ABSTRACT

The Coimbatore city of Tamilnadu is called the Manchester of South India. The effluents discharged from the industries from different operations contain heavy metals like Lead, and Nickel. These heavy metals are toxic even at low concentrations.

Commercial activated carbons are generally prepared from carbonaceous materials like bones, blood and coconut shells, which are valuable for other beneficial purposes also and, as a result, they are costly. But there are many other carbonaceous materials that simply go as waste in bulk quantities. If it is possible to produce activated carbon from such locally available materials, which are not used for any other beneficial purposes, the cost may be less. Strongly motivated by this idea, this research work was undertaken.

In this research work, three different activated carbons have been prepared from three different materials. The three materials are, (1) fruit of Leucaena Glauca Benth, (2) bark of Casuarina Equisettifolia wood and (3) Tamarind Fruit Shell. All these three materials are available locally in plenty. They are not used for any other beneficial purpose at all and they are all discarded as wastes. The utilization of these three carbonaceous materials was the strong motivating factor to take up this study.

Though many methods are available for heavy metal removal, adsorption is a technique for removing heavy metals from the industrial discharges, even at trace level concentrations. Adsorption on activated carbon is a promising technique, that has found an important place in the unit operations in the waste treatment. Hence in this research work also, adsorption experiments were conducted with the three locally prepared activated carbons for the removal of Nickel (II) and Lead (II) from aqueous solutions.

To test the abilities of the three locally prepared activated carbons in removing Nickel and Lead from the aqueous solutions, Batch adsorption experiments were conducted. For the experiments on Nickel removal, the diluted
Nickel wastewater with a concentration of 63 ppm and with a pH value of 8.2 was used. For the experiments on Lead removal, the synthetic Lead solution with a Lead concentration of 50 ppm and with a pH value of 3.6 was used. The batch experiments were conducted to assess the parameters influencing the adsorption. Experiments were conducted to explore the optimum pH, optimum dosage, optimum contact time and the optimum initial concentration of metal in the solution.

pH is an important parameter which influences any reaction. The pH of the aqueous solution is an important parameter in the adsorption process also. Hence, experiments were conducted to explore the optimum pH. The optimum pH experiments were conducted with different pH values of the aqueous solutions. To 100 ml of these solutions, known dosage of the activated carbon was added and agitated. At every 5 minute interval, the residual metal concentration was measured using an Atomic Absorption Spectrophotometer and tabulated.

To establish the amount of carbon required per litre of the waste treated and the contact time required, another set of batch experiments were conducted. The pH value and the metal concentration in the aqueous solution were kept as constants. Then, 100 ml of the aqueous solution was equilibrated with different dosages of the adsorbent. At regular intervals, the residual metal concentrations were monitored. Using the data obtained, the Optimum Dosage and Optimum Contact time were found out.

The initial metal concentration in the aqueous solution has a bearing on the metal removal efficiency. Hence, same aqueous solutions with different initial metal concentrations were agitated with a fixed dosage (optimum Dosage) of the three activated carbons. At regular intervals, the residual metal concentrations were monitored and recorded.

The isotherm is a plot of the amount of impurity adsorbed against the amount of impurity remaining in solution at constant temperature. Isotherm test is one of the important tests in selecting a particular type of carbon for water, wastewater and industrial treatment systems. A reading taken at any point on the isotherm gives the
amount of metal adsorbed per unit weight of the adsorbent, which is the adsorptive capacity at a particular concentration and water temperature. Using the data obtained from the batch experiments, Langmuir Isotherm and the Freundlich Isotherm were drawn.

Column adsorption studies are important to explore the efficiency and the break-through of the prepared activated carbons. In almost all the industries, the activated carbon treatment is carried out in a fixed bed, down flow column. Hence in this research work also, all the column experiments were conducted in fixed bed, down flow columns. The activated carbons prepared were tested in columnar experiments to establish their efficiency in removing Nickel from industrial wastewater and Lead from synthetic lead solution. Using the results obtained, the break-through curves are drawn.

Models are powerful tools by which the designers of wastewater treatment systems can investigate the performance of a number of potential systems under a variety of conditions. In most of the investigations, the relationships among variables are not known and furthermore, or too much complicated to be described by a small set of explanatory variables. In such situations the relationships must be approximated to develop models. Multiple linear regression model helps us to approximate the relationships between a response variable and a number of explanatory variables by a linear function.

Artificial Neural Network (ANN) is an information processing system that has certain performance characteristics in common with biological neural networks. An ANN consists of a large number of simple processing elements called neurons, units, cells or nodes. An ANN MODEL learns from a set of training patterns and through training, it generalizes the features within the training pattern and stores these generalized features internally in its architecture. The independent variables used for the ANN Models are, (1) the pH value of the solution (X₁), (2) the Contact time in minutes (X₂), (3) the type of carbon (X₃), the metal concentration of the aqueous solution in mg/L. (X₄) and (5) the Dosage of Activated Carbon (mg) (X₅). The only dependent variable was the percentage of metal removal (Y). Using the data obtained from the batch experiments, ANN MODELS were developed.
Selecting a specific activated carbon requires many experimental studies involving many parameters. But once the mathematical model is developed, it simplifies the tremendous works. Hence, mathematical models were developed for the three locally prepared activated carbons using the data obtained from the batch experiments and the data obtained from the column experiments.

The three types of locally prepared activated carbons were tested for their abilities in removing Nickel (II) and Lead (II) from aqueous solutions through a set of Batch Experiments and through Column Experiments. The results of these experiments reveal that, all the three Activated Carbons are efficient in removing Nickel (II) and Lead (II) from the aqueous solutions. The isotherms drawn are in conformity with the Langmuir and Freundlich adsorption isotherms. The break through curves drawn follow the typical S-shaped curve.

The misclassifications are less than 8 %, for all the ANN models developed. Hence they can very well be used by the researchers and industrialists to predict the percentage of metal removal. All the mathematical models developed are highly significant. Hence, they can very well be used by the researchers to predict the efficiency.