Simultaneous Removal of COD, Phenol and Ammoniacal Nitrogen from Industrial Waste Waters

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Ammoniacal nitrogen (AN) and phenols are the most hazardous water pollutants discharging into water receptors through industrial effluents along with COD. Chemical and allied industry where this problem is severe is scouting for cost effective solution in meeting the standards for ammoniacal nitrogen of 50 ppm, and phenol of 0.5 ppm and COD of 150 ppm.In this framework, CSIR-IICT has developed sequential biological process for the simultaneous removal of COD, phenol and AN from industrial waste waters. In this process, initially wastewater was passed through the counter current air stripper and subsequently
wastewater was subjected to sequence of bioprocesses (aerobic, anoxic and anaerobic) with specially developed microbial consortia at optimized conditions (Hydraulic Residence time (HRT) of 24 hrs, pH of 7.0, recycle ratio of 1:1). Removal efficiency of 60 to 65% in terms of AN, 70 to 75 % in terms of phenol & 80 to 85% in terms of COD was be obtained with this process from the initial levels of 150 to 155 mg/L AN, 145 to 140 mg/L of phenol & 4000 to 3900 mg/L of COD. The process was demonstrated in laboratory (capacity of 20 litres per day)

Use of Treated Waste Water for Cultivation through Hydroponics Technique

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Keywords : Hydroponics; Treated sewage; Conventionalfarming; Smart City

Today, the world is suffering with food and water scarcity due to population explosion and unevenness in the climatic conditions. The world needs food which will satisfy its nutritional need and will be available at cheaper cost. The food, which one can grow in very small space. The world needs techniques which one can implement easily and without much of an investment.

Hydroponics is one of such technique. In hydroponics, plants are grown with the use of water and nutritional solution only. The nutritional solution contains the essential nutrients which are required for growth of the crops. The crops are artificially supported in the nutrient mixtures and made to grow using the nutrients provided only.

The water which we treat in our sewage treatment plants is mostly discharged into the drainages. But, as it was containing human excreta, it is rich in the N (nitrogen), P (phosphorous) and K(potassium).N, P, K are the macro-nutrients which are required for the growth of the plants. So, such water may be used by hydroponics system to grow the plants in the most economical manner.This project is an attempt to compare conventional as well as various hydroponics techniques for growing the crops and plants which one uses in day to day life.

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This project will broadly focus on the outcomes due to chemical nutrients and organic nutrients which are cheaply available. It will be an attempt to give people an option by which they will not only satisfy their daily needs but also will be a source of earning for them.

This project is an attempt to create a new opportunity for the townships, buildings and houses through which it will be possible for buildings to become self-sustainable in satisfying their need of crops and the discharges of the waste water will be reduced as the treated waste water will be used for in the same building. This will help the townships to become self-sustainable. This project will not only manage their needs but will also allow them to sell the crops and manage their spending for maintenance works of the structure.

Performance Evaluation of Surface Aearator Assisted MBBR

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Keywords: Attached growth, designed media, MBBR, mechanical aerator, suspended growth, synthetic wastewater.

Increasing quantity of wastewater generation in India has created a need of innovative and efficient way of treating it. Moving bed biofilm reactor (MBBR) is a new technology which promises excellent result and many advantages over conventional treatments. MBBR is a wastewater treatment technology which incorporates the best characteristics of suspended as well as attached growth system.

A lab scale model of MBBR having 60 L capacity was developed using GI sheet. Certain modifications were introduced while developing the model. The MBBR treatment system was assisted with arrayed configured specially designed media along with mechanical aerator to enhance the efficiency of MBBR. The model was operated at specified operating condition. Total 3 trail were taken using different combinations of media. The system was fed with synthetic wastewater of fixed characteristic to get the uniform quality of in fluent. Rotational speed of aerator and MBBR unit was optimized by examining the effluent parameters at variable speed. The present paper highlights the observations obtained during the study. Also the effort has been made in the present paper about the overall vision of this technology and its application and future scope in the field of wastewater treatment.

Water Reuse in Public Parks using Constructed Wetlands Treatment System: A Case Study

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Keywords: Constructed wetlands, Domestic Wastewater treatment , Public Parks, Water reuse.

This poster demonstrates implementation of a natural treatment system with an anaerobic system and constructed wetlands (CWs) in a public park spread over 7 acres i.e. Dayanand Park, Nagpur under the city development agency, Nagpur Improvement Trust (NIT) in India.

Irrigation needs of the park is 100 m3/d, which is met through groundwater sources, however during summer season the groundwater level goes down and water scarcity increases. The situation is further worsened when raw sewage is used for irrigation that poses great health risks to the park users. Therefore, it becomes imperative to prioritize treatment and recycling of raw sewage.

Accordingly, a treatment system consisting of anaerobic process in three stages, followed by secondary treatment comprising of various configurations of Subsurface Flow (SSF) Horizontal Flow (HF) and Vertical Flow (VF) Constructed Wetlands is provided. Tertiary treatment is by UV disinfection. An important consideration in selecting CWs is the integration within the existing park landscape.

The envisaged benefits of the treatment scheme are minimal health risks to park users, conservation of groundwater, suitability for reuse in sprinkling and other non-potable applications.

Nitrate and Phosphate reduction by dairy effluent adapted microbes

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Keywords: Bioremediation, Dairy waste water, Microorganisms Nitrate, Phosphate, Pollution.

The dairy industry being one of the growing industries in India produces high amount of effluent per unit of production. It is one of those sectors which is the largest producer of waste water where it is directly allowed to flow in rivers or agricultural lands. This waste water has large amount of organic and inorganic load. This organic load is basically constituted of milk (raw material and dairy products), reflecting an effluent with high levels of chemical oxygen demand (COD), biochemical oxygen demand (BOD), oils, grease, nitrogen and

phosphorus Hence, degradation of these compounds from source itself is necessary which can be achieved by bioremediation. Bioremediation is an environmental clean-up technique that uses microorganisms for degrading recalcitrant chemicals by utilizing them as metabolic substrate.

In the present study effluent adapted bacteria from untreated dairy waste water were isolated and identified as Enterobacter sp. and Bacillus sp. . Physiochemical tests were performed in which BOD, COD, nitrate and phosphate values were found to be higher than standard range. These strains were inoculated in the effluent and a reduction in nitrate and phosphate was observed after 7 days. It was observed that there was reduction of 78.5% in nitrate and 63% in phosphate content by Enterobacter sp. and 85.5% in nitrate content by Bacillus sp. This approach could be utilised as a possible bioremedial measure to minimise water pollution caused by dairy sector.

Techno-economic assessment of community owned wastewater treatment management.

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Keywords : Community owned- managed, Decentralized sewage treatment, Environmental, social and governance models, Techno-economic assessment, Water and waste-water economics.

The paper provides a techno-economic assessment of decentralised sewage treatment interventions based on conventional mechanised (modified ASP) and natural (DEWATS) technologies. The modern centralised service provision for STPs has proven to be expensive, inefficient and not sustainable. The National Urban Sanitation policy-2008 desires a goal of 100% sanitation and acknowledges the importance of alternatives to be employed.

The alternative models when applied and proven would show case appropriate technology, with apt financing strategies and model governance cases. The decentralised interventions in sewage management has been tried, tested and realised in varied context. A study was conducted to assess the techno-economic performance of four sewage treatment interventions with focus on water and wastewater economics.

The two of the selected cases deploy natural and the other two mechanised sewage treatment technology. All the cases have positive features viz. (i) are community owned-managed, (ii) produce treated sewage water for re use with compost, (iii) cater to the needs of populace of distinct socio-economic profile and strata, (iv) have sustained over prolonged time, and (v) provide progressive gains in environmental assets at the respective sites.

Table1: Summary of assessment of 4 cases:

Name	Installed Capacity (KLD)	Year	Capital Cost (Million INR)
DEWATS	35	2003	0.8
Vasant Vihar, Delhi	5	2012	0.3
SOS Village, Chennai			
Modified Activated Sludge Process			
Mall Complex, Bengaluru	250	2006	10
Hotel, Bangaluru	100	2011	5

The Importance of Primary Wastewater Treatment in Slaughter House Industry

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Keywords : slaughterhouse wastewater, suspended solids, oil, fats, primary treatment

A slaughter house or abattoir is an industry where butchering of cattle is done for meat processing and other commercial purposes. This includes skin/hide for leather industry; dung for manure production; bones for poultry food, drugs, cutlery; fats for tallow manufacturing and blood for blood meal production etc. During slaughtering, allergy quantum of water is introduced which generates different wastewater streams from various slaughtering operations. This includes lairage, sticking, locally known as halal point, paunch section and various other washing and cleaning processes. These wastewater streams prominently contain suspended solids (SS), salt (TDS), meat pieces, hairs, blood, urine, internal body fluids, oil and fats and have a high organic strength. The major concern while dealing with slaughterhouse wastewater is its significant quantity of oil and fats from intestine and tripe washing, fleshing section and acid rendering plant. It also has large amount of suspended solids mainly because of lairage and paunch section. An effective primary treatment for this wastewater is necessary to ensure the steady performance of downstream secondary treatment facilities. This poster highlights the importance of primary wastewater treatment in slaughter house industry considering various solid-liquid separation equipment and devices for removing oil and fats.

Non-conventional municipal wastewater treatment based on surface filtration for the production of water suitable for irrigation

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In the framework of the Euro-India project Water4Crops (call FP7 KBBE 2012-6, contract n. 311933) long term pilot scale tests were performed for evaluating the suitability of properly treated municipal waste water effluents for irrigation. Activities were aimed at testing non-conventional technologies for the treatment of municipal sewage and the production of effluents suitable for reuse in irrigation. Tests were performed at the pilot scale, and two experimental plants were operated in order to evaluate the suitability of two different technologies and the quality of produced effluents with respect to current national water quality standards for reuse in agriculture.

Both the tested technologies were based on the coupling of biological processes and surface filtration, and two large experimental installations located at the municipal wastewater treatment plant of Castellana Grotte (Apulia Region, Southern Italy) were operated. Each of the two pilots was made of two parts: 1) a process based on surface filtration which treated a continuous flow; 2) a UV disinfection system treating only the effluent fraction used for irrigation, and operated on demand. The first plant was based on the technology IFAS-MBR (Integrated Fixed-film Activated Sludge – Membrane BioReactor, De La Torre et al. 2013), and treated raw sewage after preliminary screening.

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The second pilot plant was based on the technology FDG (Filtro a Dischi a Gravità, Gravity Disk Filter, Bourgeous et al. 2003) and treated a fraction of the effluent taken downstream the secondary settling tank of the main wastewater treatment plant. The effluents of both plants were accumulated into storage tanks and then submitted to UV disinfection operated on demand (i.e. when the irrigation line was switched on). Considering the importance of the fecal indicator Escherichia coli for the reuse of treated wastewater in agriculture, separate experiments were also performed at the lab scale to evaluate the fate of this parameter in soil (surface and subsoil). A set of soil columns was operated and monitored for E. coli concentration over time and along depth.

Results showed the effectiveness of both tested technologies in producing effluents suitable for reuse in agriculture and complying with the local standards. Soil column tests showed the decay rate of the fecal indicator as the dominant mechanism with respect to accumulation and possible leaching through the deeper soil layers.

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Role of Field Scale Constructed Wetland (CW) as bridge between Brewery Effluent and Sustainable Irrigation

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Keywords : Industrial wastewater treatment, field scale constructed wetland and corporate involvement.

In order to explore and evaluate the bioremediation potential for the treatment of brewery effluent, a field scale constructed wetland (CW) was commissioned at the Sangareddy campus of SAB MILLER. The CWwas comprised of two chambers one sub-surface cell with dimensions of 20 m X 20 m X 1 m and one holding tank for the treated wastewater of the same dimension. The sub-surface cell was having a 20 cm large (40 mm) gravel layer at the bottom, covered with successive 20 cm layers of medium (20 mm) and small gravel (10 mm) each. A 15 cm layer of coarse sand (1.5 mm) covering the small gravel layer constituted the top layer. Vegetation introduced initially were Napier (Penisetumpurpurem) and Bamboo (Bambuseae spp.). Because of long stabilization period and poor survival rate these were subsequently replaced with Cana indica. After the introduction of Cana indica the CW exhibited an average COD, TSS and inorganic nitrogen removal efficiency of 54 %, 93 % and 47 % respectively. The treated wastewater was used for irrigation in nearby black soil fields for Safflower (Khraiff) and Sugarcane (Rabi) with near normal yield. No removal efficiency was observed for sodium and chloride.

Water Quality Monitoring Using Remote Sensing and GIS Technique

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Keywords : Remote Sensing-GIS, Water quality Monitoring , Sustainable water management.

Detecting temporal changes by observing water bodies at different times is one of the most important applications of satellite sensors because of provision of multi-data imagery at short interval on global scale. The water bodies within the city and located at the outskirt play an important role being a source. Since the quality of these water resources is being hampered with eutrophication as its major cause due to introduction of nutrients through various anthropogenic sources. Hence quality monitoring of the available water resource is a basic need. A lot of experience has already been accumulated in exploring water quality techniques for medium/high spatial resolutions, but very few can be found for the new generation of very high spatial resolution Indian Satellite Sensors such as LISS-IV, CARTOSAT-I and CARTOSAT-II. This paper presents various aspects and methods related with monitoring of different water sources including lakes to oceans using Indian remotely sensed satellite data for up-to-date overviews in water quality parameter such as eutrophication, suspended matter, phytoplankton, turbidity, and dissolved organic matter. In fact the capability of this technology offers great tools of how the water quality monitoring and managing can be put to effect simultaneously within the city or country. Potential application and management is identified as key concept of sustainable water resource management. In conclusion remote sensing and GIS technologies coupled with computer integration are useful tools in providing a solution for future sustainable water management to government especially in formulating policy related to water quality.

Nutrient-Removal via Aeration Management Strategy in Cyclic Technology Based Sequencing Batch Reactor (SBR)

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Keywords: Wastewater treatment, Nutrient,Nitrifying bacteria

In today's progressively urbanized society, there is an increasing need for cost-effective, environmentally sound technologies for the removal of nutrients (carbon, phosphorous, nitrogen) from polluted water oxygen management for optimisation of nitrogen removal in a sequencing batch reactor (SBR). The first theme of the study was to validate the efficiency of N-removal by simultaneous nitrification, denitrification (SND) and phosphorous removal in the cyclic technology based SBR and investigates the dominancy of ammonia oxidizing bacteria (AOB), nitrite oxidizing bacteria (NOB) and phosphorous accumulating bacteria (PAO) population. Also, it was aimed to signify the role of PHB metabolism and the limitation during SND, which support to develop a suitable approach to manage the oxygen supply and optimize nitrogen removal by SND. Grab samples of the influent and effluent together with the aeration sludge were collected from 3 sewage treatment plants (STPs) of C-tech based SBR at Abohar, Haridwar and Dehradun and analyzed. Analytical measurements of Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), ammonia-

nitrogen (NH3-N), nitrate-nitrogen (NO3-N), total kjeldahl nitrogen (TKN) and phosphorus (PO4-P) in influent and treated wastewater, total mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solids (MLVSS) and oxygen uptake rate (OUR and SOUR) in the system were performed according to the Standard Methods [1]. Along with bacterial population through heterotrophic plate count (HPC) was enumerated [2]. 16S rRNA analysis using universal bacterial primers was concentrated to study the phylogeny of the bacterial diversity prevailing in the system [3].

Observations of the study revealed that the SBR system performed efficiently with high removal percentage of COD (>80%), BOD (>90%), ammonia-nitrogen (>80%), and phosphorus (>80%). Nitrate-nitrogen increased about >80% in the effluent.Denitrification takes place in MLSS and MLVSS of the aerated sludge were >3500mg/L and >2000mg/L and OUR and SOUR were ?20mgO2/L.h and ?10mgO2 g-1VSS.hrespectively. Culturing techniques demonstrated the FC for the inlet sample ranged in 2300-1500mg/L which reduced to nil for the effluent. HPC for inlet was 1500-800 CFU/100mL and 25-55 CFU/100mL in effluent. 16S rRNA analysis illustrated the dominance of Ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) demonstrated the higher nitrification and denitrificationefficiency of the SBR system.

Aforementioned results focused that the plant were working well producing good water quality effluent. Bacterial populations decreased in the due course of treatment resulting in almost pathogen free effluent.

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Mathematical Modeling of Solid Waste and Leachate Management: An Analytical Study

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Keywords: Garbage, Groundwater, Landfill, Leachate, Optimization, Solid Waste treatment

Municipal Solid Waste (MSW) is an increasing concern for both developed and developing nations as it contributes greatly to global warming having a major environmental and health impact. Rapid urbanization leads to disproportionate increase in the volume of garbage generated, compared to the availability of processing units and landfills. Leachate is a kind of liquor that precipitates from dumped waste after rainwater has entered the landfill. Leachate generation poses significant threat to surface and groundwater in area surrounding landfill. This paper analyzes the effect of leachate on groundwater in four major landfill sites of Pune city in Western India. Since allowing Leachate seepage will contaminate ground water, an optimal time factor has to be taken into account before shifting of the garbage. Hence optimization here has two major aspects; one is treatment of the waste at the zonal level and the second one is transportation to a safer zone for further processing purposes. A mathematical optimization model has been developed using mixed integer

programming wherein the parameters are Vp (source unit at Prabhag level), Vw (transfer unit at ward level), Vz (processing unit at zonal level), and Vl (land fill unit at city level). One of the most important aspects in optimizing the cost of transportation and the hazard involved in the process is the time gap one can allow for shifting of the waste collected at particular zones. The parameter Vz needs to be observed with extra care and the processing cost has to be accounted for before going for overall optimization. The model is at the analytical stage now and our efforts are on to go ahead with the computational aspect to gain more insight, making it useful for municipal waste (solid or liquid) treatment (or management).

Defluoridation from water by Used Tea Powder and its Activated Carbon form

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Keywords : Activated carbon, Adsorption, Defluoridation, Isotherm, Used Tea Powder.

Fluoride is important groundwater pollutant. Increasing fluoride concentration in groundwater is serious problem across the globe.The present study focuses on use of used tea powder and its activated carbon form for defluoridation from water. Batch adsorption study is conducted for both type of adsorbent with variable parameters such as contact time, adsorbent dose, pH and initial fluoride concentration and activation temperature for activated used tea powder. 120 and 90 minutes is found to be optimum contact time for used tea powder and its activated carbon form. Near neutral pH, removable efficiency increases. Excessive alkaline and acidic conditions are not favorable for defluoridation. Removable efficiency of fluoride increases with increase in adsorbent dose but decreases with increase in initial fluoride concentration after 5 mg/L for both adsorbents. Activated carbon prepared at 7000C is most efficient for defluoridation and gives 90% efficiency. The applicability of Langmuir and Freundlich adsorption isotherm is tested for used tea powder and its activated carbon form and it is found that Langmuir isotherm is best suited for both types of adsorbents.

Evaluation of Existing Water Distribution System Using EPANET

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Keywords: EPANET, Hydraulic integrity, Water distribution system.

Water has always been certifying as a primary good and an indispensable natural resource. As the standard of living increases, so dose the need for consumption of water for various anthropogenic activities. In general more people use more water. Even if the amount used individually is decreased by education, the implementation of conservation practices or technological developments in water distribution systems (WDS) are necessary. Today there is the pronounced focus on how to make the existing water distribution system more efficient in urban sectors. The purpose of this studyis to assess the performance of drinking water distribution system at proposed area of Nagpur city, using hydraulic simulation software and to address any developments require to existing infrastructure, in order to improve the quantity and quality of water

distribution to consumers. Results of model simulation obtained using EPANET identify critical area with respective pressure at various nodes. The suggestion made for controlling leakage and maintaining hydraulic integrity of the system.

Decentralized wastewater treatment and reuse using engineered wetland ecosystem in Kothapally village of Telengana, India

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Keywords: self-help group, constructed wetland, field scale, community participation

High skill and energy intensive wastewater treatment technologies are often unfeasible for small rural communities with limited resources and power supply The involvement of local self-help groups, community participation in decision making and post-implementation hand-holding was found to be crucial for successful implementation of any kind of technological intervention at the community level is often difficult and under emphasized. A field scale CW was used for the treatment of wastewater from hundred village households in the Kothapally village of Telengana in the present study. The CW was vegetated with hybrid Napier. High removal efficiencies were observed for total suspended solids, chemical oxygen demand, sulfate and inorganic nitrogen consistently. The pathogen removal efficiency was eighty seven percent in terms of measured in terms of Escherichia coli. The revenue generated through treated wastewater as well the biomass produced validated the economic sustainability of these engineered ecosystems.

Optimization of different variables used in Fenton Reagent Process for removal of Direct Red 80 dye

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Keywords: Direct Red 80, Fenton Reagent, Textile waste.

With an increasing use of dyes in pharmaceutical, food, paper, textile industries etc., huge amount of coloured waste is being discharged into the ecological system. The dye waste so exuded into the water bodies consequently increases the toxic nature of the water. Synthetic dyes make water unfit for human consumption & also increases the turbidity of water which in turn scatters the sunlight and prevents photosynthesis amongst marine vegetation. In this context of treating the textile waste prior to the discharge, a technique involving Fenton's Reagent was utilized to remove Red dye. The observations were made using Direct Red 80 dye with a concentration of 150 mg/L at various pH values&time instants, by treating them with different concentrations of Hydrogen Peroxide & Iron Sulphate. The colour removal was investigated using spectrophotometer & result was computed for optimization of different independent variables.
The experimental study so conducted came out with 99.77% of colour removal. The ideal operating conditions were found to be somewhere around pH = 3.5, H202 dose = 330 mg/l and FeSO4 dose = 30 mg at 30 minutes of reaction time.

Quantifying Potential Health Improvement by Household Water Treatment in Rural India

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Keywords: challenge testing, disinfection, household water treatment, quantitative microbial risk assessment

Drinking water safety in rural India is challenging leading to prevalence of water borne diseases. People use multiple routes for drinking water supply throughout the year. We assessed the health risk from different routes by quantitative microbial risk assessment (QMRA) and also estimated the effect of various interventions to reduce health risks. We found that for the short term, household water treatment (HHWT) will play a key role in protecting health. This requires reliable removal or inactivation of a range of pathogenic microorganisms. In this study, we compared three different commercial HHWT options (including membrane filtration and free chlorine disinfection) that are primarily designed to upgrade tap water. Since tap water is not part of all supply routes, especially in rural areas, we tested the reduction of pathogenic surrogates (Escherichia coli and MS2 viruses) under normal and challenging conditions by synthesizing river water. We found significantE. coli reduction ($\geq$ 4 log10) and lower MS2 reduction ($\leq$ 3 log10) under normal conditions. Hence, these systems can be effective in disinfection. However, water of challenging quality like river water needs pre-treatment. Since not all systems operate properly with challenging water quality, a quality assurance for HHWT options needs to be established.

"Water At Door-step" for Nutri Garden and other uses: Case study of Pathardi Village, Palghar

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Keywords: water accessibility, grey-water treatment, malnutrition, nutri-gardens, women health,

Access to water resources has always been a challenge in tribal villages of Palghardistrict, Maharashtra. Asurvey of 50 householdsinPathardi village, conducted by TERI, revealed that to fetch potable water, women walk1-1.5 kms twice a day, carrying 20-25 litres per trip,which results in immense physical exhaustion.In another survey, themicronutrient deficiencies, especially iron, vitamin D among children under 5, pregnant and lactating womenisalso persistent.
Providing watersources for food and to minimize stress level of women is thus of paramount importance. The average consumption of water is 145- 150 litres/household (HH); of which 60-80 litres of grey water/HH is recyclable.Villagers may reutilize it for cultivation of vegetablesor secondary applications. To facilitate this, grey-waterfiltration systems wereinstalled by TERI in few households at Pathardi.Further, for greater impact and sustainable implementation, youths were trained for installation of the treatment systemsand toencourage its replication at other villages. Such renewed water sourceswould definitely decreasewater fetching trips, and directly ensure yearlong supply of water to grow diverse food varieties.Further researchis required to increase the efficiency of these systems.

AQSWAT assisted DPSIR approach to assess water challenges in Indian communities under data limitation

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Keywords: Drinking water, DPSIR model, India, riverbasin, water management

Rising water demands, deficits in wastewater treatment and changing climatic conditions have led to water scarcity and pollution in many Indian regions, threatening society and ecosystems. In the EU Water4India project drinking water treatment options are studied to develop smart and cost-effective solutions and decision support for Indian communities. The selection, implementation and later evaluation of solutions to overcome challenges are site-specific and a wide array of information has to be considered to derive a robust synthesis of the local water situation. Modelling of water quantity and quality in river basins using remote sensing data such as topography and land cover combined with statistical data can help overcoming data limitations, planning cost-effective water monitoring programmes and comparing alternative future scenarios. The approach presented here entails a structured cause-effects chain of water challenges using Drivers-Pressures-State-Impacts-Responses (DPSIR) with the semi-distributed river basin water modelling tool SWAT. The plug-in QSWAT which was recently released links SWAT to the open source geographic information system QGIS. We applied the framework to communities in Karnataka State, representative for the quickly developing peri-urban/urban context in India.The framework allowed (i) deriving a structured description of the site-specific water situation and challenges, taking into account environmental, economic and socio-technical aspects, (ii) estimating effects of future developments such as further population increase, and (iii) defining possible measures to overcome challenges. Combining DPSIR with water models is proposed as practical way to develop more robust interdisciplinary and multi-stakeholder riverbasin understanding of water challenges and help bridging communication gaps between different government and non-government bodies.

Trickling-Filter-Based Solutions for Urban Wastewater Treatment and Reuse in India

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Keywords: reclaimed water reuse; sustainable solutions; trickling-filter; wastewater treatment.

Trickling-filter systems (TF) are not new in India. However, they have not been widespread as much as other conventional technologies (i.e, activated sludge). Malfunctioning and low performances, mainly related to an

inadequate design and lack of proper operation, seem the reasons for that poor implementation. On the contrary, TF solutions are commonly adopted in Europe for sustainable wastewater treatment due its robustness, high-efficiency, easy operation and relative low-costs in comparison with other intensive technologies. Concretely, in Spain TF have been successfully adopted for a wide range of populations, serving both small and decentralised systems (< 2000 population equivalent, PE) and large populations (> 10.000 PE). TF are flexible technologies and can be combined with multiple units (upstream and downstream) to meet the legal requirements for treated water discharge or reclaimed water reuse.

In the frame of SARASWATI project, two wastewater treatment plants (WWTP) based on TF technology with plastic filtering media have been planned in Madhya Pradesh State: one in Burhanpur, (38,000 PE, in 2045) and another in Raisen (8,000 PE, in 2045) (PE: population equivalents, 1 PE = 2.2 persons). The estimate was based on a daily organic load of 27 g BOD/inhabitant and a daily hydraulic load of 108-111 liters/inhabitant. In both cases, the flow-chart includes pretreatment (screening and grit&grease chamber), Imhoff tank (as primary treatment), TF, secondary settlers and unplanted drying beds (sand and gravel filters) for sludge dewatering. This initial flow-diagram can be easily complemented with sand filters and chlorination for guaranteeing the fulfilment of Indian standards for water discharge and reuse. This combination of technologies responds to the need of affordable treatment solutions for the users from very poor neighborhoods, who will be responsible for the running costs. Besides, TF are not subjected to abroad- technological items since all its components can be provide locally.

Currently, both facilities are under the tendering process and will be constructed in a near future employing a large number of local workers, and involving the final end-users.

Establishing effective decentralized wastewater treatment for direct safe water reuse under the SWINGS project

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Keywords: Constructed wetlands, decentralized treatment, developing countries, disinfection India, low energy input.

Safeguarding water resources in India with green and sustainable technologies- (SWINGS)" is a project in the framework of cooperation between the European Union (EU) and India DST. The projectaimsto develop decentralized low cost optimized treatment schemes, employing state of the art wastewater management and treatment systems to make full use of water resources while maximising energy savings SWINGS targets at combining available "green" and sustainable technologies to produce treated wastewater to be reused on site in productive activities such as irrigation, nutrient supply, soil enrichment and aquaculture activities, while

assuring no risk due to pathogen exposure and fulfilling with the national discharge standards. Additionally, the project called for the formulation of decision making tools and the development of quick determination methods for pathogen presence in the reused waters. Furthermore, SWINGS seeks to strengthen effective cooperation among the partners and to ensure knowledge and technology transfer.

The project started more than three years ago and planned to establish treatment facilities in four cities in India, including complete wastewater treatment (WWTP) and reuse for 1000 population equivalent at the campuses of IITD in Delhi and Aligarh Muslim University (AMU)both followed by tertiary treatment and disinfection units.At the International Center for Ecological Engineering of the University of Kalyani and the Indira Gandhi National Tribal University where wastewater facility already exists the planned was to stablish disinfection units to allow safe reuse.

The technology selected for WWTP at AMU wasa combination of UASB and constructed wetlands and for disinfection several technologies were installed and are being tested, namely solar powered anodic oxidation and UV. For the WWTP at IITD the selected technology was constructed wetlands but after the French development that doesn't use primary treatment. This system was not installed at IITD but is now established at the AMU site. For Kalyani the disinfection plants include passive bank filtration solar powered anodic oxidation and UV. For the IGNTU campus and since the current WWTP doesn't produce acceptable water quality it was necessary to design and construct a planted gravel filter to improve the quality before the anodic oxidation disinfection unit. Concomitant to the establishment of the technology, SWINGS has held training seminars in India and mobility and cooperation between theIndian and the EUpartners has been constant and effective.

There have been some delays in the establishment of the plants due to bureaucratic issues out of the control from the partners but currently all the plants are operative and have been producing treated water and generating data to support the research of the universities involved. Additionally to the state of the art infrastructure installed the sites are giving the opportunity to research and a showcase in decentralized wastewater treatment technologies suitable to be applied and that is already being replicated in other places of India. The SWINGS project has also given the tools for future research and set high standards for the treatment and reuse of wastewater.

Results from the three year EU/ India SARASWATI joint research project on GROW and GROW Hybrid successfully turning 'grey' wastewater into reusable 'green' water at IIT-M (Chennai).

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Chennai is a coastal city which meets 50% of its daily domestic consumption from ground water sources such as wells and boreholes. It is under the constant threat of sea water intrusion resulting in the progressive deterioration of water quality. The local government has made 'grey' water recycling mandatory for all buildings in Chennai, therefore a simple solution is required to meet this aspiration and to work towards solving the shortages of useable water in the wider community. The practical application of the research at Chennai will be of invaluable use across India.

Mr C.J. Shirley - Smith as Consultant to HYDROK Ltd has been working closely with The Institute of Indian Technology Madras (IIT- M) to design, install and monitor a simple, cheap and effective system of wastewater treatment to produce 'green' water (of high quality for secondary use) which will be appropriate for many applications particularly in rural communities in India. The funding for this research was made available under the SARASWATI (Joint India/ EU) funding programme.

The initial GROW installation donated by the UK partner HYDROK/ AWS was subsequently scaled up by IIT-M to mimic the reuse 'green' water requirements of a rural community. The scaled-up system is known as the GROW Hybrid since it contains elements of both Horizontal and Vertical Flow filtration systems. The results show very positively that the application of this simple, feasible and inexpensive technology can easily be constructed and managed by local communities especially in rural settings (of India) using predominantly local materials and plants as cleansing media. This installation partially relieves the burden on the potable water supplies whilst 'green' water can safely be used for a wide variety of applications especially for toilet flushing, agricultural irrigation, personal hygiene, public area cleansing and to reduce pollution levels in discharged waters.

The source of 'grey' water for this research was the Krishna Hostel for male student s at IIT-M, and treated 'green' water was returned to the hostel for toilet flushing. This situation is easily replicable throughout India and will contribute greatly towards India's water deficit.

Natural Water Treatment Systems for Safe and Sustainable Water Supply in the Indian Context : Insights from the Saph Pani Project

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Keywords: Water resources management, water reuse, water supply, managed aquifer recharge; bank filtration, wetlands

The presentation summarizes key outcomes and insights from the EU FP7 Project "Saph Pani" - a three-year EU-India collaborative project with a consortium of 20 partners from Europe, India, and Australia. With the aim to improve natural water treatment systems (NTS), it studied treatment methods such as Bank Filtration (BF), Managed Aquifer Recharge (MAR), and constructed wetlands on a total of nine case sites in India, building local and European expertise in this field. The overall objective was to enhance water resources and water supply, particularly in water stressed urban and peri-urban areas.
A good understanding of bank filtration performance as a function of operation and design was established. The applicability of technology was extended through an assessment of flood risks and development of flood-proof designs and other measures. A survey of other existing sites broadened the experience base and allowed identification of potential new BF sites. Special attention was given to the polluted waters (nitrogen species) in Delhi and the adjoining aquifers, representative of the conditions in the Gangetic plain. The specific cost of production was determined to be less than 0.10 €/m3 (7 INR/m3) a factor three lower than surface water abstraction followed by conventional treatment.
Based on field results and modeling, MAR performance was reliably quantified. Up to now limited data on MAR influence on quality was available and the project gave new insights, for example with regards to geogenic fluoride contamination, pathogen die-off, organic pollutant elimination and dilution effects. While NTS have a high potential for increased application in India not all pollutants often found in high concentrations can be sufficiently removed by NTS. Thus pre- and post-treatments for NTS in India and the critical water quality parameters of concern were determined.

Wastewater Treatment in Short Rotation Plantations

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Keywords: wastewater treatment, biomass production, short rotation plantations,

The treatment of wastewater in short rotation plantations (SRP), plantations of fast-growing trees that are harvested in intervals of only a few years, has three important advantages: potable water for irrigation will be saved, the wastewater will be treated naturally and cheaply and the production of wood will be increased through additional nutrients. Such a wastewater treatment system was installed in Nagpur, Maharashtra, and will be taken into full operation soon, in order to confirm the feasibility of the concept.An SRP with a size of 0.32 hectares, one half planted with Melia dubia and the other half planted with Bambusabambos, both fast-growing native species (tree and bamboo), will be irrigated with municipal wastewater pre-treated in a constructed wetland, and the effects on the environment and the produced biomass will be observed. Further details on the concept, the methodology (e.g. the planning and the operation of the plantation as well as the monitoring of the effects of the wastewater application) and on the expected results will be presented.

Pilot-scale Experiments in a Hybrid-Constructed Wetland System for the Treatment of Wastewater in Peri-urban areas of India

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Constructed wetlands (CWs) constitutea nature-based solution with great application potential in the context of decentralized sanitation, especially for developing countries due to their low cost and ease of operation and maintenancewhen compared to conventional wastewater treatment systems. The current study presents the experiences gained during the operation of a pilot-scale hybrid CW located in Barcelona (Spain) within the context of the NaWaTech project (Natural water systems and treatment technologies to cope with water shortages in urbanized areas in India). The aim was to assess the performance of the system when operating under various organic loading rates (OLRs), and with different primary treatments. A simulation of monsoon was also conducted so as to test its potential to be applied in the context of peri-urban areas of India.

The study was conducted at the facilities of the UniversitatPolitècnica de Catalunya in a CW system thattreated urban wastewater collected from a nearby sewer since 2010. Two 1.5 m2vertical subsurface flow (VF) wetlands alternated cycles of feed and rest (3.5 days each), and were followed by a 2 m2horizontal subsurface flow (HF) and a 2 m2 free water surface (FWS) wetland in series. In the interval from June 2012 to

May 2014 the system worked under two operational conditions (high and low organic and hydraulic loading rates). In period I (June 2012 - May 2013) the primary treatment was an Imhoff reactor, and the system was operated under a flow rate of 200 L d-1(OLR = 9.8 g BOD5 m-2 d-1). In period II (May 2013 - May 2014) the system had a hydrolytic upflow sludge blanket (HUSB) reactor as primary treatment, and operated under a flow rate of 800 L d-1 (OLR = 103 g BOD5 m-2 d-1).

Results show that removal efficiencies for the organic matter and solidswere similar for the two periods, being of 76% COD, 92% BOD5, and 98% TSS for period I, and of 82 % COD, 93% BOD5 and 96% TSS for period II. Conversely, the removal of NH4-Nseemed to be affected by the OLR, showing an average efficiency of 96 ± 6 % during period I, and of 75 ± 21% during period II.The high OLR of period IImay have presumably limited the growth of autotrophic bacteria responsible for the oxidation of NH4-N due to limited oxygen transfer into the bed. The Imhoff tank showed better performance than the HUSB reactor (83 ± 8% and 30 ± 10% TSS removal for Imhoff and HUSB reactors, respectively). Removal efficiencies achieved during the simulation of the monsoon did not vary significantly from the normal operation, showing a good buffer capacity to cope with large fluctuations in flow and organic load.In general, the system proved to be a robust system capable of handling large fluctuations in water quantity and quality, appropriate for the treatment of wastewater in peri-urban areas of India.

Smart Approaches for Integrated Urban Water Management : Interlinking Lakes of Ahmedabad

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Cities are gifted with innumerable water bodies but due to urbanization, lack of concern and awareness towards water bodies, these assets are getting depleted. Many have been shrunk in size due to landuse change or encroached by slum settlements, while others are polluted due to discharge of sewage, solid waste and industrial waste. Road construction and Building construction activities creates blockages to natural drainage system resulting into water logging and flooding. Excessive paved areas in the city also lead to less percolation of water.As years are passing by,city boundaries started expanding, but the number and size of water bodies are decreasing. In this rapid urbanization process, quality and quantity of water bodies are at stake.

Ahmedabad, one of the rapidly growing city, has come up with the concept of Interlinking of Lakes. It has interlinked 10 lakes in Western Ahmedabad and there are 33 more in pipeline. Lakes are getting interlinked manually by laying down storm water pipes without watershed analysis. In Town Planning schemes, being implemented by Ahmedabad Urban Development Authority (AUDA), lack of integration with natural topography is seen. Integration of natural streams with surrounding land use should be done right at the planning stage, before designing any town planning schemes. There is a need to not only restore water body but also integrate it with surrounding land use. A conserved water body will not only solve water related issues but also increase social and economic activity as well.

With this background, current study tries to check the viability of integration of lakes through watershed analysis using Geographic Information System (GIS) tool. Lakes which are already interlinked by AUDA are identified in watershed map. The watershed map is than superimposed with Development Plan 2011 for detail analysis. Subsequently, landuse of two interlinked lakes namely, Thaltej and Prahaladnagar along with their streams are analyzed. The study concludes with recommendations to be incorporated while designing a new Town planning scheme.

An overview on arsenic contamination in groundwater: health hazard and recent advances in its removal techniques

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Keywords: adsorption, anthropogenic, arsenic, contamination, groundwater, geogenic, health effects

Arsenic pollution in groundwater and its severe effects have been recognized as a major health concern globally. Arsenic is a noteworthy metal which shows significant health effects when consumed in excess. In groundwater it is mostlypresent as oxyanion compounds. Groundwater is polluted by Arsenic through various sources; naturally through the reduction of iron oxyhydroxide (FeOOH) by bacteria with subsequent desorption of arsenic from the iron surfaces, and anthropogenic activities like excessuse of pesticides, herbicides, crop desiccants, additives to animal feed and from different industrial effluents. Chronic exposure of arsenic to groundwater with concentrations significantly >50 µg/L leads to the hazardous effects that include; skin, cardiovascular, renal, hematological and respiratory disorders. Different techniques are available, for removal of arsenic from groundwater, which includes; Adsorption, Ion exchange, Membrane process, Chemical precipitationetc. The method that can be used for the removal of arsenic are depending upon the factors like; cost of treatment, handling complexity of the technology, demand of skills to operate the technology etc. In this paper, the hazardous aspects of arsenic, sources of contamination and available technologies for arsenic removal with respect to feasibility, efficiency and cost are briefly reviewed.This paper also compiles recent advances, development, present status and future scope of onsite arsenic removal facilities from groundwater in India.

Space Based Technological Solution of Water Management: A Futuristic Approach of Digital India

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Key words: Space Technology, Remote sensing and GIS, Satellite data, Water monitoring sites Planning and Management.

The existence of many civilizations (for example-Harrappa and MohanJodado) in the world near water bodies or the bank of the river (Indus river) are the great example and symbol of the importance of water for the routine as well as sustainable life. In the fast growing developmental era urbanization and industrialization is also the key factor of the fast growing economy of the India in the international market. Due to over population ,pollution, ozone depletion, global warming, climate change and disasters the world's space agencies are searching for the goldilocks zones (Earth like similar planet). The Government agencies are also planning for the most effective management of natural resources and non renewable energy resources for the sustainable development in this environment.

Now a day's metropolitan city Lucknow, capital of Uttar Pradesh (very famous city of Nawabs) are suffering from the scarcity of water due to some anthropogenic factor like concretization of parks, footpath and open areas, high rise building construction due to mobilization of rural towards urban sectors for the fulfillment of their livelihood. Space based Remote sensing and GIS technology are playing very effective role which providing the fruitful result in this digital world of India and now India become model for the whole world. The satellite data based information (Elevation, slope, aspect data etc. from CARTODEM etc. through ARCGIS 10.2 software) providing the sites for the water quality and water station monitoring sites can help to the government in District level, Block level, Tehsil level and village level planning for the water quality to checks the health issues and water monitoring sites for the proper planning and management of the digital world. This integration of technology for urban water management act as lab to land technology transfer, need of the recent times which also conserve the natural resources, save time and energy directly influenced in the economical growth of the nation.

Performance evaluation of low-cost air-cathode microbial fuel cell modified with ceramic cathode assembly by titanium di-oxide nano particles

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Keywords: Coulombic efficiency, Microbial fuel cell, Nanoparticles, TiO2, Wastewater treatment.

Microbial fuel cell (MFC) is a leading-edge technology that cansuccessfully approach towards energy production and simultaneous wastewater treatment.In this study the performances of air-cathode MFCs using nano-TiO2 catalystmodifiedcathodic assembly was tested. Two ceramic cylinders of working volume 2.5 l were used as anodic half-cell.MFC-1 was coated with layers of C/TiO2suspension with a loading of 0.5mg ofcarbon powder (XC 72/cm2), 0.75 mgof TiO2/cm2, hydrophobic binder Polyvinyl Alcohol (PVA) at 1.5mg/cm2 and Acetone, whereas, MFC-2 with same configuration but without catalyst modificationwas operated as a control. Synthetic wastewater having sucrose as carbon sourcewas introduced in a fed-batch mode for inoculum of mixed anaerobic bacteria.

The comparative study showed that MFC-1 had nearly 10% higher COD removal efficiency than in MFC-2. The polarization study revealed the maximum volumetric power density of 1.021 and 0.958 W/m3with respective coulombic efficiency of 2.09 % and 1.91 % for MFC-1 and MFC-2. It was also observed that MFC-2 was highly affected by salt deposition and bio-fouling on cathodicsurface than MFC-1. These findings demonstrate that low cost TiO2 nanoparticles are a potent alternative as cathode catalyst and fouling reducing agent in air cathode MFC.

Enhancing nitrogen removal using a two-stage vertical flow constructed wetland

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According to the Austrian design standards (ÖNORM B 2505, 2009) the requirements of the Austrian regulation (1.AEVkA, 1996) regarding maximum effluent concentrations and minimum removal efficiencies can be met using single-stage VF CWs operated with an organic load of 20 g COD.m-2.d-1 (i.e. 4 m² per person equivalent (PE)). A two-stage VF system has been developed to increase nitrogen removal. By using this new design the nitrogen removal efficiency was more than 60 % at high elimination rates of about 1300 g N.m-2.yr-1 (Langergraber et al., 2008, 2011).

The poster describes the first full-scale implementation of the two-stage CW system. The system was designed for the Bärenkogelhaus, a restaurant that is located on top of a mountain, was built in 2009 and taken in full operation in spring 2010. Results on the system performance are presented with a special focus on the performance with peak loads that occurred during events on weekends.

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Development of pilot scale solar photocatalytic reactors for the treatment of templepond water polluted with oil emulsion.

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Keywords: Ag impregnated TiO2, Pilot scale slurry reactor, Solar photocatalysis, Waste water treatment.

Shri Saneeswaran temple, located at Thirunallar, Karaikal, Pondicherry is dedicated to Lord Saneeshwar and thousands of devotees visit every day to take bath in "NalaTheertham", the sacred tank (holy pond) with sesame oil to cleanse their sins.In this present investigation, the temple tank water highly polluted with dirt and oil emulsions was treated with pilot scale photocatalytic reactor with Ag impregnated TiO2 under sunlight. The effects of various operational parameters such as, catalysts concentration, pH and addition of oxidizing agent- H2O2were optimized for the degradation organic contaminants. The results show that,

slurry operated with 300 mg/l catalyst concentration shows 98% of COD reduction (with initial COD value 1260 mg/l) within in 4 hrs of solar irradiation. Better COD reduction was observed at an optimum pH 2. Addition of oxidizing agent, H2O2 significantly increases the rate of COD reduction. Within 2 hrs, 98% of COD reduction was observed when the reactor was operated with optimum operational parameters like catalyst concentration of 300 mg/l, pH 2, addition of 250 ppm of H2O2 and a flow rate of 15 L Hr-1.The results clearly reveal that pilot scale solar photocatalytic reactors could be used for the treatment of temple pond wastewater and the resulting clean water could be reused for various purpose.

Comparative Study of Refractory COD removal from Pharmaceutical Wastewater

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Keywords: Pharmaceuticals; Common Effluent Treatment Plants (CETP'S); Refractory COD; Ammonical Nitrogen; Biodegradability Index; Advanced Oxidation Processes

Water is one of the most valuable resources on planet earth. During the last few decades, the rise of world population as well as industrial revolution has caused serious environmental pollution. Production and use of large quantities of pharmaceuticals for human and veterinary applications could lead to the release of more pharmaceuticals substances into the environment. India is the third largest producer of pharmaceutical chemicals after the USA and Europe and its turnover is expected to reach US$74 billion per year by 2020.

The main problem to operate Common Effluent Treatment Plants (CETP'S) in Gujarat is the inlet and outlet criteria's including refractory COD and Ammonical nitrogen present in the industrial wastewater.Primery and secondary treatments are not able to remove the refractory COD and Ammonical nitrogen. To Treat and improve the biodegradability index of wastewater, various advanced oxidation processes (AOP's) adopted for the removal of refractory COD individual and in combination including H2O2 , TiO2 , HCO3-, Fenton and Fenton/ozonation treatment. Among various methods, Fenton/ozonation treatment is more preferable to improve the biodegradability of pharmaceutical wastewater.

Natural and polishing treatment for removal of Pharmaceuticals and Personal Care products from urban sewage

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Keywords: Constructed wetlands; domestic wastewater; granular activated carbon (GAC); PPCPs; water reuse.

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Pharmaceuticals and personal care products (PPCPs) have been detected in water bodies and wastewater around the world. Conventional sewage treatment plants (STPs) are not very effective for the elimination of PPCPs. Hence, polishing treatment by advanced oxidation processes (AOPs), Nano filtration (NF) and adsorption on granular or powdered activated carbonis further required. However, the cost incurred in the implementation of someof these treatment schemes is fairly high.In this regard, a combination of low cost natural treatment systems such as constructed wetlands with granular activated carbon column emerge as a good alternative for PPCPs removal andwastewaterrecycle and reuse.

The presentstudy deals with prevalence of PPCPs and theirfate in a sewage treatment plant of capacity 100 m3/day. The STP is designed to treat sewage generated in a residential colony of 1000 population equivalent in Nagpur city. Analytical methodology includes pre-concentration using Solid Phase Extraction followed by detection using LC-MS analysis (USEPA-Method 1694) and HPLC.The assessment will establish the efficacy of the treatment plant for eliminatingdifferent therapeutic classes ofemerging contaminants such aspharmaceuticals, antibacterial agents etc. from sewageusing natural and polishing treatment by constructed wetlands and Granular Activated Carbon (GAC) column respectively.

TiO_2 supported polythene films for photocatalytic degradation of two dyes Methylene blue and Rhodamine B in presence of solar and ultraviolet irradiation.

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Key words: Polyethylene immobilization; sol gel synthesis, Photocatalysis; dye degradation.

TiO2 is known to be an excellent photocatalyst for thedegradation of various organic compounds, dyes and disinfection of microorganisms. However, the post separation of TiO2particles from the sample limits itspractical application.This present investigation report studies on commercial TiO2 and sol gel prepared TiO2immobilised on polythene film(PE) by microwave heating method. Methylene blue and Rhodamine B were used as model dye pollutants to investigate the photocatalytic activity of the TiO2 supported PE films. TiO2 coated polythene films were allowed to interact with the dyes in a batch mode under UV and Sunlight.Effect of various additional parameters on photocatalytic degradation of dyes like initial dye concentration, catalyst loading and pH were studied. Compared to commercial TiO2 supported PE films, sol-gel prepared TiO2 supported PE films showsbetter photocatalytic activity for the decolouration of the both dyes. Methylene blue shows more decolourationwhen compared to Rhodamine B under sunlight/UV light. The TiO2 supported PE films were reused for four cycles and the repeated reuse shows only a negligible reduction in the photocatalytic activity. This TiO2 supported PE films could be effectively used to treat various dye pollutants.

A critical review of treatment wetlands employing SWOT analysis

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Keywords: Treatment wetlands (TWs), SWOT analysis, ecosystem, wastewater, effluents

Treatment wetlands (TWs) are man-made engineered systems designed to emphasize specific characteristics of wetland ecosystem for improved treatment capacity. They can be used for secondary treatment or higher. They can also act as a buffer system in existing secondary plants and add-on to lagoons. They have been widely used on a global scale for remediation of domestic wastewater, mine water, urban storm water and industrial wastewater. The plant species affect the chemical processing and removal of contaminants from TW. The growth cycle releases nutrients, supplies oxygen to water, the litter and stems provide a niche for microbes that helps in degradation process. The carbon content of the plant provides energy for heterotrophic denitrifiers.

The TWs can be built on existing upland sites, one of the least costly, and are easy to operate and maintain. They provide habitat benefits as natural wetlands. Being a biologically productive ecosystem, they can transform most of the contaminants of concern present in conventional wastewater into harmless byproducts or essential nutrients. The weakness of TWs is that they are influenced by a variety of biological processes and biogeochemical cycles. Pretreatment and polishing of effluents are important and they are commonly not used as a standalone method. The performance may also vary significantly according to year, organic and hydraulic loading, weather conditions and vegetative communities.

Despite the acceptance and implementation of TWs on a global scale, they are yet to receive an attention in India which they deserve. The present study deals with assessment of TWs with the help of SWOT matrix, employing available information. SWOT analysis employs sorting the system attributes into four categories viz. strengths, weaknesses, opportunities and threats. Strengths and weaknesses are considered as internal factors over which some measure of control is possible. On the other hand, opportunities and threats are considered to be external factors over which no control is possible. SWOT analysis helps in critically reviewing the issues related to the performance, efficiency and implementation of TWs. The interpretation leads to a deeper insight into the factors resulting in good performance, research needs, uncertainties and emerging challenges.

Sustainability Assessment of Urban Water and Sanitation Systems employing Multi Criteria Decision Making and SWOT Approaches

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Keywords: Analytical Hierarchical Method (AHP), Multicriteria Decision Making Method (MCDM), Sustainability, SWOT Analysis.

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In the last few decades, the world has witnessed rapid urbanization. This trend has led to an increase in water demand, problems with proper sewage disposal and issues with the storm water drainage network. The water supply and sanitation sector in India suffers from chronic inefficiencies, including limited coverage and poor quality services. In order to overcome these issues at ULB level, Government of India (GoI) had launched Jawaharlal Nehru National Urban Renewal Mission (JnNURM) to augment the capacity building of ULBs in India. The urban service delivery aspect covered the status of water supply, waste water, solid waste management and storm water drainage. This paper discusses a framework proposed for assessment of sustainability of water and sanitation systems employing two methods viz. Multi Criteria Decision Making (MCDM) method and SWOT analysis method.

The MCDM method presents a capability of providing a hierarchical quantitative framework and a process of holistic integration of diverse components. The system to be studied is divided into major interacting components e.g., water supply, waste water, solid waste & storm water sub- system, presented as third level indicators. Each third level indicator is divided into a set of second level indicators (For e.g. status of utility, governance & maintenance, Environmental issue & economy) which in turn, is further subdivided into basic indicators. The basic indicators are so selected that their quantitative values may be computed with the help of available information or field monitoring. Rational opinion is needed to enable the quantification of priorities and for ascertaining best & worst values of each basic indicator. Sophisticated techniques like Analytical Hierarchy Process (AHP) may be employed to remove subjectivity in consideration of the weighting structure. The final composite index value has a minimum score of 0 and maximum score of 1. The SWOT analysis framework, on the other hand, is an important tool for analysing system strengths, weaknesses, opportunities and threats. It facilitates to focus on enhancing strengths, managing weaknesses, taking the greatest possible advantage of the available opportunities alongwith minimizing threats, enabling decisions which are important in order to make further steps towards achieving sustainability.

Decentralized Small Sewage Treatment Plants: Smart Choicefor Urban Systems

P.K. Bansil[1], Himanshu Joshi[2]

A common trend in many countries including India till recently has been to put up Sewage Treatment Plants (STPs) of large size (100-150 MLD or larger), far removed from the periphery of a city and by the side of rivers/ natural drains or other water bodies. The general argument provided has been that these plants raise an offensive smell and may neither be safe nor aesthetically suitable; and therefore need to be far removed from the city population.

In the context of the above, it was a pleasant surprise when the Development authority of Meerut town of the state of Uttar Pradesh, India agreed to a concept of installing smaller capacity localized STPs in this town. This town is about 80 km from Delhi and is inhabited by 1309023 persons. The town lies between the plains of the Ganga and Yamuna rivers. It has a monsoon influenced humid subtropical climate. Meerut is one of the very important industrial towns and the district has a rich agricultural economy.

Ten such STPs were designed and installed in the residential areas serving a population of 7000 - 8000 person

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per MLD. These plants were of small capacities (3 to 15 MLD) and used the Activated sludge Extended Aeration technology. The capital cost varied from about INR 105,00,000 to 190,00,000 per MLD including the cost of housing for the workers along with other facilities.

The preliminary capital cost of putting up these smaller plants has been observed to be only marginally higher than that of the conventional sewerage system but the sharp reduction in operation and maintenance cost tends to offset the capital cost on a long term basis. These mini plants have been very well accepted by the local residents within their locality on the basis of extremely good performance and no nuisance, and also by the local administration, as it is relieved from handling complex maintenance issues to keep the sewer and plant systems operational & clean. Besides, many associated factors like providing jobs to locals and addressing disposal issues of large wastewater quantities also finds a lot of favor. This experience establishes the inclusivity of the concept of decentralization in wastewater treatment within the domain of smart and sustainable urban systems and serves to encourage a wider application.

Guidelines and Recommendations For Wastewater Treatment and Reuse in India

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Keywords: Guidelines, recommendations, replication, up-scaling, wastewater treatment, water reuse

The aim of this work is present different tools that can help to replicate and upscale suitable technologies for wastewater treatment and reuse in India, based on the results and experiences of Saraswati project. These tools are being elaborated in consultation with relevant stakeholders and authorities from India and include: (i) guidelines for technology application on domestic wastewater treatment and reuse, where technical aspects, both of technologies evaluated in India as those introduced from EU, are dealt , as well as the summary of lessons learned and recommendations on the potential of application of each technology, (ii) technical guidelines for technology design, focused on detailed technological design of specific technologies, based on the evaluation results and pilot actions, as well as on relevant Indian-EU information, (iii) recommendations for reuse for different purposes, including a review of already existing international standards and recommendations for the Indian context in the light of evaluated technologies and pilot actions developed in Saraswati project.

Efficiency of hybrid model constructed wetland in improving quality of sugar effluent

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Key words: constructed wetland, hybrid model, sugar effluent, removal efficiency, loading rate and algal consortium . ...contd

Effective treatment and safe reuse of sugar effluent generated in large quantity are major challenges for industries that affects aquatic and terrestrial ecosystem. This necessitates innovation of low cost treatment systems that shall be deployed at different scales. Therefore Lakshmipuram sugar unit located in Andhra Pradesh was selected for the water 4 crops project to develop and demonstrate bio-treatment of sugar effluent and reuse in agriculture. Vertical and horizontal subsurface water flow wetland system comprising of 5 beds were constructed with the dimension of 21.85m×11.10mx1.0m covering an area of 242.53 m2 and filled with varied substrates. Water quality data from Jan - Dec 2015 is considered for the present analysis. Percentage removal of physico chemical parameters were computed and found that the percentage removal of COD, BOD and phosphate range between 83%-92%, 73%-80% and 61%-68% respectively. BOD loading rate computed for each compartment shows that maximum reduction in BOD loading is observed in C3 which could be attributed to the presence of emergent macrophyte i.e. Typha Angustifolia and other floating macrophytes like duck weeds and algae. Oxygen produced by algae in C3 bed increases dissolved oxygen and decreases BOD. Removal of organic and inorganic contaminants and supply of oxygen by algae reduces COD. Vertical and horizontal flow wetland system with five beds and varied substrates especially the beneficial macrophytes and algal consortium contributes in maximum removal efficiency and reduced BOD loading rate.

Safety Culture in the Management of Wastewater Treatment Plants: Culture as a Sphere of Interrogation

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Keywords : Safety Culture - Cultural Practices of Workers - Wastewater Treatment

Safety Culture is an important aspect of Safety Planning in industries. Safety culture assumes more significance in the process of reclamation and reuse of wastewater when occupational safety is not only determined by tangible aspects like type of technology, organisation efficiency but also, non-tangible aspect, such as the culture of the workers. While the use of high-end, elaborate, huge technology versus simple, low-cost technology and the performance of the agency largely characterise safety culture in wastewater treatment plant (WWTP), the cultural practices of the workers also influence the adaptation of safetymeasures and development of safety culture. The industries or any other agency that manage WWTP, set the norms for safety planning according to the type and complexity of technology. These agencies follow mandatory legal guidelines for safety. However, not all agencies follow safety norms stringently, although the set norms are well within their mandates. Because, adherence to safety measures is highly influenced by workers' culture, attitudes, values and beliefs attached to working with wastewater.

This paper argues that there is a linkage between safety culture of workers' of wastewater treatment plants and their culture. The paper is based on a research study conducted in 8 WWTPs located four states across India, which is used to examine relationship between safety culture at WWTP and workers' culture. Geert Hofstede (1980 to 2010) in his seminal work on Culture discusses how nation cultures have different ways to cope with inequality and uncertainty, gender and one's y versus Femininity, and Individualism versus Collectivism. According to the paper, the cultural dimensions proposed by Hofstede, intersect with workers' education and employment status, caste and gender that have implications for occupational safety at wastewater treatment plants. Thus, safety culture gradually develops among the workers of WWTP. These implications vary from workers' approach to adopt safety measures, workers' participation to alter safety measures to be more