

EVALUATION AND PERFORMANCE OF SAND PACKED COLUMN DEPLOYING BENTONITE CLAY FOR RAPID ADSORPTION OF RHODAMINE B FROM AQUEOUS SOLUTION

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Abstract -In the present work we have attempted to exploit the potential of Bentonite clay as an adsorbent. Sand packed Column studies were conducted to adsorb cationic dye Rhodamine B from aqueous solution. Series of studies were conducted with varying amount of clay in the column. The effect of pH of aqueous solution of Rhodamine B on adsorption was evaluated. Results reveal that Bentonite clay at very low amounts could be an ideal adsorbent. Adsorption was pH dependent. Maximum absorption was observed at pH 5.

Keywords – Rhodamine B, Bentonite Clay, Adsorption, Sand Packed Column.

1. INTRODUCTION

Textile industries utilizes large amount of water, chemicals, dyes and other colorants for production of cloths, colored threads and other textile related materials. As a result they produce large amount waste water known as aqueous which contains highly toxic chemicals especially dyes.[12]. This aqueous when released into ecosystem even with partial treatment causes soil contamination and fresh water contamination.[13]. The dye used in textile industries are main pollutants which leads to coloring of water bodies. These dyes are carcinogenic, toxic, mutagenic in nature. These dyes retards the photosynthesis process thus aquatic system also get affected very badly.

Dyes are chemicals made to resist sunlight, water, gas. They are also made resistant to washing, hence the structure of the dye is very complex. Some of the common basic dyes are Rhodamine B, Methylene blue and Crystal violet; Acetic dyes are Fuschine, Nigrosin; Vat dyes are Vat Blue1, Vat Green 11(11). Rhodamine B (Rh b) is a Fluorone Dye and is photostable. Thus used as Laser dye. Degradation of this dye is very difficult. There are many treatment technologies available viz., physical, chemical and biological. Based on contamination level of treatment technologies are adopted. Treatment like precipitation, membrane separation, Flocculation, Ion exchange, Ozonation, Oxidation, Reduction, Electrochemical destruction, Electrokinetic coagulation, Phytoremediation, Aerobic-Anaerobic digestion, Biosorption are adopted [9]. However Adsorption as a technology has several advantages over other technologies. Several studies are recently conducted using low cost adsorbent such as Coconut shell, Orange peel, Banana peel, Coir pith, Rice-husk, Sand and clay[6].

Clay is very fine material with large surface area and seems to be ideal to attract the adsorbate. They are used to treat aqueous in several industries[1]. There are several types of clay and they differ from each other in structure, core atom, particle size, physical and chemical properties. Bentonite is a fine clay formed by disintegration of volcanic ash. It has very good rheological and adsorbing property. It has more negative charge on its lattice and hence posses property to attract cat ions. In present study we have used Bentonite clay as an adsorbent to adsorb cat ionic dye namely Rhodamine B (Fig 1).

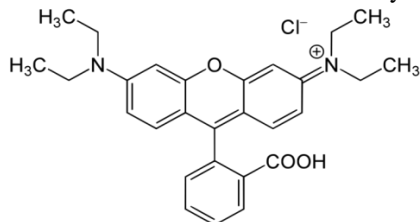


Fig:1: Structure of Rhodamine B

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2. MATERIALS AND METHODS

Preparation of clay (adsorbent): bentonite clay was purchased from mm chemicals bijapur. The clay was saturated with distilled water for about 24 hours. The clear aqueous supernatant was removed and wet clay was used for further experiments.

Preparation of Rhodamine B aqueous solution (Adsorbate): The cationic dye Rhodamine B was used as adsorbate. The aqueous stock solution of 500mg/ml prepared and used for the experiments.

Preparation of column: River sand passing through IS sieve of size 2.36mm was used to pack the column. Sand was washed thoroughly, dried and used in the study. The experimental setup was designed accordingly and is shown in Fig 2. PVC pipes were used as columns(80Cm height, 3 inch dia). The column was packed with sand and clay. Steel frame was constructed to hold the sand column. At the extreme end of the pipes mesh was provided to avoid spilling of sand particles and funnel was fixed to collect the leachate. Columns were packed with sand upto 40% height from bottom ie 32Cm. The prepared adsorbent i.e., wet clay was placed in sand column. Clay was packed in the pervious synthetic cloth to avoid loss of clay due to movement of clay particle. Again sand was packed (above the clay layer) to about 35 Cm as shown in Fig 3. 12 cm ponding depth of water was allowed on top of the column After packing column the rhodamine B aqueous solution was run through column(500ml) at constant rate. Around 9.5Litrs of distilled water was used to wash the column. Leachate was collected and tested in spectrophotometer for Rh B analysis.

Analysis of Rhodamine B dye: Rhodamine B was analyzed using UV-spectrophotometer[8]. The standard curve was prepared [Fig 4]. The leachate samples were read at 554nm and used for analysis.

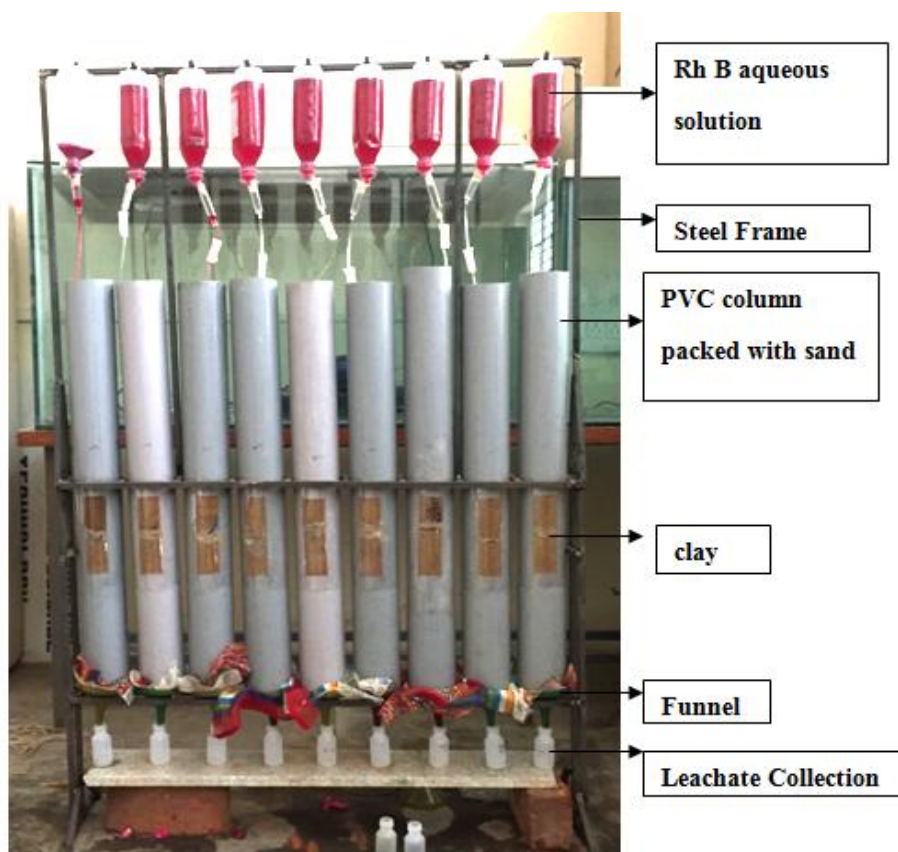


Fig 2: Experimental Setup

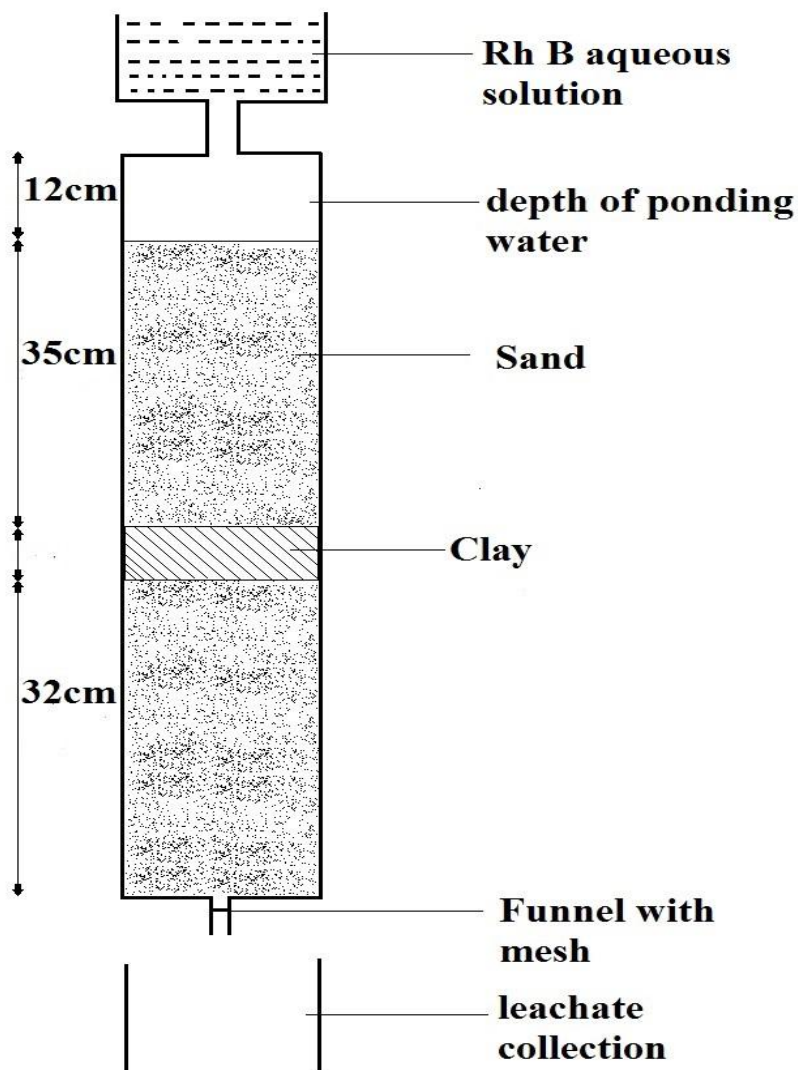


Fig3: Line Diagram Of Experimental Setup

Effect of varying amount of adsorbent Separate experiments in triplicates were conducted to study the effect on adsorption due to varying amount of adsorbent. Columns were packed using 80gm, 100gm, 120gm, 140gm, 160gm of Bentonite clay. Leachate were collected and individually read for Rhodamine B concentration.

Effect of pH of Rh B aqueous solution on adsorption The aqueous solution of Rh B was prepared as mentioned earlier. In order to study the role of pH on adsorption. the column was packed with 120 gm of Bentonite clay. The aqueous solution was adjusted to different pH viz., 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9 (using NaOH & HCL). The aqueous solution was run through columns as explained earlier. Experiments were conducted in triplicates leachate was collected. The amount of Rhodamine present in leachate was calculate and measured.

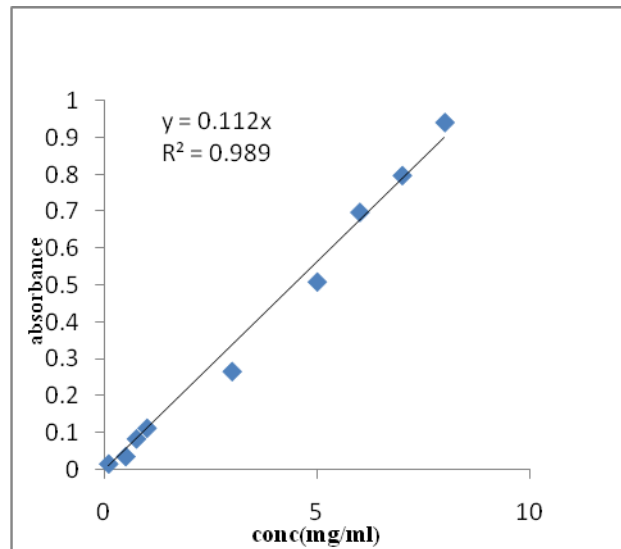


Fig 4: Standard graph

3. RESULTS AND DISCUSSION

Adsorption in the column takes place in three regions i.e., clay, Sand above the clay, sand below the clay. However since clay is negatively charged dye adsorption was more in clay. Clay has super fine particles that adhere together and prohibit water and contaminants movement, while sand has course particles which allow water and contaminants to leach too rapidly.

3.1 Effect of different amount of clay

The adsorption of dye had direct relation with amount of clay. From the graph (Fig 5) it is clear that 120gm of clay was optimum. Beyond 120gm there was no much improvement in adsorption.

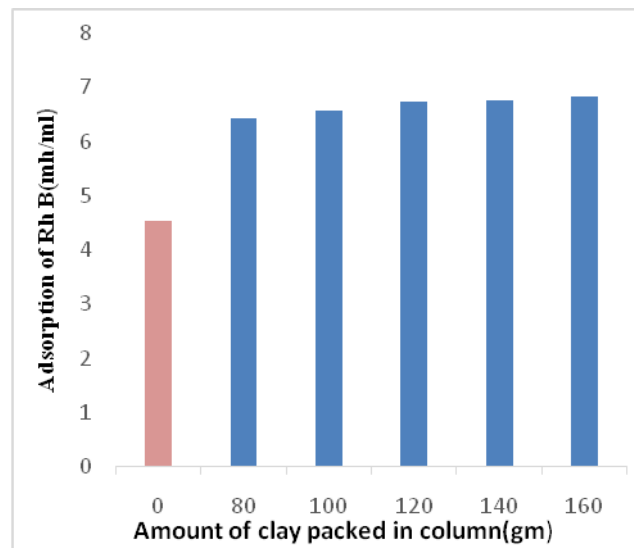


Fig 5 : Adsorption of Rh B

3.2 Effect of flow rate

The flow rate of aqueous solution was indirectly related to amount of clay packed in column. However a constant flow rate of 500ml/7min was set thorough out all experiments. From graph(Fig 6) it is evident that more amount of clay in the column takes longer time to flow. thus requires more time for the leachate to be collected. 160gm of clay in column has taking 220min to collect 10lit of leachate. Where as it took only 155 min to collect 10lit of leachate from column packed with 80gm of clay.

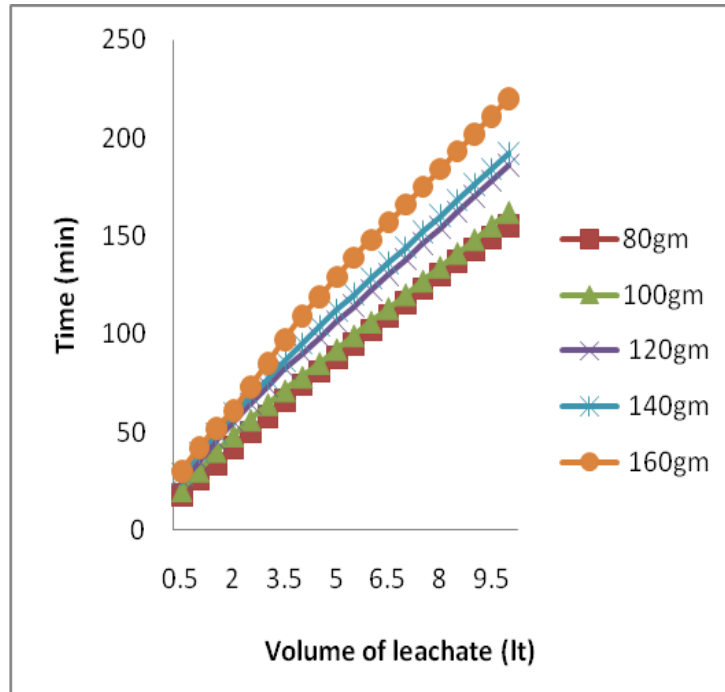


Fig: 6 : Relationship Between Time and amount Of Clay

3.3 Effect of pH

The pH played an important role in the adsorption of Rhodamine. as revealed by the results Fig[7]. pH was inversely proportional to adsorption of Rhodamine B on clay. Thus at pH 5 maximum adsorption of 10mg/ml was recorded compared to 3.6mg/ml at pH 9. This clearly indicates that the clay is more effective in acidic range. As the clay has more number of negative charge at its lattice and the dye is cat ionic in nature.

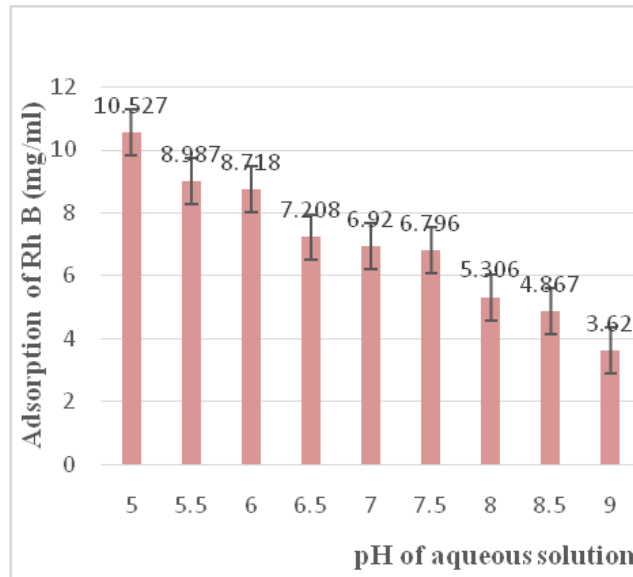


Fig 7: Effect Of pH of aqueous On Adsorption

4. CONCLUSION

Bentonite clay seems to be an ideal candidate for adsorption of Rhodamine B from aqueous solution. The adsorption studies in the column experiments infer that 120 gm of clay is optimum. pH played significant role and influenced the adsorption. Acidic range favored the adsorption. Further studies on modified Bentonite by nano compounds are warranted.

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