International e-Conference on New Horizons And Multidisciplinary Applications In Science And Technology
In Association withInternational Journal of Scientific Research in Science and Technology
Volume 9 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Removal of Dyes in Water by Adsorption Method Using Zeolite as Adsorbent

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ABSTRACT

There are various industries that make use of dyes for various application and Residual solution put back in the river which pollute the water. These dyes are toxic and health hazardous so the objective of research work is to remove this type of dye by using adsorbent (zeolite) via adsorption process.Intend of this study is to evaluate adsorption process of absorbent i.e., Zeolite and adsorbent i.e., Methyl orange dye at three different parameters such as time, concentration of adsorbent and PH of solution.

I. INTRODUCTION

Pollution is when something is added to the environment harmful or poisonous to all living things.The presence in or introduction in to the environment of a substance which has harmful.Types of pollution: air Pollution, light pollution, noise pollution, land pollution, thermal pollution, radioactive pollution, water pollution. Water pollution:Water pollutionis the contamination of water bodies e.g. lakes, rivers, oceans, aquifers and groundwater This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies withoutadequate treatment to remove harmful compounds. Water Pollutant: there are number of pollutants which pollute the water such asInorganic salt (ca+2, mg+2, cl-)[1], Microscopic matter (bacteria, algae and fungi), Inorganic impurities (clay, sand), Dissolved gas (oxygen, carbon dioxide), Chloride, sodium, sulphate, magnesium, calcium. These are the pollutants which are very dangerous to human health and environment. Causes of water pollution: water pollution causes due to Sewage and waste water, Accidental oil leakage, burning of fossil fuels, Dumping of solid waste, Acid rain Global warming, Industrial waste[2].

Industries produce huge amount of waste which contain toxic chemicals and pollutant that are extremely harmful to people and Environment. They contain pollutant such as lead, mercury, Sulphur, asbestos-nitrate etc. There are some industries they use dye or colored solution which is put back in the river or see water and which causes the water pollutionDye using IndustriesTextile industry, Leather industry, Paper industry, Chemical industry, Food, Cosmetic

Dyes are the natural or synthetic substance used to are a color to or change the color of something or a dye is color chemical substance that impart color when applied to a substrate. Dye is generally soluble in solvent. Alizarin, alizarin red S, alizarin yellow R, Chrysopidae R, Congo red, methyl orange, methyl red, naphthol green B these are examples of dyes. Methyl orange It is one of the dyes which is pH indicator used in titration.

Methyl orange shows red color in acidic medium and yellow color in basic medium.Drawback of methyl orange causes Skin irritation, Eye irritation, it causes respiratory disease. Method of water purificationthere are number of methods for water purification such asCrystallization Sublimation, Distillation, Chromatography, Adsorption.

AdsorbentIt is the solid substance on the surface of which adsorption occur. Adsorbate It is the substance that get adsorbed on the surface of solid due to intermolecular attraction.Factor affecting on adsorptionNature of Gas,nature of adsorbent,specific area of adsorbent,temperature, Pressure.

Zeolite are micro porous aluminosilicate minerals used commercial adsorbent and catalyst zeolite characterized by their ability to lose and absorb water without damage to their crystal structure. Zeolite have large surface area[3].Adsorptionin zeolite is significantly differ from adsorption in e.g., silica gel or active coal. In zeolite porosity is determined by crystalline structure i.e., the pores are arranged in a regular fashion with only one discrete pore sizes. Also pores have molecular dimensions. In this case the zeolite is used as adsorbent and molecular sieve.One of major used of zeolite is as heterogeneous catalyst in the petrochemical industry, cracking catalyst. Zeolite catalyst give high selectivity (shape selective) and their properties may be tailored by changing the chemistry[4].

Applications Heating and refrigeration, Zeolite can be used as solar thermal collector and for adsorption refrigeration. In this application their high heat of adsorption and ability to hydrate and dehydrate while maintaining structural stability is exploited. In agriculture clinoptilolite is used as soil treatment. It provides a source of slowly released of potassium. It previously loaded with ammoniumDetergentThe largest single used for zeolite is the Global laundry detergent marker.IndustryPetroleum chemistry, Biogas industry,nuclear industry[5].

II. MATERIALS & METHODS

Stock solution is prepared by adding 20 milligram methyl orange in 200 ml distilled water and this solution is diluted with 1:3 volume by volume ratio. The solution is used for further process.For removal of dye, we have use zeolite as adsorbent in adsorption process.concentration of dye in water is studied by UV visible spectrophotometer.

Table-1 Time Variation

Time (Min)	Absorbance		
	Trial-I	Trial-II	Trial-III
0	1.972	2.075	2.154
5	1.88	2.058	2.144
10	1.78	2.103	2.235
15	1.86	2.074	2.220
20	1.80	2.033	2.228
25	1.77	2.154	2.060
30	1.627	2.064	2.075
35	1.85	2.030	2.097
40	1.62	2.005	1.988
45	1.80	2.816	2.155

Procedure: (time variation)

1) 50 ml of methyl orange solution is taken.
2) This solution is poured in 10 test tubes.
3) Equal amount of sample (absorbent) is added in each test tube.
4) adsorbent and dye solution are allowed to be in contact with each other for variable time duration (0,5,10,15,20,25,30,35,40,45 min).
5) After particular time duration filter, it and its absorbance are noted by using UV visible spectrophotometer.
6) Graph is plotted between time and absorbance
7) The time for minimum absorbance is selected.

Table-2: weight of sample variation

Weight In mg	Absorbance		Weight In mg
	Trial-I	Trial-II	
0	1.977	2.25	0
1	1.949	2.26	1
2	1.942	2.22	2
3	2.052	2.23	3
4	2.037	2.22	4
5	1.952	2.26	5
6	2.137	2.31	6
7	2.022	2.318	7
8	1.966	2.27	8
9	2.068	2.38	9

Procedure:(Weight of Sample Variation)

1) 50 ml of methyl orange solution is taken
2) This will orange solution is poured in 10 test
3) Different amount of sample (1, 2, 3,4…10 mg) is added in different 10 test tube by keeping time constant which we have selected from above graph
4) Adsorbent and the solution are allowed to be in contact with each other for particular time duration
5) After particular time duration the solution is filtered and its absorbance is noted by UV visible spectrophotometer
6) Graph is plotted between weight and absorbance.
7) Minimum absorbance is selected.

Table-3:pH variation

pH	Absorbance		
	Trial-I	Trial-II	Trial-III
1	2.392	2.418	2.448
3	2.418	2.416	2.318
6	3.260	3.236	3.295
9	2.613	3.313	3.379
12	2.67	3.28	3.249

Procedure (pH variation)

1) 50 ml of methyl orange solution is taken.
2) This methyl orange solution is distributed in 10 test tubes.
3) pH of solution is maintained at(1, 3, 6, 9, 12).
4) This experiment is carried out at fixed time and fixed concentration decided from two earlier experiment
5) Adsorbent and dye solution are allowed to be in contact with each other for particular time duration.
6) After particular time duration solution is filtered and its absorbance is noted using UV spectrophotometer.
7) Graph is plotted between pH versus absorbance.
8) Minimum absorbance for pH is selected

Spectrophotometer: spectrophotometer is an instrument that measures the amount of light absorbed by a sample.

Uses: spectrophotometer technique are used to measure the concentration of solute in solution by measuring the amount of light that is absorbed by the solution in cuvette placed in spectrophotometer that is absorbance and transmittance **UV range:** 190 to 380 nm,**Visible range:** 380 to 750 nm.

Instrumentation

Instrument for measuring absorption of UV visible radiation is made up of one or more

1) sources
2) wavelength selector

3) sample container
4) radiation transducer
5) signal processor and read out devices

Sources: there are number of sources used in UV visible spectrophotometer are

1) deuterium and hydrogen lamp (190-400nm)
2) tungsten filament lamp(300-2500nm)
3) light emitting diode
4) Xenon Arc lamp(160-2000nm)

Wavelength selector: The selectors used in UV visible spectrophotometer are
fluoride prism (120-200nm)
fused silica or quartz crystal(380-2500nm)
NaCl prism (2000-15000nm)
KBR prism (10000-30000nm)

sample container: The cell or cuvette that hold the sample and solvent must be constructed of a material that possess radiation in the spectral region of interest. Quartz or fused silica is required for work in the UV region below 350 nm. Silicate glasses can be employed in the region between 350 nm and 2000nm. Plastic container used in visible region. Cylindrical cells sometimes employed in the UV visible region because they are inexpensive

Types of instruments:

1) single beam
2) double beam
3) multichannel

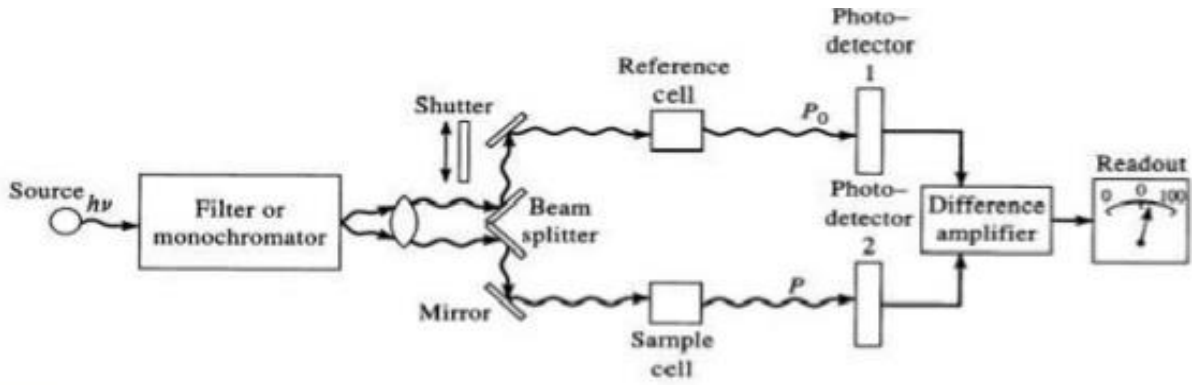

Figure-1of Double beam spectrophotometer

Many modern photometer and spectrophotometer are based on double beam design. In which two beams are formed in space by a V shaped mirror called as beam splitter. One beam passes through reference solution to a photo detector and second simultaneously transverse the sample to a second matched detector. Thetwo-output amplifier and their ratio is determined electronically or by computer and displayed by the read out devices.With manual instrument the instrument is two step operations involving first the zero adjustment with a shutter in place between collector and beam splitter. In second step the shutter opened and the transmittance

or absorbance is displayed director. The absorbance of methyl orange solution is noted by keeping water as a reference in UV visible spectrophotometer at 463 nm wavelength

III. RESULT AND DISCUSSION

Adsorption process is carried out at three different parameters such as time, concentration of adsorbent and pH of solution.

Time variation:

Graph of time versus absorbance is presented on following figure-2.

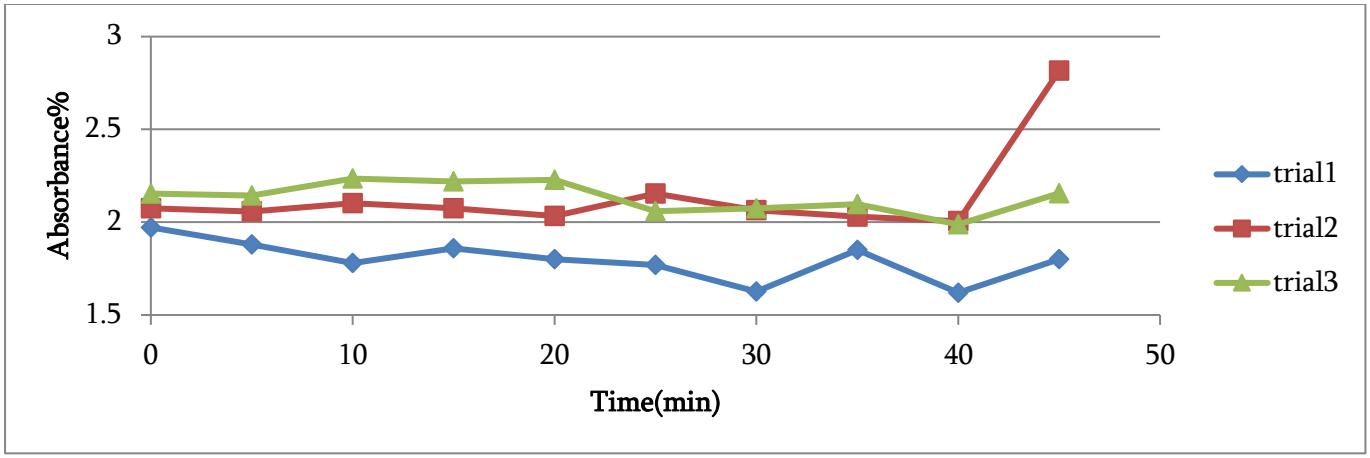

figure-2.

The absorbance changes as a function of time. there is no variation of absorbance up to 30 min. after 30 min variations in absorbance is observed and minimum absorbance is obtained at 40 min time. Hence maximum adsorption occurs at 40 min time.So, 40 min time is best for adsorption process.

Concentration variation

Graph of concentration versus absorbance is presented in following figure-3

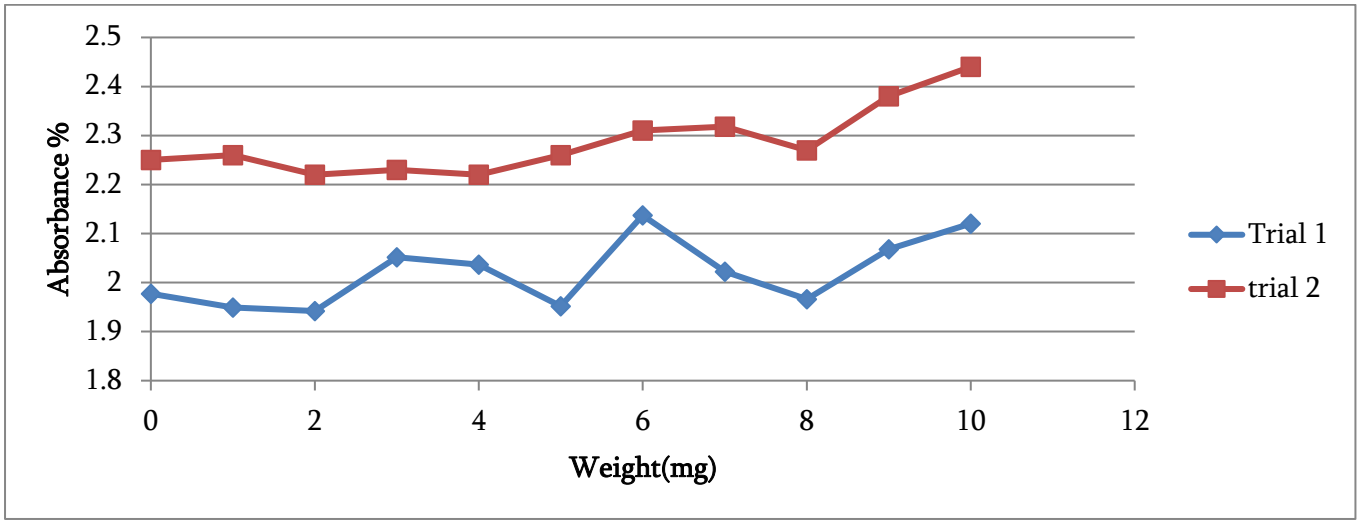

figure-3

The absorbance changes as a function of concentration of adsorbent.At a particular concentration of adsorbent (2mg) it shows minimum absorbance so maximum adsorption occur at that point. Hence 2mg concentration is selected for best adsorption process.

pH variation

Graph of pH of solution versus absorbance is presented in following figure-4

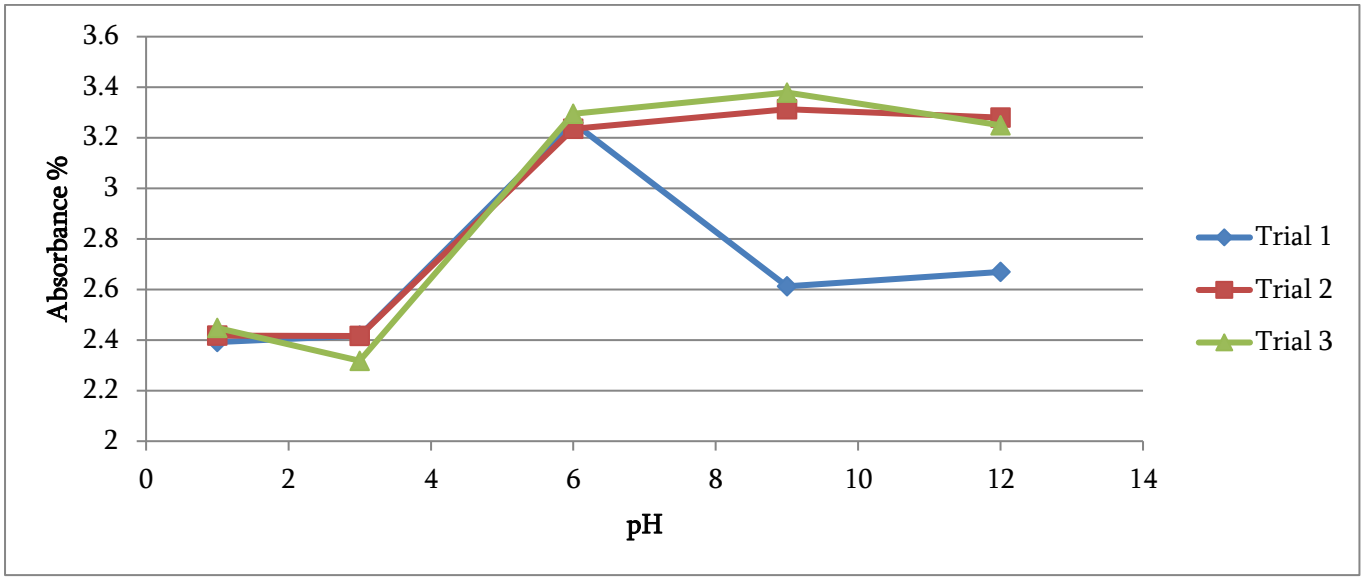

figure-4

Absorbance of solution changes as a function of pH of solution. As pH of solution increase absorbance also increases and minimum absorbance is obtained at 3 pH of solution. Hence it shows maximum adsorption at that point.

IV. CONCLUSION

Maximum adsorption is obtained at 40 min time and Maximum adsorption is obtained at 2 mg of concentration of adsorbent. Maximum adsorption is obtained at 3 pH of solution. So by overall observation it is conclude that, Maximum adsorption is obtained at 2 mg of sample (zeolite) for 40 min time and at 3 pH of solution.Natural zeolites are important low cost materials for water and wastewater treatment. Due to the nature of cation exchange, natural zeolites exhibit high performance in adsorption of cations in aqueous solution such as ammonium and heavy metals[4].

V. REFERENCES

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