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Batch Adsorption Study On Removal Of Nitrate From Aqueous Solution By Darjeeling Tea Ash

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The adsorbent was prepared from the waste residue of Darjeeling tea followed by pyrolysis process and was named as Darjeeling tea ash (DaTA). The DaTA was characterized using FTIR and BET analysis. The effectiveness of DaTA for removal of nitrate from aqueous solution was explored by batch adsorption experiments. The maximum adsorption of nitrate onto DaTA was 76.7% at pH 3 at 40 ^{0}C for 100 mg/L nitrate (as NO_3) solution at an equilibrium time of 90 min with optimum adsorbent dose of 7.5 g/L. The agitation speed (150 rpm) was kept constant in all experiments. The surface of the adsorbent was found heterogeneous and specific surface area as well as porosity of adsorbent both had contribution towards adsorption process. It was found that the kinetics of adsorption was well fitted into pseudo-second-order model and the data evaluated were adapted with D-R isotherm model as well as Freundlich isotherm model. Thermodynamic study revealed that the adsorption was endothermic in nature with an activation energy of 25.214 kJ/mol. Kinetic study, isotherm study and thermodynamic study, all confirmed that the adsorption of nitrate onto DaTA was chemisorption process. DaTA was proved as an effective adsorbent to remove nitrate from aqueous solution at low pH.

KEYWORDS

Darjeeling tea ash, Nitrate removal, Batch adsorption, Kinetic model, Isotherm study, Thermodynamic study

REFERENCES

1. Bhatnagar, A. and M. Sillanpaa. 2011. A review of emerging adsorbents for nitrate removal from water. *Chem. Eng. J.,* 168:493-504.
2. WHO. 2011. Nitrate and nitrite in drinking water (Ch 1). World Health Organization, Geneva. pp 1-2. Available from http://www.who.int/water_ sanitation_health/dwg/chemicals/nitratenitrite_ background.pdf.
3. Shukla, S. and A. Saxena. 2018. Global status of nitrate contamination in groundwater. Its occurrence, health impacts and mitigation measures. **In** Handbook of environmental materials management. **Ed** C. Hussain. Springer, Cham.
4. Rao, E.V.S. Prakasa, *et al.* 2017. Assessment of nitrate threat to water quality in India. **In** The Indian nitrogen assessment (Ch 21). pp 323-333. DOI : 10.1016/b978-0-12-811836-8.00021-5.
5. Bhattacharya, J. and S.N. Mandal. 2014. Effect of nitrate, sulphate and fluoride of wastewater on groundwater. *Res. J. Chem. Env.,* 18(2):50-56.
6. Yang, L., *et al.* 2017. Characteristics of nitrate removal from aqueous solution by modified steel slag. *Water.* 9(10):757-774.
7. Akiladevi, A.R., *et al.* 2015. Economical technology for fluoride removal from drinking water using tea ash and fish bone. *J. Chem. and Pharmaceutical Sci.,* 8 (4):824-828.
8. Mondal, Naba Kr., *et al.* 2012. Studies on defluoridation of water by tea ash : An unconventional biosorbent. *Chem. Sci. Trans.,* 1(2):239-256.
9. Parlikar, A.S. and S.S.. Mokashi. 2015. A comparative study of defluoridation of water by tea waste and drumstick as bioadsorbents. *Int. J. Multidisciplinary Res. and Develop.,* 2 (7):205-211.
10. Battacharya, J. and S.N. Mandal. 2019. Batch adsorption study on removal of fluoride from aqueous solution by Darjeeling tea ash. *Res. J. Chem. Env.,* 23(2):71-79.
11. Predoi, D., *et al.* 2018. Properties of basil and lavender essential oils adsorbed on the surface of hydroxyapatite. *Mater.,* 11:652. DOI: 10.3390/ma 11050652.
12. Ahmadi, M., *et al.* 2017. Removal of nitrate from aqueous solution using activated carbon modified with fenton reagents. *Desalination and Water Treatment.* 76:265-275.

13. Tembhurkar, A.R. and Shilpa Dongre. 2006. Studies of fluoride removal using adsorption process. *J. Env. Sci. and Eng.,* 48(3):151-156.
14. Ghosh, M.K., *et al.* 2011. Arsenic adsorption on goethite nanoparticles produced through hydrazine sulphate assisted synthesis method. *Korean J. Chem. Eng.,* 29(1):95-102.
15. Goswami, A. and M.K. Purkait. 2011. Kinetic and equilibrium study for fluoride adsorption using prophylite. *Sep. Sci. Tech.,* 46(11):1797-1807.
16. Wang, F.Y., H. Wang and J.W. Ma. 2010. Adsorption of cadmium (II) ions from aqueous solution by a new low-cost adsorbent-Bamboo charcoal. *J. Hazard Mater.,* 177:300-306.
17. Man, C.H., *et al.* 2012. Adsorption potential of unmodified rice husk for boron removal. *Bioresour.,* 7(3):3810-3822.
18. Shukla, A., *et al.* 2002. The role of sawdust in the removal of unwanted materials from water. *J. Hazard Mater.,* 95 (1-2):137-152.
19. Charles, Osu I. and S.A. Odoemelam. 2010. Studies on adsorbents dosage, particle size and pH constraints on biosorption of Pb (II) and Cd (II) from aqueous solution using modified and unmodified crasstrotrea gasar (bivalve) biomass. *Int. Archive Sci. Tech.,* 1(1):62-68.
20. Mishra, V., C. Balomajumder and V.K. Agarwal. 2010. Biosorption of Zn (II) onto the surface of non-living biomasses : A comparative study of adsorbent particle size and removal capacity of three different biomasses. *Water, Air, Soil Poll.,* 211:489-500.
21. Mohammed, C., *et al.* 2011. Characterization and application of dried plants to remove heavy metals, nitrate and phosphate ions from industrial wastewaters. *Clean-Soil, Air, Water.* 39(4):376-383.
22. Reddy, C.A., *et al.* 2015. Banana peel as a biosorbent in removal of nitrate from water. *Int. Advanced Res. J. Sci. Eng. Tech.,* 2(10):94-98.
23. Ahluwalia, S.S. and D. Goya. 2005. Removal of heavy metals by waste tea leaves by aqueous solution. *Eng. Life Sci.,* 5:1-15.
24. Fierro, V., *et al.* 2008. Adsorption of phenol onto activated carbons having different textural and surface properties. *Microporous and Mesoporous Mater.,* 111:276-284.
25. Nethaji, S., A. Sivasami and A.B. Mandal. 2013. Adsorption isotherms, kinetics and mechanism for the adsorption of cationic and anionic dyes onto carbonaceous particles prepared from *Juglans regia* shell biomass. *Int. J. Env. Sci. Tech.,* 10:231-242.
26. Bhaumik, R., *et al.* 2002. Eggshell powder as an adsorbent for removal of fluoride from aqueous solution : Equilibrium, kinetic and thermodynamic studies. *E-J. Chem.,* 9(3):1457-1480.
27. Johns, J. and V. Rao. 2011. Adsorption of methylene blue onto natural rubber/chitosan blends. *Int. J. Polymeric Mater.,* 60:766-775.
28. Arsenio, de Sa, *et al.* 2017. Polymeric materials for metal sorption from hydric resources. *Water Purification.* 7:289-232.
29. Babel, S. and E.M. Opiso. 2007. Removal of Cr from synthetic wastewater by sorption into volcanic ash soil. *Int. J. Env. Sci. Tech.,* 1(1):99-107.
30. Che Man, Hasfalina, *et al.* 2012. Adsorption potential of unmodified rice husk for boron removal. *Bioresour.,* 7(3):3810-3822.
31. Freundlich, H.M.F. 1906. Over the adsorption in solution. *J. Physical Chem.,* 57:385-470.
32. Wasewar, K.L., S. Kumar and B. Prasad. 2009. Adsorption of tin using granular activated carbon. *J. Env. Prot. Sci.,* 3:41-52.
33. Mondal, Naba Kr., *et al.* 2012. A comparative study on the batch performance of fluoride adsorption by activated silica gel and activated rice husk ash. *Int. J. Env. Sci.,* 2(3):1643-1661.
34. Onyango, M.S., *et al.* 2004. Adsorption equilibrium modeling and solution chemistry dependence of fluoride removal from water by trivalents cation-exchanged zeolite F-9. *J. Colloid and Interface Sci.,* 279:341-350.
35. Benzaoui, T., A. Selatnia and D. Djabali. 2018. Adsorption of copper (II) ions from aqueous solution using bottom ash of expired drugs incineration. *Adsorption Sci. Tech.,* 36(1-2):114-129.
36. Baybars, Ali Fil and Mustafa Korkmaz Gengiz Ozmetion. 2014. An empirical model for adsorption thermodynamics of copper (II) from solution of illite clay-batch process design. *J. Chil. Chem. Soc.,* 59(4):1-12.
37. Goswami, A. 2013. Treatment of fluoride containing water using adsorption and precipitation followed by microfiltration. Doctoral Desertation Thesis. Indian Institute of Technology, Guwahati.
38. Saha, P. and S. Chowdhury. Insight into adsorption thermodynamics. **In** Thermodynamics (Ch 16). pp 349-364. Available from http://www. intechopen. com/books/thermodynamics/insight-into-adsorption-thermodynamics.

39. Zhang, M.N., X. P. Liao and B. Shi. 2005. Adsorption of surfactants on chromium leather waste. *J. Soc. Leather Technologists Chemists.* 90:1-6.

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Ambient Air Quality Status Near Kalingnagar, Jajpur, Odisha

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Ambient air quality (AAQ) of Jajpur industrial area, Odisha has been assessed by measuring particulate matter (PM_{10}, $PM_{2.5}$), sulphur dioxide (SO_2), oxides of nitrogen (NOx), carbon monoxide (CO) and by using air quality index (AQI). The result revealed moderate air pollution at all eight sites where the highest index value of 60.25 is recorded at location A2. Correlation study shows a strong direct relation among AQI and PM_{10} (r=0.818). Regression study reflects PM_{10} is good at predicting AQI (R^2=0.6794). Multiple linear regression (MLR) study predicts AQI with very less error (rss=0.142483, R^2=0.999788) where PM_{10}, $PM_{2.5}$, SO_2, NOx and CO are independent variables. This study also identifies potential sources of pollution and the extent of air pollution.

KEYWORDS

Air quality index, Air pollution, PM_{10}, Correlation, Multiple linear regression

REFERENCES

1. Gidde, M.R., V.V. Todkar and K.K. Kokate. 2008. Municipal solid waste management in emerging mega cities : A case study of Pune city. Indo Italian Conference on green and clean environment. Pune.
2. Rathi, S. 2007. Optimization model for integrated municipal solid waste management in Mumbai. *Env. Develop. Econ.,* 12:105-121.
3. UNEP. 2002. Environmental threats to children : Children in new millennium. United Nations Environmental Programme, UNICEF, WHO, Geneva.
4. Agrawal, M. and N. Khanam. 1997. Variation in concentrations of particulate matter around a cement factory. *Indian J. Env. Health.* 392:97-102.
5. Balaceanu, C. and S. Stefan. 2004. The assessment of the TSP particulate matter in the urban ambient air. *Romanian Reports Physics.* 564:757-768.
6. Barman, S.C., *et al.* 2008. Ambient air quality of Lucknow city during use of fireworks on Diwali festival. *Env. Monit. Assess.,* 137:495-504.
7. Chaurasia, S., *et al.* 2014. Assessment of air pollution emission from cement industries in Nimbahera, Rajasthan. *Int. J. Current Microbiology Appl. Sci.,* 3(3):133-139.
8. Bates, D.V. 1992. Respiratory function in diseases. W.B. Saunders, Philadelphia, PA, USA.
9. Dockery, D.K. and C.A. Pope. 1994. Acute respiratory effects of particulate air pollution. *Innu. Rev. Public Health.* 15:107-132.
10. Bendahmane, D.B. 1997. Air pollution and child health : Priorities of action. U.S. Agency for International Development, Washington, D.C., USA.
11. Chaurasia, S. and A. Tiwari. 2016. Assessment of ambient air quality in the vicinity of cement industries. *Int. J. Appl. Res. Tech.,* 1(1):39-46.
12. West, P.W. and G.C. Gaeke. 1956. Fixation of sulphur dioxide as suphito-mercurate III and subsequent colourimetric determination. *Anal. Chem.,* 28(12):1816-1819.
13. Jacobs, M.B. and S. Hochheiser. 1958. Continuous sampling and ultra-micor determination of nitrogen dioxide in air. *Anal. Chem.,* 30(3):426-428.
14. Bhuyan, P.K. P. Samantray and S.P. Rout. 2010. Ambient air quality status in Choudwar area of Cuttack district, *Int. J. Env. Sci.,* 1 (3):343-356.
15. CPCB. 2009. National ambient air quality standards (NAAQS). Notification. Central Pollution Control Board, New Delhi.

16. Panda, B.K. and C.R. Panda. 2012. Estimation of ambient air quality status in Kalinganagar industrial complex in the district of Jajpur of Odisha. *Int. J. Env. Sci.,* 3(2):767-775.
17. Field, A. 2009. Discovering statistics using SPSS (3rd edition). Sage Publications Ltd., London.

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Economic Assessment Of Grid Connected Hybrid Green Energy System For An Institution In India

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The aim of this paper is to analyse an optimal, economic feasibility study of grid connected hybrid renewable energy sources for an educational institution situated in suburban parts of India. So it is necessary to evaluate the availability of electricity, calculate the load demand and finding the alternate energy solutions. In the present scenario, as electricity production is inadequate, the load demand is met by the conventional approaches, like diesel generator (DG), battery, etc. The tremendous increase in fuel prices and emission problems has led to a transformation in generating electricity through green energy sources. But the major problem faced is the selection of components due to the intermittent nature of the available green resources and the load demand for different sites. Keeping these demands in mind, this paper aims to find the solution to optimize various hybrid green resources, like solar PV system, wind system, diesel generator, fuel cell, battery and so on. HOMER software is used to find the techno-economic, environment-friendly suitable feasible combination of energy efficient system. The comparison is based on the reduction of greenhouse gas emission, cost of electrical energy (COE) production and operating cost (OC). The solution obtained from the analysis shows that a hybrid combination of Grid/SPV/WES/Battery sources can be a cost effective, sustainable and environmentally viable one.

KEYWORDS

Green energy, Greenhouse gas emission, Hybrid renewable energy sources, HOMER software, Techno-economic

REFERENCES

1. Lao, C. and S. Chungpaibulpatana. 2017. Techno-economic analysis of hybrid system for rural electrification in Cambodia. *Energy Procedia.* 138:524-529.
2. Usman, M., *et al.* 2018. Techno-economic analysis of hybrid solar-diesel-grid connected power generation system. *J. Electrical Systems Information Tech.,* 5(3):653-662.
3. Gan, L. K., *et al.* 2015. Hybrid wind– photovoltaic–diesel–battery system sizing tool development using empirical approach, life-cycle cost and performance analysis: A case study in Scotland. *Energy Conversion and Manage.,* 106: 479-494.
4. Isa, N. M., *et al.* 2017. A techno-economic assessment of grid connected photovoltaic system for hospital building in Malaysia. *IOP Conference Series: Mater. Sci. Eng.,* 217(1):1-12.
5. Fazelpour, F., *et al.* 2016. Techno-economic analysis of hybrid power systems for a residential building in Zabol, Iran. International Conference on Environment and Electrical Engineering. pp 1-6.
6. Benchraa, H., *et al.* 2018. Techno-economic feasibility study of a hybrid biomass/PV/diesel/battery system for powering the village of Imlil in High Atlas of Morocco. *Int. Renewable Energy Congress.,* 1-6.
7. Shahzad, M. K., *et al.* 2017. Techno-economic feasibility analysis of a solar-biomass off grid system for the electrification of remote rural areas in Pakistan using HOMER software. *Renewable Energy.* 106: 264-273.
8. Bhatt, A., *et al.* 2016. Feasibility and sensitivity analysis of an off-grid micro hydro–photovoltaic–biomass and biogas– diesel–battery hybrid energy system for a remote area in Uttarakhand state. *Renewable Sustainable Energy Reviews.* 61:53-69.
9. Upadhyay, S. and M. P. Sharma. 2015. Development of hybrid energy system with cycle charging strategy using particle swarm optimization for a remote area in India. *Renewable Energy.* 77:586-598.
10. Upadhyay, S. and M. P. Sharma. 2014. A review on configurations, control and sizing methodologies of hybrid energy systems. *Renewable Sustainable Energy Reviews.* 38:47-63.
11. Kolhe, M. L., *et al.* 2015. Techno-economic sizing of off-grid hybrid renewable energy system for rural electrification in Sri Lanka. *Sustainable Energy Tech. Assess.,* 11:53-64.

12. Sen, R. and S. C. Bhattacharyya. 2014. Off-grid electricity generation with renewable energy technologies in India: An application of HOMER. *Renewable Energy.* 62: 388-398.
13. Zhang, J., *et al.* 2017. Energy management of PV-diesel-battery hybrid power system for island stand-alone micro-grid. *Energy Procedia.* 105:2201-2206.
14. Al-Garni, H. and A. Awasthi. 2017. Techno-economic feasibility analysis of a solar PV grid-connected system with different tracking using HOMER software. *IEEE Int. Conference Smart Energy Grid Eng.,* 217-222.
15. Kebede, A. A. 2018. Design and techno-economic analysis of small-scale hybrid power system connected to grid system. *Int. Refereed J. Eng. Sci.,* 7(2): 38-50.
16. Singh, A. and P. Baredar. 2016. Techno-economic assessment of a solar PV, fuel cell and biomass gasifier hybrid energy system. *Energy Reports.* 2:254-260.
17. Heydari, A. and A. Askarzadeh. 2016. Optimization of a biomass-based photovoltaic power plant for an off-grid application subject to loss of power supply probability concept. *Appl. Energy.* 165:601-611.
18. Longe, O. M., *et al.* 2017. A case study on off-grid microgrid for universal electricity access in the Eastern Cape of South Africa. *Int. J. Energy Eng.,* 7(2):55-63.
19. Shezan, S. A., *et al.* 2016. Performance analysis of an off-grid wind-PV (photovoltaic)-diesel-battery hybrid energy system feasible for remote areas. *J. Cleaner Production.* 125:121-132.
20. Palit, D. and K.R. Bandyopadhyay. 2016. Rural electricity access in South Asia: Is grid extension the remedy? A critical review. *Renewable Sustainable Energy Reviews.* 60:1505-1515.
21. Memala, W. Abitha, *et al.* 2019. DC-DC converter based power management for go green applications. *Int. J. Power Electronics Drive System.* 10(4) : 2046-2054.
22. Amutha, W. Margaret and V. Rajini. 2015. A bidirectional isolated AC-DC converter for hybrid power systems. *Int. J. Appl. Eng. Res.,* 10(7):16613-16624.
23. Rashid, S., *et al.* 2017. Optimized design of a hybrid PV wind diesel energy system for sustainable development at coastal areas in Bangladesh. *Env. Progress Sustainable Energy.* 36(1):297-304.
24. Amutha, W. Margaret, H. Harshini and V. Rajini. 2018. A new green energy interface for telecommunications. *Int. J. Electronics.* 105(11): 1831-1854.

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Formulation Of An Efficient AB210 Azo Dye Degrading Indigenous Consortium And Dye Biodegradation Studies

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Amongst total textile dyes' consumption, 60-70% commonly used textile dyes are azo dyes and a considerable amount is lost in the environment due to low dye exhaustion. Recent studies also profiled the carcinogenic, cytotoxic and mutagenic effects of these azo dyes. Biodegradation of azo dyes has received considerable attention since advanced biological methods have been developed for remediation, which is also regarded as eco-friendly, low cost and more efficient. A consortium was developed indigenously using a designed experiment and its dye degradation efficiency was tested using AB210 as a model dye. The consortium was found capable of degrading 100 mg/L of AB210 with a rate of 2.77 mg/L/hr, under static conditions at 35±2°C in Bushnell Hass medium. The consortium was also capable of decolourizing AB210 repeatedly, without supplementation of nutrients, for 7 cycles. UV–Visible spectroscopy and visual examinations showed decolourization of dye. The ADMI value of the textile industry effluents was reduced by 77.56% upon bioremediation by the consortium.

KEYWORDS

Triazo dye, Acid Black 210, UV-Visible, Bioremediation, Consortium

REFERENCES

1. Joshi, S.M., *et al.* 2010. Exploring the potential of natural bacterial consortium to degrade mixture of dyes and textile effluent. *Int. Biodeterior. Biodegrade.,* 64(7):622-628. DOI : 10.1016/j.ibiod. 2010.07.001.
2. Agrawal, S., D. Tipre and S. Dave. 2014a. Isolation, characterization and study of micro-organisms capable of decolourizing triazo dye acid black 210. *Int. J. Env. Prot.,* 34(7):540-546.
3. Kadam, A.A., *et al.* 2011. Decolourization of adsorbed textile dyes by developed consortium of *Pseudomonas* sp. SUK 1 and *Aspergillus ochraceus* NCIM-1146 under solid state fermentation. *J. Hazard Mater.,* 189(1-2):486-494. DOI : 10.1016/j.jhazmat.2011.02.066.
4. Dave, S.R. and R.H. Dave. 2009. Isolation and characterization of *Bacillus thuringiensis* for acid red 119 dye decolourization. *Bioresour. Tech.,* 100(1): 249-253. Retrieved from http://curopepme. org/abstract/MED/18590 958.
5. Shah, P.D., S.R. Dave and M.S. Rao. 2012. Enzymatic degradation of textile dye reactive orange 13 by newly isolated bacterial strain *Alealigenes faecalis* PMS-1. *Int. Biodeterior. Biodegrad.,* 69:41-50. DOI : 10.1016/j.ibiod. 2012.01.002.
6. Haq, I. and A. Raj. 2018. Biodegradation of Azure-B dye by *Serratia liquefaciens* and its validation by phytotoxicity, genotoxicity and cytotoxicity studies. *Chemosphere.* 196:58-68. DOI : 10.1016/j. chemosphere. 2017.12.153.
7. Garg, S.K., *et al.* 2012. Biodecolourization of textile dye effluent by *Pseudomonas putida* SKG-1 (MTCC 10510) under the conditions optimized for monoazo dye orange II colour removal in simulated minimal salt medium. *Int. Biodeterior. Biodegrad.,* 74 (0):24-35. DOI : 10.1016/j.Ibiod.2012.07.007.
8. Patel, D.K., *et al.* 2018. Elucidation of biochemical mechanism involved in microbial degradation of 1:1 metal complex dye containing simulated wastewater. *Int. J. Current Microbiol. Appl. Sci.,* 7(3): 2774-2789.
9. Gomare, S.S., *et al.* 2009. Eco-friendly biodegradation of a reactive textile dye golden yellow HER by *Brevibacillus laterosporus* MTCC 2298. *Int. Biodeterior. Biodegrad.,* 63(5):582-586. DOI : 10.1016/j.ibiod.2009.03.005.
10. Srinivasan, S. and S.K. Sadasivam. 2018. Exploring docking and aerobic-microaerophilic biodegradation of textile azo dye by bacterial systems. *J. Water Proc. Eng.,* 22(1):180-191. DOI : 10.1016/j.jwpe.2018.02.004.

11. Dave, S.R., T. Patel and D. Tipre. 2015. Microbial degradation of synthetic dyes in wastewaters. *Env. Sci. Eng.,* (Subscries : Env. Sci.), part iii-iv. DOI : 10.1007/978-3-319-10942-8.
12. Agrawal, S., *et al.* 2016. Bacterial decolourization, degradation and detoxification of azo dyes : An eco-friendly approach. **In** Microbial application (vol. 1). **Ed** V.C. Kalia and P. Kumar. Springer, Cham., pp 91-124.
13. Agrawal, S., *et al.* 2010. Optimization of nutrients for bioremediation of textile industry effluent by *Providencia* sp. SRS 82. *Int. J. Agri. Biol. Res.,* 32(1):40-53.
14. Agrawal, S., *et al.* 2014b. Optimization of triazo acid black 210 dye degradation by *Providencia* sp. SRS 82 and elucidation of degradation pathway. *Proc. Biochem.,* 49(1):110-119. DOI : 10.1016/j. procbio.2013.10.006.
15. Sheth, N. and S. Dave. 2010. Enhanced biodegradation of reactive violet 5R manufacturing wastewater using down flow fixed film bioreactor. *Bioresour. Tech.,* 101(22):8627-8631. DOI : 10.1016/j.biotech.2010.06.106.
16. Agrawal, S. 2015. Bioremediation and detoxification of azo dye containing effluent by *Bacillus pumilus* SRS 83. *Res. J. Recent Sci.,* 4(3):5-9.
17. Xiao, X., *et al.* 2018. A simple method for assaying anaerobic biodegradation of dyes. *Bioresour. Tech.,* 251(12):204-209. DOI : 101016/j.biotech. 2017.12.052.
18. Dafale, N., *et al.* 2008. Decolourization of azo dyes and simulated dye bath wastewater using acclimatized microbial consortium-Biostimulation and halo tolerance. *Bioresour. Tech.,* 99(7):2552-2558. DOI : 10.1016/jbiotech.2007.04.044.

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Restoration And Exploring Possibilities Of Developing Agricultural Practices Over Mined-Out Area - A Case Study

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With increasing stress on per capita land availability in a populous country, like India, the time has come to act on the inherent mining principle of considering it as an interim use of land. Post mining reclamation and restoration of land is sine-qua-non in the contemporary mining scenario. As mining induces peoples' displacement that leads to intrusion into their human rights by a coerced change in their life and livelihood pattern. Developing sustainable agriculture practices over-restored mined-out area could be a possible solution in this regard that authors see its potentiality through the eyes of an actual case study in part practice at Lodna mining area, Jharia coalfields.

KEYWORDS

Mined-out area, Restoration, Sustainable agriculture, Inclusive growth, Human rights

REFERENCES

1. Ehrlich, P.R. 1993. The scale of the human enterprise. **In** Nature conservation 3 : Reconstruction of fragmented ecosystems, global and regional perspective. **Ed** D.A. Saunders, R.J. Hobbs and P.R. Enrlich. Surrey Beatty and Sons, Chipping Norton, New South Wales. pp 3-8.
2. Walker, L.R. and M.R. Willing. 1999. An introduction of terrestrial disturbances. **In** Ecosystem of disturbed ground. **Ed** L. Walker. Elsevier, Amsterdam. pp 1-16.
3. Cao, X. 2007. Regulating mine land reclamation in developing countries : The case of China. *Land Policy.* 24:472-483. DOI: 10.1016/j.landusepol. 2006.07.002.
4. Johnson, M.S., J.A. Cooke and J.K. Stevenson. 1994. Re-vegetation of metalliferous waste and land after metal mining. **In** Mining and its environmental impact. **Ed** R.E. Hester and R.M. Harrison. Royal society of chemistry, Letchworth, England. pp 31-48.
5. Haigh, M.J. 1993. Surface mining and the environment in Europe. *Int. J. Surf. Min. Reclaim.,* 7:91-104. DOI:10.1080/1748093930 8547568.
6. SER. 1996. Definitions 1 : Ecological restoration. Society for Ecological Restoration. www.ser.org/definitions.html.
7. Laurence, D.C. 2006. Why do mines close. First International Seminar on Mine closure. Australian Centre for Geomechanics, Perth. Proceedings, pp 83-94.
8. Worrall, R., *et al.* 2009. Towards a sustainability criteria and indicators frame-work for legacy mine land. *J. Cleaner Production.*17(16):1426-1434.
9. Mishra, P.P. and A.K. Pujari. 2008. Impact of mining on agricultural productivity : A case study of the Indian state of Orissa. *South Asia Economic J.,* 9(2):337-350.
10. Bose, S. 2004. Positioning women within the environmental justice framework : A case from the mining sector. *Gender, Tech. Develop.,* 8(3): 407-412. DOI : 10.1177/097185240400800305.
11. Dutt, K. Lahiri. 1999. From gin girls to scavengers : Women in the Raniganj Collieries. *Economic Political Weekly*. 36(44):4213-4221.
12. Bhanumathi, K. 2002. Status of women affected by mining in India : A resource kit. Mines, Minerals and People, India, New Delhi.
13. Tripathi, D.P. 2004. Planned mine decommissioning closure and reclamation of a mine site. International Seminar on Technology update in mining and mineral industries. MEAI, Bangalore. Proceedings, pp 345-355.

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Determination Of Physico-Chemical Parameters And Removal Of Ammonia From Various Drinking Water Sources In Malappuram District

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Most of freshwater sources are polluted by an excess of iron, nitrate, ammonia, suspended solids, organic wastes, etc., in which the presence of ammonia is a major and newly emerging water quality problem. Drinking water samples collected in a random manner from 198 sources of Malappuram district in Kerala were studied by standard analytical procedures to determine various physico-chemical characteristics and amount of calcium, magnesium, chloride, fluoride, iron, nitrate, sulphate and ammonia. It was found that 58 samples have various physical contaminations and further analysis of these samples showed the presence of ammonia in 23 samples. The parameters, like total dissolved solids, alkalinity, total hardness, calcium, magnesium, fluoride and sulphate are within the desirable limit in these 23 samples. Ammonia contaminated samples also show an excess of iron and nitrate which causes an unpalatable taste. Ammonia can be effectively removed by the adsorption method employing charcoals from various sources. Charcoal obtained from rice husk shows remarkable efficiency of 96.8% removal of ammonia. Coconut shell charcoal also gave a better result of 72% removal whereas activated charcoal and animal charcoal efficiencies are comparatively lesser with 25% and 21.8%, respectively.

KEYWORDS

Drinking water, Ammonia content, Adsorption, Malappuram district, Charcoal

REFERENCES

1. APHA. 2005. Standard methods for the examination of water and wastewater (21st edn). American Public Health Association, New York.
2. EPA. 2018. Safe drinking water act amendment. US Environment Protection Agency.
3. Trivedi, R.K. and P.K. Goel. 1986. Chemical and biological methods for water pollution studies. *Env. Publication (Karad).* 6:10-12.
4. KSCSTE and CWRDM Report. 2009. Environmental monitoring programme on water quality in Kerala.
5. Sony, D.C., *et al.* 2005. Water quality information for the river basins in Kerala state. CAD/Report No./088 to 106/2005.
6. Karthick, K.B., *et al.* 2010. Devaluation of the quality of drinking water in Kerala state. *Asian J. Water Env. Poll.,* 7(4): 39-48.
7. Harikumar, P.S. and K.N. Remani. 1998. Water quality problems of Kerala. Water scenario of Kerala. The State Committee on Science, Technology and Environment, Thiruvananthapuram.
8. Padmalal, D. and P. Seralathan. 1993. Heavy metal content in suspended particulates and bed sediments of a tropical perennial river and estuary, central Kerala. *J. Geol. Soc. India.* 42: 349-355.
9. WHO. 1996. Guidelines for drinking-water quality. Vol. 2. Health criteria and other supporting information. World Health Organization, Geneva. WHO/SDE/WSH/03.04/01
10. EPA. 1989. Summary review of health effects associated with ammonia. Environmental Protection Agency. EPA/600/8-89/052.
11. EPSA. 2012. Health risk of ammonium released from water filters. European Food Safety Authority, Parma, Italy. *European Food Safety Authority J.,* 10(10): 2918
12. BIS. 2015. Drinking water specification. Amendment no. 1. IS 10500:2012.
13. Jakszyn, P. and C.A. Gonzalez. 2006. Nitrosamine and related food intake and gastric and oesophageal cancer risk: A systematic review of the epidemiological evidence. *World J. Gastroenterol.*, 12(27): 4296-303.
14. Linge, K.L., *et al.* 2017. Formation of N-nitrosamines in drinking water sources: Case studies from Western Australia. *Am. Water Works Assoc.,* 109(6): 184-196.

15. Tchobanoglous, G. and E.D. Schroeder. 1985. Water quality-characteristics, modeling, modification. Addison-Wesley Publishing Company, Menlo Park, California. pp 107-121.
16. George, E., *et al.* 2019. Prescribed fire effects on water quality and freshwater ecosystems in moist temperate eastern North America. *Natural Areas J.,* 39(1): 46-57.
17. Rahmanian, N., *et al.* 2012. Analysis of physico-chemical parameters to evaluate the drinking water quality in the state of Perak, Malaysia. *J. Chem.,* 2015:1-10.
18. Akter, T., *et al.* 2016. Water quality index for measuring drinking water quality in rural Bangladesh: A cross-sectional study. *J. Health Popul. Nutr.,* 35(4).
19. Kuma, M. and A. Puri. 2012. A review of permissible limits of drinking water. *Indian J. Occu. Env. Med.,* 16(1): 40-44.
20. Zhao, X., *et al.* 2013. Nitrate and ammonia contaminations in drinking water and the affecting factors in Hailun, northeast China. *J. Env. Health.* 75(7): 28-34.
21. Rashid, N.S., *et al.* 2015. Drinking water assessment on ammonia exposure through tap water in Kampung Sungai Sekamat, Kajang. *Procedia Env. Sci.,* 30: 354-357.

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Assessing And Measuring Environmental Impact In Engineering Industry

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Environment impact assessment (EIA) activity is mandatory to get prior environment clearance for some categories of developmental projects or activities as per environment impact assessment notification of September 2006 [1]. This is aimed to pre-identify the impact on the environment before such project or activity is begun and the proposed countermeasures for mitigating those environmental impacts. The impacts can be negative or positive to the environment. However, this is done on assumptions and past available knowledge and information and actual assessment at the site is out of the scope of this process after the project or activity has been established. Draft of EIA Notification 2020 is also issued by Ministry of Environment, Forest and Climate Change in March 2020 and is shared for public comments [2]. This paper focuses on identifying the impact on the environment during actual manufacturing processes or activities and also to quantify the impacts on the basis of its significance so that the mitigation measures can be prioritised.

KEYWORDS

Environmental impact assessment, Environment aspect, Sustainable manufacturing, Sustainability

REFERENCES

1. EIA. 2006. Environment impact assessment notification dated 14 September 2006. Ministry of Environment and Forests.
2. EIA. 2020. Environment impact assessment notification dated March 2020. Ministry of Environment, Forest and Climate Change.
3. Levan, S.L. 2007. Life cycle assessment : Measuring environmental impact. *Int. J. Life Cycle Assess.,* 12(1):61. DOI:10.1065/lca2006.11. 286.
4. Klemes, J.J. 2015. Assessing and measuring environmental impact and sustainability. *Clean Tech. Env. Policy.* 17:577-578. DOI:10.1007/s10098-015-0930-0.
5. USCD. 2009. Sustainable manufacturing initiative. 2nd Annual Sustainable Manufacturing Summit. U.S. Department of Commerce, Chicago, U.S.A.
6. OECD. 2009. Sustainable manufacturing and eco-innovation : Towards a green economy. Organization for Economic Cooperation and Development.
7. Kranjc, D. and P. Glavic. 2003. Indicators of sustainable production. *Clean Tech. Env. Policy.* 5:279-288. DOI:10.1007/s10098-003-0221-z.
8. ISO 14001. 2015. Environmental management system. International Standard.
9. Failure mode and effects analysis. Quality One International. https:\\quality-one.com/fmea.
10. Sanchez, L.E. and T. Hacking. 2002. An approach to linking environmental impact assessment and environmental management system. *Impact Assess. Project Appraisal.* 20(1):25-38. DOI:10. 3152/147154-602781766843.
11. Veleva, V., *et al.* 2001. Indicators of sustainable production. *J. Cleaner Production.* 9:447-452.
12. Gangoless, M., *et al.* 2009. A methodology for predicting the severity of environmental impacts related to the construction process of residential buildings. *Building Env.,* 44:558-571.
13. Azapagic, A. and S. Perdan. 2000. Indicators of sustainable development for industry : A general framework. Institution of Chemical Engineers, Trans Ichem E. Vol 78, Part B.
14. Zolfagharian, S., *et al.* 2012. Environmental impacts assessment on construction sites. Construction Research Congress ASCE 2012.

15. Gangolells, M., *et al.* 2007. A methodology for predicting the environmental impacts related to the building construction process. CIB World Building Congress.

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Decolourization Of Disperse Red 17 Dye From Wastewater By Using Coagulation/Flocculation Process

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Coagulation/flocculation is an environment-friendly technique that can be used in decolourization of industrial wastewaters and make it reusable. In this study, the decolourization of disperse red 17 dye (DR 17) at constant initial dye concentration (60 mg/L) in wastewater were studied. Various operating parameters, such as type and dosage of oxidant (hydrogen peroxide (H_2O_2), ferric chloride ($FeCl_3$), alum (AL_2SO_4) and *Corchorus olitorus* (CR)) and its influence on the removal of colour efficiency were investigated in coagulation/flocculation process. The obtained results revealed that the best colour removal efficiency (85.24%) was achieved at optimum operating parameters as 40 mg/L of alum, 35.77 mole ratio of H_2O_2/ $FeCl_3$ and 0 mg/L of *Corchorus olitorus* (CR). All experiments were carried out using a jar test apparatus at constant temperature (room temperature).

KEYWORDS

Coagulation, Disperse red 17, Flocculation, Colour removal, Wastewater

REFERENCES

1. Iloamuzor, H. O., *et al.* 2017. Performance evaluation of *Moringa oleifera* seed powder in surface water treatment and its coagulation kinetics. *Int. J. Multidisciplinary Res. Develop.*, 4(1):36–41.
2. Farouk, K. M. W. 2015. Colour removal and COD reduction of dyeing bath wastewater by Fenton reaction. *Int. J. Waste Resour.*, 5(1). DOI:10.4172/2252-5211.1000171.
3. Cisneros, R.L., A.G. Espinoza and M.I. Litter. 2002. Photo-degradation of an azo dye of the textile industry. *Chemosphere*. 48(4):393-399.
4. Ulson de Souza, D., S. E. Forgiarne and A. Ulson Souza. 2007. *J. Hazard Mater.*, 147:1073–1078.
5. Ion, Rodica-Mariana, D. Wrobel and A. Boguta. 2001. Mixtures of synthetic organic dyes in a photoelectrochemical cell. *J. Photochem. Photobiol. A: Chem.*, 138(1):7–22.
6. Forgacs, Esther, Tibor Cserhati and Gyula Oros. 2004. Removal of synthetic dyes from wastewaters: A review. *Env. Int.*, 30(7):953–971.
7. Ong, Siew-Teng, *et al.* 2011. Dye waste treatment. *Water.* 3(4):157–176.
8. Ertugay, Nese and Filiz NuranAcar. 2017. Removal of COD and colour from direct blue 71 azo dye wastewater by Fenton's oxidation : Kinetic study. *Arabian J. Chem.*, 10(1):S1158–S1163.
9. AWWA. 1999. Water quality and treatment: A handbook on drinking water (6th edn). American Water Works Association. McGraw Hill. pp 45-74.
10. Cheremisinoff, Nicholas P. 2001. Handbook of water and wastewater treatment technologies (1st edn). Butterworth – Heinemann.
11. Degremont, O. 2002. Water treatment handbook. Lavoisier Wiley. pp 154-170.
12. AWWA. 2005. Water treatment plant design. American Water Works Association. McGraw Hill. pp 1-15.
13. Spellman, F.R. 2008. The science of water : Concepts and applications (2nd edn). CRC Press. pp 90-110.
14. Tak-Hyun, Kim, *et al.* 2003. Effect of Cl based chemical coagulation on electrochemical oxidation of textile wastewater. *Desalination.* 155(1):59–69.
15. Asilian, H. 2006. The removal of colour and COD from wastewater containing water base colour by coagulation process. *Int. J. Env. Sci. Tech.*, 3(2):153–157.
16. Hoda, R.G. 2010. Removal of azo reactive, direct dyes from wastewater using different coagulants at different pH. *J. Appl. Sci. Res.*, 6(8):956–963.

17. Diterlizzi, S. D. 1994. Introduction to coagulation and flocculation of wastewater. *Env. System Project, USA*. pp 1-4.
18. Edzwald, J. 1987. Coagulation–sedimentation filtration process for removing organic substances in drinking and wastewater. Noyes Data Corporation, Park Bridge, New Jersey, USA.
19. Menkiti, Matthew C., Chinenye A. Onyechi and Dominic O. Onukwuli. 2011. Evaluation of perikinetics compliance for the coag-flocculation of brewery effluent by *Brachystegia eurycoma* seed extract. *Int. J. Multidisciplinary Sci. Eng.,* 2(6):73-80.
20. Ugonabo, V. I., *et al.* 2013. Kinetics and functional parameters response of aluminum sulphateco-agulant to variation in coag-flocculation variables in turbid pharmaceutical industry effluent. *Int. J. Eng. Innovative Tech.,* 2(9):25-35.
21. Chu, W. 2001. Dye removal from textile dye wastewater using recycled alum sludge. *Water Res.*, 35(13):3147–3152.
22. Babayemi, A. K., O. D. Onukwuli and A. O. Okewale. 2014. Coag-flocculation kinetics of phosphorus containing effluent using *Corchorus olitorious* seed. *J. Sci. Res.*, 2(6):172-178.
23. Georgiou, D., *et al.* 2003. Treatment of cotton textile wastewater using lime and ferrous sulphate. *Water Res.,* 37(9):2248–2250.
24. Li, Ting, *et al.* 2018. Experimental and theoretical study on degradation of oxidized C_{60} in water via photo-Fenton method. *Chem. Eng. J.*, 334:587–597.
25. Dalen, M. B., *et al.* 2009. Synergy between *Moringa oleifera* seed powder and alum in the purification of domestic water. *Sci. World J.*, 4(4):6–11.
26. Sanchez-Mart n, J., J. Beltran-Heredia and C. Solera-Hernandez. 2010. Surface water and wastewater treatment using a new tannin-based coagulant : Pilot plant trials. *J. Env. Manage.*, 91(10): 2051–2058.
27. Wang, Shaobin, H. M. Ang and M. O. Tade. 2008. Novel applications of red mud as coagulant, adsorbent and catalyst for environmentally benign processes. *Chemosphere.* 72(11):1621–1635.
28. Zidanea, Fatiha, *et al.* 2008. Decolourization of dye containing effluents using mineral coagulants produced by electrocoagulation. *J. Hazard Mater.*, 155:153–163.
29. Solmaz, Seval Kutlu Akal, *et al.* 2006. Colour and COD removal from textile effluents by using coagulation combined with advanced oxidation processes. *Coloration Tech.*, 122(2):102-109.
30. Ozer, Ayla, Gonul Akkaya and Meral Turabik. 2006. The removal of acid red 274 from wastewater: Combined biosorption and biocoagulation with *Spirogyra rhizopus. Dyes Pigments.* 71(2):83–89.
31. Ragasa, Consolacion Y., *et al.* 2016. Chemical constituents of *Corchorus olitorius* L. *Int. J. Pharmacognosy Phytochem. Res.*, 8(12):2085–2089.
32. APHA, AWWA. 1989. Standard methods for the examination of water and wastewater. American Public Health Association, Washington D.C., USA.
33. Shyh-Fang, Kang, Chih-Hsaing Liao and Mon-Chun Chen. 2002. Pre-oxidation and coagulation of textile wastewater by the Fenton process. *Chemosphere.* 46(6):923–928.
34. Mohammed, A. E., H. Hamed Hussein and Waleed M. Sh. Alabdraba. 2018. Degradation of disperse blue 79 dye in aqueous solution using Fenton (H_2O_2/Fe^{2+}) process. *Sci. Int. (Lahore)*, 30(4):605–611.

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Impact Of Butanol And Pentanol On Combustion And Emission Characteristic Of Microgas Turbine

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Butanol is an effective alternative source of energy to fossil fuels. The focus of this study is to investigate the effect of butanol blends on the microgas turbine engine. The series of experiments conducted to measure the performance and emission characteristics of the engine running at different rpm. The butanol is added to the Jet A fuel at different concentrations ranging from 5-20% alongwith 1% of pentanol. The blends are mixed with the Jet A fuel by ultrasonication process. The parameters, such as thrust, thrust specific fuel consumption, CO, HC and NOx are measured for different throttle settings. From the results it is evident the addition of butanol increases the thrust about 17.6% and the emissions, such as CO, HC and NOx are reduced profound levels compared with Jet A fuel.

KEYWORDS

Gas turbine, Biofuel, Emission, Jet fuel

REFERENCES

1. Manigandan, S., *et al*. 2019. Emission and injection characteristics of corn biodiesel blends in diesel engine. *Fuel.* 235:723-735.
2. Manigandan, S., *et al*. 2020. Effect of hydrogen and multiwall carbon nanotubes blends on combustion performance and emission of diesel engine using Taguchi approach. *Fuel.* 276:118120.
3. Nithya, S., *et al*. 2018. The effect of engine emission on canola biodiesel blends with TiO_2. *Int. J. Ambient Energy.* 10:1-4.
4. Habib, Z., R. Parthasarathy and S. Gollahalli. 2010. Performance and emission characteristics of biofuel in a small-scale gas turbine engine. *Appl. Energy.* 87(5):1701-1709.
5. Lupandin, V., R. Thamburaj and A. Nikolayev. 2005. Test results of the OGT2500 gas turbine engine running on alternative fuels: Biooil, ethanol, biodiesel and crude oil. **In** ASME Turbo Expo 2005: Power for land, sea, and air. American Society of Mechanical Engineers. pp 421-426.
6. Klassen, M., *et al*. 2010. Clean combustion of liquid biofuels in gas turbines for renewable power generation. American Institute of Chemical Engineers, LPP Combustion LLC, San Antonio. pp 1-6.
7. Manigandan, S., *et al*. 2019. Suitability of pineapple leaf fiber for the reduction of noise in aircraft power plants. **In** Journal of Physics: Conference Series (Vol. 1276, No. 1, p. 012039). IOP Publishing.
8. Gunasekar, P., *et al*. 2017. Effect of TiO_2 and nozzle geometry on diesel emissions fuelled with biodiesel blends. *Int. J. Ambient Energy.* 14:1-5.
9. Manigandan, S., *et al*. 2019. Effect of addition of hydrogen and TiO_2 in gasoline engine in various exhaust gas recirculation ratio. *Int. J. Hydrogen Energy.*
10. Manigandan, S., *et al.* 2018. Influence of injection parameters on NOx emission from biodiesel powered diesel engine by Taguchi technique. *Int. J. Ambient Energy.* 18:1-5.
11. Wallner, T., S.A. Miers and S. McConnell. 2019. A comparison of ethanol and butanol as oxygenates using a direct-injection, spark-ignition engine. *J. Eng. Gas Turbines Power.* 131(3).
12. Rao, D.C., S. Karmakar and S.K. Som. 2017. Puffing and micro-explosion behaviour in combustion of butanol/Jet A-1 and acetone-butanol-ethanol (ABE)/Jet A-1 fuel droplets. *Combustion Sci. Tech*. 189(10):1796-1812.
13. Muelas, A., *et al.* 2017. Combustion behaviour of Jet A droplets and its blends with butanol. **In** ASME Turbo Expo 2017: Turbomachinery Technical Conference and Exposition. American Society of Mechanical Engineers. pp. V04AT04A073-V04AT04A073.
14. Manigandan, S., *et al.* 2020. Impact of additives in Jet-A fuel blends on combustion, emission and energetic analysis using a micro-gas turbine engine. *Fuel.* 276:118104.

15. Manigandan, S., *et al.* 2019. Effect of nanoparticles and hydrogen on combustion performance and exhaust emission of corn blended biodiesel in compression ignition engine with advanced timing. *Int. J. Hydrogen Energy.*
16. Devi, P.B., *et al.* 2020. The effect of TiO_2 on engine emissions for gas turbine engine fueled with jatropha, butanol, soya and rapeseed oil. *Int. J. Turbo Jet Engines.* 37(1):85-94.

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How Urbanization Affects Environment At Different Levels Of Development? Evidence From South Asian Countries

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Rapidly growing urban population in the Asian region has also created challenges for the environment. Thus the study focuses on investigating the effect of urbanization on the environment for the different levels of development of the South Asian countries by using the panel data from 1991 to 2018. The study has used the STIRPAT (Stochastic Impacts by Regression on Population, Affluence and Technology) model and OLS (ordinary least squares) technique to measure the parameters. This research study offers an unbiasedmeasurement of the association between urbanization and the environment. Low income countries directly present the negative relationship between urbanization and consumption of energy but urbanization shows a positive relationship with carbon emission. In the case of an upper-middle income group, the level of energy consumption is high as compared to low income and lower income countries. The findings of the study are helpful for policymakers in the context of increasing urbanization and industrialization. There is an inevitable requirement of urban infrastructure to support this increased level of urbanization and industrialization.

KEYWORDS

Urbanization, Environment degradation, South Asian countries, STIRPAT model, OLS method

REFERENCES

1. Quigly, J. 2008. Urbanization, agglomeration and economic development (2nd edn). World Bank Press. A. Buckley, Edn, Washington DC.
2. Cole, M. and E. Newmayer. 2004. Examining the impact of demographic factors on air pollution. *Population Env.,* 26 (1):5-21.
3. Jones, D. W. 1991. How urbanization affects energy use in developing countries. *Energy Policy.*19 (7): 621-630.
4. York, R. 2016. Demographic trends and energy consumption in European Union. *Social Sci. Res.*, 36(3):855-872.
5. Liddle, B. 2004. Demographic dynamics and per capita environmental impact: Using panel regression and household decompositions to examine population and transport. *Population Env.,* 26 (1):23-39.
6. Newman, P.G. and J.R. Kenworthy. 2004. Cities and automobile dependence: An international sourcebook. Gower Publishing, Brookfield, VT, United States.
7. Alam, Shaista, Ambreen Fatima and Muhammad S. Butt. 2007. Sustainable development in Pakistan in the context of energy consumption demand and environmental degradation. *J. Asian Eco.,* 18 (5):825-837.
8. Bertinelli, Luisito and Duncan Black. 2004. Urbanization and Growth. *J. Urban Eco.,* 56(1): 80-96.
9. Fay, Marianne and Charlotte Opal. 2000. Urbanization without growth: A not so uncommon phenomenon. Policy research working paper. Working paper no. 2412. World Bank, Washington DC.
10. Collier, Paul. 2006. Africa: Geography and growth. Department of Economics, Centre for the study of African Economies, Oxford University.
11. Fensom, A. 2015. Asia's urbanization 'just beginning'. Pacific Money.
12. Karca, M., M. Tayanc and H. Toros. 2016. Effects of urbanization on climate of Istanbul. *Atmos. Env.,* 29 (1):3411-3421.
13. Liu, Y. 2009. Exploring the relationship between urbanization and energy consumption in China using ARDL (autoregressive distributed lag) and FDM (factor decomposition model). *Energy.*34 (11):1846-1854.
14. UN DESA. 2018. Revision of World Urbanization Prospects. United Nation: Population Division of the United Nations Department of Economic and Social Affairs.

15. UNESCAP. 2013. UN-ESCAP: Urbanization trends in Asia and the Pacific. www.unescapsdd.org: http://www.unescapsdd.org/files/documents/SPPS-Factsheet-urbanization-v5.pdf.
16. World Bank. 2015. World Banks Group, Australian Aid: East Asia's changing urban landscape – Measuring a decade of spatial growth. World Bank Group.
17. Dietz, T. and E. Rosa. 1994. Rethinking the environmental impacts of population, affluence and technology. *Human Ecol. Review.* 2 (1):277–300.
18. Shi, A. 2003. The impact of population pressure on global carbon dioxide emissions 1975-1996 evidence from pooled cross-country data. *Ecol. Eco*., 44 (1):29-42.
19. Mol, A. and G. Spaargaren. 2015. Ecological modernization theory in debate: A review. *Env. Politics.* 9 (1):17-49.
20. Mart nez-Zarzoso, I., A. Bengochea-Morancho and R. Morales-Lage. 2015. The impact of population on CO_2 emissions: Evidence from European countries. *Env. Resour. Eco.,* 2 (1):269-384.
21. Hu, Tang. 2017. Blaming cities for climate change? Analysis of urban greenhouse gas emissions inventories. *Env. Urbanization.* 21 (1):185-201.
22. Defries, R. and D. Pandey. 2016. Urbanization, the energy ladder and forest transitions in India's emerging economy. *Land Use Policy.* 27 (2):130-138.
23. Pachauri, S. and L. Jiang. 2008. The household energy transition in India and China. *Energy Policy.* 36 (11):4022-4035.

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Removal Of Copper Ion From Aqueous Solution By Chemically Modified Bioadsorbents Of *Citrus reticulata*

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Bioadsorbents was developed by the chemical modification of *Citrus reticulate,* which is used for removal of copper ion from aqueous solution by batch adsorption technique. Various type of salts has been used for chemical modification of *Citrus reticulate.* The equilibrium adsorption level was determined to be a function of pH, particle size, contact time, agitation speed and adsorbent dosage.

KEYWORDS

Citrus retriculata, Copper ion, Bioadsorbents, Chemical modification

REFERENCES

1. Ross, S.M. 1994. Toxic metals in soil plant systems. Wiley, Chichester. pp 1-45.
2. Prasad, M.N.V. and J. Hagemeyer. 1999. Heavy metal stress in plants from molecule to ecosystems. Springer. pp 11-37.
3. Iqbal, M. and R.G.J. Edyvean. 2004. Biosorption of Pb, Cu and Zn ions on ioofa sponge immobilized biomass of *Chrysosporium*. *Mineral Eng.,* 17: 217-223.
4. Bhatti, H.N., *et al.* 2007. Removal of Zn(II) ions from aqueous solution using *Moringa oleifera* Lam (horse radish tree) biomass. *Process Biochem.,* 42: 547-553.
5. Nuhoglu, Y., *et al.* 2002. The removal of Cu(II) from aqueous solution by *Ulothrix zonata*. *Bioresour. Tech.,* 85: 331-333.
6. Antunes, W.M., *et al.* 2003. An evaluation of copper biosorption by brown seaweed under optimized conditions. *Electronic J. Biotech.,* 6 (3): 174-184.
7. Vijayaraghavan, K., *et al.* 2004. Cu(II) removal from aqueous solution by marine green alga *Ulva reticulata*. *Electronic J. Biotech*., 7 (1): 61-71.
8. Theophanides, T. and J. Anastassopoulou. 2002. Copper and carcinogenesis. *Crit. Rev. Oncol. Hematol.,* 42(1):57-64.
9. Keshinkan, O., *et al.* 2003. Heavy metal adsorption characteristics of a submerged aquatic plant *(Myriophylhum spicatum). Process Biochem.,* 39: 179-183.
10. Sternberg, S.P.K. and R.W. Dom. 2004. Cd removal using *Cladophora* in batch, semi batch and flow reactors. *Bioresour. Tech.,* 81: 249-255.
11. Nakhla, G., *et al.* 2006. Combined biological and membrane treatment of food processing waste water to achieve dry-ditch criteria: Pilot and full scale performance. *Bioresour. Tech.,* 97: 1-14.
12. Hanif, M.A., *et al.* 2007. Kinetic studies for Ni(II) biosorption from industrial wastewater by *Cassia fistula* (golden shower) biomass. *J. Hazard Mater.,* 145: 501-505.
13. Iftikhar, A.R., *et al.* 2009. Kinetic and thermodynamic aspects of Cu(II) and Cr(III) removal from aqueous solutions using rose waste biomass. *J. Hazard Mater.,* 161: 941-947.
14. Goksungur, Y., S. Uren and U. Guvenc. 2005. Biosorption of Cd and Pb ions by ethanol treated waste baker's yeast biomass. *Bioresour. Tech.,* 96: 103-109.
15. Tunali, S., A. Cabuk and A. Akar. 2006. Removal of Pb(II) and Cu(II) ions from aqueous solutions by bacterial stains isolated from soil. *J. Eng. Chem.,* 115: 203-211.
16. Rosales, E., *et al.* 2016. *Grapefruit peelings as a promising biosorbent for the removal of leather dyes and hexavalent chromium. Process Saf. Env. Prot.,* 101:61-71.

17. Sudha, R., K. Srinivasan and P. Premkumar. 2015. Remoal of nickel (II) from aqueous solution using *Citrus limettioides* peel and seed carbon. *Ecotoxicol. Env. Saf.,* 117:115-123.
18. Torab-Mostaedi, M., *et al.* 2013. Equilibrium, kinetic and thermodynamic studies for biosorption of cadmium and nickel on grapefruit peel. *J. Taiwan Inst. Chem. Eng.,* 44 (2) : 295-302.
19. Shakoor, Sadia and Abu Nasar. 2016. Removal of methylene blue dye from artificially contaminated water using *Citrus limetta* peel waste as a very low cost adsorbent. *J. Taiwan Inst. Chem. Eng.,* 66:154-163.
20. Romero-Cano, L.A., *et al.* 2017. Functionalized adsrobents prepared from fruit peels : Equilibrium, kinetic and thermodynamic studies for copper adsorbption in aqueous solution. *J. Clean Prod.,* 162:195-204.
21. Nuran, A., E. Zeynep and B. Necla. 2016. Removal of Cu (II) ions by activated poplar sawdust (Samsun clone) from aqueous solutions. *J. Hazard Mater.,* 137:909-914.
22. Khormaei, M., *et al.* 2007. Copper biosorption from aqueous solution by sour orange residue. *J. Hazard Mater.,* 149:269-274.
23. Hanif, M.A., *et al.* 2007. Ni (II) biosorption by *Cassia fistula* (golden shower) biomass. *J. Hazard Mater.,* 39: 345-355.
24. Bhatti, H.N., R. Khalid and M.A. Hanif. 2009. Dynamic biosorption of Zn(II) and Cu(II) using pretreated *Rosa gruss an teplitz* (red rose) distillation sludge. *Chem. Eng. J.,* 148: 424-443.
25. Pavasant, P., *et al.* 2006. Biosorption of Cu2p, Cd2p, Pb2p and Zn2p using dried marine green macroalga *Caulerpa lentillifera. Bioresour. Tech.,* 97: 2321-2329.
26. Pal, A., S. Ghosh and A.K. Paul. 2006. Biosorption of cobalt by fungi from serpentine soil of Andaman. *Bioresour. Tech.,* 97: 1253-1258.
27. Cabuk, A., *et al.* 2005. Pb2ρ biosorption by pretreated fungal biomass. *Turkish J. Biol.,* 29:23-28.
28. Bhatti, H.N., G. Samin and M.A. Hanif. 2008. Enhanced removal of Cu(II) and Pb(II) from aqueous solutions by pretreated biomass of *Fusarium solani*. *J. Chinese Chem. Soc.,* 55:1235-1242.
29. Yan, G. and T. Viraraghavan. 2000. Effect of pretreatment on the bioadsorption of heavy metals on *Mucor rouxii. Water SA.* 26(1):119-124.
30. Kapoor, A. and T. Viraraghvan. 1998. Biosorption of heavy metals on *Aspergillus niger* : Effect of pretreatment. *Bioresour. Tech.*, 63:109-113.
31. Benguella, B. and H. Benaissa. 2002. Cadmium removal from aqueous solution by chitin : Kinetic and equilibrium studies. *Water Res.,* 36:2463-2474.
32. Moreno-Castilla, A., *et al.* 1997. Effects of non-oxidant and oxidant acid treatments on the surface properties of an activated carbon with very low ash content. *Carbon.* 36:145-151.
33. McGahren, W.J., *et al.* 1984. Chitosan by fermentation. *Process Biochem.,* 19:89-90.
34. Muraleedharan, T.R. and C. Venkobachar. 1990. Mechanism of cobalt biosorption. *Biotech. Bioeng.,* 33:823-831.
35. Dow, J.M. and P.H. Rubery. 1977. Chemical fraction of the cell walls of mycelial and yeast like of *Mucor rouxii*: A comparative study of the polysaccharide and glycoprotein components. *J. Gen. Microbiol.,* 99:29-41.
36. Mcafee, B.J., *et al.* 2011. Biosorption of metal ions using chitosan, chitin and biomass of *Rhizopus oryzae. Sep. Sci. Tech.,* 36:3207-3222.
37. Loaec, M., R. Olier and J. Guezennec. 1997. Uptake of lead, cadmium and zinc by a novel bacterial expolysaccharide. *Water Res.,* 31(5):1171-1179.

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Spatial Mapping Of Traffic Noise Level Using GIS Software - A Case Study

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Traffic noise from roads creates problems for surrounding areas, especially when there are high traffic volumes and high speeds. In India, the transportation segment is growing promptly at over 7.50% per annum and the number of vehicles on Indian roads is growing at a very fast rate. This has led to overcrowded roads resulting in increased noise level. The objective of this study is to build a GIS model for the selected study areas to predict noise levels due to road traffic. The methodology adopted for achieving the objective is to conduct a volume count survey, spot speed survey and noise level measurement for developing the GIS model. The road noise generated is normally in the linear form along the roads. Hence roads were taken for the study purpose. Three study locations selected in this study. GIS model is developed for three road sections at different locations for this study purpose. It is found that road noise is about 60-85 dB and level of sound in that particular area has good relation with the public until the continuous noise level above 80 dB is heard.

KEYWORDS

Noise level prediction, Geographical information system, Traffic noise map, ArcGIS

REFERENCES

1. Wolfgang, G. Babisch, *et al.* 2013. Noise annoyance-A modifier of the association between noise level and cardiovascular health ? *Sci. Total Env.,* 452:50-57.
2. Agarwal, S., B.L. Swami and A.B. Gupta. 2009. Development of a noise prediction model under interrupted traffic flow conditions : A case study for Jaipur city. *Noise Health.* 11(45):189-193.
3. Prabut, K.D. and H.P. Nagarnaik. 2007. Assessment and ANN modeling of noise levels at major roads intersections in an Indian intermediate city. *J. Res. Sci., Computing Eng.,* 4(3):39-49.
4. Pathak, V., B.D. Tripathi and V.K. Mishra. 2008. Dynamics of traffic noise in a tropical city Varanasi and its abatement through vegetation. *Env. Monitoring Assess.,* 146:67-75.
5. Zannin, P.H., C.A.M. Ferreira and B. Szermetta. 2006. Evaluation of noise pollution in urban parks. *Env. Monitoring Assess.,* 118:423-433.
6. WHO. 2005. Occupational and community noise. World Health Organization. WHO-OMS.
7. Kumar, K. and V.K. Jain. 1998. A predictive model of noise for Delhi. *J. Acoustical Society America.* 103(3):1677-1679.
8. Ali, S.A. 2004. Investigation of the dose-response relationship for road traffic noise in Assiut, Egypt. *Appl. Acoustics.* 65:1113-1126.
9. Skanberg, A. and E. Ohrstrom. 2002. Adverse health effects in relation to urban residential soundscapes. *J. Sound Vibration.* 250(1):151-155.
10. Panadya, G.H. 2003. Assessment of traffic noise and its impact on the community. *Int. J. Env. Studies.* 60(6):595-602.
11. Tripathi, B.D., V. Pathak and A.R. Upadhyay. 2006. A case study of noise pollution in the city of Varanasi. *Indian J. Env. Prot.,* 26(8):737-741.
12. Chowdhury, Anirban Kundu, Anupam Debsarkar and Shibnath Chakrabarty. 2012. Analysis of day time traffic noise level : A case study of Kolkata. *Int. J. Env. Sci. Res.,* 2 (1):114-118.
13. Kalaiselvi, R. and A. Ramachandraiah. 2010. Environmental noise mapping study for heterogeneous traffic conditions. 20th International Congress on Acoustics. Sydney, Australia.

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Influence Of Piggery Wastewater Concentrations In *Chlorella vulgaris* Cultivation For Oil Production

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Influence of piggery wastewater concentrations on *Chlorella vulgaris* cultivation for oil production was to determine an optimal concentration of piggery wastewater for algal cultivation, reveal water quality before and after algal cultivation and quantify the biomass and oil production. The studies showed that the highest growth of microalgae cultivated when cultivating *Chlorella vulgaris* in the 20% concentration culture. The pH during the cultivation period was 7.99-8.98, while electrical conductivity (EC), total dissolved solids (TDS), total nitrogen (TN) and total phosphorus (TP) removal were ranging from 31.08-32.56%, 28.98-34.43%, 35.16-67.25% and 15.00-72.14%, respectively after 15 days of treatment. The highest biomass productivity was 3.382 g and the highest oil productivity was 0.0114 mL when cultivating *Chlorella vulgaris* in the 80% concentration culture. Nutrient in piggery wastewater was efficiently removed among all the treatments. The specific growth rate and oil productivity were different among all the cultures. This study showed that simultaneous production of biofuel, bioelectricity and wastewater treatment were possible by *Chlorella vulgaris*.

KEYWORDS

Microalgae, Piggery wastewater, Algae oil, *Chlorella vulgaris,* Cultivation

REFERENCES

1. Malcata, F.X. 2011. Microalgae and biofuels: A promising partnership. *Trends Biotech*., 29:542-549.
2. Chisti, Y. 2007. Biodiesel form microalgae beats bioethanol. *Trends Biotech*., 26: 126–131.
3. Liu, Z.Y., *et al*. 2008. Effect of iron on growth and lipid accumulation in *Chlorella vulgaris*. *Bioresour. Tech*., 99: 4717-4722.
4. Smith, V.H., *et al.* 2009. The ecology of algal biodiesel production. *Trends Ecol. Evol*., 25: 301–309.
5. Chen R., *et al*. 2012. Freshwater algal cultivation with animal waste for nutrient removal and biomass production. *Biomass Bioenergy*. 39:128–138.
6. Hongyang, S., *et al.* 2011. Cultivation of *Chlorella pyrenoidosa* in soybean processing wastewater. *Bioresour. Tech*., 102: 9884-9890.
7. Zhu, L., *et al.* 2013. Nutrient removal and biodiesel production by integration of freshwater algae cultivation with piggery wastewater treatment. *Water Res*., 47: 4294-4302.
8. APHA, AWWA, WEF. 1992. Standard methods for the examination of water and wastewater. American Public Health Association, Washington, USA.
9. Lu, A., *et al.* 2012. Characterization of algae oil (oilgae) and its potential as biofuel in Kenya. *J. Appl. Tech. Env. Sanit*., 1(4): 147–153.
10. Xin, L., *et al.* 2010. Growth and nutrient removal properties of a freshwater microalga *Scenedesmus* sp. LX1 under different kinds of nitrogen sources. *Ecol. Eng*., 36(C4): 379–381.
11. Park, J., *et al.* 2010. Ammonia removal from anaerobic digestion effluent of livestock waste using green alga *Scenedesmus* sp. *Bioresour. Tech*., 101(C22): 8649–8657.
12. Li, Y., *et al.* 2011. Characterization of a microalga *Chlorella* sp. well adapted to highly concentrated municipal wastewater for nutrient removal and biodiesel production. *Bioresour. Tech*., 102: 5138-5144.
13. Feng, P., *et al.* 2012. Lipid accumulation and growth of *Chlorella zofingiensis* in flat plate photobioreac-tors outdoors. *Bioresour. Tech*., 102:10577-10584.
14. Mostafa, S.S.M., *et al.* 2012. Cultivating microalgae in domestic wastewater for biodiesel production. *Not. Sci. Biol*., 4: 56-65.

15. Silambarasan, T., *et al.* 2012. Biological treatment of dairy effluent by microalgae. *World J. Sci. Tech*., 2(C7):132-134.
16. Cai, T., *et al.* 2013. Nutrient recovery from wastewater streams by microalgae: Status and prospects. *Renewable Sust. Energy. Rev*., 19: 360–369.
17. Tan, X.B., *et al.* 2016. Outdoor cultures of *Chlorella pyrenoidosa* in the effluent of anaerobically digested activated sludge: The effects of pH and free ammonia. *Bioresour. Tech*., 200: 606–615.
18. Xu, M., *et al.* 2014. Algae-facilitated chemical phosphorus removal during high-density *Chlorella emersonii* cultivation in a membrane bioreactor. *Bioresour. Tech*., 153: 383–387.
19. Abou-Shanab, R., *et al.* 2013. Microalgal species growing on piggery wastewater as a valuable candidate for nutrient removal and biodiesel production. *J. Env. Manage*.,115: 257–264.
20. Griffiths, M.J. and S.T.L. Harrison. 2009. Lipid productivity as a key characteristic for choosing algal species for biodiesel production. *J. Appl. Phycol*., 21: 493-507.
21. Feng, Y., *et al.* 2011. Lipid production of *Chlorella vulgaris* cultured in artificial wastewater medium. *Bioresour. Tech*.,102: 101-105.
22. Khozin-Goldberg, I. and Z. Cohen. 2006. The effect of phosphate starvation on the lipid and fatty acid composition of the freshwater eustig-matophyte *Monodus subterraneus*. *Phytochem*., 67: 696-701.

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Technical Modifications In Gasoline Engine For Blending Methanol In Automobile Fuels

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Methanol is a clean burning drop-in fuel which can replace both petrol and diesel in transportation and LPG, wood, kerosene in cooking fuel. It can also replace diesel in railways, marine sector, generator sets, power generation and methanol based reformers could be the ideal complement to hybrid and electric mobility. Methanol has a higher octane rating than petrol. Hence compression ratio to be achieved while using methanol is more than that while using petrol. Also, the calorific value of methanol is less than petrol; hence more fuel is needed to be burnt to obtain a certain amount of energy, as compared to petrol. Methanol is a cleansing agent. When used in an engine, it cleans the dirt and filth is formed in the engine. This may damage some parts of the engine and make them useless. Taking into account these properties of methanol, certain modifications are required in the engine. The modifications vary depending on the maker of an engine; technologies used, percentage of fuel to be used, etc.

KEYWORDS

Fuel for spark ignition engine operation, Greenhouse effect, Methanol economy, Renewable methanol by capturing CO_2, Air/alcohol mixture

REFERENCES

1. Elfasakhany, A., *et al.* 2013. Pulverised wood combustion in a vertical furnace: Experimental and computational analyses. *Appl. Energy.* 112:454-464.
2. Sileghem, L., *et al.* 2015. Experimental investigation of a disi production engine fuelled with methanol, ethanol, butanol and isostoichiometric alcohol blends. SAE Technical Paper No. 2015-01-0768.
3. Sharudin, Hazim, *et al.* 2017. Investigation of the effects of iso-butanol additives on spark ignition engine fuelled with methanol-gasoline blends. *Appl. Thermal Eng.,* 114:593-600.
4. Fan, Zhang, *et al.* 2009. Influence of methanol gasoline blend fuel on engine and catalyst performance, Tsinghua University, China. SAE 2009-0101182.
5. Bang-Quan, H., M. Liu and H. Zhao. 2015. Comparison of combustion characteristics of n-butanol / ethanol-gasoline blends in a HCCI engine. *Energy Convers. Manage.*, 95:101-109.
6. Storey, J.M., *et al.* 2010. Ethanol blend effects on direct injection spark-ignition gasoline vehicle particulate matter emissions. *SAE Int. J. Fuels Lubr.*, 3:650-659.
7. Çelik, M.B. 2008. Experimental determination of suitable ethanol-gasoline blend rate at high compression ratio for gasoline engine. *Appl. Thermal Eng.*, 28: 396-404.

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Degradation Of Methylene Blue Dye Using Hydrodynamic Cavitation And Adsorption

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An amalgamation of hydrodynamic cavitation and adsorption with the use of hydrogen peroxide as a catalyst has been explored in support of the treatment of dye industrial wastewater. The effects of various operating parameters, such as the effect of concentration, pH and contact time have been considered with the aim of amplifying the degree of removal. It was observed in the present investigation by means of raising the pH of the solution, the extent of methylene blue (MB) removal increased. The impact of original methylene blue concentration on the dye removal efficiency of the zeolite was thoroughly examined by varying the original dye concentration. It was monitored that due to an increase in the original concentration of the methylene blue in the inlet flow, the breakthrough time reduces so as to zeolite bed reached the saturation earlier. This may take place because the concentration increases and the rate of the mass transfer enhances due to enlarged concentration, hence the ability of zeolite to take up the methylene blue dye diminishes with increase in original concentrations in inlet flow, therefore such occurrence took place. Effects of different process variables, such as original concentration, solution pH, time and addition of H_2O_2 on the removal kinetics were studied. The degradation of methylene blue was established to be pH dependent and the basic medium was found to be favourable for elevated degradation. It was found that operating pH, state of the molecule (molecular or ionic) and nature (hydrophobic and hydrophilic) are the vital factors which finally determine the effective degradation of pollutants.

KEYWORDS

Methylene blue, Hydrodynamic cavitation, Adsorption, Industrial wastewater

REFERENCES

1. Gogate, P.R. and A.B. Pandit. 2004. A review of imperative technologies for wastewater treatment-Oxidation technologies at ambient conditions. *Adv. Env. Res.,* 8:501.
2. Gogate, P.R. and A.B. Pandit. 2004. A review of imperative technologies for wastewater treatment-Hybrid methods. *Adv. Env. Res.,* 8:553.
3. Adewuyi, Y.G. 2001. Sonochemistry: Environmental science and engineering applications. *Ind. Eng. Chem. Res.,* 40:4681.
4. Petrier, C., Y. Jiang and M. F. Lamy. 1998. Ultrasound and environment: Sonochemical destruction of chloroaromatic derivatives. *Env. Sci. Tech*., 32:1216.
5. Sivakumar, M. and A.B. Pandit. 2001. Ultrasound enhanced degradation of rhodamine B: Optimization with power density. *Ultrason. Sonochem.,* 8: 233.
6. Mahamuni, N.N. and A.B. Pandit. 2006. Effect of additives on ultrasonic degradation of phenol. *Ultrason. Sonochem.,* 13:165.
7. Gogate, P.R., *et al.* 2004. Destruction of phenol using sonochemical reactors: Scale-up aspects and comparison of novel configuration with conventional reactors. *Sep. Purif. Tech.,* 34:25.
8. Kidak, R. and N.H. Ince. 2006. Ultrasonic destruction of phenol and substituted phenols : A review of current research. *Ultrason. Sonochem.,* 13:195.
9. Petrier, C. and A. Francony. 1997. Incidence of wave-frequency on the reaction rates during ultrasonic wastewater treatment. *Water Sci. Tech.,* 35:175.
10. Entezari, M.H., C. Petrier and P. Devidal. 2003. Sonochemical degradation of phenol in water: A comparison of classical equipment with a new cylindrical reactor. *Ultrason. Sonochem.,* 10:103.
11. Sivakumar, M. and A.B. Pandit. 2002. Wastewater treatment: A novel energy efficient hydrodynamic cavitational technique. *Ultrason. Sonochem.,* 9:123.
12. Kalumuck, K.M. and G.L. Cahine. 2000. The use of cavitating jets to oxidize organic compounds in water. *J. Fluids Eng.,* 122:465.

13. Yavuz O. and A.H. Aydin. 2006. Removal of direct dyes from aqueous solution using various adsorbents. *Pol. J. Env. Stud.,* 15(1):155-161.
14. Rafatullah, M., *et al.* 2010. Adsorption of methylene blue on low-cost adsorbents : A review. *J. Hazard Mater.,* 177:70-80.
15. Mason, T.J. 2000. Large scale sonochemical processing: Aspiration and actuality. *Ultrason. Sonochem.,* 7:145.
16. Gogate, P.R. and A.B. Pandit. 2000. Engineering design methods for cavitational reactors-Hydrodynamic cavitation. *AIChE J.,* 46:1641.
17. Suslick, K.S., M.M. Mdleleni and J.T. Ries. 1997. Chemistry induced by hydrodynamic cavitation. *J. Am. Chem. Soc.,* 119:9303.
18. Entezari, M.H. and P. Kruus. 1996. Effect of frequency on sonochemical reactions-Temperature and intensity effects. *Ultrason. Sonochem.,* 3:19.
19. Vichare, N.P., *et al.* 2000. Energy analysis in acoustic cavitation. *Ind. Eng. Chem. Res.,* 39:1480.
20. Tusar, N.N., *et al.* 1995. A zinc-rich CHA-type aluminophosphate. *Zeolite.* 15:708-713.
21. Han, R., *et al.* 2007. Comparison of linear and non-linear analysis in estimating the Thomas model parameters for methylene blue adsorption onto natural zeolite in fixed-bed column. *J. Hazard Mater.,*145:331-335.

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Correlation Between Distance Of Cipayung Landfill And Chromium (VI) Concentration In Ground water Bulak Barat Village, Depok, Indonesia

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Cipayung landfill is the only landfill in Depok; the processing method still is open dumping. Open dumping can cause environmental degradation, pollution of groundwater due to leaching. Leachate water generally contains organic and inorganic compounds (heavy metals), one of the heavy metals contained in leachate is chromium (VI). This study aims to determine the correlation between the distance of the landfill with chromium (VI) concentration in the community groundwater. This research is an observational analytic study with cross-sectional design and uses purposive sampling technique. The chromium (VI) concentration in groundwater around Cipayung landfill was taken from 45 groundwater samples belonging to the community neighbourhood and Hamlet, Bulak Barat village, Cipayung urban village, Depok, were analyzed in a laboratory by using the atomic absorption spectrophotometry method (AAS). The correlation between the landfill distance with the chromium (VI) concentration in groundwater was tested using a non-parametric Spearman correlation test and simple linear regression analysis because the concentration of chromium (VI) data in groundwater is abnormal. The results of the analysis revealed that the distance of the landfill does not correlate with the chromium (VI) concentration in 45 groundwater samples.

KEYWORDS

Chromium (VI), Concentration, Distance, Landfill, Groundwater

REFERENCES

1. World Population Prospects. 2019. Revision 2019. World population by country. Available from : http://world population review.com/.
2. Riyanto, Joko. 2018. Population growth and demographic bonuses. *Investor Daily Indonesia.* Available from : https://investor.id/archive/pertumnbu-han-penduduk-dan-bonus-demografi.
3. World Bank. 2019. Solid waste management.
4. Directorate of waste management. 2016. Waste production in Indonesia. Ministry of Environment and Forestry, Republic of Indonesia.
5. Rushbrook, P. and WHO. 2001. Minimum approaches for improvements to existing municipal waste dumpsites. Regional Office for Europe and European Centre for Environment and Health Guidance, World Health Organization, Copenhagen.
6. Ministry of Public Works and Housing. 2016. Strategic plan of the directorate of human settlements for 2015-2019. Ministry of Public Works and Housing, Republic of Indonesia.
7. Anikwe, M.A.N and K.C.A. Nwobado. 2002. Long term effect of municipal waste disposal on soil properties and productivity of sites used for urban agriculture in Abakaliki, Nigeria. *Bioresour. Tech.,* 83:241-250.
8. Fard, M.O., *et al.* 2017. Heavy metals monitoring in leachate from landfill size of Qazvin, Iran. *Arch. Hyg. Sci.,* 6(1):44-48.
9. Gworek, B., *et al.* 2016. Impact of the municipal solid waste Lubna landfill on environmental pollution by heavy metal. *Water.* 8(10):470-485.
10. Junita, L.N. 2013. Profile of heavy metal distribution around Pakusari landfill in Jember. Thesis. Jember University, Indonesia.
11. Department of Sanitation and Gardening Depok city. 2019. Get to know Cipayung landfill in Depok. Ministry of Environment and Forestry, Republic of Indonesia.
12. Boateng, T.K., O. Francis and A. Osei. 2019. Heavy metal contamination assessment of groundwater quality : A case study of Oti landfill site, Kumasi. *Appl. Water Sci.,* 9(2):1-15.
13. Mansouri, B., J. Salehi and M. Rezaci. 2014. Leachate and pollution levels of heavy metals in the groundwater near municipal solid waste landfill site of Mashhad, Iran. *Iranian J. Toxicol.,* 8(25):1068-1072.

14. Government Regulation of the Republic of Indonesia. 2001. Management of water quality and water pollution control. No. 82.
15. WHO. 2011. Guidelines for drinking water quality (4th edn). World Health Organization, Geneva.
16. Government Regulation of the Republic of Indonesia. 2012. Management of household waste and similar household waste. No. 81.
17. Monavari, S.M., *et al.* 2012. Study of solid waste landfill suitability using regional screening method and AHP in Rasht city. *World Academy Sci., Eng. Tech.,* 62:820-825.
18. Ferina, T. 2015. Efficiency of crome hexavalent reduction in leachate using (constructed wetland), Thesis. Universitas Indonesia, Indonesia.
19. Effendi, H. 2003. Water quality study for water resources and environmental management. Kanisius, Indonesia.
20. WHO. 1998. Environmental health criteria 61:Chromium. International Programme on chemical safety (IPCS). World Health Organization, Geneva.
21. Sherene, T. 2010. Mobility and transport of heavy metals in polluted soil environment. *Biological Forum Int. J.,* 2(2):112-121.
22. Liao, P., S. Yuan and D. Wang. 2016. Impact of redox reactions on colloid transport in saturated porous media : An example of ferrihydrite colloids transport in the presence of sulphide. *Env. Sci. Tech.,* 50(20):10968-10977.
23. Mishra, S., *et al.* 2018. Assessment of groundwater quality using WQI and GIS near the Karsara municipal landfill site, Varanasi. *Arabian J. Geosci.,* 11(252):01-09.
24. Wijesekara, S., *et al.* 2014. Fate and transport of pollutants through a municipal solid waste landfill leachate in Sri Lanka. *Env. Earth Sci.,* 72(5):1707-1719.
25. Nagarajan, R., S. Thirumalaisamy and E. Lakshumanan. 2012. Impact of leachate on groundwater pollution due to non-engineered municipal solid waste landfill sites of Erode city, Tamil Nadu. *Iran J. Env. Health, Sci. Eng.,* 9(35):1-12.
26. Ashar, T., D.N. Santi and E. Naria. 2013. Chromium, lead and mercury in dig well resident around the dumping site. *J. Kesehatan Mayarakat Nasional.* 7(9):408-414.
27. Yuliati, Y. 1999. The relationship between the distance of the landfill to well with manganese and iron content in well water in Banyurip village, Tegalreja district, Magelang Regency. Thesis. Diponegoro University, Indonesia.

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Geochemical Studies On The Groundwater Of Kistapur Village, Medchal District, Telangana

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Groundwater is one of the sources of drinking water and various other usages. With an increase in urbanization and industrialization, health conditions are influenced by the chemical aspects of groundwater and geology of the region. Access to safe drinking water remains an urgent necessity in the world as it is directly related to health. Groundwater accounts for more than 80% of the rural domestic water supply in India. The integrated groundwater prospects maps are preferred by using different thematic layers, like geology, geomorphology, structures, hydrology, etc. Drinking water quality data of rural water supply sources situated in Medchal district of Telangana state is studied for the parameters, like total dissolved solids, total hardness, alkalinity, pH and chlorides to assess the spatial distribution of ground quality in terms of portability or non-portability. The results were compared with the standard values given by the World Health Organization and the Bureau of Indian Standards.

KEYWORDS

Groundwater, Potability, pH, Alkalinity, Dissolved solids, Dissolved oxygen, Hardness

REFERENCES

1. European community.1980. Council directive of 15 July 1980 relating to the quality of water intended for human consumption. *Official J. Eur. Community, Brussels, Belgium.* 23 (1229):11-23.
2. Nickson, R., *et al.* 2005. Arsenic and other drinking water quality issues, Muzaffargarh district, Pakistan. *Appl. Geochem.,* 20:55-68.
3. Gustafson, D.L. 1993. Pesticides in drinking water. Van Hosfrand Reinhold, New York. pp241.
4. Eaton, E.M. 1950. Significance of carbonate in irrigation water. *Soil Sci.,* 69(2):123-133.
5. Hamzaoui-Azaza, F., *et al.* 2011. Hydrogeochemical characteristics and assessment of drinking water quality in Zeuss-Koutine aquifer, southeastern Tunisia. *Env. Monit. Assess.,* 174:283-298.
6. Aghazadeh, N. and A.A. Mogaddam. 2011. Investigation of hydrochemical characteristics of groundwater in the Harzandat aquifer, north-west of Iran. *Env. Monit. Assess.,* 176(1-4):183-195.
7. Ahmad, Z. and A. Qadir. 2011. Source evaluation of physico-chemically contaminated groundwater of Dera Ismail Khan area, Pakistan. *Env. Monit. Assess.,* 175(1-4):9-21. DOI:10.1007/s/0661-010-1489-1.
8. Alexakis, D. 2011. Assessment of water quality in the Messolonghi-Etoliko and Necohorio region (West Greece) using hydrochemical and statistical methods. *Env. Monit. Assess.,* 182:397-423. DOI:10.1007/s10661-011-1884-2.
9. Jeevanandam, M., *et al.* 2006. Hydrochemistry and groundwater quality assessement of lower part of the Ponnaiyar river basin, Cuddalore, South India. *Env. Monit. Assess.,* 132(1):263-274.
10. Laluraj, C.M., G. Gopinath and P.K. Dinesh Kumar. 2005. Groundwater chemistry of shallow aquifers in the coastal zones of Cochin. *Ind. Appl. Ecol. Env. Res.,* 3(1):133-139.
11. Subramani, T., *et al.* 2005. Geological setting and groundwater chemistry in Chithar river basin, Tamil Nadu. *J. Indian Miner.* 39:108-119.
12. Sujatha, D. and B. Rajeswara Reddy. 2003. Quality characterization of groundwater in the south eastern part of the Ranga Reddy district, Andhra pradesh. *Indian J. Env. Geol.,* 44:579-586.

13. Garrers, R.M. 1967. Genesis of some ground waters from igneous rocks. **In** Ahelson researches in geochemistry. Wiley, New York. pp 405.
14. Davis, S.N. and J.M. Dewiest. 1966. Hydrogeology. Wiley New York. pp 463.
15. APHA-AWWA-WEF. 1998. Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, Water Environment Federation, Washington, D.C.
16. APHA. 1992. Standard methods for the examination of water and wastewater. American Public Health Association, Washington, D.C.
17. BIS. 2003. Drinking water specification. IS: 10500,11. Bureau of Indian Standards, New Delhi.
18. Jeff, Lewis and Birgitta Liljedahl. 2010. Groundwater surveys in developing regions. *Air, Soil Water Res.,* 3(3):95-140.
19. Gupta, S.K. and I.C. Gupta. 1987. Management of saline soils and water. Oxford and IBH Publication Co., New Delhi. pp 399.
20. Karanth, K.R. 1987. Groundwater assessment, development and management. Tata McGraw Hill Publication Co. Ltd., New Delhi.
21. McCarthy, M.F. 2004. *Medical Hypothesis.* 63:138.
22. Hem, J.D. 1991. Study and interpretation of the chemical characteristics of natural water (3rd edn). United States Geological Survey professional paper 2254. Scientific Publishers, Jodhpur.
23. Craig, E. and M.P. Anderson. 1979. The effect of urbanization on groundwater quality-A case study. *Ground-water.* 17(5):456-462.
24. Garg, V.K., *et al.* 2009. Drinking water quality in villages of south-western Haryana : Assessing human health risks associated with hydrochemi-stry. *Env. Geo.,* 58(6):1329-1340. DOI:10.1007/s00254-008-1636-y.
25. WHO. 2004. Guidelines for drinking water quality. World Health Organization, Geneva.
26. Patil, P.N., D.V. Sawant and R.N. Deshmukh. 2012. Physico-chemical parameters for testing of water : A review. *Int. J. Env. Sci.,* 3(3):1194-1207.

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Experimental Investigation On Municipal Wastewater Treatment By Using *Murraya koenigii* Leaves As A Coagulant

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A physico-chemical parameter imparts a great impact on wastewater treatment. In this present study, an attempt has been captious to appraise the potency of locally available *Murraya koenigii* (curry leaves) leaf powder as natural coagulation for reduction of physical parameters to enhance the peculiarity of municipal water. The tests were consummate using municipal wastewater with the conventional jar test apparatus. The dosing of water soluble extract of *Murraya koenigii* leaf powder ash showed a reduction in the concentration of physico-chemical parameters in municipal wastewater. The various ages of *Murraya koenigii* leave carried out during the wastewater treatment are 5 days, 10 days, 20 days and 30 days dried under sunlight. It brought to notice that natural coagulant worked finer with turbid water. The physico-chemical parameters reduction efficiency of about 76.13% was observed from the analysis. Influence of the pH also plays an important part in the efficient removal of parameters. Use of locally available *Murraya koenigii* leaf powder ash as natural coagulant was found to be suitable, easier, cost effective and eco-friendly for municipal wastewater treatment process. Optimal mixing ardour and duration were determined.

KEYWORDS

Wastewater, Physico-chemical, *Murraya koenigii*, Natural coagulant

REFERENCES

1. Balamurugan, P., K. Shunmugapriya and S. Arunkumar. 2018. Design of systems for recycling of wastewater for sustainable development. *Int. J. Civil Eng. Tech.,* 9(2):955-962.
2. Al-Asheh, S. and Z. Duvnjak. 1997. Sorption of cadmium and other heavy metals by pine bark. *J. Hazard Mater.,* 56:35-51.
3. Ofomaja, Augustine E. and Yuh-Shan Ho. 2008. Effect of temperatures and pH on methyl violet biosorption by Mansonia wood sawdust. *Bioresour. Tech.,* 99:5411-5417.
4. Balamurugan, P. and K. Shunmugapriya. 2019. Treatment of urinal wastewater using natural coagulants. *Int. J. Recent Tech. Eng.,* 8(2):355-362. DOI:10.35940/ijrte.B1478.078219.
5. Huang, Chih-pin, Chin-pao Huang and Allen L. Morehart. 1990. The removal of Cu(II) from dilute aqueous solutions by *Saccharomyces cerevisiae. Water Res.,* 24(4):433-439.
6. Fristoe, Bradley R. and Peter O. Nelson. 1983. Equilibrium chemical modeling of heavy metals in activated sludge. *Water Res.,* 17(7):771-778.
7. Sud, Dhiraj, Garima Mahajan and M.P. Kau. 2008. Agricultural waste material as potential absorbent for sequestering heavy metal ions from aqueous solutions : A review. *J. Bioresour. Tech.,* 99:6017-6027.
8. Tiwari, Diwakar, Shuddhodan P. Mishra and R.S. Dubey. 1999. Biosorptive behaviour of mango (*Mangifera indica*) and neem (*Azardirachta indica*) bark for Hg^{2+}, Cr^{3+} and Cd^{2+} toxic ions from aqueous solutions: A radiotracer study. *J. Appl. Radiation Isotopes.* 50:631-642.
9. Rubini, S., P. Balamurugan and K. Shunmugapriya. 2019. Exploring the use of cactus and neem leaf powder as an alternative coagulant in treatment of wastewater. *Int. J. Recent Tech. Eng.,* 8 (2): 1561-1564. DOI: 10.35940/ijrte.B2241. 078219.
10. Balamurugan, P., *et al*. 2020a. Non-carcinogenic risk assessment of groundwater in southern part of Salem district in Tamil Nadu. *J. Chilean Chem. Soc.,* 65(1):4697-4707.
11. Alomal, I., *et al.* 2012. Removal of nickel (II) ions from aqueous solution by biosorption on sugarcane bagasse. *J. Taiwan Inst. Chem. Eng.,* 43:275-281.
12. Dhana Goud, H., L.J. Parekh and C.V. Ramakrishnan. 1985. Bacterial profile of petrochemical industry effluents. Environmental pollution series A. *Ecol. Biol.,* 39(1):27-37.

13. Ali, Gundogdu, *et al.* 2009. Biosorption of Pb(II) ions from aqueous solutions by pine bark (*Pinus brutia Ten). Chem. Eng. J.,* 153:62-69.
14. Arafath, Md. Azharul, S.S. Mobarak Hossain and Raihan Sourav Alam. 2013. Studies on adsorption efficiency and kinematics of dye removal from textile effluent using some natural bio-sorbent. *Int. J. Sci. Eng. Tech.,* 2(9):853-856.
15. Balamurugan, P. and G. Vinnilavu. 2020b. Removal of methyl violet dye from industrial wastewater using neem leaf powder. *Indian J. Ecol.,* 47(2):442-445.
16. Balamurugan, P., P.S. Kumar and K. Shankar. 2020c. Dataset on the suitability of groundwater for drinking and irrigation purposes in the Sarabanga river region, Tamil Nadu. *Data Brief.* 29. DOI:10. 1016/j.dib.2020.105255.
17. Vinnilavu, G. and P. Balamurugan. 2019. Colour removal using neem leaf powder. *Indian J. Env. Prot.,* 30(12):1148-1153.
18. Sharma, Arunima and Krishna G. Bhattacharyya. 2005. *Azadirachta indica* (Neem) leaf powder as a biosorbent for removal of cadmium (II) from aqueous medium. *J. Hazard Mater.,* B125:102-112.
19. Curds, C.R. and A. Cockburn. 1970. Observed protozoa in biological sewage treatment processes. I. A survey of the protozoan fauna of British percolating filters and activated-sludge plants. *Water Res.,* 4 (3):225-228.
20. APHA. 2005. Standards methods for the examination of water and wastewater (19th edn). American Public Health Association. Washington, D.C.
21. IS : 3307. 1977. Tolerance limit for industrial effluents discharged on land for irrigation purposes. Indian Standards Institute. New Delhi.
22. Kumar, P.S. and P. Balamurugan. 2018. Evaluation of groundwater quality by using water quality index near magnesite mines, Salem district, Tamil Nadu. *Indian. J. Ecol.,* 45(2):380-383.