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Comparative study of the adsorption of cobalt (II)ions from aqueous solution using low cost adsorbents

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ABSTRACT

In recent years there is a search for inexpensive alternate materials as a source of adsorbent to remove the heavy metal in aqueous solution; in the present study coconut shell and shale are used as adsorbents for the removal of cobalt. The study also aims to find the suitable pH, temperature and dosage for the removal of Co (II) ions.

Keywords: Coconut shell, Cobalt (II), Adsorption and Waste water.

INTRODUCTION

Water is our lifeline and feeds us. Water has played a role not only in the history of countries, but in religion, mythology, and art. Water in many religions cleanses the soul through holy water. The water or hydrologic cycle explains interactions between the atmosphere, hydrosphere, and lithosphere. Uses of water include agricultural, industrial, household, recreational and environmental activities [1].Water pollution is a major threat to living thing. The ground water pollution of mainly higher than that in the most contaminated surface water supply. Many of the chemicals are tasteless and odorless and beyond certain concentrations is a threat to human health. The major pollutants in aquatic systems are chlorites, nitrates heavy metals, and toxic organisms. Adsorption technique is used to combat water pollution [2]. Adsorption is a surface phenomenon. It is observed at the surface of the solution. Adsorption is process that occurs when a gas or liquid solute accumulates on the surface of solid or a liquid (adsorbents), forming a film of molecules or atoms (the adsorbate).

In the present work shell and coconut shell are used as adsorbents in the removal of cobalt (II) Ion
Coconut shell is used for manufacture a variety of products with commercial importance including activated carbon. Shell is carbonized by using methods like pit method, drum method destructive distillation. Activated carbon manufactured from coconut shell is more effective for adsorbing gas/vapor and aids in the removal of color from compounds.

Shale
shale is fine-grained, classic sedimentary rock sedimentary rock composed of mud, which is a mix of flasks of clay minerals and tiny fragments (silt-sized particles) of other minerals especially quartz and calcite. The ratio of clay to other mineral is variable. A shale is characterized by breaks along thin laminae or parallel layering or bedding less than one centimeter in thickness.

MATERIALS AND METHODS

Preparation of Adsorbent
Coconut shell is collected from the used coconut. The shell is carbonized in a muffle furnace kept under400 -500ºC 7 hours. The shale is used in finely ground form.

Standard calibration curve for cobalt (II)
10ug of cobalt solution is prepared. Various volumes of this solution are pipetted out into reviews of 50ml standard flasks. To each flask 6ml of cobalt solution, 2g sodium acetate and 2ml nitro-R-salt is added and added and made up to the mark [3]. The photoelectric colorimeter is standardized using blank solution. The percentage transmittance and absorbance for each solution is measured by using photoelectric colorimeter at a wavelength of 425nm [4].

Effect of pH
The influence of the solution on the percentage removal of the cobalt at equilibrium is examined at an initial concentration of about 10ug at room temperature at various 2 to 8.

Effect of equilibrium time
The contact time experiments are useful to investigate the influence of system parameters on the rate and extent of adsorption. Experiments is done by conducting batch mode studies with cobalt solution of known concentration, and known pH at room temperature using 2g adsorbent at various time intervals[5].

Effect of the dose of the adsorbent
The effect of the dose of the adsorbents on equilibrium time is examined by conducting batch mode experiments with 10ug cobalt solution at the optimal pH respectively. The agitation speed and the size of adsorbent were kept constant for all experiments [6].

Effect of temperature on the adsorption process
The adsorption is studied by conducting experiments at equilibrium time under identical conditions but different temperature 35ºC,45ºC, 55ºC …etc at the optimum pH with 2g adsorbent.

RESULTS OF DISCUSSION

Batch mode adsorption study is conducted and the effects of pH, contact time, dose and temperature on the adsorption process were studied using adsorbents, coconut shell, and shale.

Optimum pH
The pH of the solution is a dominant parameter in controlling process on the adsorption process on to the adsorbent. Hence the influence of pH in the removal of metal is examined initially and the optimum pH for the adsorption study is determined by conducting experiments at various pH from 1 to 8.The adsorption of the metal on coconut shell is found effective at pH 8 (table 2) and a maximum of 79% of the metal adsorbed at this pH (graph 2). Simultaneously adsorption studies is conducted using shall and it's found that 80% of the metal is adsorbed at pH 5 (table 6 and graph 6). The optimum pH both are pH 5. So is used and further experiments is carried out this optimal pH [7].

Equilibrium time
The minimum time needed to reach equilibrium is called equilibrium time. During any adsorption process adsorption and desorption proceed till equilibrium is reached. The extend of removal of cobalt metal by adsorbents is found to increase, as the contact time increase, as the contact time increases (graph 3 and 7). Hence, 75 minutes is taken as the equilibrium time for the adsorption experiments. It is found that 72% of the metal is removed by coconut shell and 66% of the metal removal in 15 minutes in shale [8].

Influence of adsorbent dose
The effect of adsorbents dose on the removal ratios of the metal are shown using graphs (4 and 8). The percentage of metal adsorbed increases as the sorbent dose is increased over the range 2.0g. Coconut shell shows maximum 82 % and shale shows a maximum of 65% optimal pH and at the equilibrium time. Increase in adsorption with sorbent dose could be attributed to increase surface area and the availability of more sorption sites.

Influence of temperature

From graph 5 and 9, it is obvious that amount of the metal adsorbed by the adsorbents decreases with increase in temperature. The uptake of metal by the adsorbents declines from 60% to 79% (table 5) and 58% to 70% (table 9), when temperature was raised. From 30 to 45° c. the retardation in extent of adsorbate is due to the fact that at higher temperature the solubility of adsorbate increases and chemical potential decreases. As the temperature increases, the rate of diffusion of adsorbate molecules across the external boundary layer and interval pores of the adsorbent particles increases. Hence, the change in the temperature will change the equilibrium capacity of adsorbent for a particular adsorbate [9]. In the presence study, coconut shell and shale are used as adsorbents for removal of cobalt. Out of these two adsorbents, shale is found to be more effective in removing the metal from aqueous solution.

Graph: 1 Standard graph Temperature: 30±2^{0}C

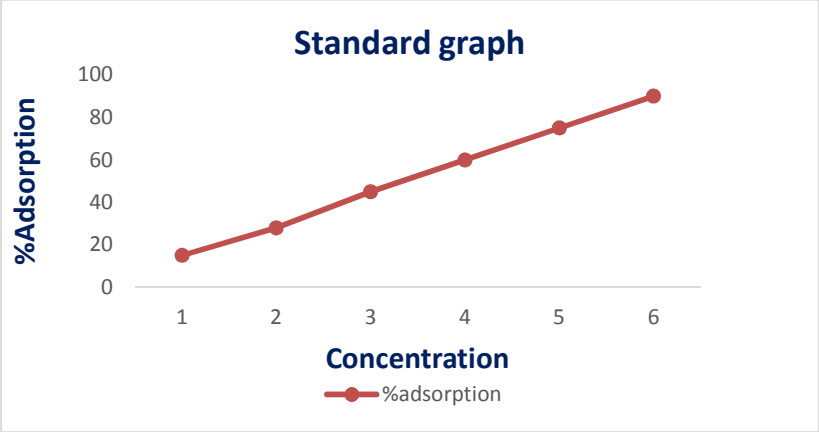

Fig.1 Standard graph

Graph: 2 Effect of pH

Adsorbent: coconut shell
Concentration: 10ug/ml
Adsorbent: coconut shell
Contact time: 1 hour
Dose: 2g
Temperature: 30±2^{0}C

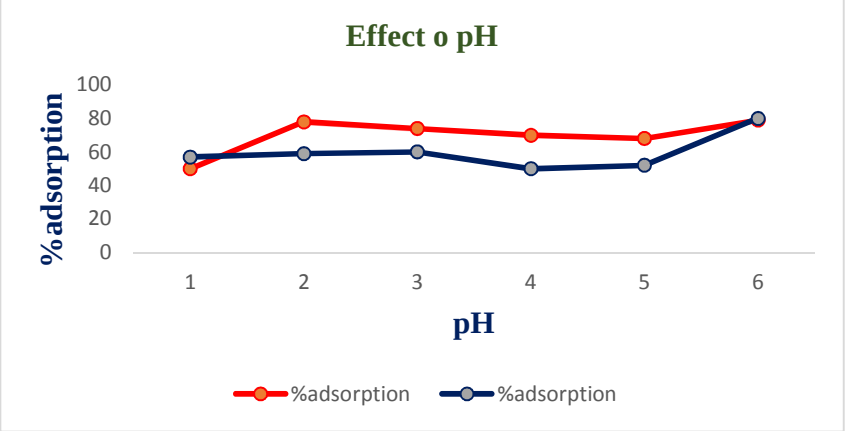

Fig.2 Effect of pH

Graph: 3 Effect of contact time

Concentration: 10ug/ml
pH :5
Adsorbent: coconut shell
Dose: 2g
Temperature: 30±2^{0}C

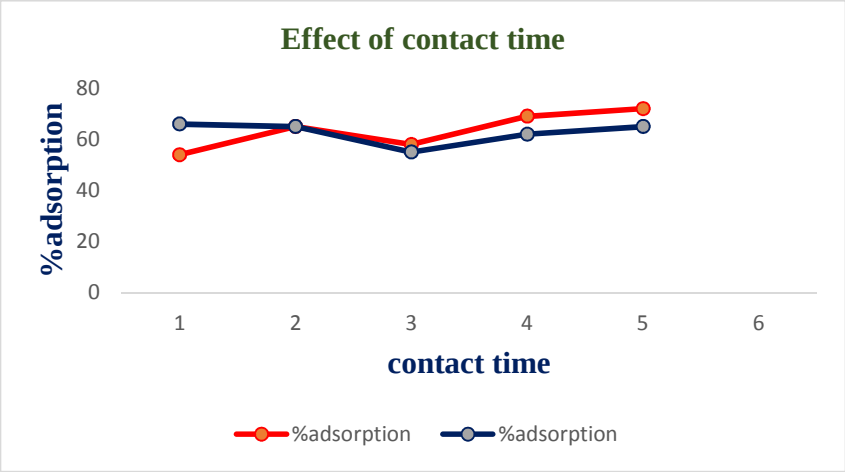

Fig.3 Effect of contact time

Graph: 4 Effect of dosage

Concentration: 10ug/ml
pH: 5
Adsorbent: coconut shell
Temperature: 30±2^{0}C
contact time: 45 minutes

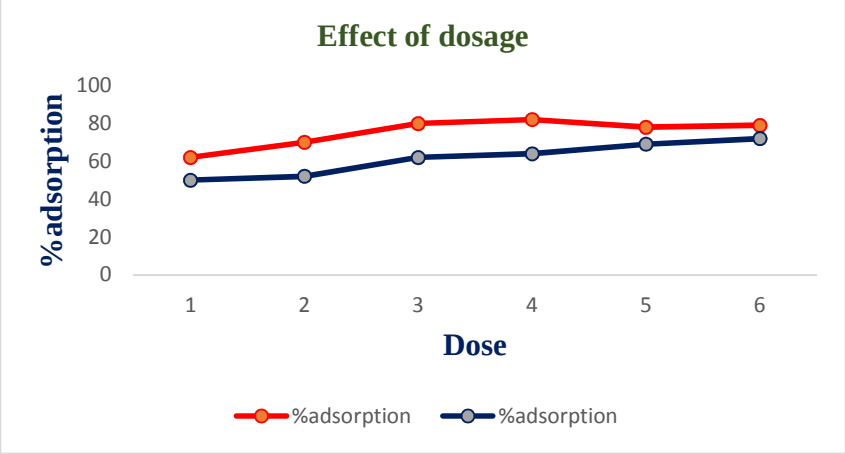

Fig.4 Effect of dosage

Graph: 5 Effect of Temperature

Concentration: 10ug/ml
Dose: 2g
pH :5
Adsorbent: coconut shell
Temperature: 30±2^{0}C
contact time: 45 minutes

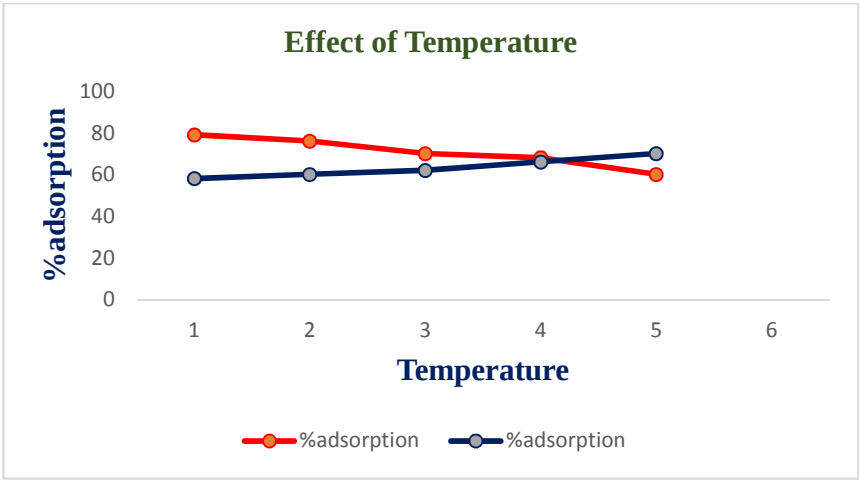

Fig.5 Effect of Temperature

CONCLUSION

Shale and coconut shell were used as solid adsorbents for the removal of cobalt ion from aqueous solution through batch mode studies. The influence of contract time, pH and concentration of metal ions on adsorbent were investigated. Sixty minutes of adsorption time was found sufficient to reach equilibrium for cobalt ion using carbonized coconut shell and 45 minutes time interval for shale. Adsorption of metal ions were pH dependent and the results indicate the optimum pH for the removal of Co using carbonized shell to be 5 & for shale it was found to be 7. Shale better adsorbent than the carbonized coconut shell in most of the studies. Besides the use of these adsorbents under investigation does not pose a problem for it disposal.

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