Waste Water treatment by using low cost adsorbent: A Review

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ABSTRACT

Industrial, agricultural, and domestic activities of humans have affected the environmental system, resulting in drastic problems such as wastewater containing high concentration of pollutants. In most of the industry waste water treatment is mostly done by a conventional method and advance technique like ion-exchange, membrane separation etc but it required large space for establishing treatment plant and hence its required substantial financial input and their use is restricted because of cost factors. Alternative method for waste water treatment is adsorption by using activated carbon but The coal-based activated carbons is expansive. If we use cheaper alternatives low cost material for adsorption then adsorption is becoming inexpensive. Various low- cost adsorbents is also derived from agricultural waste, industrial by-products or natural materials like Neem Leaf, Pineapple Peels, Orange peel, Bentonite Clay, coal etc can be used as adsorbents for waste water treatment.

Keyword : - *Low cost Adsorbent, Adsorption, Waste water, Continuous Process, Batch Process*

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1. Preparation and activation of adsorbent:-

First, Raw material (neem leaves (Ghanshyam et al(2013))[67],cacao shell (Mylsamy et al(2012))[68],corn cub,(Shivayogimath et al(2014))[69], durian rind(Akshar et al(2013))[67],orange & banana peel(Bin Abdur Rahman et al(2013)[70], coconut shell (Upendra et al(2006))[71], tea waste (Anonio et al(2013))[45], Citrus fruit (grapefruit) peel (Akshar et al(2013))[67]) were washed 2 to 3 times with general pipe water for removal of mud ,dust and unwanted external materials

i. Use single distilled water for second time washing purpose, then dried the material up to $70^{O}C$ to $90^{O}C$ for 1hr.

ii. The dried material transfer into the pyrolytic reactor and reactor put inside the furnaces, by maintaining $400^{0}C$ for neem leaves, cacao shell, corn cube, durian rind, orange peel, banana peel, coconut shell, tea waste, charred citrust fruit peel.

iii. After pre-carbonized of material ,material crushed into powder or granular form using hand blender

iv. After blending of carbonaceous material, we sized it with the help of sieving technique by taking different size of sieve and choose the 30 BSS (British Standard Scale) sieve which was 500 micron size as our particle size.

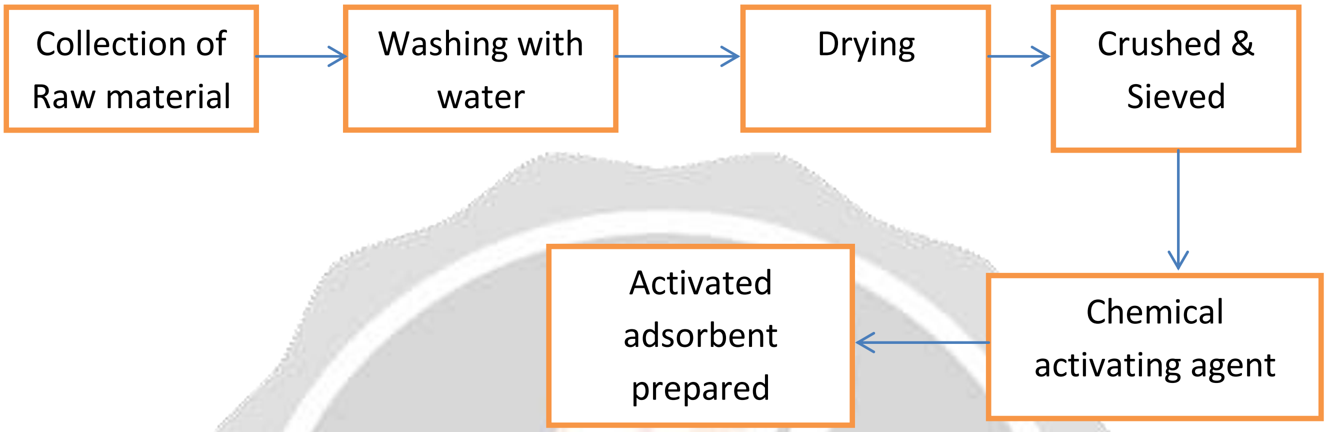
v. Resulting sample is washed with distilled water and unwanted material gets separated as waste filtrate.

vi. Properly washed carbonized carbon is impregnated with 40% diluted H_3PO_4acid solution with an impregnated ratio (W/W) of 4:1 for nearly 20 hours.

vii. Resulting chemically acid washed Activated Carbon was again washed with single distilled water continuously up to a constant pH reached.

viii. Finally the washed AC is kept in the oven at 110^{0}C for 3hrs for removal of moisture.

ix. Dried activated adsorbent kept in plastic storage bottle container for further use.



1.1 Preparation activated carbon from neem

Neem leaves have to be washed repeatedly with distilled water to remove dust and soluble impurities. Initially leaves have to be kept for drying at room temperature in a shade for 6 h and then in an air oven at 800C till they turn pale yellow. Then they have to be crushed and passed through 15-20mesh.

Activated Neem leaves have to be prepared by treating one part of Neem leaves with 1.8 parts by weight of concentrated HCl (36 N) and keeping it an oven at 1500C for 24 h. The treated leaves have to be washed with distilled water to remove free acid and dried at 1000C for 5 h. Now 100 ml of copper solution (initial pH 8.5) is to be added to 10 g of treated Neem leaves. The mixture is to be shaken for 24 h at 300C and filtered with membrane filter paper. Copper impregnated Neem leaves is to be washed several times with distilled water until the filtrate is to be free from copper. Finally the adsorbent is to be dried at 800C for 6 h (Ghanshyam *et al*)[67].

1.2 Preparation activated carbon from Cocoa

(Theobroma cacao) shell collected from local agricultural field is to be air–dried and allowed to chemical activation, by the addition of 50 percentage sulfuric acid with constant stirring (w/v). The resulting product obtained is to be kept in muffle furnace maintained at 550°C for 7 hours.

The carbon obtained is to be washed with double distilled water and soaked in 10 percentage sodium bicarbonate solution and allowed to stand overnight to remove the residual acid from pores of the carbon. The material is to be washed 100±5°C for 12 hours. The dried material is to be ground and sieved to get the particle size of 150µm and stored in an airtight container (Mylsamy *et al*)[68].

1.3Preparation activated carbon from corn cub

Raw materials: The first precursor material used is to be corncob. Dried whole corncobs which have to be crushed and separated from pith or chaff are sieved to mesh size 12£16 (1.2-0.7 mm) as precursor material that is corn-cob granules of 1.2-0.7mmgrain sizes.

The second precursor material used is to be acacia nilotica stalk, Acacia nilotica trees are growing abundantly in en weed and which is generally being used as a fuel wood by the local poor people. The precursor material i.e. acacia nilotica stalk of 4-6 mm in diameter is to be cut into length of 10-20 mm in size. The broken tiles have to be collected locally and it is to be washed several times to remove earthy matter and finally is to be washed with distilled water. These have to be air dried and ground manually to the desired mesh size of 20×40 (Shivayogimath *et al*)[69].

Chemical activation is to be impregnated with potassium hydroxide (KOH) to remove inert material present in it. 15 g of KOH pellets have to be dissolved in 1 liter of distilled water then the oven dried and cooled precursor material granules of broken waste tiles is to be thoroughly mixed with KOH solution in a beaker and kept on magnetic stirrer at 80 0C for 1 hour. Then the beaker taken out of them magnetic stirrer and cooled and is to be washed 4 to 5 times with distilled water till we get pH of is to be washed water to nearly 7 is to be washed precursor material is to be kept in the oven for 24 hours at 110±5 0C, after 24 hours the oven dried material have to be taken out from oven and aloe to cool. These granules have to be kept in beaker which contains out from oven and allow it to cool. These granules have to be kept contains 0.2N HCl for 30 min at 80 0C on magnetic stirrer. After that once again the said material is to be washed with distilled water for 4 to 5 times or till we get pH of is to be washed water as 7.Then the material is dried out and kept in a oven for 12 hours under 110 ± 5 0C.

1.3 Biosorbent Preparation by durian rind

Durian rind (DR), a by-product of durian is to be collected from the local markets. The DR is to be washed exhaustively with water and finally with deionized water to remove dirt, sand, clay and the particulate material from their surface.After washing it is to be dried in the oven at 50 – 60 °C for 2 – 3 days to ensure all moisture is removed to ease the rind processing step. Dried DR is to be separated and subsequently is to be cut, grounded and then sieved to particle size of 150–300 &m.The powdered DR is to be stored in a bottle to be used for the experiment (Akshar *et al*)[67].

1.4 Preparation of Adsorbents for orange peel, banana peel

(Bin Abdur Rahman et al.)[70] suggested that Adsorbents like Orange Peel and Banana peel collected from the local areas. The peels and leaves collected should be dried at temperature (<105 °C) for 48 hrs to remove moisture content. After drying process, peels have to be ground to fine powder and sieved through 600 μ size.

1.5 Preparation activated carbon from coconut shell

The coconut shells derived from various waste sources have to be cleanly shaved to remove all the fibers on its surface. They have to be cut into small pieces, is to be washed with distilled water to remove the dirt. The samples have to be pyrolyzed at 400 0C for 3 hrs. It results in black carbonized matter. It is again is to be washed with distilled water and dried at 100 0C and sieved to the required size. (Upendra *et al*)[71]

1.6 Preparation of activated carbon from tea waste

Material: The raw material used for preparation of activated carbon in tea waste

Method : Activated carbon preparation

Preparation methods of activated carbon from Tea waste is to be taken from the waste tea leaves after tea making process .The tea waste as is to be washed several times with distilled water to remove surface impurities and dried at 100°C. This tea waste is to be directly collected from house, café tries, tea stall, Hotel. This tea waste have to be dried and digested by using sulfuric acid followed by carbonization in muffle furnace.

Preparation of sample: All the tea waste is to be collected from the house, cafes. This tea waste is first dried in the sunlight for 20 days. This naturally dried material then kept in the oven for 12 hours at the temperature 500C. (Anonio *et al*)[45].

Digestion of the sample: 100 gm. of sample is to be crushed manually. dil. Sulfuric acids solutions have to be prepared.70 ml of acid are utilized to utilize to digest the tea waste. This is to be kept at 300c for 12 hours.

Washing of the Digested sample: The digested tea waste have to be washed using distilled water, 10 to 12 washing have to be given.

Determination of pH: The determination of pH of the carbonized material had been done.

Carbonization of the sample: The whole sample is taken in a container and kept at 5000C in muffle furnace for 15 minutes. Then oversize and under size particle is separated by using 300 meshes.

Feed container: The feed container is to be a Crucible which could sustain temperature 5000C and above.

Desiccators: The activated carbon is to be collected in air tight packets kept inside the desiccators. It keepsactivated carbon moisture free.

Sieving: The carbon obtain from above procedure is to be crushed manually and passed through the 300 mesh sieve plate to produce carbon of uniform size.

1.7 Preparation of Charred Citrus Fruit Peel (CCFP)

Citrus fruit (grapefruit) peel is to be collected from a local juice maker and is to be washed thoroughly with distilled water to remove any acidic substances and dirt. It is to be then dried in sunlight for 2 days. Dried citrus fruit peel is to be fed to a mixer and grinder and thus ground. Then any one of the following activating agent like, ortho-phosphoric acid (88percentage GR, MERCK) or zinc chloride (MERCK) or sulfuric acid (98 percentage Pure, MERCK) is to be mixed with the dried powdered fruit peel of size lesser than 90 μm. This is to be then carbonized in a muffle furnace by heating it at an elevated temperature. The weight ratio of dried citrus fruit peel to activating agent is to be varied in the range of 1:1 to 3:1, temperature in the range of 450°C–550°C and the time of carbonization is to be varied from 0.75 h to 1.5 h.The charred material is to be cooled and is to be washed with dilute ammonia solution and then with distilled water in order to remove any unconverted activating agent from carbonaceous material.The washing of the sample is to be continued until the pH of the filtrate is to be found to be exactly 7. The charred material is to be left for drying overnight in ambient conditions. The dried samples have to be crushed and fractionated into different size fractions. (Akshar *et al*)[46].

2 Literature:-

2.1 Activated carbon

The adsorption of dye such as (acid dye, basic dye, methylene blue, reactive azo dye), surfactant, metals(Al, Fe, Pb), organic compound like(para-chlorophenol, furfural, naphthalene 2-sulfonic acid) using activated carbon(tan et al (2008) [1], walker *et al* (1997) [3],lin *et al* (2009)[6],sze *et al*(2008)[7],auta *et al*(2015)[17],jung *et al* (2016)[19],ahmad *et al* (2010) [20],sing *et al*[21],sotelo *et al*[26],goel *et al*[28],song *et al*[32])was investigated in fixedbed column. The effect of selected operating parameters such as bed capacity, initial concentration , bed height was evaluated. The breakthrough data fitted well to Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm models, pseudo-second-order model. The highest bed capacity was obtained at 40.86 mg/g . The results showed that activated carbon prepared from oil palm shell can be an effective adsorbent for dye such as (acid dye, basic dye, methylene blue, reactive azo dye), surfactant, metals(Al, Fe, Pb), organic compound like(para-chlorophenol, furfural, naphthalene 2-sulfonic acid) removal.

2.2 Industrial waste

The adsorption of phenol and chromium(VI) using immobilized activated sludge(aksu *et al* (2004) [15], aksu *et al* (2006)[12]) investigated in batch and fixed bed column. The effect of selected operating parameters such as flow rate was evaluated. The breakthrough data fitted well to Yoon and Nelson model. The highest bed capacity was obtained at 18.5 mg/g . The results showed that immobilized activated sludge can be an effective adsorbent for phenol and chromium(VI) removal .

The adsorption of cationic dyes using sugarcane bagasse was investigated in fixed bed column. The effect of selected operating parameters such as flow rate, initial con, was evaluated. The breakthrough data fitted well to Yoon–Nelson models. .The results showed that sugarcane bagasse can be an effective adsorbent for cationic dyes removal.

The adsorption of Drimarine Black CL-B using lignocellulosic (noreem *et al* (2013)[10]) waste was investigated in batch and fixed bed column. The effect of selected operating parameters such as biomass dose, contact time, solution pH and temperature. was evaluated. The breakthrough data fitted well to Langmuir, Freundlich, Dubinin-Radushkevich (D-R) . The results showed that lignocellulosic waste can be an effective adsorbent for Drimarine Black CL-B removal.

2.3 Clay & Natural material

The adsorption of salicylic acid, clofibric acid, carbamazepine, caffeine, surfactant using calcined inorganic–organic pillared clay (lin *et al* (2009)[6], Cabrera *et al* (2015)[30]) was investigated in batch and fixed bed column. The effect of selected operating parameters such as stages was evaluated. The results showed that calcined inorganic–organic pillared clay can be an effective adsorbent for salicylic acid, clofibric acid, carbamazepine, caffeine, surfactant removal.

The adsorption of 2,4-dichlorophenol using immobilized Phanerochaete chrysosporium biomass (wu *et al* (2008)[13]) investigated in fixed bed column. The effect of selected operating parameters such as flow rate, initial concentration, pH was evaluated. The breakthrough data fitted well to Thomas model. The results showed that immobilized Phanerochaete chrysosporium biomass can be an effective adsorbent for 2,4-dichlorophenol removal .

The adsorption of Nitrate and methyl orange using pristine and HCl-activated montmorillonite (teng *et al* (2006)[25]) (teng *et al* (2006)[29]) was investigated in fixed bed column. The effect of selected operating parameters such as flow rate, initial con,height was evaluated. The results showed that pristine and HCl-activated montmorillonite can be an effective adsorbent for basic dye removal.

2.4 Agriculture waste & product

The adsorption of heavy metal(Zn^{2+}, Cu^{2+} and Pb^{2+}), phenol on to to chemically modified Pinus pinaster bark(Vazquez *et al* (1994)[4], Vazquez *et al* (2006)[33]) was investigated in batch mode. The effect of selected operating parameters such as bed capacity,initial con,bed hight was evaluated. The breakthrough data fitted well to Freundlich isotherms. The results showed that chemically modified Pinus pinaster bark can be an effective adsorbent for removal heavy metal ions (Zn^{2+}, Cu^{2+} and Pb^{2+}), phenol.

The adsorption of basic dye(crystal violet, methylene blue) using jackfruit leaf powderwas (tamez *et al* (2009)[5], saha *et al*(2012) [9]) investigated in batch and fixed bed column. The effect of selected operating parameters such as bed capacity, initial concentration , bed height was evaluated. The breakthrough data fitted well to Langmuir isotherm model , Dubinin–Radushkevich (D–R) isotherm model,pseudo-second-order kinetic model. The highest bed capacity was obtained at 43.9 mg/g . The results showed that jackfruit leaf powder can be an effective adsorbent for basic dye(crystal violet, methylene blue)removal.

The adsorption of Copper (II) From Aqueous mediam on Kenaf Fibres (dan *et al*(2012) [2]) was investigated in fixedbed column. The effect of selected operating parameters such as flow rate and bed depth was evaluated. The breakthrough data fitted well to Thomas models with higher correction coffecient. The highest bed capacity was obtained at 47.27 mg/g . The results showed that Kenaf Fibres can be an effective adsorbent for Copper (II) removal.

The adsorption of dye (direct dye, Congo red (CR) using seed husk of Bengal gram(nirmala *et al*(2013) [11]) investigated in batch and fixed bed column. The effect of selected operating parameters such as bed capacity, initial concentration, bed height was evaluated. The breakthrough data fitted well to BDTS model. The results showed that seed husk of Bengal gram can be an effective adsorbent for dye (direct dye, Congo red (CR) removal.

The adsorption of methylene blue using phoenix tree leaf powder (han *et al*(2009) [18]) was investigated in batch and fixed bed column. The effect of selected operating parameters such as bed depth, pH was evaluated. The breakthrough data fitted well to The Thomas and Clark models. The highest bed capacity was obtained at 99.13 mg/g .The results showed that phoenix tree leaf powder can be an effective adsorbent for methylene blue removal.

The adsorption of diazo dye Reactive Black 5 using Sunflower seed shells (tosma *et al* (20107) [31]) was investigated in batch and fixed bed column. The effect of selected operating parameters such as removal was evaluated. The highest removal efficiency was obtained is 85%.The breakthrough data fitted well to Freundlich and multilayer adsorption isotherm. The results showed that treated Sunflower seed shells can be an effective adsorbent for diazo dye Reactive Black 5 removal.

The adsorption of Pb(II) using bael leaves (Kumar *et al*(2009) [61],Kumar *et al* (2009) [62]) was investigated in batch adsorption. The effect of selected operating parameters such as pH, initial concentration removal was evaluated. The highest removal capacity was obtained is 180.2 mg/L..The breakthrough data fitted well to Langmuir isotherm and Freundlich isotherm adsorption isotherm. The results showed that treated bael leaves can be an effective adsorbent for Pb(II).

The adsorption of Pb(II) using sulfuric acid-carbonized coconut shell (Amuda *et al* (2007) [41],Pino *et al* (2006) [42] ,Gaikwad *et al* (2004) [43],Guea *et al*(2006) [44]) was investigated in batch adsorption. The effect of selected operating parameters such as pH, removal was evaluated. The highest removal capacity was obtained is 26.5 mg/L..The breakthrough data fitted well to Langmuir isotherm, Freundlich isotherm and Tempkin adsorption isotherm. The results showed that sulfuric acid-carbonized coconut shell can be an effective adsorbent for Pb(II).

The adsorption of Cu(II) and Ni(II) using grape stalk wastes (Florido *et al* (2009) [57],Martinez *et al*(2005) [58]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time and pHremoval was evaluated..The breakthrough data fitted well to Langmuir isotherm. The results showed that grape stalk wastes can be an effective adsorbent for Cu(II) and Ni(II).

The adsorption of Cd(II) and Pb(II) ions using Mango peel waste (Murugan *et al* (2010) [64],Patel *et al* (2009) [65]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, removal was evaluated. The highest removal capacity was obtained is 99.05 mg/L..The breakthrough data fitted well to Langmuir isotherm, Freundlich isotherm. The results showed that Mango peel can be an effective adsorbent for Cd(II) and Pb(II) ions.

The adsorption of Pb(II) using orange peel (Feng *et al* (2008) [54], Feng *et al* (2010) [55], Feng *et al*(2010) [56]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time was evaluated. The highest removal capacity was obtained is 204.50 mg/L. The breakthrough data fitted well to Freundlich isotherm. The results showed that orange peel can be an effective adsorbent for Pb(II).

The adsorption of Cu(II) and Cr(III) ions using peanut shell (liu *et al*(2010) [63]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH was evaluated. The highest removal capacity was obtained is 27.86 mg/L. The breakthrough data fitted well to pseudo second-order and Langmuir isotherm. The results showed that peanut shell can be an effective adsorbent for Cu(II) and Cr(III) ions.

The adsorption of Cd(II) ions using pomelo peel (Saikeaw *et al* (2009) [66]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH, initial concnetration was evaluated. The highest removal capacity was obtained is 21.83 mg/L. The breakthrough data fitted well to Langmuir isotherm and Freundlich isotherm. The results showed that pomelo peel can be an effective adsorbent for Cd(II) ions.

The adsorption of Cu(II) ions using potato peel(Abdullah *et al*(2009) [35],Aman *et al* (2007) [74],Moreno *et al* (2010) [36]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH, initial concnetration was evaluated. The highest removal capacity was obtained is 120 mg/L. The breakthrough data fitted well to Langmuir isotherm and Freundlich isotherm. The results showed that potato peel can be an effective adsorbent for Cu(II) ions.

The adsorption of Pb(II) ions using rice husk (Ajmal *et al*(2002) [37],E1-halwany*et al* (2009) [38],Said *et al* (2010) [39],Shafey *et al* (2009) [40]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH, initial concnetration was evaluated. The highest removal capacity was obtained is 91.74 mg/L. The breakthrough data fitted well to Redlich-Peterson isotherm and Freundlich isotherm. The results showed that rice husk can be an effective adsorbent for Pb(II) ions.

The adsorption of Pb(II) ions using rubber leaves powder (Hanafish *et al*(2006) [59],Ngah *et al* (2007) [60]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH was evaluated. The highest removal capacity was obtained is 46.73 mg/L. The breakthrough data fitted well to pseudo second-order model. The results showed that rubber leaves powder can be an effective adsorbent for Pb(II) ions.

The adsorption of Pb(II) ions using seaweeds (Cuizano *et al* (2009) [49],Hashim et *al*(2007) [50]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH was evaluated. The highest removal capacity was obtained is 730 mg/L. The breakthrough data fitted well to Langmuir isotherm and Freundlich isotherm. The results showed that seaweeds can be an effective adsorbent for Pb(II) ions.

The adsorption of Cu(II) ions using sunflower leaves(Benaissa *et al*(2006) [48]) was investigated in batch adsorption. The effect of selected operating parameters such as pH was evaluated. The highest removal capacity was obtained is 89.37 mg/L. The breakthrough data fitted well to Langmuir isotherm and pseudo second-order kinetic models. The results showed that sunflower leaves can be an effective adsorbent for Cu(II) ions.

The adsorption of Pb(II) ions using spent leaves of green and black tea (Dhanakumar *et al* (20007) [51],mondal *et al*(2010) [52], Mahyi*et al*(2010) [53]) was investigated in batch adsorption. The effect of selected operating parameters such as contact time, pH was evaluated. The highest removal capacity was obtained is 101 mg/L. The breakthrough data fitted well to Langmuir isotherm. The results showed that spent leaves of green and black tea can be an effective adsorbent for Pb(II) ions.

2.5 Other

The adsorption of acid dyes (acid red 88, acid green 3, acid orange 7, acid blue 15)using macro alga Azolla filiculoides (padmesh *et al*(2005) [8], padmesh *et al*(2006) [14]) was investigated in batch and fixed bed column. The effect of selected operating parameters such as bed capacity, initial concentration , bed height was evaluated. The breakthrough data fitted well to Thomas models. The highest bed capacity was obtained at 28.1 mg/g . The results showed that macro alga Azolla filiculoides can be an effective adsorbent for acid dyes (acid red 88, acid green 3, acid orange 7, acid blue 15) removal.

The adsorption of Mitigation of orange II dye using bimetallic chitosan particles (ramavandi *et al*(2014) [22])was investigated in fixed bed column. The effect of selected operating parameters such as flow rate, initial con, was evaluated. The breakthrough data fitted well to Thomas, bed depth/service time (BDST), Yoon–Nelson, and Clark models. .The results showed that bimetallic chitosan particles can be an effective adsorbent for Mitigation of orange II dye removal .

The adsorption of Nitrate using poly-o-toluidine zirconium(IV) ethylenediamine (rahman *et al*(2016) [24]) was investigated in fixed bed column. The effect of selected operating parameters such as flow rate, initial con,height was evaluated. The breakthrough data fitted well to Thomas, Yoon–Nelson models. The results showed that poly-o-toluidine zirconium(IV) ethylenediamine can be an effective adsorbent for Nitrate removal.

The adsorption of Congo red dye using Ag-doped hydroxyapatite (Vazquez *et al* (2016) [34]) was investigated in batch and fixed bed column. The effect of selected operating parameters such as flow rate, initial conc was evaluated. The breakthrough data fitted to Langmuir, Freundlich models. The results showed that Ag-doped hydroxyapatite can be an effective adsorbent for Congo red dye removal.

3. CONCLUSIONS

Water treatment by adsorption using low cost adsorbent is a demanding area as it has twofold advantages i.e. water treatment and waste management. As inspected in this article different waste products have been converted into low cost adsorbents and utilize for water treatment. There are greater chances of utilizations of low cost adsorbents for water treatment in near future. Besides, the universal and inexpensive natures of adsorption technology are other assets for bright future of low cost adsorbents. Moreover, it is believed that the future of low cost adsorbent is quite bright in developing and under developed countries. These adsorbents should be prepared eco-friendly and utilized in a controlled way to avoid any environmental hazards. Various papers discussed herein describe adsorption by batch mode and continuous mode. But there are few researches describing water treatment at pilot and industrial scales. Therefore, future is seeking for the design and development of effective columns for treating water at large scale. There is a need to develop more efficient selective, inexpensive and eco-friendly low cost adsorbents for water treatment. Briefly, there is demand to module low cost adsorbents for making them inexpensive, fast and eco-friendly in nature.

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