Batch studies to evaluate heavy metals removal potential of low cost adsorbents

Gopi G M.[1], Girish M G [2], Kavya S [3] , Pratibha M Kulakarni [4], Avinash Patel K.L [5]

[1,2,3,4] Department of civil engineering, S.T.J. Institute of Technology, Ranebennur, Karnataka, India.
[5] Asst. Professor, Dept. of civil engineering, S.T.J. Institute of Technology, Ranebennur, Karnataka ,India.

Abstract – *The study reveals the potential of Egg shell powder and lemon peel powder used as the adsorbent for removal of heavy metals such as zinc and nickel by considering different P^H, Initial concentration, adsorbent dosages etc., It also come to know that adsorbent will be best in removal of Nickel by egg shell as compare to the zinc by egg shell. Under varied conditions of experimentation the lemon peel adsorbents will be adsorb maximum of 62.5 % and 62.1% of Zn and Ni respectively, the egg shell adsorbent will be adsorbing maximum of 82.3% and 86.1% of Zinc Nickel respectively.*

Key Words: Heavy metals, Adsorbent, Egg shell powder, Lemon peel powder, AAS(Atomic Absorption Spectrophotometer).

1. INTRODUCTION

Environmental pollution is the one of the most important issue facing the humanity. Water is one of the important mineral which can be used for domestic, agricultural, industrial and commercial purposes .Water pollution is one of the major problem increasing exponentially in past few years. Water pollution causes due to addition of heavy metals from different sources. Toxic heavy metals are considered as the one of the pollutant that have direct affect on both man and animals, which causes many problems and health issues. Heavy metals present in water are soluble in nature and affects the life of aquatic animals. Hence it is necessary to treat the waste water before discharging into the natural water bodies. So demand for the unpolluted water is increased day by day. It is necessary to treat the polluted water before reaching into natural water bodies. There are several methods are used to treat the heavy metals removal from the waste water among these adsorption process is found to be most economical and effective method. The need of safe and economical method for the removal of heavy metals from contaminated water has developed interest towards to the adsorption process by using low cost adsorbents.

1.1 SOURCES OF METALS

The two main sources of heavy metal are natural and man. Natural factor include soil erosion, volcanic activities, urban runoff while the human factor include metal finishing, electrode plating, mining extraction operations, textile industries, and nuclear power.

Fig 1: Source of heavy metals

1.2.EFFECTS OF HEAVY METALS

In general the toxicity of metal ions to mammalian system is due to chemical reactivity if the ions with cellular structural proteins, enzymes. The untreated heavy metal contaminated water causes many health and environment impacts on aquatic life also it may lead to the depletion of aquatic life and causes economical imbalance also. It is reported that individual metals exhibit specific sign of their toxicity the sign associated with cadmium, lead, arsenic, mercury, Zinc, Nickel, copper and aluminium poisoning are gastro intestinal disorders diarrhea, stomatitis, tremor, hemoglobinuria causing a rustred colour to stool, ataxia, paralysis, vomiting and convulsion, depression and pneumonia when volatile vapours are inhaled. Toxicity due to lead accumulation may lead to a decreasing in haemoglobin production, Kidney, joints, reproductive and cardio vascular system disorders and long term injury to central and peripheral nervous system. While high exposure levels could cause obstructive lung disease, cadmium pneumonitis, bone defects, osteomalacia, osteoporosis, and spontaneous fractures, increased blood pressures. More concentration of heavy metals also decreases the concentration of oxygen in the water.

1.2 TREATMENTS USED IN HEAVY METAL REMOVAL

- Chemical precipitation
- Ion exchange
- Membrane process
- Chemical coagulation
- Floatation
- Electrochemical method
- Adsorption

1.2.1. Chemical precipitation

It is one if the process in which chemical reagent are added foe treating waste water. The chemicals are used such as alum, lime, iron salts and other organic polymers. Excessive sludge generation and disposal of sludge is the drawback of this method.

1.2.2. Ion exchange

The ion exchange process is based on the exchange of ions with metals in the waste water. In this method different type of materials are used which are natural alumina, carbon, silicate or synthetic zeolites and resins. Among these zeolites are commonly used. Both anions and cations are exchange in aqueous solution. High sensitivity to P^H of solution is one of the drawback.

1.2.3. Membrane process

In this process the different types of membranes are used to removal of heavy metals in aqueous solution. It is most commonly used for removal of heavy metals suspended solids, Oils, organic and inorganic materials. Different techniques are used in this process are Ultra filtration(UF),Nanofiltration(NF), Reverse osmosis(RO) and electro dialysis depending on size and particles.

1.2.4. Chemical coagulation

Chemical coagulation technique is used to prepare a colloidal solids. Some coagulants are used ferric chloride, ferrous sulphate and aluminium. The chemical reactions are takes place when coagulants are added to the water.

1.2.5. Floatation

It is widely applied process for removal of toxic metal ions. Some techniques of floatation are ion floatation, dissolved air floatation, precipitate floatation.

1.2.6. Electrochemical method

It involves the removal of heavy metals under the influence of external direct current in electrolyte solution. For increase in the rate of coagulation, the flocculation process takes place which enhances the change of unstable particles into bulky floccules.

1.2.7. Adsorption

It is basically a mass transfer process by which a substance is transferred from liquid phase to the surface of solid, and becomes bond by physical or chemical interactions. Adsorption is one of the economical, effective and eco friendly treatment method. It also helps in removing the heavy metals from the waste water. All adsorption are depending of solid, liquid, equilibrium and on mass transfer rate. Adsorption process can be batch, semi batch, and continuous process.

Types of adsorption

- Physical adsorption
- Chemical adsorption

Physical adsorption: It is defined as the process in which binding of adsorbate on the adsorbent surface. It is caused by Vander walls force of attraction.

Chemical adsorption: It is defined as the process in which chemical reaction takes place between the adsorbent and adsorbate. The strong attraction between adsorbate and adsorbent create one type of electronic bonds such as covalent bond and ionic bond.

LOW COST ADSORBENTS

These are the materials which are easily available, economical, eco friendly and must have the suitable efficiency to remove the heavy metals such natural materials(clay, zeolites, peat mass), agricultural wastes(Rise husk, lemon peel powder, neem bark, waste tea), Industrial by products(waste slurry ,fly ash, blast furnace sludge ,liquor waste from paper industry).

2. OBJECTIVES

- To evaluate the metal removal potential of metals(zinc and nickel) adsorbent selected under various experimental conditions like dosage, contact time, p^H, initial concentrations etc.,
- To find very effective methodology/technique to treat liquid hazardous wastes.
- To find the cost effective naturally available adsorbent.
- To find the hazardous free and re-useful adsorbent.
- The main objective of this investigation is to establish the suitable conditions for the best sorptive capacity of the removal of the metal ions/dyes.

3. MATERIALS AND METHODOLOGY

To meet the objective of present project work the detailed experimental programs was worked out and is discussed in this part. In this project we are consider the two heavy metals they are Zinc and Nickel. The various considerations to carry out this project include

3.1. METALS STUDIED

ZINC

It is one of the important trace element. High concentration of zinc causes depression, lethargy, neurological science. The zinc also contributes physical and metabolic process in many process. In this study we are taken Zinc sulphate Hecta hydrate($ZnSO_4.7H_2O$).

NICKEL

It is one of the metal present in environment at very low level. When Nickel concentration is high it is dangerous to the human life it causes some disorder like lung cancer, Nose cancer, Sickness, Dizziness and respiratory failure. In this study we consider the Nickel chloride Hexa hydrate ($NiCl_2.6H_2O$).

3.2. ADSORBENTS USED

- Lemon peel powder
- Egg shell powder

3.3. PREPARATION OF ADSORBENTS

3.3.1 Lemon peel powder

Lemon peels from different sources are first collected, they are washed thoroughly with water remove the odour and other particles. Lemon peels are dried in the presence of sun light. After drying the peels are powdered and sieved through the IS sieve of size 300µ passing and 150µ and the powdered was collected and stored in air tight container.

3.3.2. Egg shell powder

Egg shells are collected from different sources are collected they are washed thoroughly with water for removal of bad odor and other suspended particles. After washing the shells are dried in oven at temperature of 105^0c-110^0c. After drying the shells are powdered and sieved through the IS sieve of size 300µ passing and 150µ, the powder was collected and stored in air tight container.

3.4. PREPARATION OF AQUEOUS SOLUTIONOF ZINC AND NICKEL

3.4.1. Aqueous solution of zinc

Analytical grade of zinc sulphate Hecta hydrate was used for preparing a stack solution of zinc. We are taken 287.54 mg of $ZnSO_4.7H_2O$ are added to 1000 ml of water. Now the stalk solution of Zn is prepared, and further it is diluted into some experimental concentrations.

3.4.2. Aqueous solution of Nickel

Analytical grade Nickel chloride Hexa hydrate was used for preparing a stack solution of nickel. We are taken 237.69 mg of $NiCl_2.6H_2O$ are added to 1000 ml of water. Now the stalk solution of Ni is prepared, and further it is diluted into some experimental concentrations.

3.5. EXPERIMENTAL VARIALBLES

Table -1: variables of experiment

SI NO	Variable	Ranges		
1	P^H	5	7	9
2	Metals tried	Zinc	Nickel	
3	Concentration mg/l	30	60	90
4	Contact time in min	60	120	180
5	Adsorbent tried (Sizes :300µ passing 15oµ retaining)	Lemon peel powder	Egg shell powder	
6	Adsorbent dosages, gm	0.3	0.6	1
7	Experimental setup	Jar test		
8	Analysis of metals	Atomic absorption spectrophotometer(AAS)		
9	P^H adjust	P^H meter		

3.6. EXPERIMENTAL PROCEDURE

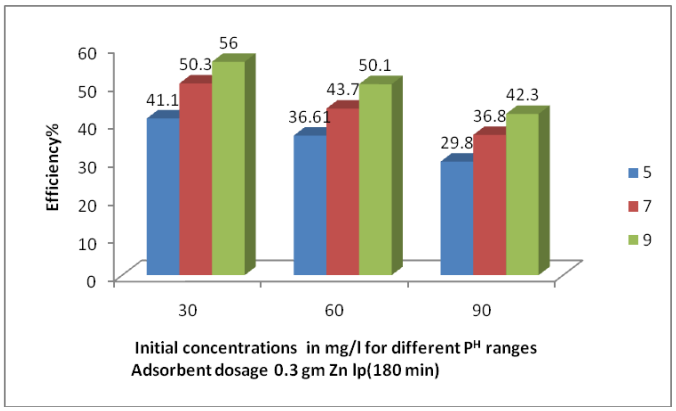
This test was conducted in batch process. In this batch studies we consider jar test. Here we are considered the two adsorbents they are Lemon peel powder and Egg shell powder. These adsorbents are taken in different dosages for experimentation (0.3,0.6,1.0 gm per liter of solution). In this test we are taken stack solution of 1000mg/l was prepared further it is diluted to some experimental concentrations(30,60,90 mg/l) and also each samples were tested for different P^H ranges like 5,7,9,(acidic, neutral, alkaline.). with different contact time of 60 min, 120min, 180 min.. After the completion of test the samples was analyzed in AAS.

Figure 2 : Atomic Absorption Spectrophotometer

4. RESULTS AND DISCUSSIONS

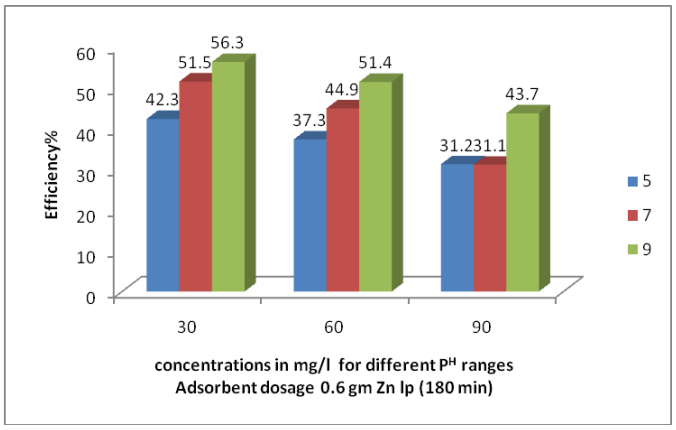
4.1 Zinc metal removal by using lemon peel powder adsorbent with different P^H For ranges.

4.1.1



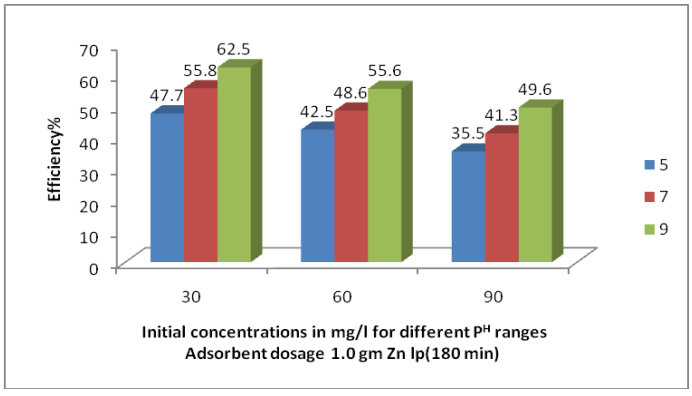
For zinc metal using lemon peel powder as a adsorbent of dosage 0.3 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,7 P^H ranges.

4.1.2



For zinc metal using lemon peel powder as a adsorbent of dosage 0.6 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,7 P^H ranges.

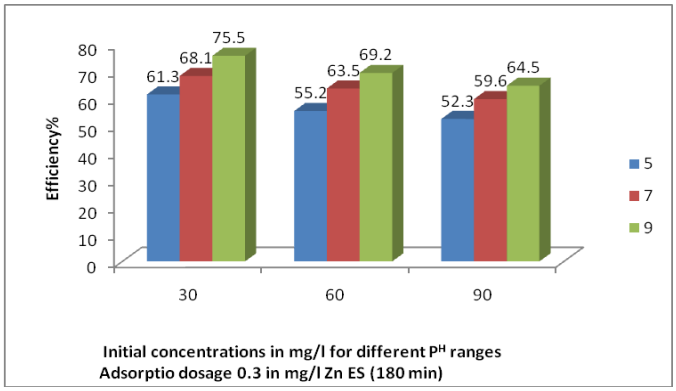
4.1.3



For zinc metal using lemon peel powder as a adsorbent of dosage 1.0 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,7 P^H ranges.

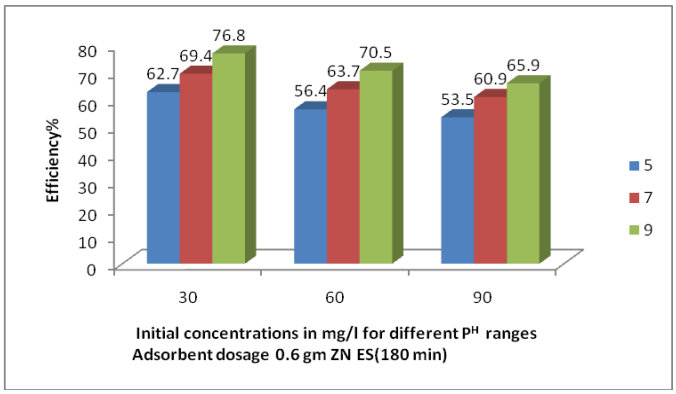
4.2. Zinc metal removal by using egg shell powder adsorbent with different P^H For ranges.

4.2.1



For zinc metal using egg shell as a adsorbent of dosage 0.3 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,7 P^H ranges.

4.2.2



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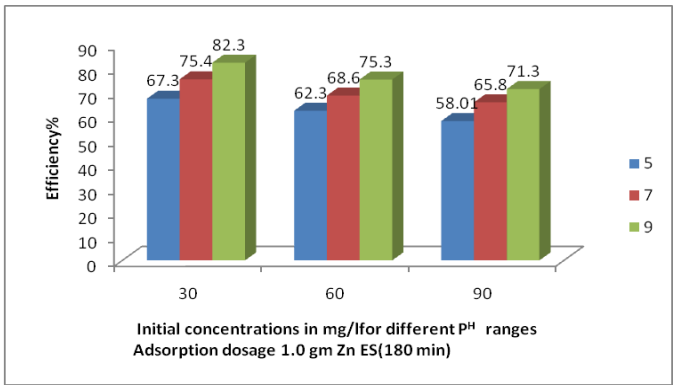
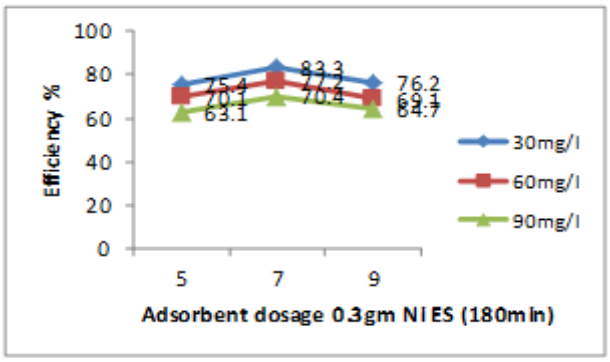


For zinc metal using egg shell powder as a adsorbent of dosage 1.0 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,7 P^H ranges.

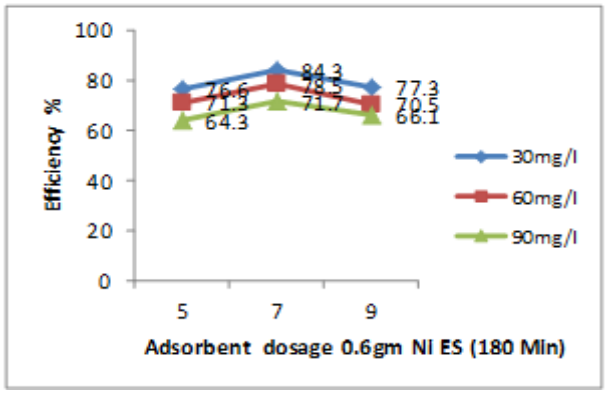
4.3 Nickel metal removal by using egg shell powder adsorbent with different P^H For ranges.

4.3.1



For Nickel metal using egg shell powder as a adsorbent of dosage 0.3 gm gives better efficiency in 180 min at P^H 7 compare to 60 and 120 min contact time and 5,9 P^H ranges.

4.3.2



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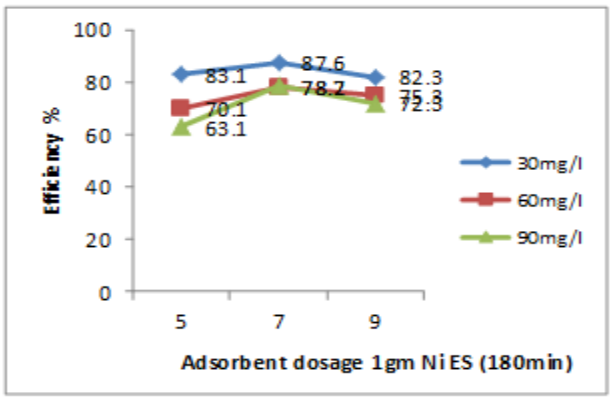
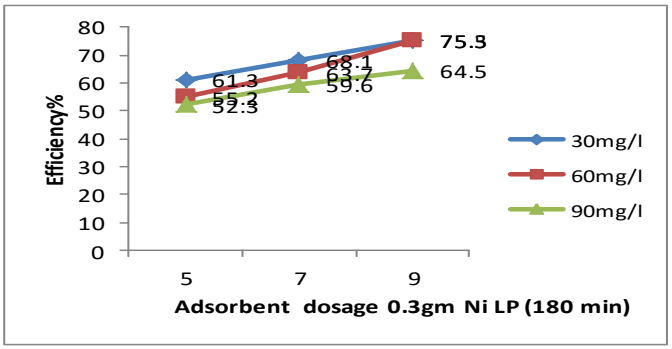


For Nickel metal using egg shell powder as a adsorbent of dosage 1.0 gm gives better efficiency in 180 min at P^H 7 compare to 60 and 120 min contact time and 5,9 P^H ranges.

4.4 Nickel metal removal by using lemon peel powder adsorbent with different P^H For ranges.

4.4.1



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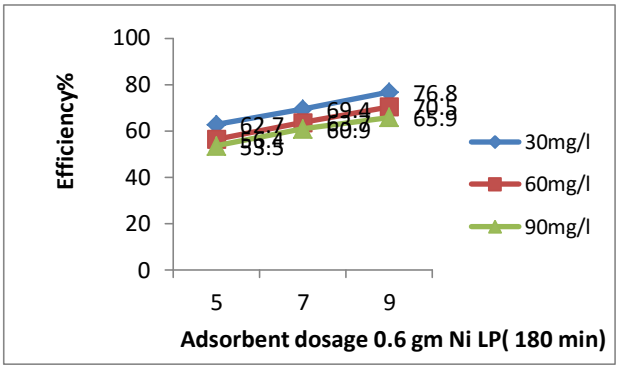
4.4.2



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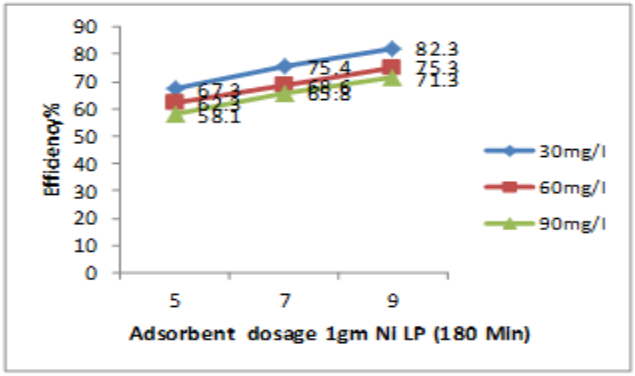
4.4.3



For Nickel metal using lemon peel powder as a adsorbent of dosage 1.0 gm gives better efficiency in 180 min at P^H 9 compare to 60 and 120 min contact time and 5,9 P^H ranges.

5. CONCLUSIONS

- It is concluded that up to certain values of optimum contact time ,P^H, Initial concentration of metals and adsorbent dosage the removal efficiency is increases.
- It is concluded that the adsorbent particle size(300µ-150 µ) is more efficient in removing metals and hence this adsorbent are used for further studies.
- It is concluded that removal efficiency increases in all the contact time
- It is concluded that initial concentration of metal 30 mg/l P^H 7 and 9 180 min contact time adsorbent dosage 1.0 gm, the removal efficiency increases
- It is concluded that the maximum metals removal by the adsorbents can be achieved at P^H 7 and 9, the initial concentration of metals of 30 mg/l, 180 min, contact time and 1.0 gm adsorbent dosages.
- It will be concluded that the adsorbent will be best in removal of Nickel by egg shell as compare to the zinc by egg shell.
- It is concluded that under varied conditions of experimentation the lemon peel adsorbents will be adsorb maximum of 62.5 % and 62.1% of Zn and Ni respectively, the egg shell adsorbent will be adsorbing maximum of 82.3% and 86.1% of Zinc Nickel respectively.

6. SCOPE FOOR FUTURE STUDY

- The issue covered in the conclusions can be considered as subject matter for further study.
- The percentage of removal of metals can be studied in this project work by other adsorbent can be considered for further study.
- The removal efficiency of removing other metals by the various adsorbent studied in the present project work is consider for further study.
- Waste products are effectively used for water treatment.

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BIOGRAPHIES

	Pratibha M Kulakarni AT/PO, Tilavalli Dist: Haveri
	Kavya S AT/PO Kalkere, Dist: Chitradurga

	Girish M Gorappanavar AT/PO, Sunakalbidari
	Gopi G M AT/PO, Harihar Dist: Davanagere Email:
	Avinash patel K L AT/PO, Davanagere Dist: Davanagere