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Removal of Turbidity of Waste Water by Adsorption Technology

Nazia Fathima¹, Uzma Baig², Dr.Smita Asthana³, Dr. D. Sirisha⁴

Lecturer, Department of Chemistry, St. Ann's College for Women, Mehdiapatnam, Hyderabad, India¹

Lecturer, Department of Chemistry, St. Ann's College for Women, Mehdiapatnam, Hyderabad, India²

Reader in Chemistry, St. Ann's College for Women, Mehdiapatnam, Hyderabad, India³

Head, Centre for Environment & Climate change (CECC), School of Environmental Sciences (SES), JNIAS, India⁴

ABSTRACT: The presence of particulate matter in water due to algae, clay, silt, organic pollutants and solute materials is never ending problem in many places of India during rainy season. Environmental regulation and public health concerns require that wastewater collected from municipalities and communities must be treated to a set standard before it is returned to surface waters or land or even reused. The water in rainy season is highly turbid due to the discharge of storm water into surface water and introduction of muddy particles into water. It is very important to measure the turbidity of domestic water supplies, as these supplies often undergo some type of water treatment which can be affected by turbidity. High turbidity fill tanks and pipes with mud and silt, and can damage valves and taps. Where chlorination of water is practiced, even quite low turbidity will prevent the chlorine killing the germs in the water efficiently. Many particles with less density will not settle and float in the water. Taking that factor into consideration the present paper deals with the removal of turbidity by concrete powder by adsorption technique. Nephelometer is used to determine the concentration of suspended particles in a sample of water by measuring the incident light scattered at right angles from the sample. Adsorption parameters such as pH, contact time, temperature, concentration, shaking time were carried out and the results were optimized. Solutions of different concentrations (10NTU - 100NTU) were prepared and concrete dosage was varied from 0.2gms to 2.0 gms. The results are found to show effective removal of turbidity from high concentration solutions. High percentage removal of turbidity (90% removal) is observed with the solution of 80NTU treated with an optimum dosage of 1.2 grams.

KEYWORDS: Adsorption, Nephelometer, Concrete, pH, Temperature, Optimum dosage

I. INTRODUCTION

Water is a universal solvent used in every single industrial process. Hence it is expected to contain a diverse range of organic, inorganic, metallic, hydro carbonic and biological effluents of all classes and properties. Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand (the settable solids), very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid.

Treatment of water and wastewater having turbidity requires a suitable and effective method. Membrane filtration [1], precipitation [2], nanofiltration [3], ion-exchange [4], electrocoagulation flotation [5], and adsorption [6] have been used extensively for removing turbidity of waste water. Among these methods, adsorption is the most effective and widely used method because it is universal, has a low maintenance cost, and is applicable for the removal of Turbidity at high concentrations. In recent years, considerable attention has been focused on the study of Turbidity removal using natural, synthetic, and biomass materials such as activated alumina [7], fly ash [8], alum sludge [9], chitosan beads [10, 11], red mud [12], zeolite [13], calcite [14], hydrated cement [15], and acid-treated spent bleaching earth [16]. As the many regions in Telangana have waters with high turbidity, the present study is carried out to develop a

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cheap and effective method for the removal of turbidity of waste water using adsorption technology. Adsorption is the process of surface phenomena where particles have the tendency to stick on to the surface of adsorbent by means of vanderwaal Forces that attract and hold particles. Since the measurement of turbidity is a key test of [water quality](#). The present paper deals with the measurement of turbidity using an instrument Nephelometer and its removal using low cost natural coagulant Bentonite and concrete as an adsorbent to obtain better quality of treated water which can be reused and acceptable for consumers.

II. MATERIALS AND METHODS

A. SELECTION OF AN ADSORBENT

In this experiment the removal of turbidity of synthetic turbid water is tested with Concrete. Concrete material is a mixture of silica, stones and cement in the ratio of 1:2:4. As the material consists of all these substances, it is selected as adsorbent. Concrete powder which is a mixture of Portland cement, sand stones in the required strength has adsorption capacity in removing turbidity from waste water. Since concrete also plays a very prominent role in removing fluoride ions from water, it is selected for further studies to check the effect of contact time, concentration, adsorbent dosage and temperature on adsorptive removal of turbidity. In recent days due to rapid industrialization and urbanization the construction of buildings are taking place, for that they are using concrete as an ingredient to construct a building. After usage builders are dumping the waste concrete into dump yards of Hyderabad city. Taking this factor into consideration concrete is selected as adsorbent for removal of turbidity from waste water.

Components	Ratio
Cement (Portland cement)	11%
Air	6%
Sand	26%
Gravel/crushed stones	41%
Water	16%

Figure 1.1 shows the Composition of concrete

B. SELECTION OF A NATURAL COAGULANT

At present, in order to decrease waste hazards and to restrict the resulted effects on the environment, investigators studying the possibility of using new methods and materials to treat wastewater. In this study bentonite is used as a natural coagulant as it is used frequently in treating waters containing heavy color, low turbidity. Bentonite is a natural material that contains essential components such as aluminium, iron, and clay materials. Moreover bentonite is cheaper than chemicals and it fulfils the economic benefits of the operators as well as environmental concerns.

Bentonite clay can treat oil, sulfate, phosphate, and metals and is extremely effective at removing certain cationic components from wastewater also.

C. PREPARATION OF SYNTHETIC TURBID WATER

Synthetic turbid water was prepared by adding bentonite in (gms) into 1 L of distilled water. Bentonite suspension was resuspended by rapid mechanical agitation followed by slow mixing to obtain a uniform dispersion of bentonite particles. After the agitation the bentonite turbid solution was allowed to settle for 1-2 days. The synthetic turbid solution is now filtered. The resultant solution obtained upon filtration is the Stock solution, with which the experiment is carried out with concrete to study the effect of various parameters such as Dosage, Concentration, pH, contact time, Temperature. Initially the turbidity of the stock solution is measured by an instrument Nephelometer and units are expressed in nephelometric turbidity unit (NTU). Since the stock solution has very high turbidity, it is diluted to 100NTU.

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D. EFFECT OF SHAKING TIME

A synthetic turbid solution of concentration 100NTU is taken in 6 well stoppered bottles and 1 gm of concrete is added to the solutions. The solutions are subjected to vigorous shaking at a time interval of 10mins, 20mins, 30mins, 40mins, and 50mins and are allowed to settle at room temperature followed by filtration. The results tabulated in figure 1.2 plotted between the % removal and contact time indicates the optimum contact time of 20mins where maximum removal of turbidity (90% removal) is seen.

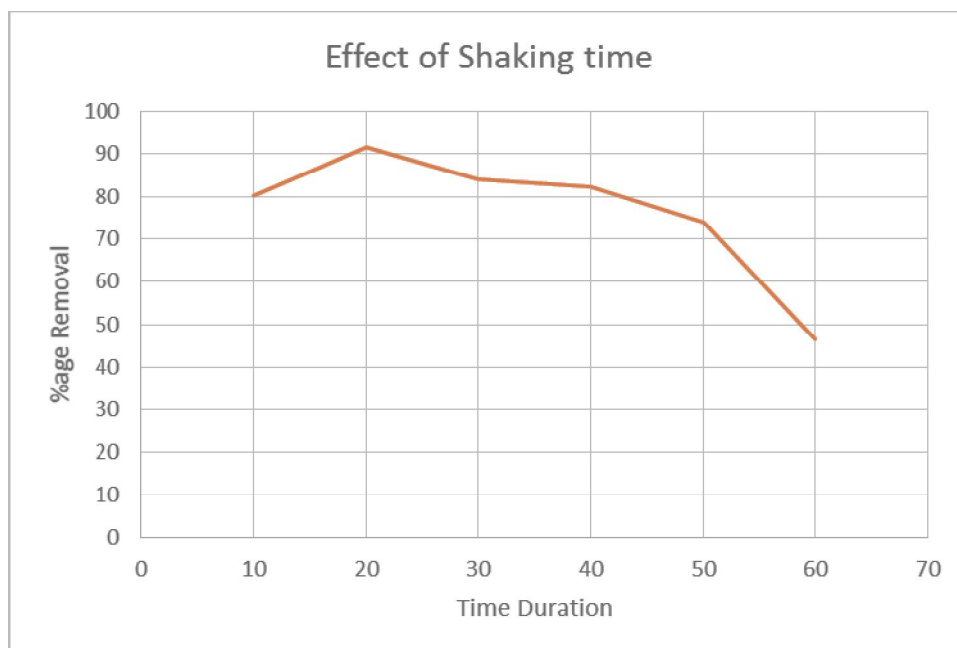


Figure 1.2 – Plot between Time duration and Percentage removal showing 90% of removal of turbidity at the time duration of 20 mins.

E. EFFECT OF CONCENTRATION

Initially the concentration of synthetic turbid solution is varied from 10NTU -100NTU and a constant concrete amount of one gram is added to the different concentration solutions taken in 10 well stoppered bottles. As the optimum contact time obtained from figure 1.2 is 20mins where turbidity removal is maximum. The solutions are mixed thoroughly at a constant contact time of 20mins and are allowed to settle at room temperature for one day and are filtered. The turbidity of the solutions with different concentrations is now measured. The results are tabulated in figure 1.3.

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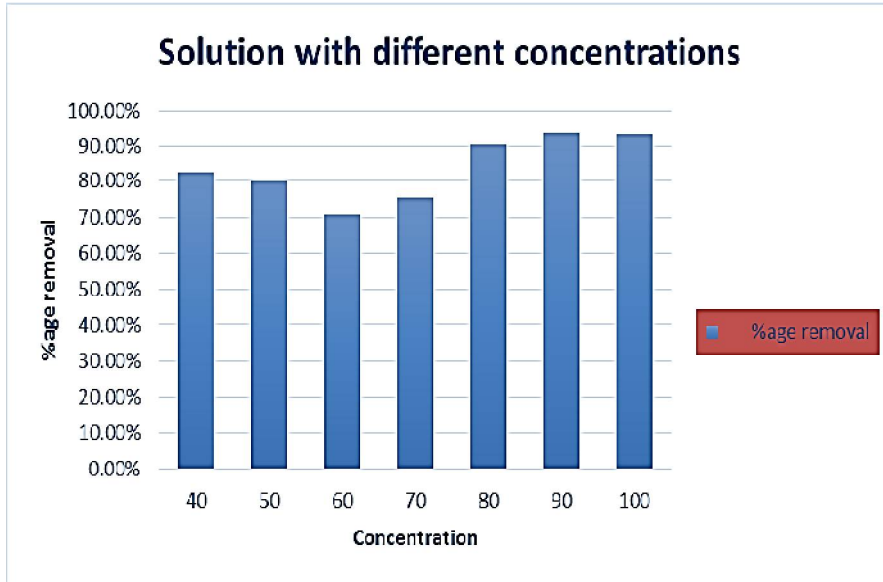


Figure 1.3 – Concentration v/s percentage removal of turbidity indicating that the removal is very efficient at the concentration of 80NTU.

F. EFFECT OF DOSAGE

The amount of concrete adsorbent was varied from 0.2 gms to 2.0 gms with a constant concentration of 80 mg/L and agitation time of 20 minutes at room temperature. The amount of colloidal particles adsorbed per unit mass of the adsorbent increases with increase in amount of adsorbent and became constant at 1.2 gms of adsorbent. Results are shown in figure 1.4

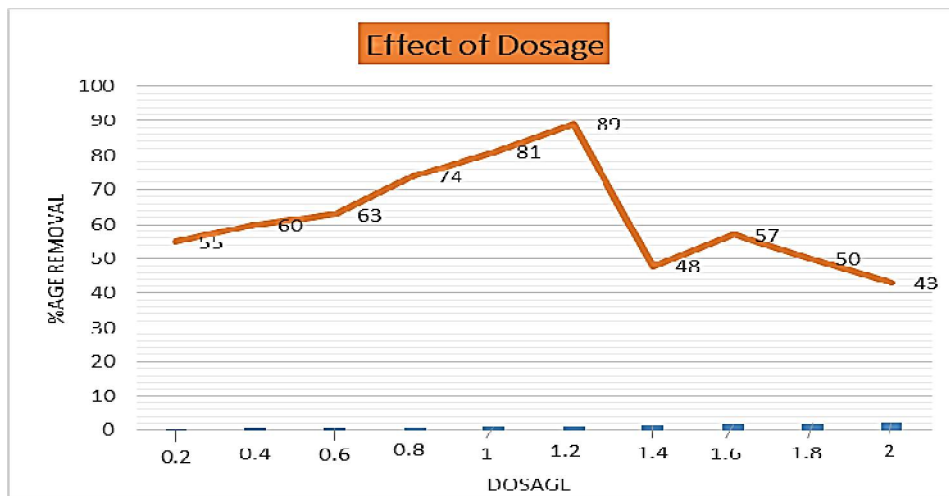


Figure 1.4 - Plot between Dosage on x- axis and percentage removal of turbidity on y- axis showing a steep rise in curve at the dosage of 1.2gms of adsorbant(Concrete)

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G. EFFECT OF TEMPERATURE

Temperature also plays a prominent role in removal of turbidity. Temperature is varied for the solution with optimum concentration and it has been found that high and low temperature conditions has negligible effect on the removal of turbidity. Whereas the solution at room temperature is found to show effective removal of turbidity (90% removal) and hence the temperature is considered as an optimum temperature. Results are shown in figure 1.5 plotted between %age removal and temperature. Steep rise in curve indicates the optimum concentration.

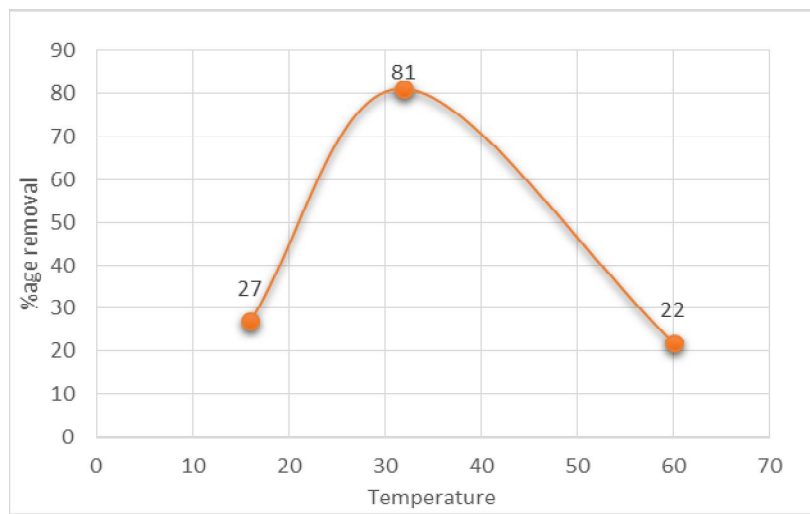


Figure 1.5– The above graphical data between %age removal and temperature indicates efficiency is maximum at room temperature, whereas low and high temperature has negligible effect on the removal of turbidity.

H. EFFECT OF PH

The influence of the pH on the system found to be significant showing positive and negative correlation on turbidity removal. Solution with optimum concentration(80NTU) and optimum dosage (1.2gms concrete) is taken into 250ml conical flask and after continuous agitation and filtration the pH of the solutions is set to 3,4,5,6,7,8,9,10 by using NaOH and Hcl The turbidity of the solutions with varied pH is measured and the results are tabulated .optimum pH value is obtained by plotting a graph between %removal and PH . Results are shown in Figure 1.6

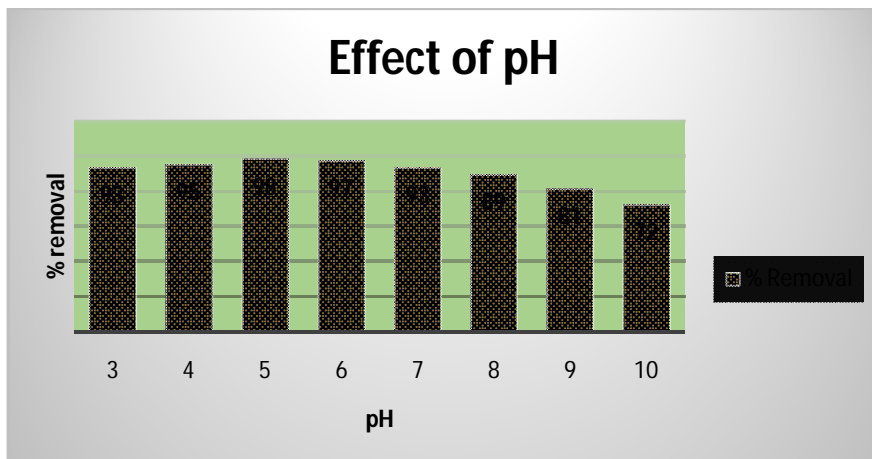


Figure 1.6 – a Graph plotted between Effect of pH and %age removal indicating at low pH the results are very effective.

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III. RESULTS AND DISCUSSIONS

Based on the above data it is concluded that

1. When the solutions are agitated at an interval of 20 mins maximum removal of turbidity is seen (90%) as shown in figure 1.2, Hence time factor plays a very prominent role in removal of turbidity from waste water.
2. The removal of turbidity is efficient only with high concentrated solutions as low concentrated solutions has no effect. As shown in figure 1.3 90% of turbidity removal is observed.
3. Greater the concentration of solution greater is the percentage removal of turbidity, hence more clear the water is.
4. Removal of turbidity of synthetic turbid waste water is effective with concrete as an adsorbent. The removal of turbidity is carried out by a phenomena of physical adsorption.
5. When a dosage of 1.2gms of concrete is mixed with a turbid solution of 100NTU. removal of turbidity was found to be maximum and the results are even more effective with a concentrated solution of 80NTU as shown in figure 1.4.
6. From the figure 1.5, it is observed that removal of turbidity is high only at room temperature, whereas High and low temperature conditions have negligible effect.
7. PH plays a very prominent role in removing the turbidity of waste water. When the pH of the solutions is varied it is observed that as the pH increases %age removal of turbidity decreases. Turbidity removal is maximum upto 90% at low pH (Acidic range) as shown in figure 1.6.

IV. CONCLUSION

Water that is fit for domestic use (drinking water) must comply with specific requirements. The most important requirement is that it must be safe to drink.

The principal objective of water treatment is to produce water that is fit for domestic use reliably and consistently from a raw water source at a cost that is reasonable to the consumers. Measurement of turbidity provides a rapid means of process control to determine when, how, and to what extent the water must be treated to meet specifications.

The paper briefly highlighted the importance of adsorption process and its benefits. Also the overview of various papers publishes in various journals on removal of turbidity from water or wastewater by adsorption using various low cost adsorbents instead of expensive commercial adsorbents. The efficiency of different adsorbents in the removal of turbidity depends on dose of adsorbate, characteristics of adsorbent, pH, temperature, contact time, speed of agitation, etc. A review of various low cost adsorbents presented here shows a great potential for the turbidity removal. The use of commercially available adsorbents can be replaced by the inexpensive and effective low cost adsorbents. There is need for more studies to better understand the process of low-cost adsorption and to demonstrate the technology effectively.

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