Removal of Sodium Dodycl Sulfate by using copper doped ZnONanoparticles

1Dudekula Parveen, 2Basheera Hussain Khatoon, 3Vundavalli Venkata Sravanth, 4A.Ajay Raj, 5Venkata Rao Poiba, 6Meena Vangalapati
1,2,3,4M.Tech student, Department of Chemical Engineering, Andhra University
5Assistant Professor, Department of Chemical Engineering, Andhra University
6Professor, Department of Chemical Engineering, Andhra University
Corresponding Author E-Mail: meenasekhar2002@yahoo.com

Abstract. In present study Sodium Dodycl Sulfate (SDS), an anionic surfactant by using copper doped ZnO nanoparticles (Cu/ZnO-Np) are investigated. Further (Cu/ZnO-Np) were synthesized by using precipitation method in aqueous solution with sulfates of metallic precursors. By using XRD (X-ray diffraction) the crystalline analysis of nanoparticles were observed and by using SEM (scanning electron microscopy) the structure of nanoparticles were observed. For Cu/ZnO-Np the SEM size is 107.7nm. For phase identification and crystalline material XRD was used and to observe chemical properties of Cu/ZnO-Np, studied FTIR (Fourier Transmission of Infra-Red). The maximum percentage removal of Cu/ZnO-Np was found to be 98.5% by varying different conditions by time, dosage, pH, initial concentration and temperature parameters.

1.Introduction
Surfactants are reduce the surface tension between liquid and solid or two liquids such as emulsions, detergents, wetting agents etc. [1]. Commonly surfactants are deposited in so many ways on land and also into water systems, whether as part of an intended process or as industrial and household waste [2], alkali and chelating agents that can be damaging to plants and should not be applied to soils[3][4]. For a considerable period the continuous work will be done by commercial soil wetting agents, by soil micro-organisms they will eventually degraded. To protect the aquatic organisms care should be taken that reduction of pumping these materials into streams. The application of sludge, wastewater irrigation, and remediation processes the Anionic Surfactants can be found in soil. Relatively high concentrations of surfactants together with multi metals can represent an environmental risk. On trace metal mobility the surfactant application is unlikely to have a significant effect at low concentrations [5]. Sodium Dodycl Sulfate can be removed using many processes like catalysis method, adsorption method, electro cogulation method[6]. Copper doped ZnO nanoparticles (Cu/ZnO-Np) used as a catalyst in this present research.
2. Material and Methods

2.1 Materials: Sodium Carbonate, Zinc Sulfate, Copper Sulfate, Sodium Hydroxide, Hydrochloric Acid, Toluene, Glacial Acidic Acid, Acridine Orange.

2.2 Equipments: Magnetic stirrer, Separating funnel, Glass beakers, Measuring Jars, Ultra-Violet Spectrometer and pH meter.

2.3 Synthesis of Cu/ZnO-Np

By using Precipitation method Cu/ZnO-Np was prepared. 0.1M of Sodium Carbonate was dissolved under 100ml distilled water under continuous stirring and heating. Then in 100ml of distilled water 0.2M of Zinc Sulfate was dissolved. Then in Zinc Sulfate solution 0.2M of Copper Sulfate is added. This solution is slowly added to Zinc Sulfate solution up to pH reaches to 4. This mixing solutions stirred for 4 hrs under 600rpm and maintained Temperature is 80°C. For the removal of impurities the precipitate was washed with distilled water up to 4 to 5 times. And then filtered and centrifuged for 20 mins at 500rpm, that precipitate was dried at hot air oven at 60°C for 6 hrs[7],[8],[9].

2.4 Determination of Sodium Dodycl Sulfate

By using spectrophotometric method Sodium Dodycl Sulfate is determined by acridine orange. A 100µL of glacial acetic acid and acridine orange each is added to 10ml sample of synthetic water and added 5ml of toluene and these solution is kept in separation funnel and it is shaken for one minute and allowed to settle for 5mins then separation takes place. Take 2.5 ml of toluene layer presented in the top and the absorbance is measured directly by using UV-Spectrophotometer at the wavelength of 467nm [10],[11],[12].

2.5 Experimental procedure for removal of Sodium Dodycl Sulfate

Sodium Dodycl Sulfate was prepared by taking 1g Sodium Dodycl Sulfate sample into 1 liter of distilled water and it is taken as sample of experimentation. Consider 300ml of Sodium Dodycl Sulfate solution from stock solution and add 0.25 gm of Cu/ZnO-Np in a beaker. Then kept this solution on continuous stirring for 20mins at 600 rpm. Collect the sample for every mins and observed optical density of Sodium Dodycl Sulfate solution. And also observed the removal percentage of Sodium Dodycl Sulfate increases up to certain time then it is constant for time increases. Then go for other parameter to get maximum removal percentage of Sodium Dodycl Sulfate. Then 50ml of sample was taken and add different dosages of nanoparticles. When dosage of Cu/ZnO-Np increases removal percentage also increases. And we got maximum percentage removal of Sodium Dodycl Sulfate from water was observed. And we had experimental procedures with different PH values. The Anionic Surfactant removal was increases with the increase of temperature. Temperature values are 313K, 323K, 333K, 343K. Obtained maximum percentage removal of Sodium Dodycl Sulfate from water by varying different parameters at different conditions.

2.6 Characterization of Cu/ZnO-Np

2.6.1 Scanning Electron Microscope(SEM) and X-Ray Diffraction(XRD) Analysis of Cu/ZnO-Np

SEM producing images of Cu/ZnO-Np by scanning the surface with a focused beam of electrons interacting with atoms in the Cu/ZnO-Np, producing various signals and contain information about comparison of the Cu/ZnO-Np and the surface topology[13],[14],[15]. SEM achieved better resolutions for more than one nanometer. SEM image of Cu/ZnO-Np shown in figure 1 clearly indicating the small structures and different sizes of Cu/ZnO-Np. The produced nanoparticles were in the range of 107.7 nm to 150nm providing higher resolutions.

X-Ray diffraction (XRD) relies on the dual wave particle nature of X-Ray, gives information about the structure of the crystalline material. The main use of this technique is to identify and characterize the compounds by diffraction pattern basis [16]. Cu/ZnO-Np also has the hexagonal wurtzite structure and Peak positions of all four samples are not exactly same there.
is some difference in the position of the peaks represented in figure 2. The peaks at 2θ values of 14°,16°,22°,28°,30°,33°, 36° and 53°. Corresponding lattice points with preferred orientations which are belongs to four strongest peaks (1 0 0),(0 0 2),(1 0 1) and (1 1 0).

FIGURE 1: Scanning electron microscope image of Cu/ZnO- np

3. Results and Discussions
3.1 FTIR analysis for Cu/ZnO- np
Figure 3 and 4 presents FTIR spectrum of Cu/ZnO-Np. The broad peak at 3740 – 3000 cm⁻¹ in higher energy region and due to O − H stretching and peak in the range at 1640 – 1680 cm⁻¹ sulfate (O-S-O). All other peaks are attributed to the characteristics of the prepared Cu/ZnO nanoparticles. The bands appear near at 1020 – 1250 cm⁻¹ indicates the N-H deformation. The bands appear near at 610 – 700 cm⁻¹ indicates the O − H out of plane bending.

FIGURE 2: X-ray diffraction image of Cu/ZnO-Np
3.2 Effect of various parameters

3.2.1 Effect of time for the removal of SDS: Time course profiles for the Catalysis of SDS solutions of 2, 4, 6, 8, 10 and 12 mins are shown in Fig. 5. The data obtained from the catalysis of SDS onto used Cu/ZnO-Np showed that a contact time 4 mins was required to achieve an equilibrium catalysis, % removal is 65.77 and there was no significant change in concentration of the SDS with further increase in contact time. For further studies of catalysis with other parameters with this Cu/ZnO-Np as a catalyst, the equilibrium time of 4 mins has been chosen for contact period.
3.2.2 Effect of dosage for the removal of SDS: For studying the effect of catalytic dosage on removal of SDS the catalytic dosage is varied from 0.1 to 0.7 g/L, fixing other parameters constant. The contact time was 4 mins for Cu/ZnO-Np. The Fig. 6 shows an increase in percent SDS removal with an increase in catalytic dosage. The % removal increased from Cu/ZnO-Np 65.77% to 70.57% for 10 ppm SDS solution. With an increase of catalytic dosage from 0.1 to 0.7 g/L, the increase in Anionic Surfactant removal with catalytic dosage will increased surface area and large number of available catalytic sites.

3.2.3 Effect of pH for the removal of SDS: To study the effect pH on the removal of SDS by changing the pH from 4 to 8 and fixing the other parameters are time 4mins, Catalytic dosage 0.6g/L. By increase in pH the percentage removal also increases and highest %removal is takes place at pH 7 shown in fig 7 and the %removal is 74.77. Further increases in the pH the %removal is decreases.
3.2.4 Effect of Initial Concentration for the removal of SDS: To study the effect of Initial Concentration on the removal of SDS by changing the concentration from 2ppm to 10ppm and fixing the other parameters are time 4mins, Catalytic Dosage 0.6 g/L, pH 7. By increase in the Initial Concentration of SDS the % removal of SDS is decreases. The highest %removal takes place at 2ppm as shown in fig 8 i.e., 93.10.

3.2.5 Effect of Temperature for the removal of SDS: To study the effect of Temperature on the removal SDS by changing the Temperature from 313K to 353K and fixing the other parameters are time 4 mins, Catalytic Dosage 0.6g/L, pH 7 and also Initial concentrations are varying from 2ppm to 10ppm. The highest %removal is takes place at 353K as shown in fig 9 and the %removal is 98.5. By increase in the Temperature % removal also increases, because catalysis is takes place at highest temperatures.
4. Conclusion
The current research was focused to find the optimized condition of the removal of SDS by Cu/ZnO-Np as catalyst. The nano sized particles of Cu/ZnO were synthesized using precipitation method with sulfates of metallic precursors. The particle size was determined by using SEM analysis and found to be 107.7nm to 150nm. XRD clearly confirms the crystalline structure of synthesized Cu/ZnO-Np as hexagonal wurtzite structure and FTIR shows the different functional groups present in them. The result present in this research was showed how the nanoparticle will effect on the different parameters like optimum time as 4 min, Dosage as 0.6g/L, Ph as 7, Temperature as 353K, Initial concentration AS 2ppm of SDS from aqueous solution. Optimum parameters we can effectively remove the SDS from aqueous solution with removal percentage of 98.50%.

5. References
[1] Matthew J. Scott, Malcolm N. Jones 2000 The biodegradation of surfactants in the environment, Elsevier Science, 235-251.
[2] Bilaspur (Chhattisgarh), A Study of Spectrophotometric Determination of Ion Association Complex, Formed by Anionic Surfactant (SDS) Sodium Dodecyl by Using Crystal Violet as A Cationic Dye in Region oriental journal of chemistry, ISSN: 0970-020 X, CODEN: OJCHEG,Vol. 30, No. (3):Pg. 1335-1341, (2014).
[3] J. Rivera-Utrillaa,, J. Me´ndez-Di´aza, M. Sa´ nchez-Poloa,b, M.A. Ferro-Garcı´aa, I. Bautista-Toledo 2006 Removal of the surfactant sodium dodecylbenzenesulphonate from water by simultaneous use of ozone and powdered activated carbon: Comparison with systems based on O3 and O3/H2O2 Elsevier, Vol 40, pp. 1717-1725.
[4] Kanchi S., Niranjan T., K. Babu Naidu, *Naidu Venkatasubba N., Monitoring the Status of Anionic Surfactant (SDS)s in Various Water Systems in Urban and Rural Areas of Tirupati, Andhra Pradesh, South India, International Journal of Research in Chemistry and Environment Vol. 2, Issue 3, (144-156) , ISSN 2248-9649, (2012).
[5] Abdelhafidh Dhouib , Nai´ma Hamad, Ilem Hassa’ri, Sami Sayadi 2002 Degradation of
Anionic Surfactant (SDS) by Citrobacter braakii 1245-1250.

[6] Paritosh das, Anjali Pal, Manas Bandyopadhyay 2002 Catalysis of Anionic Surfactant (SDS) by a low-cost adsorbent Journal of Environmental Science and Health, vol 37(5):925-38.

[7] Thutiyporn Thiwawong , Korakot Onlaor , Natpasit Chaithanatkun and Benchapol Tunhoo 2018 Preparation of Copper Doped Zinc Oxide Nanoparticles by Precipitation Process for Humidity Sensing Device, AIP Conference Proceedings.

[8] Ruby Chauhan, Ashavan i Kumar and Ram Pal Chaudhary 2010 Synthesis and Characterization of Cu/ZnO-Np"", J. Chem. Pharm. Res., vol.2 178-183

[9] Chauhan, Shrivastav , Dugaya and Pandey 2017 Synthesis and Characterization of Ni and Cu Doped ZnO Journal of Nanomedicine & Nanotechnology, vol.8.

[10] Shaveta Thakur, Neha Sharma, Anamika Varkiaand Jitender Kumar 2014 Structural and optical properties of Cu/ZnO-Np and thin films"", Advances in Applied Science Research, vol.5 18-24.

[11] Dilip B.Patil*, A. Kshirsagar and Ajay P. Ganorkar 2005 Estimation Of Surfactants At Ppm Level From Synthetically Polluted Water, Jr. of Industrial Pollution Control 21 (2), pp 293- 298.

[12] Asok Adak, Anjali pal & Manas Bandyopadhyay 2005 Spectrophotometric determination of Anionic Surfactant (SDS) in waste water using acridine orange Indian Journal of Chemical Technology, Vol 12, pp. 145-148.

[13] Varunkumar, Rafikul Hussain, Gurumurthy Hegde, Anita Ethiraj 2017 Effect of calcination temperature on Cu doped NiO nanoparticles prepared via wet-chemical method: Structural, optical and morphological studies Materials Science in Semiconductor Processing, vol.66149–15.

[14] Ruby Chauhan, Ashavani Kumar, Ram Pal Chaudhary 2011 structure and optical properties of Zn1-x NixO nanoparticles by coprecipitation method, Journal of Optoelectronics and Biomedical Materials, Vol. 3 17-23.

[15] Muhammad Sajjad, Inam Ullah, Khan, Jamshid Khan, Yaqoob Khan and Muhammad Tauseef Qureshi 2018 Structural and optical properties of pure and copper doped zinc oxide nanoparticles, Results in Physics , vol.9 1301–1309.

[16] Jyotsna Chauhan, Neelmani Shrivastav, Ashish Dugaya, Devendra Pandey 2017 Synthesis and characterization of Ni and Cu doped Zno, MOJ Polymer Science, vol.1.