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Novel Metal Adsorbent and Their Use for Industrial Waste Water

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Abstract: Nano-Materials have unique properties physical, chemical, optical, catalytic and electrical made a prominent candidate for waste water purification.

Nano-sized metal oxides have unique properties. The most important feature is large surface volume ratio, which is suitable for different form of water treatment (adsorption, photo catalysis, membrane process Nano size metal oxides(NMOS), including ferric oxides, manganese oxides, Aluminum oxides, titanium oxides, magnesium oxides, zinc oxide and Cerium oxides, provide high surface area and specific affinity for heavy metal adsorption from aqueous systems. The Municipal and industrial solid waste are another important source of pollution ,which are consider a main source of the heavy metal like Hg, Cd, Fe, Mn, Pb, and the treatment of these wastes must be agreed with the environmental standard before it is reused or returned to surface water.

Keywords: Novel adsorbent, Nano - particles, Wastewater, Heavy metals.

Introduction - Environmental pollution is a major burning issue, pay attention to the need for the surviving and Eco-friendly for environment as well as human being. Environmental pollutants are hazardous, persistent and easily contaminate into water and soil. So consequences of born different type of water born disease e.g. Cholera, Diarrhea, Abdominal pain & cramps, Typhoid.

Nanotechnology is one of the most effective technologies in purification of contaminant water. Purpose of the synthesis new novel adsorbent which has multifarious application helpful for society because these may be Eco-friendly, cast effective and easily synthesis.

The word “Nano” originated from Greek word “dwarf “means much smaller than the usual size of the particles based on the lecture of Richard Feynman at an annual meeting of the American physical society at Caltech, called as “There is plenty of room at bottom “ The term nanotechnology refers to various Nano-level technologies which is a wide range of application in different areas such as – Waste water purification, energy consumption, space and other field.

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The Municipal and industrial solid waste are another important source of pollution ,which are consider a main source of the heavy metal like Hg, Cd, Fe, Mn, Pb, and the treatment of these wastes must be agreed with the environmental standard before it is reused or returned to surface water [1]. There are many technique have been developed such as chemical precipitation, reverse Osmosis, Ion exchange and adsorption to remove heavy metal and other hazard materials from wastewater [2].

Among all of the previous techniques, the adsorption on clay and other chemical substances is considered to be a particularly more effective process especially by using low cost and environment friendly material for the removal of heavy metals from industrial waste water and aqueous solutions [3].

Adsorption is frequently used technique because of its low cost, Eco-friendly and easily opera table.

Different types of adsorbents:

(A) Commercial activated Carbons

Ex.- wood, peat, coconut shell, coals(anthracite, bituminous, lignite.)

(B) Inorganic materials.

Ex – activated alumina, silica gel, Zeolites, molecular sieves.
(C) Natural materials- clays(bentonite, diatomite etc.)
(D) Agricultural wastes – sawdust, bark, solid wastes (date pith, corn cob, wheat straw, orange peel.)
(E) Industrial by products – fly ash red mud, sludge metal, hydroxide sludge.

Naturally adsorbents and synthetic adsorbents both are used in waste water treatment but synthetic adsorption capacity. Therefore recently frequently used adsorbents.

Review of literature

The present chapter deals with the literature review of the relevant research work investigations regarding the synthesis and characterization of novel adsorbents and their utilization for multifarious applications. Various analyses in India and outside have been earlier undertaken by so many chemists. Some of the important work is cited here, which are closely related to the present study. The literature of review are carried out following steps –

Low cost adsorbents can be used for the removed of heavy metals with a Concentration range of 20-60mg/l also, using real waste water showed that rice husk was effective in the Simultaneous removal of Cd and Cu [5].

Removal of chromium (vi) from waste water by using low cost dolochar adsorbent is an effective for the removal of chromium (vi) from aqueous solution .Dolochar was found to be effective , as the removal of Cr(vi) reached 100% at normal temperature [6].

Natural diatomite used as a adsorbents for the removal of different metal ions from aqueous solutions. The batch study was performed at various conditions such as pH, adsorbent dose and contact time. The maximum percent of many heavy material ions where observed at pH-4 and significantly decrease at higher pH value, while metal ions removal is positively influenced by an increase in the adsorbent dosage and contact time [7].

Artificial and naturally occurring nanoparticles will identify their nanoscale characterization and explain vital knowledge gaps related to the risk assessment of nps[8].

Heterogeneous photocatalysis is playing a key role in controlling environmental pollution. We can use this technique easily to convert toxic organic substances into less toxic substances.in this process of photocatalysis visible light is used. The purpose of doping of semiconductor with d -block metals to reduce the effective band gap and vital techniques for water purification [9].

Hexagonal porous ZnO nanoparticles were synthesized through the hydrothermal method by varying the concentration of the alkaline solution (0.2and0.3). The structural characteristics of the obtained samples showed good cry stability the synthesized Zno nanoparticles corresponding to the hexagonal form particles crystallized in the form of overlapping rods, which slightly differed in size and shape due to the engagement the alkaline solution also a lower concentration determined a reduction of agglomeration. The thermo gravimetric analysis showed a slight mass loss by the two samples(1.93-2.1%) indicating the thermal stability of the ZnO nanoparticles by hydrothermal methods[10].

Ni-doped ZnO nanoparticles by solgel chemical route synthesized naoparticle size will 21 nm which is proven by XRD. Author explains photo catalytic activity and optical analysis by using Burstein – moss effect and taucrealtion to calculate bond gaps. Autor also describe future scope for synthesizing iron-ZnO doped nanoparticles [11].

Iron oxide nanoparticles synthesis is a major efficiently because it has paramagnetic, large surface area, cheaper and low energy consumption and inert. Treatment of industrial waste water by iron-oxide nanoparticles which is based on principal of adsorption iron-oxide nanoparticales is a prominent candidate for removal of toxic heavy metal such as (Hg, Cd, As, Ni, Pd) from polluted water. The advantage of this nano particles is they follows 3r (reduce,reuse and recycle) principle [12].

Soft chemical method at low temperature to synthesized bismuth ferrite nano powder with the help of taken tartaric acid and nitric acid as an oxidizing agent. This synthesis method over come problem of the usual method (pechinis method of auto combustion to make $BiFeO_3$nanopowder) impurity formation phase. This process was quite easy, energy saving and cheaper. Author used TGA, IR spectroscopy, DTA and SEM to characterization of nano particles the size of particles was obtained range between 3-16 nm and also using scherrer formula to calculate size of the particles.[13]

A rapid convenient and environmentally benign method has been developed for the fabrication of Pd Rh and Ru are deposited into functionalized mw carbon nano tubes via reduction of metal- beta diketone precursor using supercritical carbon-di-oxide. Characterization technique were adopted e.g. XPS, TEM, EDX Nanoparticle has excellent adhesive property,narrow particle size arrangement for catalytic properties-the author reveals that pdnano particles have rich electro catalysis character in oxygen reduction for application in fuel cell[14].

Synthesis of Low dimensional iron oxide nanoparticles. TEM analysis given result that is, diameter of nanoparticles size obtained approximately 60 ± 10nm. Beta-Fe_2O_3nps were investigated by uv-visible absorption which show the presence of characteristics beta Fe_2O_3 optical properties [15].

In modern scenario some prominent waste water treatment technique are widely adopted due to specific property of nanomaterials e.g. More efficiency, time consuming, cost effective, environment acceptable. Besides this technology need to elaborate in globally some gapes still need to fill [16].

Synthesis of iron-oxide nanoparticle for removal of heavy metal from aquatic system. author explain magnetic properties which has help in removing contaminants and purify water Fe-oxide nanoparticles passes quite large

efficiency and cheaper than other metal oxide nanoparticles[17].

Synthesis of nano composite nanomaterial for purification waste water, Reveals photocatalytic property of nanomaterials e.g. TiO_2,zinc oxide and so on water filtration nanotechnology resolve the problems of recovery and reuse of the nanomaterials for purify contaminated water. Improvement in the quality of water author suggests macroporale photo catalysis and biological treatment [18]. Synthesis of nanohybrid materials which has application in hetero genous catalysis, fuel cell and advanced eco-friendly biosensor. Method will use like electrochemical deposition, electrode less deposition,dispersion and physical method. The ultimate aim is to gain high dispersion and nano size particles on the surface of CNTS [19].

Metal nanoclusters pay a tremendous attention towards purification of waste water due to unique characteristics e.g. Photo luminescence. Intrinsic magnetic property, electrochemical property, chirality and catalytic property, and so on . Cu is extensively used as a catalyticnano -particles because it has high conductivity, homogeneity same as ag and au nanoparticles and also cost effective. Recent work focused on synthesis of Sn-Cu nanocluster and analogy protects clusters with unique optical and catalytic properties. This literature author used to adopt templet base synthesis,electrochemical method, water in oil ,microemulsion techniques, brust-shiffrin method and microwave assisted payol method is use .evidence from XRD ,TEM and mass spectrometry reveals that newly formed cu nanocluster is quitly more stable and smaller than Cu13 and Cu8 synthesis wet chemical synthesis method [20].

Laser irradiation method for synthesis of nanoparticles .this technique is analternative of bottom up chemical reduction method.this technique based on green principle and highly reproductive.plasma bands of UV visible spectroscopy for calculate surface coverage of nanoparticles applications in synthesis multifunctionalization [21].

The Effect of fertilizer, faucal pollution of water presence of heavy metal in contaminated water(Pb, Fe and Cr) in excessive amount pay a vital attention towards industrial process because they produce water poisoning disease which has harmful for aquatic fauna[22].

Precipitation method

Metal salt + Alkali (NaOH, KOH)
↓
Precipitation of metal hydroxide
↓
Sinterring at calcination 300^{0}C
↓
Metal Hydroxide particles
↓
Calcination (500^{0}C, 600^{0}C, 700^{0}C)
↓
Grind
↓
Sample

Conclusion : Synthesized adsorbents effectively used for removal of heavy metals and other impurity from synthetic as well as industrial waste water. Low cost method. Effective removal of heavy metals and impurities within a permissible limit. Preparation of other useful materials such as tiles, bricks, utilizing exhausted adsorbents.

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References:-

1. Ali, M.M., El-Sayed, E.E., Kamel, M.Z., Removal of hazardous contaminants from waste water using natural zeolite. j. Water Res.Photon (2017) 138, 333-347.
2. Shi, W.Y. Shao, H.B., Li, H., Shao, M.A., Du, S., Progress in the remediation of hazardous heavy metal-polluted polluted soils by natural zeolite. J.Hazard. Mater. (2009) 170 (1), 1-6.
3. Lin, S.H., Juang, R.S., Heavy metal removal from water by sorption using surfactant-modified montmorillonite. J.Hazard. Matter (2002) 92 (3)315-326.
4. Crini G (2006) Non – Conventional low cost adsorbent for dye removal. BioresourTechnol 97:1061-1085. https://doi.org/10.1016/j.biortech.2005.05.001
5. Hala Ahmad Hegazi, removal of heavy metals from waste water using agricultural and industrial waste as adsorbents. J. HBRC. (2013) ; 9, 276-282.
6. H.panda, N.Tiadi, M. Mohanty, C.R.Mohanty, studies on adsorption behavior of an Industrial waste for removal of chromium from aqueous solution J.C.Che.Eng. South Africa (2017); 23, 132-138.
7. ElsauedEl Bastamy Elsaued, Natural diatomite as an effective adsorbent for heavy metals in water and waste water treatment(a batch study) J. water science (2018); 32, 32-43.
8. JaisonJeevanandam,Ahmed Barhoum, Yen S. Chan, Alain Dufresne and Michal Danguah, Review on nanoparticles and nanostructured materials.Belistein J. Nanotechnol. (2018); 9,1050-1074.
9. SuvardhanKanchi, Nanotechnology for water treatment.J.Environ.Anal. Chem. (2004); 1(2), 1-3.
10. GyorphyDeak,Florin Diana, Dumitiri Michaela, Andrea Moncea and Maria, Synthesis of ZnO nanoparticles for water treatment application. Inter. J. Conser. Sci. (2019);10(2),343-350.
11. Shashi Kant and Amit Kumar, A comparative analysis of structural optical and photocatalyic properties of ZnO and Ni doped ZnO oxide nanosphere prepare by sol-gel method. J. Adv.Mat.Lett. (2012); 3(4),350-354.
12. Macros Fernandez Garcia and Jose Rodriquez,

Nanomaterials:inorganic and bioinorganic perspective (2009);Encyclopedia of Inorganic and Bioinorganic Chemistry, DOI: 10.1002/9781119951438.eibc0331

13. SushmitaGhos, Subrata Das Gupta,AmaranthSen and HimadriSekharMaiti, Low temperature synthesis of nanosized bismuth ferrite by soft chemical route. J.Am.Ceram. Soc., (2005); 88(5) 1349-1352.
14. Xiang Rong Ye, Yuchelin, ChongmingWang, Mark H. Engelhard. Yong Wang and Chien M. Wai, Supercritical fluid synthesis and characterization of catalytic metal nanoparticle on carbon nanotubes. J. Mater. Chem. (2004); 14(5),908-913.
15. Mohammad M. Rahman, SherBhadur Khan, AslamJamel, Mohamad Faisal, Abdullah M. Aisiri, Iron oxide nanoparticles(2011): Doi: 10.577-2/-27698.
16. Asim Ali, Yaqoob, TabassumParveen, Khalid Umar, Mohammad NasirMohammad Ibrahim.Role of nanomaterials in the treatment of waste water. Water (2020);12(2),495.
17. Pragnesh N. Dave and Lakhan V. Chopda. Application iron oxide nanoparticles for the removal heavy metals. J. Nanotechnol. Hindawi.(2014)Doi. https://doi.org/10.1155/2014/398569
18. S. Mustupha, N.M. Ndamisto,A.S. Abdullhakareem J.O. Tijani,Dt. Sohaib, A.O. Ajula, A.k. Mohammed, Application of TiO_2 and ZnO nanoparticles immobilized an clay in wastewater treatment. J. Appl. Water Sci. (2020): 10(1),1-36.
19. Bohua Wu, Yinjiekuang, Xiao Huazhang, Jinhua Chon. Noble metal nanoparticales/ carbon nanotubes nanohybrid:synthesis and applications. J. Nano Today. (2011);(20) 6, 75-90.
20. Lu, Yizhang ,Weiwen Tao, Chenwei. Copper nanoclusters Synthesis, Characterization and Properties. J. Chinese Sci. Bul. (2012); 57, 41-47.
21. VincezoAmendola and Moreno Meneghetti, Laser ablation synthesis in solution and size manipulation of noble, metal nano particles. J. Physical Chem. Chemical Phy. (2009); 11(20), 3805-3821.
22. P. N. Patil, D.V. Sawant, R. N. Deshmukh. Physio-chemical parameter for testing of water. Inter. J. Environ. Sci. (2012); 3(3), 1194-1207.

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