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## CONTENTS

### *Environmental System Design Modelling and Optimization*

Equilibrium and Kinetic Modeling for the Biosorption of Reactive ...183-189

Red 120 by *Ludwigia peploides* Biomass

N. Naveen, P. Saravanan, N. Nagendra Gandhi and S. Renganathan

Solar Induced Photo Degradation of Phenol Using Titanium ...190-196

Dioxide as Catalyst

V R Sankar Cheela and Swaminathan G

Impedance and Photoaction Spectral Studies of Tungsten Diselenide ...197-202

Thin Films

M D. Rashid Tanveer, Deepak Mishra and Aradhana Kashyap

Rapid and Green Synthesis of Gold Nanoparticles by the Use of an ...203-213

Otherwise Worthless Weed *Lantana camara* L.)

J. Anuradha, Tasneem Abbasi and S. A. Abbasi

### *Environmental Monitoring*

Anthropogenic Mercury Contamination of Vembanad Backwater, ...214-224

Western Coast, India – Evidence from Sediments

Shylesh Chandran M.S., Jayasooryan K.K., Subin K. Jose, Mahesh Mohan and E.V. Ramasamy

Macrobenthic Invertebrates as Coastal Ecological Bioindicators of ...225-229

Environmental Health

Mary Teresa P. Miranda, Rajesh B. R., Sreelekshmy S. G, Udayakumar P and Jean Jose J.

Spatial and Temporal Characteristics of Flood in Kaithal District ...230-238

Haryana, India

Pushpendra Singh Rajpoot, Ajay Kumar and R.K.Trivedi

Physico-chemical Properties and Heavy Metals Estimation in Drinking ...239-245

Water from Different Sources in and around Sindri (Dhanbad), Jharkhand, India

Prashant Kumar Singh and Shashi Shankar Tiwari

## Impact of pH on Cell Morphometry of *Scenedesmus abundans*

Ruchi Acharya, Tayyab Saify, Jaswinder Mehta and Bhawna Sharma

...246-25

## Hazardous Waste Management

### Performance Evaluation of Developed Concrete through Long Term Leaching, Durability and TCLP

Rubina Chaudhary and Smita Badur Karmankar

...251-26

## Review

### Packing Media for Anaerobic Fixed Film Reactor – A Review

Samir Vahora, Himmali Mehta and Nikita Chokshi

...263-2

### A Review on Water Resources Availability and Management Practices in India

Sushant B. Wath and Poonam Prasad

...271-2

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# Equilibrium and Kinetic Modeling for the Biosorption of Reactive Red 120 by *Ludwigia peploides* Biomass

N. NAVEEN, P. SARAVANAN, N. NAGENDRA GANDHI AND S. RENGANATHAN\*

Biosorption of Reactive Red 120 from an aqueous solution using *Ludwigia peploides* biomass was investigated. Biosorbent dosage (0.2 to 1.0 g/L), initial solution pH (1-7) and initial dye concentration (15 to 110 mg/L) for the maximum uptake of dye removal by *L. peploides* was studied. The maximum dye uptake capacity was found to be 132 mg/g at an initial dye concentration of 110 mg/L. Equilibrium data were analyzed by Langmuir and Freundlich adsorption isotherm. Freundlich model fitted very well for equilibrium data obtained. Kinetics data fit well with pseudo-second order when compared to pseudo-second order models. The functional groups present in the *L. peploides* were analyzed by FTIR spectra. The surface morphology of the *L. peploides* biomass was analyzed by scanning electron micrograph.

**Key words:** *Biosorption, Ludwigia peploides, kinetic modeling, adsorption isotherm*

## Introduction

Today, textile effluent discharge seems to be one of the biggest problems faced by the industries. Particularly, reactive dyes are highly resistant to conventional wastewater treatment methods. Though new technologies have been evolved and applied in industrial treatment plants, color removal still remain as a challenge for engineers.

Currently, new biosorbent materials are well poised for commercial exploitation. However, the expansion in the science of biosorption provides deeper understanding of the phenomenon and supports effective application<sup>1</sup>. No experiment has ever performed using *Ludwigia peploides* as adsorbent.

*L. peploides* is an aquatic vascular plant found in the lake. Its habitats are shallow and slow moving waterways. The prostrate stems grow laterally and rooting adventitiously at nodes. Once rooted, secondary shoots grow up to 5 feet in height. *L. peploides* creates a perceived public health threatening. Densely-grown patches create protective habitat for mosquito species which carries West Nile virus (WNV). *L. peploides* has a tall upright stature, bright yellow five-petal flowers and lanceolate leaves<sup>2</sup>.

The presence of chromophore attached to a substituent on the Reactive dye reacts with the fibre

using covalent bonds<sup>3</sup>. We are using Reactive dyes for dyeing cotton and other cellulose fibers. Mostly azo compounds (N=N) of Reactive dyes are used in tex-tile processing industries. These dyes are designed to be chemically and photolytically stable<sup>4</sup>. They exhibit a high resistance to microbial degradation and are highly persistent in natural environment. The undesirable effect of these compounds release into the environment was unknown. Many azo dyes and their breakdown products are toxic and induce mutagenesis<sup>5</sup>.

The aim of the present work is to utilize *L. peploides* for the removal of Reactive Red 120 dye from aqueous solution. The factors influencing initial biosorbent dosage, pH, initial dye concentration, and temperature were investigated. The kinetics was derived for the biosorption of Reactive Red 120 using *L. peploides* was analyzed using Pseudo-first order and Pseudo-second order kinetic models. Equilibrium data were analyzed using Langmuir and Freundlich biosorption isotherm model.

## Materials and methods

### Preparation of biosorbent

The aquatic plant used in this study was collected from a pond nearby Guduvanchery Chennai,

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# Solar Induced Photo Degradation of Phenol Using Titanium Dioxide as Catalyst

VR SANKAR CHEELA<sup>1\*</sup> AND SWAMINATHAN G<sup>2</sup>

The present study investigates the photo degradation of phenol using titanium dioxide as catalyst. The key focus is on the utilization of solar radiation in treating phenolic waste for degradation after discounting for evaporation due to solar heat. Titanium dioxide was observed to be good catalyst in solar radiation induced degradation of phenol. The optimum time for initial adsorption by  $\text{TiO}_2$  was observed to be 30 minutes. The optimum contact time and dosage were found to be 8h and 3 g/L for initial concentrations of 25ppm and 100 ppm with a removal efficiency of 98 % and 70%. The study reveals that the thermal degradation of phenol does not take place under the conditions of experiment and maximum degradation of phenol is due to the photocatalytic process only.

**Key words:** *Evaporation, photocatalysis, solar radiation, phenol, titanium dioxide*

## Introduction

The phenomenal growth in population and subsequent increase in the necessities led to industrial revolution. The wide variety of industries generate toxic waste products (Paradesi and Patil, 2008; Shanmuga Priya *et al.*, 2008; Sarvanan *et al.*, 2009). The effluents of these industries often contain aromatic compounds which are resistant to natural degradation and often an integral part of these effluents persist in the environment (Dorian *et al.*, 2009; Paradesi and Patil, 2008). Phenol is one of the major organic pollutants found in industrial wastewaters (Paradesi and Patil, 2008; Shanmuga Priya *et al.*, 2008; Sarvanan *et al.*, 2009; Dorian *et al.*, 2009; Movahedyan *et al.*, 2009). The effective concentration of phenol in the wastewater is found to range from 10–20000 ppm, production and processing industries are recycling or extracting the phenol and related compounds while coke processing unit effluents release phenol concentration of 100–500 ppm (Polat *et al.*, 2006; Shanmuga Priya *et al.*, 2008; Movahedyan *et al.*, 2009).

The existence of these tainted macrobiotic compounds in wastewater bilge water is a major barrier

(Mahmoodi *et al.* 2007). Due to their stability and bioaccumulation, they remain in the environment for longer period (Wang *et al.*, 1999). High toxicity and carcinogenic character of substrate causes lot of stress on the eco-system (Gracia and Coca 1989).

As per Hazardous Wastes (Management and Handling) Amendment Rules, 2000, phenol and phenolic compounds are classified under category of Class B (B-19) of Schedule-II in the hazardous waste list. The discharge limit in inland water as per IS: 2490-1974 is 1 mg/L and in public sewers as per IS: 3306-1974 is 5.0mg/L. Photocatalysis is one the advanced oxidation processes (AOPs) for treating phenolic wastewaters. Oxidizing hydroxyl radicals generated during the photocatalytic process degrade the pollutants in wastewater. Semiconductor assisted photo degradation is widely applied in the present scenario. Titanium dioxide ( $\text{TiO}_2$ ) is having a wide band gap i.e., 3.2eV proving it to be a successful semiconductor photocatalyst treating organic pollutants<sup>1-5</sup>. Utilization of solar energy for the production of hydroxyl radicals is one of the best photo catalysis methods. In this process the near UV light induced excites titanium dioxide catalyst to produce the oxidizing radicals in

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## Impedance and Photoaction Spectral Studies of Tungsten Diselenide Thin Films

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Titanium supported photoelectroactive semiconductor electrodes based on thin films of tungsten diselenide have been prepared by electrochemical codeposition technique through galvanostatic route. The deposited films were then subjected to thermal treatment at 300° C for two hours in the inert environment. These thin films were also characterized by studying their capacitance characteristics and electrochemical corrosion behaviour on the basis of impedance spectral studies. Tungsten diselenide thin films were found to be most photoelectroactive and exhibit substantially high resistance towards electrochemical corrosion when deposition was carried out galvanostatically at 5mA current. The capacitance studies show that the thermally treated tungsten diselenide deposited thin films exhibit n-type of semiconductivity. Photoaction spectral studies of these films were carried out for the determination of band gap.

**Keywords:** *Electrosynthesis, galvanostatic deposition, impedance, Photoaction spectral studies, semiconductor, band gap, corrosion*

roduction

The capture and conversion of solar energy to electricity is the promising way of generation of non-polluting energy. This requires photovoltaic and photoelectrochemical cells consisting of semiconducting materials. Recently there has been a great interest in developing inexpensive techniques for preparing large area polycrystalline thin films of binary semiconductors, for this purpose<sup>1-6</sup>. The photoelectrochemical cells essentially consist of a semiconductor electrolyte junction. Among binary semiconductor, tungsten diselenide is particularly of interest<sup>7-11</sup>. This is because its band gap matches adequately the solar spectral distribution.

Tungsten diselenide thin films based on titanium substrate have been prepared by electrochemical codeposition technique under potentiostatic as well as galvanostatic control. In our earlier studies<sup>12</sup> we have reported some of the photoelectrochemical aspects of tungsten diselenide thin films and it was established that galvanostatic method is more suitable for the preparation of these films. It

was shown that this method of synthesis yields more photoactive thin films.

In the present studies we have reported the tungsten diselenide thin films deposited galvanostatically on titanium substrate at different applied constant current. Photoaction spectral studies were carried out for the determination of their band gap. The quantitative estimation of corrosion behavior was investigated on the basis of impedance spectral studies. Variation of capacitance values with applied potential has also been investigated to construct Mott-Schottky plots.

### Materials and methods

Tungstic acid (CDH, India) and selenium dioxide (Fluka Chemika, Switzerland) were used for the preparation of electroplating solution. 0.05 M tungstic acid solution was first prepared in 100 mL of 10 M ammonia solution. 0.02 M selenium dioxide solution prepared in 100 mL of distilled water was then mixed with tungstic acid solution. The deposition was made on titanium substrate. Flag shaped titanium plates were used for this purpose. The titanium plates



# Rapid and Green Synthesis of Gold Nanoparticles by the Use of an Otherwise Worthless Weed *Lantana* (*Lantana camara* L.)

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The phyto-fabrication of gold nanoparticles utilizing the highly invasive terrestrial weed, *Lantana camara*, is presented. In an attempt to utilize the entire plant, the extracts of all its parts – leaves, stem and root – were employed in various proportions with the gold precursor, HAuCl<sub>4</sub> solution, for the synthesis. The reduction of gold ions to nanoparticles was tracked using UV-Vis spectroscopy. The electron micrographs of the synthesized nanoparticles revealed the presence of particles of monodispersed spherical and polydispersed triangular, pentagonal, rod and truncated triangular shapes in sizes ranging 15–55 nm and 7–100 nm respectively. The presence of gold atoms was confirmed from the EDAX and X-Ray diffraction studies. The FT-IR spectral study indicated that the alkanes in the plant extract could have been responsible for the reduction of the gold ions to gold nanoparticles.

**Key words:** *Phyto-fabrication, Lantana camara, gold nanoparticles, monodispersed particles, TEM*

## 1. Introduction

Gold nanoparticles (GNPs) find wide application due to their special catalytic, optical, sensor, magnetic and electrical properties<sup>1-4</sup>, and their use has led to the opening of new avenues in immunology, nanomedicine, and nanobiotechnology<sup>5</sup>. This is due to the properties of GNPs which vary subtly with their sizes and shapes. Hence synthesis of different forms of GNPs in an economical and eco-friendly manner forms an important thrust area of nanotechnology.

Among the available means for GNPs synthesis, the physical and chemical methods often require high temperatures/ pressures, and/or high energy inputs, and involve hazardous chemicals either as reducing agents and/or as stabilizing agents for the nanoparticles (NPs) formation. The physical conditions required for NPs generation is highly intensive and expensive; and the use of toxic chemicals in the synthesis process releases hazardous byproduct that may affect the environment in addition to human health. Consequently, the bioinspired GNP synthesis is gaining importance not only due to its low cost and high

reproducibility, but also its eco-friendliness. Recently there have been numerous reports on extra-cellular Au NPs synthesis using living organisms such as actinomycetes, bacteria, fungi, algae, and/or vascular plant extracts. Of these the phyto-fabrication of NPs is beneficial over the other bioagents because it is rapid and convenient. It is not constrained by the need for elaborate and fine maintenance that characterize microorganism-base NP synthesis method. These are also free from the risk of microbial contamination; and are easy to be scaled up for large scale NPs synthesis<sup>6-10</sup>.

Several plant species have been explored for their potential to generate nanoparticles when the plant extracts are combined with Au (III) solutions. However most of these studies have employed species encompassing fruits, vegetables, cereals, spices, medicinals and other foodstuff, which already have well-established uses and entail substantial costs of production<sup>11, 6, 8, 12, 10</sup>. Some of the attempts that have been made in the past to utilize *lantana* in the synthesis of silver<sup>12, 13-15</sup> and copper nanoparticles<sup>16</sup> but there is no report on the possible use of the weed in the manufacture of GNPs. In the present work, we have

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# Anthropogenic Mercury Contamination of Vembanad Backwater, Western Coast, India – Evidence from Sediments

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Mercury concentration and its pollution profile in the sediments of polluted (Mulavukadu) and less polluted (Kumarakom) regions of Vembanad Backwater, a Ramsar site were studied. Sediment core samples and surface sediment samples were collected seasonally from these sites and analyzed for total mercury (THg), organic carbon and pH. Mean THg concentrations in the surface sediments ranged from 61.1 to 2054.3 ng/g. High THg content was observed in the sediments collected from the Mulavukadu region with an average value of 1238 ng/g. The high concentration of THg was observed during pre-monsoon season. Kumarakom (less polluted) region showed comparatively lower values (20.9 ng/g – 370 ng/g). THg in surface sediments showed significant correlation with pH and organic carbon. The high concentration observed in the Mulavukadu region was a clear indication of anthropogenic contamination. The core samples collected from Mulavukadu region exhibited higher values than the core taken from the Kumarakom region. The core sediment samples showed that THg values were much higher in the subsurface sediment than that of surface sediments. These low concentrations in the upper few centimeters of the sediment suggest that recent mercury inputs were substantially low in these areas. High mercury content in the subsurface sedimentary region might be due to the historic discharges from a chloralkali plant which had stopped the use of mercury cell process few years ago.

**Key words:** *Aquatic systems, mercury, pollution profile, sediment*

## Introduction

Mercury, a global pollutant <sup>1</sup>, is an extremely toxic trace metal, naturally occurring in air, water and soil <sup>2</sup> and is one of the most studied pollutants <sup>3</sup>. Because of its transboundary nature, mercury popping up in places where it was never expected before and it burdens in sediments and other non-biological materials are estimated to have increased up to five times pre-human level; primarily as a result of human activities <sup>4,5</sup>. A lot of studies have been undertaken on mercury contamination<sup>7-9</sup>, speciation<sup>9</sup>, bioavailability<sup>11-12</sup> and bioaccumulation<sup>13</sup> in various ecosystems. A very recent study showed that at least 150 tons of mercury being released annually to the estuaries around the world<sup>14</sup>. Earlier studies estimated a global natural mercury emission of 1920.6 tons/year <sup>1,6,15,16</sup>. Out of the total global anthropogenic release of mercury into the atmosphere, two third appear to come from Asian sources, with China as the largest contributor worldwide<sup>17</sup>. The United States of America and India

are the second and third largest emitters, but the combined total emissions are only about one third of China's. Mercury deposition significantly increased in the given period in East and South Asia, 26% and 18% correspondingly<sup>18</sup>. Burning of fossil fuels is the largest single source of mercury emissions from human sources accounting for about 45% of the total anthropogenic emissions followed by artisanal gold mining (18%), cement production, industrial gold production (27%)<sup>17</sup>.

The presence and behavior of Mercury in aquatic systems are of great interest and importance since it is the only metal which bioaccumulates and magnifies through all the levels of aquatic food chain<sup>19</sup>. Sediments can act as both sink and source of mercury. The accumulated mercury in the sediments can be remobilized or re-enter into the water column through bioturbation or dredging. Hence it is important to study the mercury accumulated in the subsurface

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# Macrobenthic Invertebrates as Coastal Ecological Bioindicators of Environmental Health

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UDAYAKUMAR P AND JEAN JOSE J.

The distribution of zoobenthic organisms in relation to the textural characteristics of the sediments in five stations (Veli, Varkala, Alappad, Neendakara and Cochin) was studied along the southwest coast of India. Sampling was done during the post monsoon of the year 2011 followed by the pre monsoon and monsoon seasons of the year 2012. The importance of zoo benthic communities in pollution studies is well established. Results revealed that the sediment texture for Veli, Varkala, Alappad and Neendakara was in the order sand > silt > clay while in Cochin it was silt > sand > clay. Organic carbon varied throughout the study and was expressed in the sequence Cochin>Alappad>Neendakara>Varkala>Veli. Wide variations in zoobenthic species diversity was also observed. The sinking range of coastal surface water received pollutants routed from fresh water input and these were estimated through the evaluation of bottom water nutrient characteristics. The present study thus focuses on the concept that the seabed acts as a sink for most of the pollutants entering the marine ecosystem, and the more stable sediments along with their inhabitant fauna give a clear picture of the severity of contaminants. The study has identified *Littorina scabra*, *Modiolus metcalfei* and *Trochida* sp as indicator organisms along south west India.

**Key words:** *Macrobenthos*, *sediment*, *organic carbon*, *bio-indicator*

## Introduction

Macrobenthos play an important role in aquatic communities as they are involved in mineralization, promotion and mixing of sediments, flux of oxygen into sediments, cycling of organic matter and for assessing the quality of inland water<sup>1</sup>. Abundance and distribution of macro benthos is affected by various physical and chemical conditions of the water body such as depth, organic contents of the sediments, contamination of bed sediments, toxicity of sediments and rapid sedimentation. These appear to cause shifts towards lower abundance of macro benthic species. Opportunistic species will dominate in a pollution stressed environment and the conservative species may become rare or may disappear. Therefore, both these species can serve as pollution indicators<sup>2</sup>.

Bays and harbours are mostly exposed to pollution because of anthropogenic activities, industries

and harbourage operations. Often, the effects of pollution are reinforced by natural features of bays as the organic and inorganic pollutants tend to deposit in the fine sediments, limited circulation of water and the reduced tidal flux<sup>3</sup>. Marine pollution management is based on monitoring various physico-chemical and biological parameters to detect changes in the environment. Recent studies carried out in the coastal waters of India reveal that the coastal belt including the water and sediment is continuously being threatened by various pollutants discharged directly from industrial plants<sup>4</sup>. Zoo benthos are relatively sessile and sensitive to environmental changes such as nutrient level and oxygen concentration. Benthic communities usually have a long life cycle and stable community composition and can therefore often be used as a monitoring index for pollution<sup>5</sup>. The objective of the present work was to study the preference of habitat and seasonal abundance of benthic fauna along the Kerala coast,



# Spatial and Temporal Characteristics of Flood in Kaithal District Haryana, India

PUSHPENDRA SINGH RAJPOOT<sup>\*,</sup> AJAY KUMAR<sup>\*\*</sup> AND R.K. TRIVEDI<sup>\*\*\*</sup>

Floods are reoccurring natural hazard. Major part of Kaithal district of Haryana, is drained by Ghaggar River and its tributaries and faces the problem of flood. All the tributaries of Ghaggar River meet in this region and brings huge amount of sediments and blocks the drains. Present study presents the outcome of flood frequency analysis using rainfall data and by integration of different parameters (slope, landform, soil, drainage and land use/land cover). Flood risk zone spatial analysis showing high, moderate and low flood risk zone is done using Remote Sensing & GIS techniques and discharged data is also considered. Frequency and recurrence interval shows that low to moderate flood risk is a regular phenomenon and extreme moderate to high flood occurs three or four times in two decades. High flood risk zone is found in northern part (Guhla block) and covers an area of about 19%, a large northern part of Kaithal district. Moderate flood risk zone is found in north along with the high flood risk zone and covers about 7% area. Remaining 74% of the study area is characterized by no/low flood risk zone.

**Key words:** *Spatial, temporal, land use/land cover, flood distribution, Kaithal and Ghaggar river*

## Introduction

Floods are a natural phenomenon that occur when water from rainfall, snow melt, dam failure or any combination of these is released into a stream at rates that exceed the transfer and storage capacity of the channel. Flooding is responsible for both annual loss of large number of life and huge amount of property. In Kaithal district of Haryana in Ghaggar river basin, flood is one of the regularly occurring disaster and its effects are getting worse.

Ghaggar basin is also characterized with number of palaeo channels which are in the low-lying part of the alluvial plains within basin; they act as conduits and become instrumental in carrying the floodwaters<sup>1</sup>. Studies on flood risk assessment in the part of Kosi River basin are conducted by integrating hydrological, geomorphological, land cover, topographic and social (population density) parameters using RS

& GIS technique to obtain the Flood Risk Index (FR). Present study is an attempt to analyze the temporal and spatial characteristics and impact of flood risk in Kaithal district to help the administrators and planners for making development plan to minimizing the loss due to flood.

Kaithal district is situated between 29° 49" to 30° 12' 40" N latitude and 76° 10' to 76° 29' E longitude. It is a part of Ghaggar River and its major tributaries i.e. Markanda, Tangri and Patialewali b. Saraswati, Pachhisdhara are the few important tributaries. Total basin area of Ghaggar is 8024.0 km. The normal annual rainfall is 563 mm and about 85% of annual rainfall is contributed by southwest monsoon during last week of June and early September. July and August are the wettest months. Rest 15% rainfall is received during non-monsoon period.

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# Physico-chemical Properties and Heavy Metals Estimation in Drinking Water from Different Sources in and around Sindri (Dhanbad), Jharkhand, India

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Water resource shortage and pollution have seriously threatened the survival and development of developing countries. Because of India's specific economical and social circumstances, complete adoption of developed countries experience is unrealistic. At present, India needs to develop strategies and technologies in source water pollution control and industrial and municipal environmental remediation that embrace the country's specific need to battle the water resource problem. This study was aimed to estimate physico-chemical properties and heavy metals in drinking water samples collected from different sources in and around Sindri (Dhanbad), Jharkhand, India. A total number of 30 water samples were collected from different sources like hand pumps, wells and taps. The gross appearance, pH, EC, total hardness, Ca, Mg, total alkalinity, Na, K, Cl,  $\text{SO}_4$ ,  $\text{NO}_3$ , F, TDS and heavy metals like Cu, Pb, Zn, Ni, Cd, Cr, Mn and Fe were analyzed. The results of physico-chemical parameters and heavy metal estimation of all water samples were found to be within permissible limit and safe for drinking purpose.

**Key words:** *Water resource, physico-chemical properties, hardness, heavy metals*

## Introduction

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends on its availability<sup>1</sup>. The provision of potable water to the rural and urban population is necessary to prevent health hazards<sup>2</sup>. Ground water is generally considered as safe source of fresh drinking water<sup>3</sup>. But rapid population growth, increasing living standards in urban areas and industrialization have resulted in greater demand of quality water on one hand, while on the other hand pollution of water sources is increasing steadily. Therefore the ground water is getting polluted among which wells are generally considered as worst type of ground water sources in terms of physico-chemical contamination due to the lack of concrete plinth and surrounding drainage system<sup>4-5</sup>. The incidence of ground water pollution is highest in urban areas where large volumes of waste are discharged into relatively small areas<sup>6</sup>. There are various factors, which are responsible for ground water contamination such as use of fertilizer in farming<sup>7</sup>, seepage from effluent bearing water body<sup>8</sup>. Once the groundwater is contaminated, its quality cannot be

restored by stopping the pollutants from the source. Therefore it becomes imperative to regularly monitor the quality of groundwater and to devise various means to protect it<sup>9</sup>. The surface water sources, in general, are not acceptable for drinking purpose as these are often loaded by various organic, inorganic and biological constituents<sup>10-11</sup>.

In the recent years, the availability and access to fresh water has become the most critical issue in the world. Freshwater is essential to human health, agriculture, industry and natural ecosystems, but is now running scarce in many regions of the world<sup>12</sup>. The desirable properties of water quality should include adequate amount of dissolved oxygen, relatively low organic content, pH value near neutrality, moderate temperature, and free from excessive amount of infectious agents, toxic substances and mineral matter<sup>13</sup>. Potable water should be free from disease producing microorganisms and chemical substances that are dangerous to health<sup>14</sup>. Majority of the rural people do not have access to potable water and therefore, depend on well, stream and river waters for domestic use. Excessive use of limited water resources, disposal of



# Impact of pH on Cell Morphometry of *Scenedesmus abundans*

RUCHI ACHARYA<sup>1</sup>\*, TAYYAB SAIFY<sup>2</sup>, JASWINDER MEHTA<sup>3</sup> AND BHAWNA SHARMA<sup>4</sup>

Global climate change is expected to dramatically impact the structure and function of freshwater aquatic ecosystems. Regional climate change in the upper and lower lake of Bhopal, India is expected to increase air and stream temperatures, modify hydrologic regimes, and increase the amount and frequency of disturbance events (debris flows, landfill, and human encroachment to the catchments area). These climatic changes combined with species-specific tolerances to regime extreme (e.g., pH variability) will likely result in significant changes in the distribution, abundance, and diversity of many aquatic species, particularly *Scenedesmus* species, a phenotypic plastic microalga. In the present study, the effect of pH on cell morphometry *Scenedesmus abundans* var. *brevicauda* was investigated. In the low pH (below 5.0) range, no growth of *Scenedesmus abundans* var. *brevicauda* was detected and the measured cell dimensions were 6.0×2.7µm. The coenobium became almost colourless and lost its obvious green colour. The cells were shrunken and perforated. The cells became quadratic in their outline. At the alkaline pH, the cell dimensions increased to 7.5×3.3µm with an increase in chlorophyll content.

**Key words:** *Scenedesmus*, pH, phenotypic plastic

## Introduction

The continuing rapid growth in the requirement for potable water has increased the importance for studying and understanding the interactions between chemical substances used in the treatment of drinking water. One of the major environmental factors of freshwater ecosystem is pH. It is impacted by biological processes, such as photosynthesis or respiration<sup>26</sup> as well as influencing the morphological characteristics of freshwater algae both in experimental and natural conditions<sup>3, 5, 14, 23</sup>. Major eco physiological traits and sinking parameters of phytoplankton can be related to the cell size and cell morphology<sup>20</sup>. Shift in size structure has been observed in planktonic organisms over centennial time scales<sup>12, 22</sup>, and these shifts have been linked to the changing climate. This suggests that shift in the cell size is a function of changing physical conditions and supports other observations that abiotic fluctuation plays an important role in maintaining algal structure in natural communities<sup>10</sup>.

The environmental pH, along with other factors such as high acidity and high ion concentrations strongly affects the biota, due to which algal species diversity becomes quite low and decrease as the pH level decreases<sup>7, 25</sup>. However, certain species of algae flourish<sup>15, 25</sup>. Lund *et al.*<sup>21</sup> demonstrated that the members of chlorophyceae seems to prefer neutral pH range (i.e. 5-7).

Brock<sup>6</sup> observed a wide variety of acidic environments, both natural and artificial, and revealed that blue-green algae (*Cyanophyta*) is completely absent from habitats in which the pH is less than 4.0, whereas eukaryotic algae flourishes. With increasing acidity, there was decline in the number of planktonic species, and pronounced change in the taxonomic composition<sup>16, 17</sup>.

The pH level was related to the nutrient dissolution, which caused a change in species composition and biomass of the phytoplankton<sup>9</sup>. Amount of nutrient determines the phytoplankton growth rate

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# Performance Evaluation of Developed Concrete through Long Term Leaching, Durability and TCLP

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Solidification/Stabilization is a common practice for the treatment of hazardous waste containing heavy metals before it is disposed of in a secure landfill or for reuse. In order to evaluate the stability of the solidified waste for utilization, EPA Solids Water Leaching Test (SWLT) 846-1311, long term durability and leaching (NEN 7345) methods were used. Weight loss from the freeze/thaw (FT) durability test ranged from 0.37 – 0.98% and heat- thaw (HT) durability test ranged from 0.28 – 0.42% after 4 cycles. The obtained values were less as compared to the 30% weight loss standard. L1 and L2 concrete samples were soiled during FT & HT durability test. Iron Leaching was found less than other metals (Cu, Zn) due to formation of high iron complex. FT was found to be more deteriorating as compared to HT. During diffusion test conductivity increased with the increase in the waste content in the mix design and higher for the extractions with longer contact period. Diffusion was obtained in the start path and middle path of all concrete samples. The leaching mechanism showed low leaching of copper and zinc as compared to iron. Iron release decreased with increase in waste/binder ratio. Chromium, nickel and manganese were completely stabilized in concrete matrix. The order of fixation of metals on the basis of their leachability index are  $Fe > Zn > Cu > Cr > Ni > Mn$ . The TCLP result proved that the developed materials were in the permissible limits of Hazardous Waste (Management & Handling) Rules.

**Key words:** Durability, diffusion, TCLP, leachability index, concrete

## 1. Introduction

This paper is focused on the long term stability (durability), leachability indexing and to fulfill the mandatory requirement by performing the TCLP. The durability of concrete refers to the extent to which the material is capable of resisting deterioration caused by exposure to service conditions while maintaining its desired engineering properties<sup>1,2</sup>. Different concretes require different degrees of durability depending on the exposure to the environment. Concrete ingredients, their proportion, interactions between them, placing, curing practices, and the service environment

determine the ultimate durability and life of the concrete. No standards are currently established to determine whether stabilized material had passed durability test. It was suggested that 30% weight loss is acceptable<sup>3</sup>. This is one of the important test to levy long term risk assessment for the waste reuse. It is necessary to verify whether the pollution release from developed matrix is compatible with the specified environmental conditions<sup>4,5</sup>. This diffusion test can be used to determine the long term leaching behavior of solid, non-granular building materials and waste products<sup>5</sup>. This test determines the nature and properties of the material matrix to be studied by

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## Packing Media for Anaerobic Fixed Film Reactor – A Review

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One of the most important aspects in the anaerobic fixed film reactor design is the selection of efficient support material. It has been reported that the organic matter removal efficiency in these reactors is directly related to the characteristics of the support materials used for the immobilization of anaerobes. Anaerobic fixed film reactors have displayed better performance than any other type of anaerobic reactors. They not only work as anaerobic biological treatment for organic matter in the wastewaters but also trap passage of active biomass out of the reactor. This paper reviews the use of fixed-bed reactors in various fields reported by different researchers using variety of packing media.

**Key words:** *Anaerobic fixed film, organic loading rate, packing media, wastewater treatment*

Recent years have seen marked increase in wide renewable energy installations – annual rate varying from 10-60% for different countries. Research is underway in the field of energy technologies distinctively in the area of bioenergy and biofuels like biodiesel, bioethanol etc. Adequate amount of energies which will be essential renewable energy source in next decades until solar, wind and geo-thermal power offers an economical alternative.

Rapid industrialization has given rise to generation of a large quantity of effluents with high organic composition (biochemical oxygen demand) which has potential to produce bio-energies through biomethanation. Thus, in spite of the fact that biomethanation has negative environmental impact related with industrialization, the effect could be controlled to some extent and energy can be produced simultaneously.

Extensive interest has been paid towards the development of anaerobic reactors for waste treatments. Conversion of organic molecules into biogas. Modern high rate biomethanation processes are

based on the concept of retaining high viable biomass by using different mechanism. Reactors like up-flow anaerobic sludge blanket (UASB) employs sludge granules, expanded/ fluidized bed reactors use fine inert particles and up-flow and down-flow packed bed reactors and hybrid reactors have inert packing media for entrapment of active biomass within the reactor. This paper reviews efficiency of different types of packing material used for anaerobic fixed film reactors handling a variety of wastewaters.

### Packing media characteristics

Anaerobic fixed film reactors are biological wastewater treatment systems in which a fixed packing medium provides an attachment surface that supports the anaerobic microorganisms in the form of a biofilm. Treatment occurs as wastewater flows upwards or downwards through this bed and dissolved pollutants are absorbed by biofilm. These were the first anaerobic systems that eliminated the need for solids separation and recycle while providing a high Solid Retention Time to Hydraulic Retention Time (SRT/HRT) ratio. Their resistance to shock loads and inhibitions make them suitable for the treatment of both dilute and high strength wastewaters.

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# A Review on Water Resources Availability and Management Practices in India

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Conservation and management of water resources is critically important for a vast and fast developing country like India. However, rapidly increasing population and continuous betterment of lifestyle has put tremendous pressure on water resources around major cities leading to alarmingly reduction in per capita water availability. Moreover, increasing fluctuations in precipitation over the country has only aggravated the problem. This paper presents the current and future water scenario in India and also discusses the impacts of various factors like population, pollution, mismanagement, climate change, government laws and regulations etc. on water resources and its availability. While emphasis has been laid on water productivity and various government initiatives, the paper also discusses and analyzes limitations in water management. Based on study and analysis, the paper finally recommends Best Management Practices (BMP) and Best Available Technologies (BAT) used and practiced worldwide for effective and efficient water management in India. The paper also highlights the importance of Public Private Community Partnership (PPCP) along with the recently developed monitoring tools and data information systems for sustainable and effective water resource management to meet present requirements without compromising the future needs.

**Key words:** *Water resources, management, pollution-point and non-point sources, public private partnership*

## Introduction

India's vital asset is 1/25<sup>th</sup> of the world's water<sup>1</sup>, and as per the water and its associated statistics of Water Resources Information System, Directorate of Central Water Commission (CWC), 2013<sup>2</sup>, the average annual water resources are presented in Table 1. As per Meteorological Department of India<sup>3</sup>, South-West and North-East monsoons, shallow cyclonic depressions and local disturbances on local storms are mainly responsible for the rainfall in India. North-East monsoon mainly influences Tamil Nadu during October to November whereas South-West monsoon influences rest of India between June and September. International Water Management Institute (IWMI) estimates average annual rainfall of India as 1958 mm (approx.) with a maximum of 3005 mm in Konkan and Goa and minimum of 313 mm in West Rajasthan measured by different Meteorological divisions<sup>4</sup>.

## Surface water (SW) and ground water (GW) resources

The surface and ground water are the primary water resource for agriculture, forestry, fisheries, hydropower generation, industrial activities, livestock production navigation and recreational activities, etc. India's 20 major rivers with several tributaries flow through the different parts of the country<sup>5</sup> with many big, medium and small rivers with the total length, around 18,597 km and the total catchment area of 26,76,371 sq. km flowing through various states of India. Annual per capita water availability changes from 16,589 cu. m for the Brahmaputra-Barak basin to 360 cu. m. for Sabarmati basin<sup>6</sup>. GW sources are primarily used for domestic, agriculture, industrial uses etc. and contribute to approximately eighty percent of domestic water need and >45% of total irrigation in India. Potential of natural rejuvenation by rain water is approximately 342.43 cu.km per annum in India which is about nine percent of total yearly rainfall<sup>7</sup>.

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