Utilization of Light Weight Expanded Clay Aggregate in Waste Water Treatment –A Review

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Abstract – LECA stands for light weight expanded clay aggregate. LECA is manufactured in rotary kiln at 1200˚C. Its dark brown in color with interior black color in round shape. LECA is a versatile material. It is almost used in concrete fillings, construction sites, hydroponics, aquaponics , geo fillings[1] . It was first developed in the year of 1917. LECA can be used effectively in waste water treatment. This paper scrutinizes the use of LECA and modified LECA for the treatment of waste water.

Index Terms – LECA,aggregate,waste water treatment.

1. INTRODUCTION

LECA is light weight aggregate made by heating clay in a rotary kiln to around 1200˚C .due to yielding gases the clay expands forming a honey comb structure.it is almost round in shape and it is also available in various size and densities[1]. LECA is anadroit material and can be used in number of applications. It can be used in geofillings and in construction industries. LECA is environment friendly and low of cost.so it can be effectively used in the treatment of waste water. Few researches have been done for the application of LECA in waste water treatment. LECA has the ability to adsorb the heavy metal ions in effluent.

2. PROPERTIES OF LECA[3]

Lightness –(400 -800 Kg/m^3)

Thermal Insulation-(0.09 ~0.101 w/mc^2)

Sound insulation

Fire resistance

Non –decomposability (resists against alkaline and acidic substance)

Water absorption (40% volume in saturated state)

Durability –remains stable against climatic change

Frost stricken resistance –resist on freezing cycles.

3. DENSITY OF LECA AGGREGATES [2]

LECA Gradation (mm)	0-4	4-10	10-25	0-25
Weight (Kg/m^3)	800	600	380	450

Figure 1) Light weight expanded clay aggregate

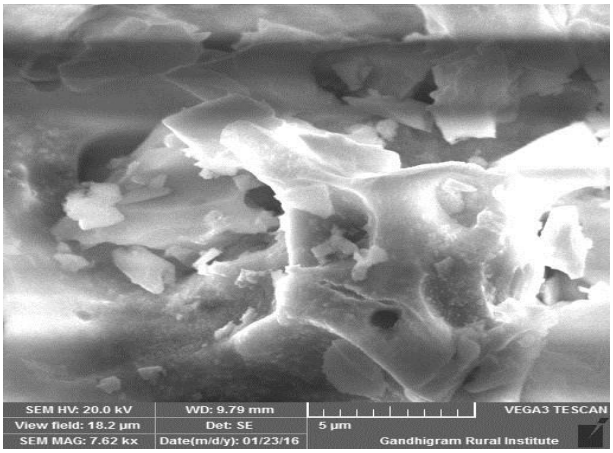

Figure 2) Scanning electron microscope of LECA

Spectrum: sample 7674

El	AN	Series	unn. C [wt.%]	norm.C [wt.%]	Atom. C [at.%]	Error (1 Sigma) [wt.%]
O	8	K-series	44.89	48.98	64.78	6.96
Si	14	K-series	20.68	22.56	17.00	0.98
Al	13	K-series	13.67	14.92	11.70	0.74
Fe	26	K-series	7.33	7.99	3.03	0.25
Mg	12	K-series	1.43	1.56	1.36	0.14

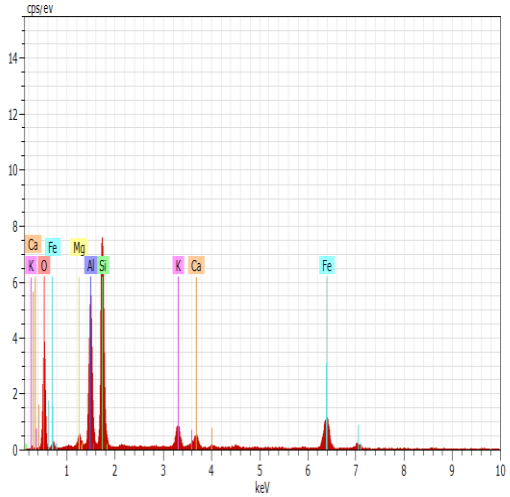

Figure 3)EDAX analysis of LECA particles

4. LECA AS AN ADSORBENT

4.1. Ammonium

Ammonium is an inorganic form of nitrogen impurity. High concentration of ammonium can lead to growth of flora and fauna and result in depletion of oxygen .The hazardous effect of ammonium are corrosion rate of soil materials, convulsion and even death of aquatic life's. The pollutant sources are fertilizers, metal finishing industries, sewage treatment plants etc. The maximum adsorption capacity was 0.254 mg/g[4].

4.2. Arsenic

Arsenic is highly toxic to humans. It is a first group carcinogen. Even smaller exposure may cause skin cancer, lung, bladder and liver cancer. Its removal is tedious. Light weight expanded clay aggregate is used to remove arsenic from waste water. Anoxic reaction was carried out using Mno2. Induced reaction shows high efficiency [10].

4.3. Cadmium

Cadmium is an extremely toxic heavy metal and it is considered as a carcinogen. It is generally used in manufacturing of batteries and extensively used in cadmium electroplating and paint industries. The limit of cadmium in drinking water is 0.05 mg/l.Cadmium is considered as a human carcinogen (group 1 -according to international agency for research on cancer, Group 2a - according to environmental protection agency (EPA) and 1B carcinogen classified by European chemical agency) [11]. The maximum removal efficiency for cadmium is 89.7%[5].

4.4. Chromium

Chromium is a toxic heavy metal. It is emitted from various sources like leather tanning, electroplating, paint etc. The maximum permissible limit for chromium is 0.05 mg/l. Chromium may result in health issues like liver damage , nausea, severe diahorrea and kidney damage.Maximum adsorption capacity of LECA for chromium is found to be 198.39 mg/g[8].

4.5. Copper

Copper is a heavy metal. Copper is emitted from various sources like paint manufacturing ,copper polishing ,electro plating and in printing process. Copper consumption may cause severe damage to dizziness ,diahorrea,neuro toxicity etc. World health organization (WHO) permissible limit for copper is 1.5 mg/l. For the pH 4.5 and temperature of 50˚C,LECA dosage 50 mg the optimum adsorption capacity was 99.289 mg/g[9]

The use of LECA for the adsorption of copper is high so it can be effectively used as an alternative low cost adsorbent.

4.6. Fluoride

Fluoride is an essential element for human health if its level is 0.75-1.75 mg/L.it prevents tooth decay. if it exceeds the standard level it results in results in cancer ,alzheimers syndrome ,infertility ,thyroid etc. Sorption is one of the best technique for defluoridation[6]. The fluoride levels were reduced to 0.39 mg/L by using LECA particles.

4.7. Lead

Lead is a toxic heavy metal. Lead contamination is due to batteries ,paintindustry.High amount of lead can result in chronic disorder,high blood pressure,coma ,lead poisoning etc. LECA particles absorb lead.the maximum adsorption efficiency of LECA for lead is 93.75%[5].

4.8. PAH (Phenathrene, Fluoranthene and pyrene)

Polycyclic aromatic hydrocarbons are considered as pollutants in water streams. They are carcinogenic and mutagenic materials. PAH occur in water due to oil spills of crudeoil.The European union , EEC directive 98/83/EC has set a limit of 0.1 ng/L of PAH in drinking water.

Sorption is one of the best method for removing PAH from water. The maximum sorption was reached at a mass of 4g of LECA[7] .The removal efficiency were 92.61% for phenatherene,93.91% for fluoranthene and 94.15% for pyrene.

5. MODIFIED LIGHT WEIGHT EXPANDED CLAY AGGREGATE

The surface of the LECA can be modified by the use of various chemicals.it also effectively removes the impurities in water. Modified LECA removal is reviewed.

5.1. Aluminum oxide Coated LECA

It is coated with the help of $Al(NO_3)_3.9H_2O$.it is used for the arsenic removal. Results show that coating increases the adsorption capacity[10].

5.2. Iron oxide coated LECA

Iron oxide coated LECA is used for the removal of arsenic. LECA is coated with the help of $Fe(NO_3)_3.9H_2O$[10].Results shows that the coating increases the adsorption capacity more than LECA.

5.3. Hydrogen peroxide LECA(HML)

Hydrogen peroxide LECA is used for the removal of toxic chromium .for the modification H_2O_2 is used. Chromium removal is found to be 53.72 m^2/g , which is higher than the normal LECA[8].

5.4. Magnesium chloride LECA

Magnesium chloride LECA is used for the removal of toxic chromium .chromium removal is found to be 76.12 m^2/g,which is higher than the normal and H2O2 modified LECA[8].

6. CONCLUSION

Light weight expanded clay aggregate is found to be a potential adsorbent for heavy metals .LECA is of low cost. Its cost is very low when compared to other adsorbents.so it can be effectively used in waste water treatment. Availability of clean and pure water is now a glaring topic everywhere in the world. Tremendous increase in human population, due to industrialization and urbanization has resulted in the contamination of water resources.so to purify the water LECA can be used effectively.

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