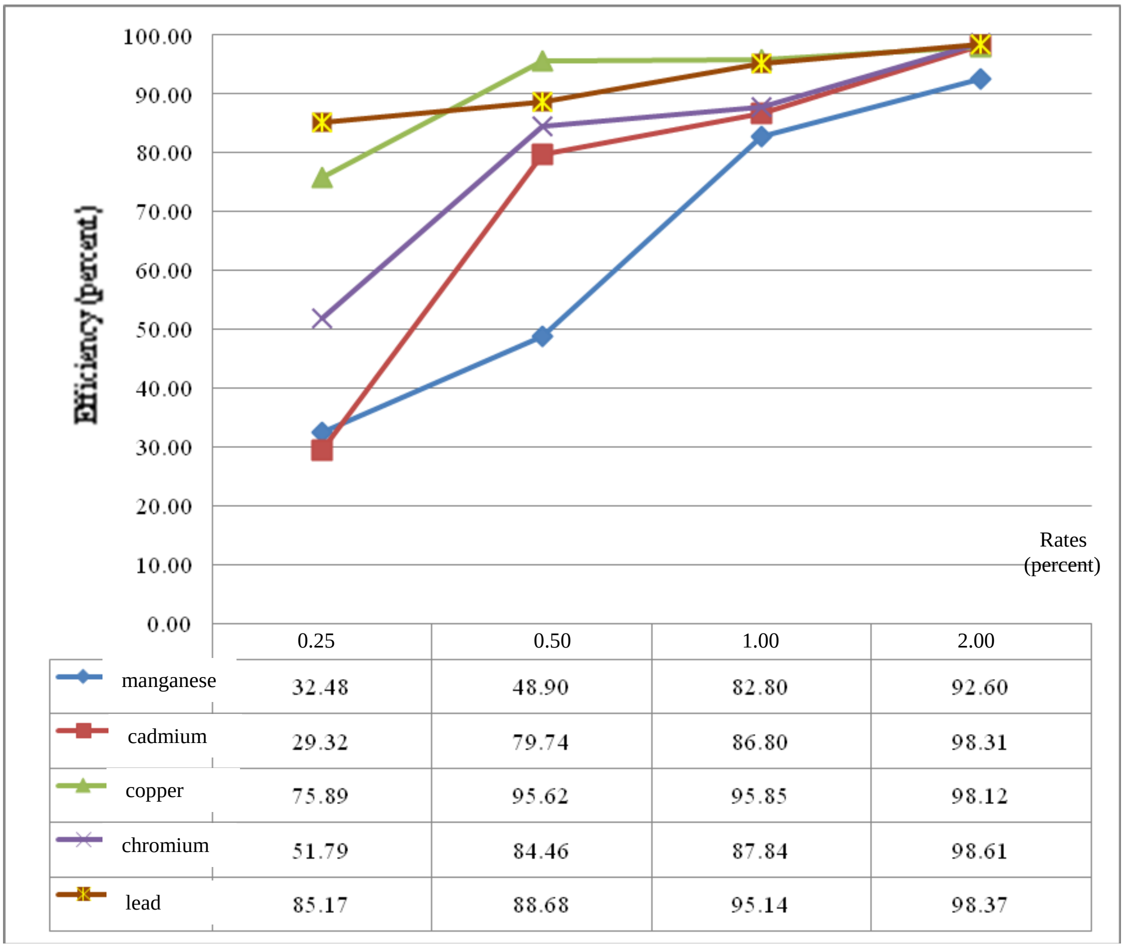
Pb removal efficiency at pH 10.00 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 99.95, 99.95, 99.98, and 99.98 percent respectively, while the results of unburnt oyster shell application was 97.86, 99.94, 99.97, and 99.99 percent, respectively (Figure 4.4 E).

Pb removal efficiency at pH 11.00 with 0.25, 0.50, 1.00, and 2.00 percent of burnt oyster shells application in percentage were 99.94, 99.95, 99.97, and 99.98 percent respectively, while the results of unburnt oyster shell application was 97.96, 99.94, 99.96, and 99.98 percent, respectively (Figure 4.4 F).

4.3 Comparing the efficiency with true wastewater

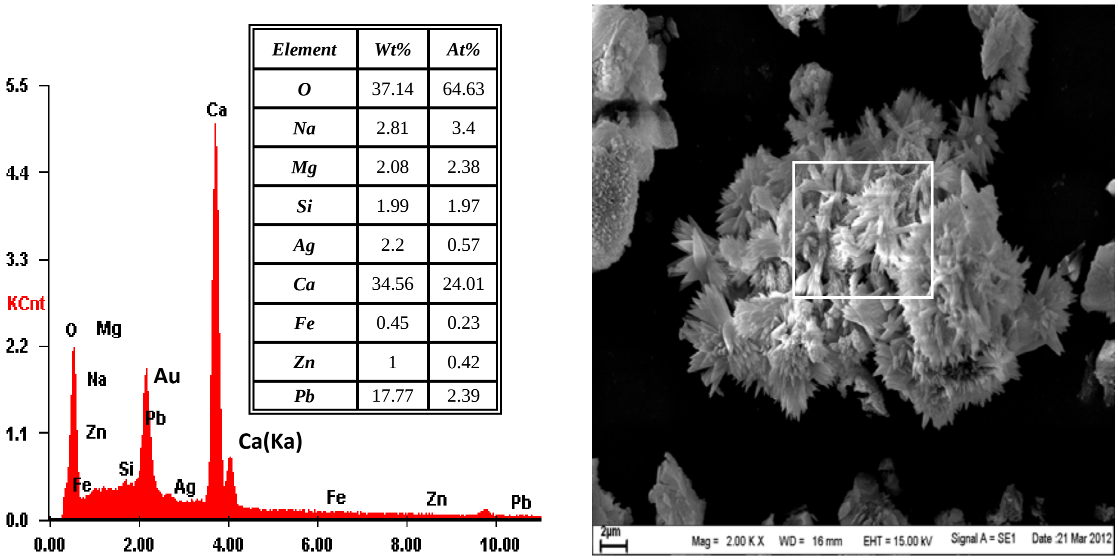
Burnt and unburnt oyster shell was applied to remove heavy metal in the true wastewater from chemistry laboratory faculty of science Burapha University by keep 4 position round a pond then bring mixed for a sample to the initial analyse the quantity. The results of contamnated heavy metal identification showed that it composes of manganese, cadmium, copper, chromium and lead. The treatments were performed at pH of 10.34 and then the results were taken to calculate removal efficiency.

The percentage of burnt shell used in this treatment was 0.25, 0.50, 1.00, and 2.00 percent, respectively.



	0.25	0.50	1.00	2.00
manganese	32.48	48.90	82.80	92.60
cadmium	29.32	79.74	86.80	98.31
copper	75.89	95.62	95.85	98.12
chromium	51.79	84.46	87.84	98.61
lead	85.17	88.68	95.14	98.37

Figure 4.5 Show the burnt oyster shells for adsorbtion heavy metal out of the true wastewater.



Element	*Wt%*	*At%*
O	37.14	64.63
Na	2.81	3.4
Mg	2.08	2.38
Si	1.99	1.97
Ag	2.2	0.57
Ca	34.56	24.01
Fe	0.45	0.23
Zn	1	0.42
Pb	17.77	2.39

Figure 4.6 Surface of oyster shells burnt at 950 °C adsorbtion heavy metal out of the true wastewater from electron microscope magnification of 2,000 X.

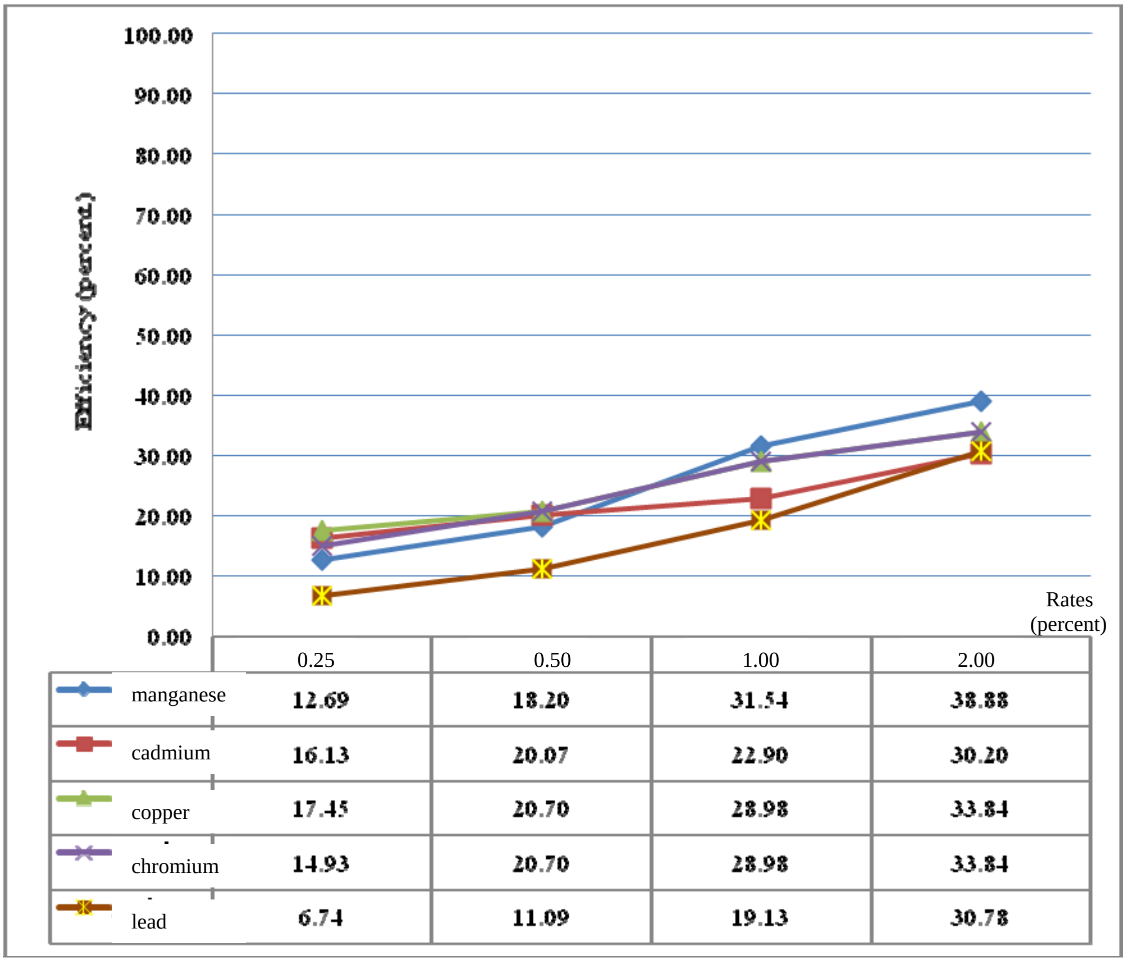
For 0.25 percent burnt oyster shell application, the result showed the highest removal in lead (85.17 percent) and then accompanied by copper, chromium, manganese, and cadmium which were 75.89, 51.79, 32.48, and 29.32 percent, respectively.

For 0.50 percent burnt oyster shell application, the result showed the highest removal in copper (95.62 percent) and then accompanied by lead, chromium, cadmium, and manganese which were 88.68, 84.46, 79.74, and 48.90 percent, respectively.

For 1.00 percent burnt oyster shell application, the result showed the highest removal in copper (95.85 percent) and then accompanied by lead, chromium, cadmium, and manganese which were 95.14, 87.84, 86.00, and 82.80 percent, respectively.

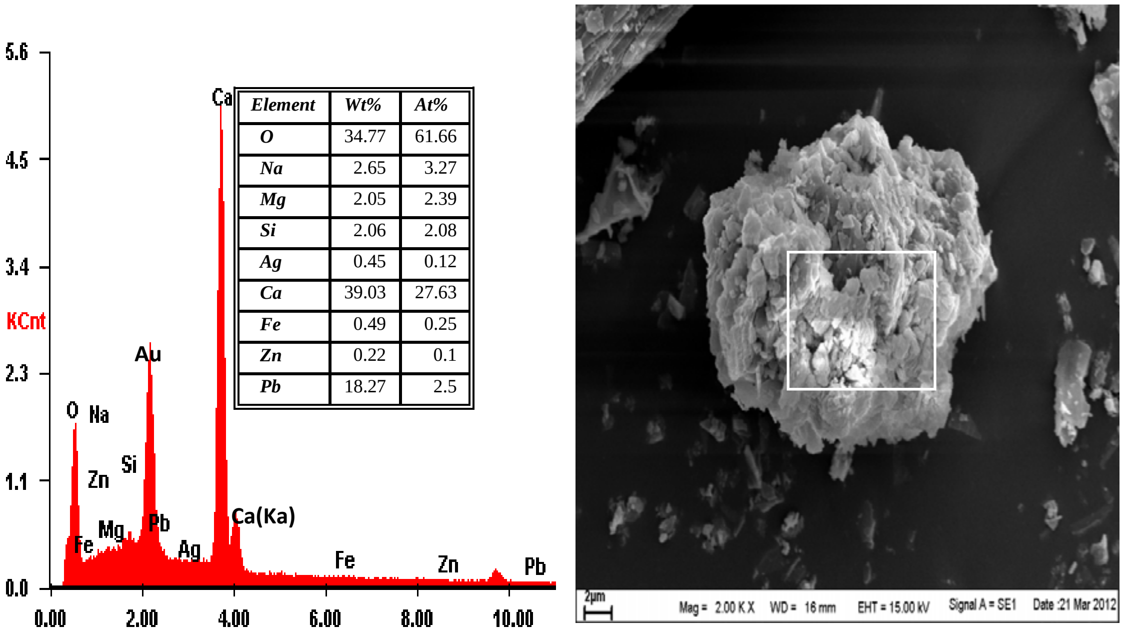
For 2.00 percent burnt oyster shell application, the result showed the highest removal in chromium (98.61 percent) and then accompanied by lead, cadmium, copper, and manganese which were 98.37, 98.31, 98.12, and 96.60 percent, respectively.

The percentage of burnt shell used in this treatment was 0.25, 0.50, 1.00, and 2.00 percent, respectively.



	0.25	0.50	1.00	2.00
manganese	12.69	18.20	31.54	38.88
cadmium	16.13	20.07	22.90	30.20
copper	17.45	20.70	28.98	33.84
chromium	14.93	20.70	28.98	33.84
lead	6.74	11.09	19.13	30.78

Figure 4.7 Show the unburnt oyster shells for adsorbtion heavy metal out of the true wastewater.



Element	*Wt%*	*At%*
O	34.77	61.66
Na	2.65	3.27
Mg	2.05	2.39
Si	2.06	2.08
Ag	0.45	0.12
Ca	39.03	27.63
Fe	0.49	0.25
Zn	0.22	0.1
Pb	18.27	2.5

(A) (B)

Figure 4.8 Surface of unburnt oyster shells after adsorbtion heavy metal out of the true wastewater from electron microscope magnification of 2,000 X

For 0.25 percent unburnt oyster shell application, the result showed the highest removal in copper (17.45 percent) and then accompanied by cadmium, chromium, manganese, and lead which were 16.13, 14.93, 12.69, and 6.74 percent, respectively.

For 0.50 percent unburnt oyster shell application, the result showed the highest removal in chromium (95.62 percent) and then accompanied by cadmium, manganese, and lead which were 20.07, 18.20, and 11.09 percent, respectively.

For 1.00 percent unburnt oyster shell application, the result showed the highest removal in manganese (31.54 percent) and then accompanied by copper, chromium, cadmium, and lead which were 28.98, 29.98, 22.90, and 19.13 percent, respectively.

For 2.00 percent unburnt oyster shell application, the result showed the highest removal in manganese (38.88 percent) and then accompanied by copper, chromium, lead, and cadmium which were 33.84, 33.84, 30.78, and 30.20 percent, respectively.

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This objectives of research for study the feasibility of using oyster shells as well as to reduce the lead content in synthetic wastewater by comparing the adsorbtion efficiency between the burnt oyster shells and unburnt oyster shells. This experimental were study the lead in synthetic wastewater 0.15 percent at pH 6 levels 5.63 (begin) 7.00, 8.00, 9.00, 10.00, and 11.00 quantities of oyster shells 4 levels 1.25, 2.50, 5.00, and 10.00 g. equal to 0.25, 0.50, 1.00, and 2.00 percent by repeat experimental 3 times for average the result were as.

Analysis of the components of burnt oyster shells at 950 °C for 5 hours and unburnt oyster shells grind and sift through 100 mesh sieve (standard ASTM). The result were as an important component is calcium (Ca) 42.27 and 41.67 percent by weight and sodium (Na), magnesium (Mg), aluminum (Al) aluminum silicon (Si), potassium (K) manganese (Mn) and iron (Fe) in small quantities.

The comparing the adsorbtion efficiency of the lead in synthetic wastewater have volume of 0.15 percent, 500 ml. between the burnt oyster shells at 950 °C and unburnt oyster shells quantities at 0.25, 0.50, 1.00, and 2.00 percent with pH 5.63, 7.00, 8.00, 9.00, 10.00, and 11.00 achieve flocculation to principle of Jar-test the result were as.

The synthetic wastewater have volume of 1.25 g. or 0.25 percent, with pH 5.63, 7.00, 8.00, and 9.00 the result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than unburnt oyster shells at 87.33/7.67, 88.99/47.45, 91.01/86.01, and 94.07/89.36 percent but pH 10.00 and 11.00 the result were as the unburnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than burnt oyster shells at 99.95/97.86 and 99.94/97.96 percent.

The synthetic wastewater have volume of 2.50 g. or 0.50 percent, with pH 5.63, 7.00, 8.00, and 9.00 the result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells at 90.90/11.82, 89.31/58.05, 97.16/89.13, and 98.12/96.76 percent but pH 10.00 and 11.00 the result were as the unburnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than burnt oyster shells at 99.95/99.94 and 99.95/99.94 percent.

The synthetic wastewater have volume of 5.00 g. or 1.00 percent, with pH 5.63, 7.00, and 8.00 the result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells at 97.28/21.22, 98.15/55.53, and 99.16/92.86 percent but pH 9.00, 10.00, and 11.00 the result were as the unburnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than burnt oyster shells at 99.95/99.38, 99.98/99.97, and 99.97/99.96**.**

The synthetic wastewater have volume of 10.00 g. or 2.00 percent with pH 5.63, 7.00, 8.00, and 10.00 the result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells at 99.96/34.32, 99.68/75.67, 99.90/98.97, and 99.99/99.98 percent but pH 9.00 the result were as the unburnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than burnt oyster shells at 99.98/99.94 and pH 11.00 have adsorbtion efficiency be equal at 99.98/99.98 percent.

The synthetic wastewater at pH 5.63, 7.00, 8.00 with the quantity 1.25 2.50 5.00 and 10.00 g. The result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells but at pH 9.00 with the quantity 1.25 and 2.50 g. The result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells but at the quantity 5.00 and 10.00 g. the result were as the unburnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than burnt oyster shells. The synthetic wastewater at pH 10.00 with the quantity 1.25 2.50 and 5.00 g. The result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells but at the quantity 10.00 g. the result were as the unburnt oyster shells have the efficiency of the lead in synthetic wastewater more than burnt oyster shells. The synthetic wastewater at pH 11.00 with the quantity 1.25 2.50 and 5.00 g. the result were as the burnt oyster shells have the adsorbtion efficiency of the lead in synthetic wastewater more than the unburnt oyster shells but at the quantity 10.00 g. the result were as have adsorbtion efficiency be equal.

The comparing the adsorbtion efficiency of the burnt oyster shells and the unburnt oyster shells with true wastewater.

The burnt oyster shells for adsorbtion heavy metal out of the true wastewater at the quantity 1.25, 2.50, 5.00, and 10.00 g. or 0.25, 0.50, 1.00, and 2.00 percent. The result were as adsorbtion maximum is the lead, copper, copper, and chromium at 85.17, 95.62, 95.85, and 98.61 percent.

The unburnt oyster shells for adsorbtion heavy metal out of the true wastewater at the quantity 1.25, 2.50, 5.00, and 10.00 g. or 0.25, 0.50, 1.00, and 2.00 percent. The result were as adsorbtion maximum is the copper, copper and chromium, manganese and manganese, at 17.45, 20.70, 31.54, and 38.88 percent.

5.2 Recommendation

Recommendation for further study

5.2.1 Selected treatment condition in experimental with true wastewater should be used as design criterion for large scale study.

5.2.2 Selected treatment condition in term of experimental with true wastewater from industrial factory.

5.2.3 Comparative study of the others heavy mental and other etc. between using synthetic wastewater and others adsorbent.

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APPENDICES

APPENDIX A

Appendix A-1 The result of the burnt oyster shells for adsorbtion heavy metal out of the true wastewater from Chemistry laboratory, Faculty of Science, Burapha University, Amphoe Muang, Changwat Chonburi.

	Rates (percent)	Efficiency (percent)			Average
		Time1	Time2	Time3	
manganese	0.25	31.15	33.27	33.01	32.48
	0.50	49.20	48.50	49.01	48.90
	1.00	82.93	83.02	82.45	82.80
	2.00	92.50	93.01	92.28	92.60
cadmium	0.25	29.67	29.50	28.78	29.32
	0.50	79.93	79.10	80.20	79.74
	1.00	86.32	85.97	88.11	86.80
	2.00	98.97	98.01	97.95	98.31
copper	0.25	76.43	75.28	75.96	75.89
	0.50	95.73	95.02	96.11	95.62
	1.00	96.25	96.08	95.23	95.85
	2.00	98.62	97.55	98.19	98.12
chromium	0.25	52.23	51.18	51.96	51.79
	0.50	84.21	84.39	84.77	84.46
	1.00	87.56	87.01	88.95	87.84
	2.00	99.01	98.62	98.21	98.61
lead	0.25	85.43	85.01	85.08	85.17
	0.50	88.73	88.21	89.11	88.68
	1.00	95.53	95.12	94.78	95.14
	2.00	98.50	98.73	97.89	98.37

Appendix A-2 The result of the unburnt oyster shells for adsorbtion heavy metal out of the true wastewater from Chemistry laboratory, Faculty of Science, Burapha University, Amphoe Muang, Changwat Chonburi.

	Rates (percent)	Efficiency (percent)			Average
		Time1	Time2	Time3	
manganese	0.25	12.17	13.08	12.81	12.69
	0.50	18.62	18.01	17.98	18.20
	1.00	31.41	31.17	32.03	31.54
	2.00	38.39	39.15	39.09	38.88
cadmium	0.25	16.47	16.02	15.89	16.13
	0.50	20.11	19.88	20.23	20.07
	1.00	22.68	22.95	23.08	22.90
	2.00	29.74	30.55	30.32	30.20
copper	0.25	17.31	17.63	17.40	17.45
	0.50	20.77	21.01	20.33	20.70
	1.00	28.62	29.00	29.31	28.98
	2.00	33.28	34.27	33.98	33.84
chromium	0.25	15.15	14.91	14.73	14.93
	0.50	22.19	22.02	22.87	22.36
	1.00	23.38	24.15	24.10	23.88
	2.00	30.88	30.95	30.51	30.78
lead	0.25	6.55	6.86	6.81	6.74
	0.50	10.97	11.23	11.08	11.09
	1.00	18.62	19.21	19.55	19.13
	2.00	30.21	31.33	30.79	30.78

Appendix A-3 The efficiency of the burnt oyster shells for adsorbtion lead from synthetic wastewater.

pH values	Rates (percent)	Efficiency (percent)			Average
		Time1	Time2	Time3	
stock pH 5.63	0.25	85.46	86.22	88.91	86.86
	0.50	90.96	90.48	90.15	90.53
	1.00	97.31	97.36	97.20	97.29
	2.00	99.47	99.72	99.66	99.62
pH 7.0	0.25	88.45	89.63	88.48	88.85
	0.50	89.58	89.96	88.60	89.38
	1.00	98.30	98.14	98.12	98.19
	2.00	99.87	99.87	99.43	99.73
pH 8.0	0.25	90.93	91.37	90.66	90.99
	0.50	98.05	97.87	96.22	97.38
	1.00	99.37	99.10	99.17	99.21
	2.00	99.93	99.89	99.90	99.91
pH 9.0	0.25	94.74	93.32	94.65	94.24
	0.50	97.87	98.13	98.21	98.07
	1.00	99.18	99.36	99.45	99.33
	2.00	99.90	99.95	99.93	99.93
pH 10.0	0.25	98.13	97.59	98.08	97.93
	0.50	99.95	99.97	99.90	99.94
	1.00	99.98	99.97	99.97	99.97
	2.00	99.98	100.00	99.98	99.98
pH 11.0	0.25	97.66	97.97	98.02	97.88
	0.50	99.96	99.96	99.92	99.95
	1.00	99.97	99.97	99.96	99.97
	2.00	99.99	99.98	99.98	99.98

Appendix A-4 The efficiency of the unburnoyster shells for adsorbtion lead from synthetic wastewater.

pH values	Rates (percent)	Efficiency (percent)			Average
		Time1	Time2	Time3	
stock pH 5.63	0.25	7.67	7.40	7.94	7.67
	0.50	10.90	16.29	8.26	11.82
	1.00	20.59	21.94	21.13	21.22
	2.00	33.78	34.05	35.13	34.32
pH 7.0	0.25	44.94	50.29	47.14	47.45
	0.50	60.98	56.58	56.58	58.05
	1.00	58.78	56.26	51.54	55.53
	2.00	73.32	79.74	73.95	75.67
pH 8.0	0.25	86.23	85.74	86.08	86.01
	0.50	90.22	89.22	87.93	89.13
	1.00	93.78	94.00	90.78	92.86
	2.00	99.43	98.98	98.51	98.97
pH 9.0	0.25	90.08	89.12	88.88	89.36
	0.50	96.41	97.20	96.68	96.76
	1.00	99.98	99.92	99.94	99.95
	2.00	99.99	99.97	99.97	99.98
pH 10.0	0.25	99.94	99.94	99.97	99.95
	0.50	99.95	99.95	99.95	99.95
	1.00	99.98	99.99	99.98	99.98
	2.00	99.99	99.98	99.98	99.98
pH 11.0	0.25	99.92	99.94	99.97	99.94
	0.50	99.96	99.95	99.96	99.95
	1.00	99.99	99.95	99.98	99.97
	2.00	99.99	99.98	99.98	99.98

APPENDIX B

Appendix B Preparation of adsorbent from oyster shells stack abandons last 6 - 12 months, Tumbol Seansuk and Tambol Ang-sila Amphoe Muang, Changwat Chonburi.

Figure B-1 Show the fresh oyster shells before processing

Figure B-2 Show the oyster shells processing

Figure B-3 Show the oyster shells after processing was waste materials

Figure B-4 Show the oyster shells stack abandons last 0 - 3 months

Figure B-5 Show the oyster shells stack abandons last 0 - 3 months

Figure B-6 Show the oyster shells stack abandons last 0 - 3 months

Figure B-7 Show the oyster shells stack abandons last 3 - 6 months

Figure B-8 Show the oyster shells stack abandons last 6 - 12 months

Figure B-9 Show the oyster shells of the people to leave their homes in their own communities and around the vacant area

Figure B-10 Show the oyster shells of the people to leave their homes in their own communities and around the vacant area

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