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KUWAIT INSTITUTE FOR SCIENTIFIC RESEARCH

International Conference Wastewater Management in Arid and Semi-Arid Regions as a Mitigation Measure to Combat Climate Change

14 – 17 March 2022

Kuwait Institute for Scientific Research, Kuwait City, Kuwait

Conference Program and Abstract Proceedings

U D C

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Kuwait Foundation for the Advancement of Sciences

Scope of the Conference

Scarcity of fresh water resources in the GCC countries and the Arab World at large has become a critical challenge to development and livelihoods. Exacerbated with climate change, this challenge is affecting viable sectors such as the industrial, agricultural and touristic activities to name a few. Therefore, proper mangement of wastewater streams in this semi-arid region will help development region wide.

Wastewater is collected, treated and mange for its reuse potential as an integral component of Integrated Water Resources Management (IWRM). Management can be centralized and/or decentralized in view of local conditions and socio-economic opportunities and challenges. In arid and semi-arid regions, the reuse/recycle wastewater both domestic and industrial is indispensable to help gap the deficit between demand and supply of fresh water resources. In an era when climate change is already, taking place and its extreme events are widely noticed, careful management and reuse of wastewater stand as a significant adaptation option for climate change impacts on water resources.

WTRT Program of WRC at KISR plans to organize a 4-day international/regional conference to address the following main themes of wastewater management in arid regions:

- New advances in domestic wastewater technologies.
- New advances in industrial wastewater treatment and resource recovery.
- Decentralized management of wastewater.
- Wastewater reuse as an adaptation for climate change.
- Management of sewage collection/transfer infrastructure under extreme hydrological events.
- Viruses removal from wastewater

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Opening Program

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is pleased to invite you

to attend the Virtual International Conference

Wastewater Management in Arid and Semi-Arid Regions as a Mitigation Measure to Combat Climate Change

Monday, 14 March 2022

09:00 – 10:00 a.m.	Registration
10:00 – 11:00 a.m.	National Anthem The Holy Quran **Opening Speech: H.E. Dr. Ali Fahad Al-Mudhaf,** Minister of Education, Minister of Higher Education and Scientific Research- Chairman of the Board of Trustees of Kuwait Institute for Scientific Research
Conference Program	
Day One: Monday, 14 March 2022	
09:00 – 10:00	Registration
10:00 – 11:00	Opening Ceremony
11:00 – 11:30	Refreshment Break
Session 1: Wastewater Reuse	
Session Chair/Moderator: Mr. Adnan Akbar	
12:00 – 12:30	**Dr. Mohamed A. Dawoud,** Environment Agency, UAE, The Role of Wastewater Reuse in GCC Countries Water Sustainability (Paper ID # 10)
12:35 -13:05	**Eng. Huda Al Lanqawi,** Ministry of Public Works, Kuwait, Kuwait Wastewater Strategy (ID # 19)
13:10 – 13:40	**Mr. Adnan Akbar,** Kuwait Institute for Scientific Research, Kuwait, Managed Aquifer Recharge (MAR) Using Membrane Treated Municipal Wastewater: A Possible Solution for Kuwait's Current and Future Water Needs (Paper ID # 2)
13:45 – 14:15	**Mr. Hamed Al-Mazidi,** Kuwait Oil Company (KOC), Kuwait, Utilizing Rejected Stream from Sulaibiya Wastewater Treatment & Reclamation Plant for KOC Industrial Applications, Case Study (Paper ID # 16)
14:20 -14:40	**Dr. Mohamed Taieb Labiadh,** Arid Regions Institute – Tunisia, Olive Mill Wastewater for Degraded Soil Restoration (Paper ID # 1)

Day Two: Tuesday, 15 March 2022	
Session 2: Wastewater Treatment	
Session Chair/Moderator: Dr. Adel Al-Haddad	
10:00 – 10:30	**Mr. Adnan Akbar,** Kuwait Institute for Scientific Research, Kuwait. Augmentation of Kuwait's Usable Water Resources by Unconventional Soil Aquifer Treatment (SAT) Technique (Paper ID# 14)
10:35 – 11:05	**Mr. Saleh Al-Haddad,** Kuwait Institute for Scientific Research, Kuwait. The impact of enzymatic hydrolysis of sewage sludge as a pre-treatment for dark fermentation (Paper ID # 18)
11:10 – 11:40	**Eng. Ohoud Bushaibah,** Kuwait Institute for Scientific Research, Kuwait. Preliminary Assessment of Wastewater Quality near Emergency Outfalls in Kuwait's Bay (Paper ID # 7)
11:45 – 12:15	**Dr. Mishari Khajah,** Kuwait Institute for Scientific Research, Kuwait. Characterization of Reverse Osmosis (RO) Reject Wastewater Generated from Sulaibiya Wastewater Treatment Plant (Paper ID # 5)
Prayer & Refreshment Break	
Session 3: Wastewater Treatment	
Session Chair/Moderator: Dr. Abdallah Abusam	
12:30 – 13:00	**Dr. Viruthachalam Thiagarajan,** Bharathidasan University, India, Magnetic iron oxide nanoparticles-based nanocomposites for wastewater remediation (Paper ID # 20)
13:35 – 14:05	**Dr. R. Arthur James,** Bharathidasan University, India, Natural Nano-structures designed for Biofilm Management in Wastewater Treatment Industries (Paper ID # 9)
14:10 – 14:40	**Dr. A. Al-Haddad,** Kuwait Institute for Scientific Research, Kuwait, Coliphage Viruses Removal from Treated Wastewater Using Gravely Sandy Columns, Kuwait (Paper ID # 12)
14:45 – 3:15	**Dr. Abdullah Al-Matouq,** Kuwait Institute for Scientific Research, Kuwait, Assessment of Volatile Organic Compounds Removal in Kabd Wastewater Treatment Plant (Paper ID # 17)

Day Three: Wednesday, 16 March 2022	
Session 4: Industrial Wastewater Treatment	
Session Chair/Moderator: Dr. Abdullah Al-Matouq	
10:00 – 10:30	**Dr. Mahalakshmi Mathivanan,** SASTRA University, India. Removal of dye from textile effluent using Saccharomyces Cerevisiae (Paper ID # 3)
10:35 – 11:05	**Dr. Kuppusamy Vaithilingam Selvakumar,** Dire Dawa University Institute of Technology, Dire Dawa, Ethiopia, Electrochemical reduction of Cr6+ ions from effluents by three-dimensional cathode reactor (Paper ID # 4)
11:10 – 11:40	**Dr. Andrzej Mydlarczyk,** Poland, Evaluation of Wastewater Quality Generated by Hospitals, which is Discharged into Public Sewage Network in Kuwait (Paper ID # 8)
11:45 – 12:05	**Dr. Dhanu Radha,** S.V.V, Kuwait Institute for Scientific Research, Kuwait, Efficacy of Nanoparticles in Removing Targeted Bacteria from Wastewater (Paper ID # 6)
Day Four: Thursday, 17 March 2022	
Session 5: Onsite Wastewater Treatment	
Session Chair/Moderator: Dr. Mohd Elmuntasir Ahmed	
10:00 – 10:30	**Dr. Mohd Elmuntasir Ahmed,** Kuwait Institute for Scientific Research, Kuwait, Multi-criteria Assessment of Onsite Packaged Wastewater Treatment Systems (Paper ID # 15)
10:35 – 11: 05	**Dr. Hussain Abdullah,** Kuwait Institute for Scientific Research, Kuwait. Performance Evaluation of Commercial Package Systems used in Kuwait for On-Site Treatment and Reuse of Domestic Wastewater (Paper ID # 11)
11:10 – 11:40	**Ms. Fatemah Dashti,** Kuwait Institute for Scientific Research, Kuwait, Assessment of Removal Salmonella Bacteria from Domestic Wastewater Biological Treatment Unit (Paper ID # 13)
11:45 – 12:15	**Ashraf A Ramadan,** Kuwait Institute for Scientific Research, Kuwait, Assessment of Kuwait's Wastewater Treatment Plants Emissions (paper ID #21)

Note: All times are Kuwait times. Kuwait is GMT/UTC + 3h during Standard Time.

Conference Abstracts			
Day 1			
Session 1: Wastewater Reuse			
Sl.No.	**Abstract Title**	**Authors**	**Affiliation**
1	The Role of Wastewater Reuse in GCC Countries Water Sustainability	Mohamed A. Dawoud1, Hatem Abdel Rahman2	(1)Water Resources Advisor, Environment Agency, Abu Dhabi, P.O. Box 45553, Email: mdawoud@ead.ae (2) Professor, King Abdul Aziz University, KSA

Abstract

Gulf Cooperation Council (GCC) countries faces the challenges of freshwater resources scarcity which pose severe constraints on economic, social and environmental development. In GCC countries, there are no available permanent renewable surface freshwater bodies. This lead to over pumping of nonrenewable groundwater aquifer systems which has resulted in lowering the groundwater table, increase its salinity, depletion, as well as ecological degradation. In the last three decades GCC countries have witnessed growing water demand which lead to investment more in non-conventional water resources such as desalination and wastewater treatment and reuse. Increasing water demand, scarcity of renewable freshwater resources, groundwater deterioration, and desalination costs and environmental impacts have prompted many governments to seek more efficient treated wastewater reuse to support developing interventions to minimize the increasing gap between freshwater supply and demand. GCC countries occupy a total land area of 2.7 million km^2, with a combined population over 50 million in 2014. The total water uses in GCC is about 35,100 million cubic meters, out of them over 27,800 million cubic meter is from nonrenewable aquifers, 5,100 from desalination and only 2,200 from treated wastewater. The total present (2015) production of treated wastewater 4,000 million cubic meter and it is increased by 11% annually. The predicted production of treated wastewater will be about 17,000 million cubic meters by 2030. The extended reuse of treated wastewater for irrigation, aquifer recharge, district cooling and other purposes could contribute considerably to reduce the freshwater stress and water scarcity as part of an Integrated Water Resources Management (IWRM) approach. For this to be achieved, political will, sound policies, strategies, regulatory framework, financed plans of action and cooperation platforms are urgently needed and extremely essential parameters for future success. Risks due to any environmental impacts should be addressed through cost-effective treatment options and alternatives depending on the end users requirements. This paper will analyze the present and future statues of treated wastewater production and reuse and how can help in long term water sustainability in GCC countries and recommend the future way forward.

Keywords: TSE, wastewater, water quality, water stress, groundwater depletion, desalination.

2	Kuwait Wastewater Strategy	Eng. Huda Al Lanqawi	Ministry of Public Works (MPW) Contact No. 99785889
	Presentation highlights: 1. Sanitary Engineering Strategy in MPW 2. Kuwait P.S & WWT Planet 3. Wastewater Treatment Phases 4. Technologies used in Treatment Plant 5. Wastewater Reuse 6. Future Projects		
3	**Managed Aquifer Recharge (MAR) Using Membrane Treated Municipal Wastewater: A Possible Solution for Kuwait's Current and Future Water Needs**	A. Akber, A. Mukhopadhyay and A. Al-Haddad	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: aakbar@kisr.edu.kw
	Abstract Kuwait is a water-starved country with only minor natural fresh and brackish groundwater accumulations at its disposal. The fresh groundwater reserve in the northern part of the country is about 100 Mm^3 which is equivalent to about 50 days of consumption at the current rate and is set aside for emergency use. Desalination of seawater meets almost all freshwater needs of the country. Seawater desalination is, however, a costly and environmentally unfriendly process and as the demand for water increases, desalination capacity needs to be increased at regular intervals to keep pace with the demand. Also, desalination plants are vulnerable to various accidental mishaps such as mechanical failure, shortage of fuel supply and pollution of intake water as well as subversive activities. Aquifer water storage and recovery (ASR), also known as managed aquifer recharge (MAR), is becoming a widely used tool for the integrated management of the available water resources around the world. The technique is being used for a wide range of purposes such as augmentation of depleting groundwater reserves due to exploitation, improvement of groundwater quality, countering seawater intrusion, smoothening of seasonal variation in water demand and creation of a strategic water reserve for use during an emergency. For an arid country like Kuwait where natural useable water is in short supply, MAR can be an answer to confront all of the above problems. The reverse osmosis (RO) membrane treatment of municipal wastewater currently yields very high-quality water in Kuwait with an estimated current production of 425,000 m3/d that is expected to reach 600,000 m^3/d by 2030. A large part of this high quality water will remain unutilized, especially during the winter months. This water can profitably be used to recharge the groundwater aquifers and hence can provide an additional source of water to meet Kuwait's current and future needs.		

4	**Utilizing Rejected Stream from Sulaibiya Wastewater Treatment & Reclamation Plant for KOC Industrial Applications, Case Study**	Hamed Al-Mazidi1, Saja Al-Mass, Imad Al-Maheimid, and Abdullah Bushehri	Imad Maheimid Kuwait Oil Company (KOC) TPL Senior Specialist (Res & Petroleum Engg) Innovation & Technology Group KOC, Ahmadi Email : (1) HMazidi@kockw.com (OR) IMaheimid@kockw.com

Abstract

As the state of Kuwait is located in an arid climatic area (rainwater 110 ml / year) which is affected by a water shortage, especially shortage in the water intended for industrial applications. Therefore, in this particular climatic context, treating, reuse and utilizing any available source of wastewater will partially overcome Kuwait Oil Company, KOC future industrial water demands and protect Kuwaiti environment.

The rejected Reverse Osmosis (RO) wastewater stream (Brine) from Sulaibiya Waste Water Treatment & Reclamation Plant was identified as a sustainable source water for KOC industrial applications. Treating of this rejected stream will not only overcome KOC future industrial and low salinity water demands but also would protect public health and Kuwaiti environment.

To conclude whether this rejected stream will be suitable and can be utilized in KOC assets, a pilot plant was successfully implemented to treat this rejected stream (Brine) from SWWT&RP, this second generation of wastewater is currently dumped in Kuwaiti seashore after primary treatment, this rejected wastewater could have a negative impact in Kuwait marine live.

The objectives of the pilot project was to select an innovative and cost-effective technology to treat the rejected stream from Sulaibiya Waste Water Treatment and Reclamation Plant SWWT&RP. The pilot trial was successfully completed and the results were very encouraging. The implemented technology can be scaled up to treat 300,000 barrels /day of wastewater; moreover, this technology can be implemented to treat any wastewater within or outside KOC assets.

Keywords: Wastewater, Sewage, Treatment, Sulaibiya Waste Water Treatment & Reclamation Plant SWWT&RP.

5	**Olive Mill Wastewater for Degraded Soil Restoration**	M. T. Labiadh	Dr. Mohamed Taieb Labiadh Arid Regions Institute - Tunisia 4119 Medenine, Tunisia. Email: Mohamed.labiadh@ira.rnrt.tn Phone: +216 75 633 005, Fax: +216 75 633 006 mohamed.labiadh@ira.rnrt.tn

Abstract

In Southern Tunisian arid regions, the main issues of soil degradation on the surface by wind erosion (loss of nutrients and organic matter) and in depth by reduction of water reserves were diagnosed. In order to preserve these soils, improve biological activity and maintain their productivity, a restitution of organic amendments becomes necessary. Among the remedial solutions, the composting of olive tree by-products (Ramial Chipped Wood (RCW), Olive Mill Waste Water (OMW)) could be used for these soils.

In this context, an experiment in pots was carried out on Medicago sativa L. in order to evaluate the effects of compost on ecosystem services of a sandy soil sampled from an experimental olive orchard in Chammakh. Two treatments (RCW and RCW with OMW) were applied and compared to a control soil. The results showed that RCW was the most effective treatment for improving soil phosphorus properties and above-ground biomass. The highest nitrogen content is recorded with the composite compost (RCW and OMW) (0.26 g kg-1). The Electric Conductivity of treated soil decreased by 60% over time. The RCW compost and the RCW combined with OMW allowed to keep almost the same soil moisture (141.10 and 147.23 g kg-1, respectively) but almost 3 times more compared to a control soil (52.30 g kg-1).

Keywords: Olive tree by-products, compost, sandy soil, Medicago sativa L., ecosystem services.

Day 2			
Session 1: Wastewater Treatment			
6	**Augmentation of Kuwait's Usable Water Resources by Unconventional Soil Aquifer Treatment (SAT) Technique**	A. Akber and A. Al-Haddad	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: akbar@kisr.edu.kw

Abstract

The absence of natural surface water resources, extremely low natural groundwater reserves, harsh climatic conditions and dependence on the environmentally unfriendly and costly seawater desalination technologies to secure the freshwater needs of the country pose a serious threat to Kuwait's prosperity and wellbeing. The magnitude of the problem is further exasperated by population growth and agricultural and industrial expansions. Treated wastewater is a promising source of water that can increase Kuwait's usable water supply and thus can contribute to adjusting the country's water balance. Despite Kuwait's extremely low natural water reserves, less than 50% of its wastewater is reused, especially in agricultural and greenery landscaping activities. Soil aquifer treatment (SAT) is a low-cost process for the improvement of the quality of wastewater as it infiltrates through the soil. This study was carried out to investigate the changes in the quality of treated wastewater as it infiltrates through the soil and its effects on the groundwater quality, soil chemistry, hydraulic conductivity, plant growth, crop productivity and the concentrations of various trace and minor elements in one of the major local farms in the Sulaibiya area that has been using treated wastewater for crop irrigation purposes for the past three decades. The study results suggest that SAT process can work reasonably well in Kuwait for the renovation of the secondary/tertiary treated wastewater if an area with suitable soil characteristics and hydrogeological conditions is selected for its implementation. This will, in turn, provide an additional source of water for agriculture and other non-potable uses. The study results also suggest that a good quality water mound has been created under the central part of the farm by almost three decades of irrigation with treated wastewater which is expected to augment the brackish/saline groundwater reserves and improve their quality with the passage of time.

Keywords: Treated wastewater, infiltration, soil, hydrogeological, prosperity, and water balance.

7	**The impact of enzymatic hydrolysis pre-treatment on enhancing glucose and bio-hydrogen production from sewage sludge**	Saleh Al-Haddad, M. A. Camargo-Valero, L. Fletcher	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: shaddad@kisr.edu.kw

Abstract

Sewage sludge is processed for methane production in anaerobic digestion reactors at wastewater treatment plants around the world. And it is produced in large quantities and is rich in biodegradable organic materials, and from these contents, sugars (e.g., glucose) can be produced, recovered and used as a substrate to support hydrogen production through the dark fermentation (DF) process. Champagne [1] reported that 6.22 Mt/yr of sugar can be produced from municipal sludge and livestock manures generated in Canada. DF is one of several methods used for bio-hydrogen production, whereby fermentative bacteria are used to hydrolyse organic substrates to produce hydrogen gas. As one of the main fermentable substrates for hydrogen production is carbohydrates (sugars), as they are considered the most favourable substrate for fermentative bacteria (e.g., Clostridium bacteria)[2]. Several studies have reported high hydrogen production in DF processes using sugars such as glucose as substrate [3-5]. Although the current routes for sewage sludge processing at wastewater treatment plants use AD, there is still an opportunity to move towards sugar production to support biohydrogen production. The result shows that using enzymatic hydrolysis (EH) process as pre-treatment for sewage sludge, has enhanced the glucose content in sewage sludge and convert some of macro sewage flocs to easy digestible micro flocs (glucose). And therefore, the substrate was more favourable and easier to digest by bacteria in dark fermentation reactor which led to enhance hydrogen and VFAs production. More research needs to be done to find the optimum enzyme dosage, initial substrate concentration, operation temperature (especially when enzyme is used inside DF reactor).

8	**Preliminary Assessment of Wastewater Quality near Emergency Outfalls in Kuwait's Bay**	O. Bushaibah, A. Al-Haddad, M. Khajah, F. Dashti, E. Ibrahim	Environmental and Life Sciences Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: ashaiba@kisr.edu.kw

Abstract

A total of Twenty-two wastewater discharging emergency outfalls located within Kuwait Bay has the potential ability to pollute marine life, the quality of wastewater discharged to the sea has a direct significant impact on the ecosystem including marine organisms, and an indirect effect on human health. The aim of the current study is to evaluate the quality of wastewater discharged at selected sites of Kuwait's Bay and to compare the obtained results with Environmental Public Authority (EPA) standards for discharging treated wastewater to Kuwait Bay. Five locations were selected near emergency outfalls and onsite field measurements for water quality were carried out, including temperature, pH, Electrical conductivity (EC), and dissolved oxygen (DO). Furthermore, a total of fifteen mixed water samples (Wastewater and seawater) were collected throughout November 2021 and January 2022 during low and high tides and within one meter away of wastewater discharging outfalls and analyzed for nutrients, heavy metals, and bacteria parameters. The field results indicated presence of slightly alkaline (pH,7.01-8.0), freshwater to saline water type (EC, 1.27 µs/cm - 65.07µs/cm) oxidized environment (DO, 0.91 mg/l - 5.28 mg/l). The laboratory results of water samples revealed that the concentrations of nutrients (total nitrogen, 2.0 - 35 mg/l), and all targeted heavy metals were detected in mixed samples for all sites in concentrations of microgram per liter and within EPA acceptable limits. On the other hand, phosphate concentration (4.2 - 13.6 mg/l) and the counts of microbial indicators (Fecal coliform, E. coli, and Fecal Streptococci) were high and above EPA standards, which show the serious biological pollution that occurred to these sites. The variation in the contamination levels at the selected locations indicates the need for periodic monitoring for mixed water quality near wastewater emergency outlets and searching for the appropriate solutions to reduce the contaminated wastewater discharged directly into the beaches.

Keywords: Environmental, Heavy metals, microbial, nutrient, water samples

9	**Characterization of Reverse Osmosis (RO) Reject Wastewater Generated from Sulaibiya Wastewater Treatment Plant**	Mishari Khajah, Mohd Elmuntasir Ahmed, A. Al-Matouq	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: mkhajah@kisr.edu.kw

Abstract

Sulaibiya wastewater treatment plant is considered as one of the largest wastewater treatment plant using ultrafiltration and reverse osmosis membranes in their processes to reclaim water for indirect potable water reuse from municipal wastewaters. An additional waste stream is generated composed of the reject of the membrane treatment or the brine, which includes contaminants such as include nutrients, trace organic chemicals, effluent organic matter and pathogens. Many of the organics that are concentrated in these brines are of considerable concern and can hinder the beneficial use of reclaimed water concentrate. Currently, there are no legally binding regulatory guidelines for brine management in Kuwait as in many countries around the world such as the United States, Australia, and Spain. There are presently no specific government regulations or regulatory guidelines containing technical requirements, recommendations, and engineering guidance for permitting brine discharges. This paper studies the characteristics of the reverse osmosis (brine) wastewater generated from the Sulaibiya wastewater treatment plant. The main aim is to characterize and understand the variation of the quality of the brine wastewater discharged from the plant.

Day 2			
Session 2: Wastewater Treatment			
10	**Magnetic iron oxide nanoparticles based nanocomposites for wastewater remediation**	Ramalingam Suhasini[1], Vetrimurugan Elumalai[2], Viruthachalam Thiagarajan[1*]	Photonics and Biophotonics lab, School of chemistry, Bharathidasan University, Tiruchirappalli- 620 021, India 2 Department of Hydrology, University of Zululand, Kwa-Dlangezwa, 3886, South Africa. E-mail: v.thiagarajan@bdu.ac.in
	Abstract Water, a valuable, precious and demanding source on earth, needs a suitable remediation for global welfare. Normally, dedicated wastewater treatment plant requires pre-treat industrial wastewater. On the subject of sustainable, economic development, new technologies for the treatment of impaired and unconventional water are crucial. Magnetic materials which play a main role in water remediation based on their magnetic, surface functionalisation and recovery properties. Magnetic iron oxide nanoparticles (MINOPs) provide robustness in stability, eco-friendly and relative in economical relevant solutions. The nanomaterial's small size, large surface area, mobility in solution and easy separation make them highly as a significant materials for water remediation applications.1 In this presentation, we will briefly discusses about the source of water pollutants, methods available for water remediation, structure and properties of magnetic materials and their applications towards wastewater treatment including zero-valent metal nanoparticles, metal oxide nanoparticles, nanocomposites, and layered double hydroxides with MINOPs.2.		

11	**Natural Nano-structures designed for Biofilm Management in Wastewater Treatment Industries**	R. Arthur James, K. Muthukumar, S. Henciya and Hans Uwe Dahms	Department of Marine Science, Bharathidasan University, Tiruchirappalli – 620 024, India. Email: james@bdu.ac.in

Abstract

Biofilm has become one of the worldwide most serious environmental problems and so far, the most effective method to control is based on the application of toxic antifouling coatings like tributyltin (TBT), copper or organic compounds and other toxic materials. Effects ascribed to the presence of tributyltin and toxic materials in the environment are acute toxicity, results in imposex, bioaccumulation, increased shell thickness, leading to a serious ecological crisis and decreases reproductive viability of various organisms.

Currently, a novel and green photocatalytic technology based on semiconductors has attracted great concern towards potential application in the degradation of organic pollutants, antifouling, hydrogen productions from water and disinfection. Eco-friendly products with anesthetic, repellent and settlement inhibition properties, without being biocidal to non-target organisms are desirable as potential antifoulants. Development of reliable non-toxic methods for the synthesis of nanoparticles (NPs) would be important booming field of bio-mimetic which allows one to mimic nature. Biosynthesis of bio-mimetic NPs or bimetallic (Bi-NPs) nanocomposite is an important eco-friendly benign source for beneficial aspects in the ecosystem. Inspired from nature, which reveals excellent super hydrophobicity implemented bio-mimetic super hydrophobic surfaces in a variety of simple ways. Scientists have been attracted broad attention towards new NPs and Bi-NPs composite of photocatalytic activity and biocides which include new elastomeric coatings for antifouling and foul-release formulations.

Multifunctional NPs composite photocatalytic activities, coatings are in urgent demand for the emerging fields which was further used in photocatalysis and effective non-biocidal coatings. These findings would results in patent value with natural eco-friendly degradation of organic pollutants and antifouling coatings for the entire scientific world in near future.

Keywords: Nano-structures, Wastewater, Biofilm, Antifouling, Natural treatment.

12	**Coliphage Viruses Removal from Treated Wastewater Using Gravely Sandy Columns, Kuwait**	A. Al-Haddad	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: ahadad@kisr.edu.kw

Abstract

A research study was carried out to determine soil type of gravely sandy for removal of Coliphage viruses from treated wastewater. Treated wastewater containing viruses was passed through soil columns filled with soil collected from Sulaibiya area, Kuwait. The two soil column experiments were under operation for eight months during period from August 2004 to March 2005. The first and second soil columns filled with gravely sandy soil. All soil columns had soil depth of 0.1 m and with constant hydraulic head of 0.1 m above soil surface. For each experimental condition, two identical columns were set up, so that the reproducibility of the results can be evaluated. For all columns, the tests were conducted under alternating 1 day flooding and 1 day drying conditions. Influent and effluent water samples were collected and analyzed following cycles of flooding periods. The Coliphage virus counts in the treated wastewater ranged between 0 and 62800 pfu/100 ml. The laboratory results revealed that Coliphage removal for gravely sandy soil ranged between 10 and 100% with average value of 75.5%. The presence of clay in the soil increased the Coliphage removal from treated wastewater.

Keywords: Coliphage viruses, Treated wastewater, Soil Column experiments, effluent

13	**Assessment of Volatile Organic Compounds Removal in Kabd Wastewater Treatment Plant**	Abdullah Almatouq, Mohd Elmuntasir Ahmed, Mishari Khajah, and Rashed AlYaseen	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: amatouq@kisr.edu.kw

Abstract

Volatile organic compounds (VOCs) are highly reactive hydrocarbons that are characterized by low water solubility. There are common compounds that can be found in every wastewater treatment plant around the world such as toluene, benzene, xylene, 1, 3, 5 trimethylbenzene, 1, 4 dichlorobenzene, dichloromethane, chloroform, and tetrachloroethene. The concentrations of these VOCs in wastewater may vary depending on the treatment plant's operational conditions and temperature. In this study, the most common volatile organic compounds in wastewater (toluene, benzene, xylene, 1, 3, 5 trimethylbenzene, 1, 4 dichlorobenzene, dichloromethane, chloroform, and tetrachloroethene) were identified and quantified using gas chromatography coupled to mass spectrometry (GC/MS) in 140 wastewater samples from 4 sampling points (inlet, pre-aeration tank, aeration tanks, outlet) in Kabd wastewater treatment plant. Wastewater samples from the selected locations were collected once a week for more than ten months. The results showed that the overall removal efficiency for dichloromethane, toluene, Tetrachloroethene, 1,4-Dichlorobenzene was 33.3, 100, 89.4 and 49.0 % respectively. For the other compounds such as M-Xylene, P-Xylene and O-Xylene, since the concentrations were very low the VOCs were not detected in the effluent neither within the treatment scheme. Surprisingly, It was noticed that chloroform has a negative overall removal efficiency. Due to VOCs volatilization, some VOCs we completely removed during the primary treatment such as Tetrachloroethene, while 1,4-Dichlorobenzene was completely removed during the secondary biological treatment. Therefore, continuous monitoring of VOCs in wastewater treatment plants is required to protect the environment, operators and effluent users.

Keywords: Kabd wastewater plant; Benzene; Cancer; Hydrocarbon

Day 3			
Session 3: Wastewater Treatment - Industrial			
14	**Removal of dye from textile effluent using Saccharomyces Cerevisiae**	Mahalakshmi Mathivanan	Assistant Professor, School of Civil Engineering, SASTRA University Corresponding Author: mahalakshmi@civil.sastra.edu
	Abstract Due to the breakdown products of dyes, their disposal into the environment causes considerable damage and is hazardous to various aquatic organisms. Bacteria, fungi, cellular membrane, and other absorbents can be used in biological techniques. In this study, the potential of Saccharomyces Cerevisiae in the decolorization of Congo red dye was investigated. The impact of various conditions on concentration, time, and pH in that study was conducted in order to determine the ideal condition for maximum decolorization. The greatest wavelength was observed in 496.93 on the UV Spectrum. The greatest decolorization of 87.9% was reported at room temperature for 30ppm(0.003g/100ml), which occurred after 18 hours. In the next experiment, a maximum decolorization of 96.88% was recorded for 40ppm (0.004g/100ml) and pH 4 at 17 hours in rt, which is considered to be the optimal condition. The preceding results demonstrate Saccharomyces Cerevisiae›s ability to degrade dyes. **Keywords: Saccharomyces Cerevisiae, Congo red dye, UV Spectrum, Dye degradation.**		

15	**Electrochemical reduction of Cr6+ ions from effluents by three dimensional cathode reactor**	Kuppusamy Vaithilingam Selvakumar, Mani Jayakumar and Selvakumar Periyasamy	Department of Chemical Engineering, Dire Dawa University Institute of Technology, Dire Dawa, Ethiopia kvselvakumar73@gmail.com selvaa26kumar@gmail.com

Abstract

Chromium and its salts find an extensive application in various industries. The toxicity of chromium is a very well-known. Chromium in its higher oxidation state is more toxic than in the lower valency state. Hexavalent chromium (Cr6+) can be easily reduced to trivalent chromium electrochemically on a variety of cathodes over a wide range of concentration. With a view to develop a process of electrochemical reduction for application in effluent treatment, the present investigation has been undertaken. Owing to the very low concentration of Cr6+ in the effluent, the reaction is diffusion controlled. In order to enhance the mass transfer and hence the conversion, at the electrode surface, a three dimensional electrode with a high space time yield has been used for the process. The results of the investigations indicate that the rate of conversion depends on flow rate and an optimum flow rate of 120 Lh-1 is found to yield the maximum current as well as conversion efficiency for the reduction of Cr6+. The relation between variation in concentration with time is found to be exponential and mass transfer coefficient reaches a maximum at the optimum flow condition. In conclusion, it is possible to reduce cathodically hexavalent chromium to trivalent chromium with the 100% conversion efficiency using packed bed reactor system.

Keywords: Electrochemical reduction; Chromium ions; Three dimensional electrode; Electrochemical packed bed reactor

16	**Evaluation of Wastewater Quality Generated by Hospitals, which is Discharged into Public Sewage Network in Kuwait**	A. Mydlarczyk, A. Al-Haddad, A. Abusam and M. E. Ahmed	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: mydlarczyk51@yahoo.com ahadad@kisr.edu.kw

Abstract

All Kuwaiti Hospitals discharging their wastewater into public sewage network. Afterwards wastewater has been pumped into municipal wastewater treatment units in Kuwait. Scientists have studied quality of final effluent from sewage treatment plants and they have found that effluent contains significant amount of pharmaceutically active compounds, which are danger, if effluent is applied for irrigation purposes. In the study, samples of wastewater from four Kuwaiti hospitals (Al-Sabah, Al-Razi, Maternity and Chest Diseases) were collected on the weekly basis. There was measurements of the following parameters in the field: temperature, pH, electrical conductivity, dissolved oxygen and oxy-redox potential. Besides them, the following parameters were analyzed in Sulaibiya Research Plant (chemical laboratory): physical - total suspended solids (TSS), chemical - total dissolved solids (TDS), alkalinity, organic compounds as chemical oxygen demand (COD) and biochemical oxygen demand (BOD5) as well as total organic carbon (TOC). Moreover, other chemical parameters were tested like: ammonia nitrogen, organic nitrogen, total nitrogen, total phosphate, sulfates, sulfides, surfactants and heavy metals concentration. There was extra analyses of antibiotics (five the most popular antibiotics in Kuwait). Microbiological laboratory of KISR in Shuwaikh determinate concentration of total coliform, faecal coliform and salmonella. Moreover, concentration of radioactive elements was investigated in ELSRC laboratories of KISR, to check presence of radioactive materials in the hospital wastewater. It was found that wastewater from Al-Sabah hospital usually contains isotope of iodine (123 and 131) with concentration between 15 – 50 µg/l. The results proved that hospital wastewater exceeds parameter values fixed by KEPA for wastewater, which can be dumped to public sewage network. In accordance with obtained quality data, there is recommendation for construction of wastewater treatment units, beside each hospital, to avoid pharmaceutically active compounds in final effluents of municipal wastewater treatment plants.

Keywords: analysis, antibiotics, hospital wastewater, radioactivity, treatment of wastewater

17	**Efficacy of Nanoparticles in Removing Targeted Bacteria from Wastewater**	Dhanu Radha. S.V.V, A. Akber & Chidambaram. S	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: vdhanuradha@kisr.edu.kw

Abstract

Nanoparticles are extremely small particles that are undetectable by the naked eye. They range in size from 1 to 100 nanometers and can exhibit significantly different physical and chemical properties. Therefore, they are used in a multitude of applications. One of the prime applications of nanoparticles is their proven ability to remove microbes from polluted media. Therefore, they could be used in the removal of pathogens from effluent wastewater in treatment plants that fail to efficiently remove such pollutants by conventional disinfection treatment methods. However, removing pollutants from waste water has proven to be a formidable challenge. With this paradigm in mind, a study was developed to synthesize and utilize nanoparticles for the removal of specific pathogenic bacterial groups from waste water. Hence, the study focused on the extraction of Curcumin from turmeric powder and subsequent synthesis of nanoparticles using the precursor Zinc acetate in an eco-friendly manner. The synthesized nano Curcumin Zinc (II) complex was characterized by Ultra Violet Spectroscopy, H1 and C13 Nuclear Magnetic Resonance Spectroscopy, Fourier Transformation-Infra-Red Spectroscopy and X-ray diffraction. The Complex's morphology was determined using Scanning Electron Microscopy and the elemental composition using Energy Dispersive X rays. The complex formation was confirmed by the above techniques and observed with an average size of 68.2nm. Different proportions of the synthetic nano complex were added and optimized for the removal of targeted bacteria in waste water. The study findings proved that synthesized nano Curcumin Zinc (II) complex had a noticeable anti-bacterial effect as it was able to remove with 100% efficiency, the targeted bacteria such as Total Coliform, E.coli, Fecal Coliform and Salmonella from waste water in 1:1 ratio and 1 in 100ml and 2 in 100ml diluted samples.

Keywords: Waste water, disinfection, pathogens, synthesis, bacteria.

Day 4			
Session 4: Onsite Wastewater Treatment			
18	**Multi-criteria Assessment of Onsite Packaged Wastewater Treatment Systems**	Mohd Elmuntasir Ahmed, A. Al-Matouq, M. Khajah, H. Abdullah	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: miahmed@kisr.edu.kw
	Abstract Onsite wastewater treatment systems and small scale packaged wastewater treatment plants have been used on a large scale in developing and developed countries where centralized sewerage facilities are not feasible. Generally, onsite systems continuously work under large variations in both quantity and quality of the influent wastewater. Therefore, their, suitability need to be assessed before installation and operation to ensure their suitability and sustainability. The aim of this paper is to define a set of context specific criteria to assist in the selection of the best onsite wastewater treatment system and to breakdown these criteria into measureable parameters. Furthermore, the developed multi-criterial assessment tool was validated using the results of the performance monitoring of a selected wastewater treatment system. This work is important since the selection of onsite systems, in many cases, is done based on declared performance by the supplier and the costs involved. **Keywords: packaged wastewater treatment systems, onsite wastewater treatment, wastewater reuse, wastewater treatment assessment**		

19	**Performance Evaluation of Commercial Package Systems used in Kuwait for On-Site Treatment and Reuse of Domestic Wastewater**	H. Abdullah, A. Abusam, M. E. Ahmad and R. AlYaseen	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: hsafar@kisr.edu.kw

Abstract

The wastewater management scheme of Kuwait consists of a huge centralized sewerage system that transport all generated wastewater for treatment at central municipal wastewater treatment plants. However, there are some remote sites that are still not connected to the public sewerage system. In such sites, on-site systems (conventional septic tank or package systems) are commonly used. The study aims at carrying out technological appraisal and performance assessment of the on-site package systems commonly sold in Kuwait's market. Specifically, two on-site wastewater treatment package systems will be technically appraised and their actual performance will be determined. Further, the suitability of their effluent for agricultural reuse will be checked. This study assessed the performance of two package systems used in Kuwait for on-site wastewater treatment and reuse. Wastewater samples were collected weekly for five months from influent and effluent streams of two package systems located at Ahmadi and Kadhmah areas of Kuwait. Results of laboratory analysis indicated that effluent of both systems met the standards of Kuwait Public Authority for Environment (KEPA). However, Obtained results have also showed that pollutants' removal efficiencies for both systems were highly fluctuating.

Keywords: Wastewater, Treatment, Reuse, Onsite systems, Package systems.

20	**Assessment of Removal Salmonella Bacteria from Domestic Wastewater Biological Treatment Unit**	F. Dashti, A. Al-Haddad, G. Ahmad and E. Ibrahim	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: fmdashti@kisr.edu.kw

Abstract

Recently Water Research Center (WRC) installed wastewater biological treatment unit for Kuwait Institute for Scientific Research (KISR) for treatment of wastewater discharging from WRC and Hydraulic buildings. The biological treatment unit were built for a purpose of using treated wastewater for irrigation activates inside KISR. The treatment unit consists of five stages, which is influent (raw sewage), primary settling tank, aeration tank, secondary settling tank and effluent. The aim of the research study is to evaluate the present of pathogenic salmonella bacteria before and after passing each treatment stage. Total of 44 wastewater samples were collected during December 2021 to January 2022, from four stages of the treatment unit including influent, primary settling tank, secondary settling tank and effluent. The collected samples were analyzed for the present of pathogenic salmonella bacteria. The preliminary laboratory results of water samples revealed that the counts of the salmonella bacteria for influent were ranged between 24000 to 96000 cfu/100ml, their counts in primary settling tank were ranged between 21 to 170 cfu/100ml, while their counts was reduced in secondary settling tank and ranged between 4 to 48 cfu/100ml and finally, their counts in effluent were ranged between 0.0 to 11 cfu/100ml. The study recommended periodic monitoring for analyses of wastewater quality of biological treatment unit.

Keywords: Raw wastewater, Laboratory results, Treatment stages and Effluent

21	**Assessment of Kuwait's Wastewater Treatment Plants Emissions**	Ashraf A Ramadan	Water Research Center Kuwait Institute for Scientific Research, Kuwait E-mail: miahmed@kisr.edu.kw

Abstract

As of 2016, Kuwait had six domestic wastewater treatment plants (WWTPs), five of which employ tertiary treatment method while the sixth employ reverse-osmosis. Wastewater flows in a large network of 8,200 km long pipelines, the majority of which, i.e. 97.6%, relies on gravity as the driving force of the flow and the rest is pressurized. Pipelines diameters range between 0.15 to 2.25 m. The design treatment capacity of Kuwait's WWTPs is planned to increase by 116% by 2030 compared to the value in 2015. Resulting from several domestic, commercial and industrial processes, wastewater is yet another emissions source which needs to be considered when developing an emission inventory. Kuwait Institute for Scientific Research (KISR) has developed the country's first national emission inventory following a bottom-up approach and this article addresses the part related to WWTPs emissions. For this part of the project, the Intergovernmental Panel for Climate Change (IPCC) methodology was adopted to calculate the CH4 and N2O emissions resulting from the WWTPs. Tier 2 method, which is considered and improved version of Tier 1 due to its reliance on country specific activity data, was used. Lack of information on industrial wastewater meant only emissions from domestic wastewater were calculated. The calculated emissions from WWTPs for 2016 were 1.80E+08 for CH4 and 6.25E+04 for N2O, equivalent to 40.3% and 0.75% of the national emissions for these two compounds. The high contribution of WWTP to the national CH4 emissions has invited attention on the importance of employing suitable CH4 recovery mechanisms at these facilities.

Keywords: Methane, Greenhouse gases, Climate change, tertiary treatment

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