

“INTEGRATION OF RESEARCH TO INDUSTRIAL APPLICATION”



Gujarat Cleaner Production Centre

Established by: Industries & Mines Department, Government of Gujarat

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The abstracts have been received from final year Bachelor / Master / PhD students of Chemical / Environment Engineering and Environmental Science streams. The same has been compiled in this document without any changes except sentence formation and spelling mistakes. The document is intended to disseminate the research of student to the academia, industries and Government for further research and implementation purpose. The GCPC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this document. This publication may be reproduced in whole or in part and in any form for educational or nonprofit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. GCPC would appreciate receiving a copy of any publication that uses this publication as a source. No use of this publication may be made for resale or for any other commercial purpose what so ever without prior permission in writing from the GCPC.

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FOREWORD

This Project is a flagship initiative of GCPC as well as Forests and Environment Department, GoG, intended to build a strong network or link among the Academician, Technical Expert, Industries and Government Organization. The main aim of this project is to empower sustainable development in industries through innovative ideas of students in terms of Cleaner Production/ Cleaner Technology/Waste minimization/Pollution Prevention/ Resource Efficiency by implementation of their research. Also, we are aware that compliance of Environmental Laws is a big concern. Often, small & medium scale units are unaware of Environmental Issues and its solution. Hence, through this Project, GCPC has tried to set a clear path for Industries by providing options for waste minimization/pollution prevention.

Young Engineers today have the conviction to venture out on their own so, let their ideas come to life. For all young Engineers who have the courage to enter into the environment of risk by presenting different sustainable development options, this project is a platform where students can share their ideas which can broaden the outlook of industries and government.

This Year, GCPC has invited abstract of Dissertation / Thesis / Research Paper from Graduate, Post Graduate & Ph. D (Chemical, Environment Engineering & Environmental Science) Students of the state and received total of 54 abstracts. This book is compilation of those abstracts and it will be distributed to the industries; so industries can implement the work done by the student where it is feasible. With this, GCPC makes an effort to fill the gap between the Industries and Academia and Government.

My Best Wishes to all students and Guides.

Dr. Bharat Jain
Member Secretary
Gujarat Cleaner Production Centre

Programme Outline

- Invite Abstract of dissertation/thesis from the final year students of Chemical / Environment Engineering and Environmental Science on Cleaner Production, Clean Technology, Waste minimization, Reduction in energy & water & raw material consumption, Process change and Environment conservation.
- Selection of best five abstract by Panel of Expert amongst the abstracts received by GCPC
- Presentation and Prize distribution of best five abstracts
- Publication of book compiling all abstracts received by GCPC
- Dissemination of book to Major Industrial Estates, Industries, Engineering Colleges and Government Offices of Gujarat for further research and implementation purpose.

We are thankful to Panel of Experts for the selection of best five abstract:

1. Dr. Bharat Jain, Member Secretary, GCPC
2. Mr. M. A. Hania, President, Dahej Industries Association and Senior Vice President of M/s. Meghmani Ltd. Dahej
3. Mr. Sanjiv Vaijanapurkar, Deputy Environment Engineer, Gujarat Pollution Control Board (GPCB)
4. Mr. Alok Kumar, Managing Director, Narmada Clean Tech Ltd. (NCTL), Ankleshwar
5. Mr. R. Gnanasegaran, Chief Executive Officer, Vapi Green Enviro Limited, Vapi
6. Dr. Ravji Patolia, Proprietor, M/s. Parth Chem & Technologies, Vatva
7. Mr. Amit Dhruv, Chief Executive Officer, Ester India, Nandesari
8. Mr. Paresh Mevawala, Director, Enpro Envirotech and Engineers Pvt. Ltd., Surat

We are thankful to the Students, Guides, HoD's and Principals of following Chemical / Environment Engineering and Environmental Science Colleges of Gujarat for participating in our Project:

1. Om Engineering College, Rajkot
2. Pandit Deendayal Petroleum University, Gandhinagar
3. Maharaja Sayajirao University, Baroda
4. Pacific School of Engineering, Surat
5. G. H. Patel College of Engineering & Technology, V. V. Nagar
6. Nirma University, Ahmedabad
7. Vishwakarma Government Engineering College, Gandhinagar
8. L.D. College of Engineering, Ahmedabad
9. Government Engineering College (GEC), Bharuch
10. SAL Institute of Technology & Engineering Research, Ahmedabad
11. V.V.P. Engineering College, Rajkot
12. Sardar Vallabhbhai National Institute of Technology, Surat
13. BVM Engineering College Vallabh Vidyanagar
14. Hemchandracharya North Gujarat University, Patan
15. Government Science College, K. K. Shastri Educational Campus, Khokhra Road, Ahmedabad
16. ISTAR, Vallabh Vidyanagar
17. College of Renewable Energy and Environmental Engineering, S.D. Agricultural University, S. K. Nagar
18. Government Engineering College, Valsad
19. Government Engineering College, Bhuj

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ABSTRACT TITLE

PhD (Chemical Engineering)

1. Pervaporation separation of ethylene glycol-water using PVA/PES composite membrane

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Distillation, liquid-liquid extraction and drying are the most common and traditional technologies used for the separation in chemical and allied process industries. All these conventional separation techniques demand extensive amount of energy, external entrainer and downstream processing to recover key component. As an alternative option, pervaporation is widely recognized to be an eco-friendly advanced separation process in which a binary or multi-component liquid mixture is separated by partial vaporization through a dense lyophilized membrane. It is an energy efficient combination of membrane permeation and evaporation. The present study would involve the dehydration of aqueous ethylene glycol (EG) solution using pervaporation (PV) with polyvinyl alcohol (PVA) membrane supported on polyether sulfone (PES). The prepared membrane was cross linked with formaldehyde. In order to see the swelling characteristics of the prepared polymeric membrane, sorption experiment was performed with a wide concentration range of ethylene glycol (EG)-water binary mixture at ambient temperature. The composite membrane was used for the Pervaporation performance with 30 to 90% vol feed concentration of EG aqueous solution with a temperature range from 60 to 90°C. The total flux of permeation was found to be decreased and the separation factor was increased as feed EG concentration increases.

2. Studies on Extraction of Essential Oil from Palmarosa Using Novel Techniques

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Cymbopogon martinii (Palmarosa), an essential oil bearing mandate industrial grass of India. Palmarosa oil has wide applications in various fields viz., cosmetics industry, perfumer industries, flavoring tobacco products, foods, non-alcoholic beverages, etc. Considering the wide spectrum of applications, it is imperative to find the most suitable technique for the extraction of palmarosa oil, which should not only provide a quality product but also alleviate the energy and environment related issues. In this regard, microwave assisted extraction (MAE) was adopted for extracting essential oil while ultrasound assisted hydrotropic extraction (UAHE) and ultrasound assisted ionic liquid extraction (UAILE) have been investigated for isolation of geraniol Hydro distillation for essential oil extraction was also studied and compared. The comparison of the techniques was done in terms of quality and quantity of essential oil, extraction time, energy and carbon footprint. In addition, it is advisable to assess the biological activities of the essential oil for strengthening the method employed for the extraction. Furthermore, the wastes generated after extraction were assessed for possible utilization as co-product for fuel and thereby, employing bio-refinery concept.

3. Solar Photo catalysis for Wastewater Treatment

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Treatment of industrial wastewater prior to its discharge into natural water bodies is essential since it could be carcinogenic and toxic. While conventional treatment methods are energy and cost intensive, Solar Photocatalysis can degrade the organic chemicals to harmless water and Carbon dioxide, with the help of solar energy. The objective of this work is to evaluate the treatability of a model dye (Methylene Blue) in an effective manner. In the present study, a series of hybrid $\text{Ag}_2\text{CO}_3/\text{SiC}$ and $\text{Ag}_2\text{CO}_3/\text{ZnO}$ composites were successfully synthesized. The performance of the photocatalysts was also investigated on industrial effluent in terms of TOC. A CPC solar photo reactor (CPC-P) was also designed and fabricated and investigated for its performance. Present work was carried out in natural solar light and would be useful in real-time design of solar photocatalytic reactors and other solar applications for environmental remediation. In Gujarat several dyes and textile industries are present. Current work is an attempt to propose better option to conventional techniques for degradation of such dyes from wastewater.

4. Degradation of RB21 Dye in Wastewater

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The catalyst NiFe_2O_4 ferrites with spinel structure were successfully employed by a co-precipitation, sol-gel, citrate, reactive grinding methods. Performances of NiFe_2O_4 /irradiation synergistic effect for Reactive Turquoise Blue 21 solution with $50\text{W}/\text{m}^2$ intensity under 250 nm

low pressure and 450 nm Ultraviolet lamp of high pressure and under natural sunlight of with 66 Watt lamp and 1.1 W/m^2 intensity. The investigation of removal kinetics of RB21 indicates that the removal process obeys the rate of first-order kinetic equation. The degradation studies have been carried out for different irradiation time, varying pH, effect of milling time and catalyst dosage. The experimental results revealed that the best photocatalytic performances was achieved by reactive grinding method reach up to COD degradation of 60% at 120 min followed by 85% at 240 min and decolorization 99% at 120 min remains constant till 240 min irradiation with optimal conditions and afforded under visible light irradiation. Comparison studies were conducted using TiO_2 and ZnO reveals that due to broad band-gap it cannot gain high efficiency. The samples characterized by TGA, XRD, FTIR, LC/MS, particle size, SEM, TEM, EDX, UV-NIR, VSM, BET, COD, UV-visible spectrophotometer techniques. The magnetic measurements show that the NiFe_2O_4 samples exhibit soft ferromagnetism with the 22.22 emu/g of 11h milled sample with saturation magnetization (Ms) at room temperature which can be easily separated by magnetic field from the suspension and reused for next cycle. Further industrial effluent treatment where more than 65% COD and complete color removal was achieved.

5. Effective Combustion in a Furnace using Oxygen-rich Stream and Flue Gas Recirculation

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Air pollution is increasing in world and became a global problem. Oxy-fuel combustion will be the one of possible alternative solution for air pollution. It was proposed as emerging carbon capture technology for newly built and retrofitted coal-fired power plants, steel plants, ceramic industries, etc. A hot flue gas recycle will play a significant role to control the instantaneous combustion due to oxy-fuel in the furnace. The energy is also being saved using this new technique. From the efficiency analysis, it is predicted that oxy-fuel combustion can give an approximately 40% enhancement in efficiency compared to air-fuel combustion. Zeolite based membrane technologies will be developed to replace Pressure Swing Adsorption (PSA) for oxygen generation, which will enhance the economy.

6. Studies in Vapour – Liquid Equilibrium of Systems Involving Green Solvents

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Green Solvents are the substances that have little or no toxicity to human health and environment compared to the classical solvents. Wide synthetic utility and a detailed toxicity study suggest Cyclopentyl Methyl Ether (CPME) as a green and sustainable ethereal solvent of choice for modern chemical transformations. 2-Methyl tetrahydrofuran (2-MeTHF), an ethereal solvent that has its origin from renewable sources, can also provide a cost effective green alternative to tetrahydrofuran and diethyl ether. The experimental data of vapour-liquid equilibrium (VLE) are essential for the design of chemical and separation processes. Unfortunately, very limited work has been reported on the VLE study of binary mixtures CPME and 2-MeTHF. Hence, VLE data were obtained experimentally by modified Raal apparatus which is a vapour recirculating type equilibrium still. The thermodynamic consistency of the experimental data was confirmed by the Herington's area test and point-to-point test of Van Ness. The experimental binary data were correlated using various activity coefficient models such as Van Laar, Wilson, NRTL, and UNIQUAC. The aim of this work was mainly to investigate the VLE data of binary systems comprising the green solvents and hence to supply basic data for simulation and design of the distillation processes.

7. Synthesis of solvo thermal derived TiO₂ nano crystals supported on ground nano egg Shell \waste and its utilization for the photocatalytic dye degradation

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TiO₂ nanoparticles with excellent crystallinity were synthesized via solvothermal method and supported on the ground nano-sized eggshell waste at different loading concentrations. The photocatalytic degradation of the mixture of Methylene blue (MB) and Rhodamine6G (Rh 6G) in aqueous solution utilizing prepared TiO₂ nano composite under visible light irradiation was analyzed. Different characterizations including UV-Visible (UV-Vis) spectroscopy, Field emission scanning electron microscopic (FE-SEM), energy dispersive studies (EDS), Transmission electron microscopy (TEM) were performed to investigate the physicochemical properties of the prepared catalyst. In addition, FE-SEM and EDS analysis of the prepared egg shell support were carried out to confirm the morphology, particle size distribution, and composition. The solvothermal derived TiO₂ nanocrystals supported on ground nano-sized egg shell waste exhibited enhanced photocatalytic activity as compared to the as-prepared TiO₂ nanoparticles. The synergistic effect of TiO₂ nanoparticles and nano egg shell support is attributed to the effective dispersion of TiO₂ that offers high specific surface area.

PhD (Environment Engineering)

1. Hydro geochemical Studies for Diffused Contamination in an Irrigation Command Area

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Over exploitation of groundwater because of sprouted urbanization, industrial development and agricultural activities, shallow aquifers are experiencing an increasing threat of pollution. An attempt has made for identifying hydro geochemical processes that control the chemistry of groundwater, suitability of water for irrigation use, assessing groundwater vulnerability in shallow aquifer and to suggest suitable groundwater protection measures for the Mahi Right Bank Command Area in central Gujarat, India. Groundwater sources in the study area were evaluated for their chemical composition. The groundwater quality of the study area has a primary problem of salinity followed by high concentration of Mg^{2+} and K^+ . Large spatial variability of groundwater quality parameter has been observed in the study area. Groundwater suitability for irrigation purpose in this study area was assessed. Intense agricultural activities in the MRBC area have led to the pollution of shallow aquifers. An attempt was made to assess the aquifer vulnerability of the MRBC groundwater basin employing the empirical index DRASTIC model. The resulting DRASTIC and pesticide DRASTIC maps of the MRBC area indicated that almost all area is in the high vulnerability zone.

PhD (Environmental Science)

1. Assessment of Land Use Land Cover Change in Gulf of Kachchh with Special Reference to Conservation of Marine Ecosystem

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Urban expansion has increased the utilization of natural resources and has altered land use and land cover patterns. Coastal zones are most susceptible for land use changes in this rapid era of industrialization and urbanization. To conserve the present natural resources and to be aware of the causes and consequences of over exploitation of soil and water resources a land use and land cover mapping and monitoring was done in the coastal area of Gulf of Kachchh, one of the most rapidly growing industrial hub in India. Remote Sensing and Geographical Information System (GIS) techniques were used as a tool to monitor the land use and land cover change in the study area. The main objective of this study is to monitor and evaluate land use land cover (LULC) changes during the year 1997 to 2016 at the five years time period gap. The impact of these LULC change on marine ecosystem was analyzed and the future prediction model for this area was given. LISS-III satellite data and digital change detection techniques were used. The mangrove and coral reef area were also calculated and compared in these years. Bird diversity was also observed. The future prediction model for the LULC was given for the next ten years. The study exposes that the important coastal land use type of GoK coast. The mangrove vegetation has been reduced drastically and after that it increased. The coral reef area was increased on islands but it destructed at the coastal line because of the anthropogenic activities along the coastal zone. The built up area and industries are increased and agriculture land and other land are decreased in the next ten years.

2. "Production of bio-plastic from various industrial pollutants and exploring its social applicability"

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Plastic are present in the every smear in human life. Plastic are causing serious environmental problem due to their non-biodegradability. The microorganism isolated from industrial influents from various zones of Gujarat respectively dairy, food processing and fertilizer industry. Ten different types of micro organisms screened for further work. These all isolates were identified with Sudan black B plate assay and Tributyrin agar plate and various staining like Sudan stain, Gram stain, various morphological and Biochemical analysis. Sewage and buttermilk used as a carbon source for the cheap production and minimizing the waste. For the extraction of sodium hypochloride-chloroform used to produce PHB granules. Quantification shows bacillus cereus showing high production 86.54% and similarly pseudomonas spp showing 62.07% production. One novel Spp arthrobactor nicotinae 58.33% result with glucose used a carbon source. Molecular identification of isolates were characterized by 16s rRNA partial genetic sequencing. Further check their similarities to standard PHB and sample PHB were characterized by Flourier Transform Infrared Spectroscopy, Nuclear Magnetic Resonance and Thin layer chromatography. Finally present study showing the similarity between both granules. Mechanical properties was checked of PHB Based plastic and synthetic plastic. All parameter were statically significant through two ways Factorial Completely Randomized Design ANOVA.

3. Industrial Air Pollution Control: Selection of trees for Green belt development using Anticipated Performance Indices – A case study of Nandesari Industrial area, Vadodara, Gujarat, India.

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Air pollution is a global phenomenon arising out of the unmanageable, unplanned, and rapid industrial development. The quality of air is deteriorated day- by- day because of rising concentrations of several gaseous pollutants in the atmosphere. The plants can survive well with higher pollutant concentrations and act as pollution scavenger. The most efficient greenbelt development not only abates/ diminish pollution, but also helps in prevent soil erosion, increase underground water levels, rainwater runoff, but helps in increasing biodiversity index, reduce pollution cost-effectively, etc. In India, greenbelt development is legally mandatory as per the rules and regulation by MoEF, CPCB and State Pollution Control Boards. Therefore, in the present investigation an attempt has been made on air pollution status, Air pollution Tolerance index and Anticipated Performance Index in Nandesari industrial area, Gujarat- *A case study*, and carryout in three sites along with control site by common plant species *F. benghalensis* (vad) ranked first as an Excellent Performer followed by *F. religiosa* (pipal), *longifolia* (*asopalav*) tree species expected as Good performer, while *M. champaca*.,(champo) *A. cordifolia*, *C. simea* (*kasod*) to serve as a gaseous sink, sequestration and recommended for plantation in Nandesari industrial areas of Gujarat.

M.E / M.Tech (Chemical Engineering)

1. Surface Activation of Adsorbents using Ionic Liquids; Its Characterization and Applications

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One of the most important areas of green chemistry is the application of environmentally friendly solvents in catalysis and synthesis. Ionic liquids are promising green solvent alternatives to the volatile variety of organic and organo metallic compound. They form liquids composed in most ions. This gives these materials the potential to behave very differently when they are used as solvents compared to conventional molecular liquids. The search for their application is growing in every area of analytical chemistry. The main advantage for other application of ionic liquids is its low volatility, non-flammable, high viscosity etc. which makes them useful as solvents for working in both high temperature and high vacuum environments. Present study emphasis on the activation of adsorbents such as activates charcoal, sewage sludge char with ionic liquid (ILs) tetra butyl ammonium bromide. Study includes the extend of adsorption of various concentration of reactive dyes and acetic acid with varying dosage of adsorbents. Further adsorption isotherms were studies and the characterization of modified and unmodified adsorbents using SEM, FTIR technology was carried out. Sewage sludge char Modified by 3% concentration of ILs shows maximum adsorption percentage for reactive dyes. Also the Freundlich and Langmuir Isotherms were also studied to identify which isotherm it follows accurately.

2. Dry Wash Technology for Purification of Crude Biodiesel Using Biomass Derived Adsorbents

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Biodiesel is considered as one of the most alternative fuel for diesel engine due to its non-toxicity, renewability and biodegradability. Biodiesel is produced by trans-Esterification of various fatty acids with methanol in presence of suitable catalyst. After transesterification the two layers are obtained; one is of crude biodiesel and other is glycerol. The obtained crude Biodiesel need further purification to improve the quality of biodiesel. There are three methods of purification of biodiesel viz. i) water wash, ii) dry wash and iii) membrane separation. Water wash technology have major drawback of generation of wastewater and subsequent purification which adds to the cost of biodiesel. This drawback can be overcome by dry wash technology. The dry wash technology uses different biomass derived adsorbents for purification of biodiesel. In the present study, crude biodiesel purification was carried out by using biomass derived adsorbents such as tea waste and rice husk. The various parameters such as adsorbent dosage, particle size of adsorbent and time of adsorption were studied. It was observed that H_3PO_4 Activated tea waste has given the better results as compared to NaOH activated. The properties of biodiesel were tested and found to be at par with the ASTM standards.

3. Treatment of Complex Effluent of Paper Industry Using Electro-Coagulation and Various Membrane Modules a Novel Approach Based On Real Time Experiment

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This project focuses on Treatment of Complex effluent of Paper industry using electro-coagulation and various membrane modules a novel approach based on real time experiment on Mainly Paper industrial effluents is caused by high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) along with fats, oil–grease and many other recoverable nutrients like Nitrogen, Phosphorous and Potassium. Now a day's industrial effluents treatment using alum and activated charcoal powder as adsorbent. Mainly observe water parameters are pH, Electrical Conductivity, Total Dissolved Solids (TDS), COD, BOD, Turbidity and Hardness. In thesis the Micro filtration and Nano filtration are used, using new applications combine with Electro coagulation in the area of waste water treatment Pre-treatment draw to additional investment costs. But, total management cost and sustenance costs decrease because of a more steady overall system performance with lower cleaning frequencies and longer membrane lifetimes and Electro coagulation process comparative operating cost decrease in term of electrical energy, electrode and less time for complete Process.

4. An Environment Friendly Approach: In-Vessel composting and Anaerobic Digestion for Methane gas generation from Secondary sludge of GESCSL, CETP-Vatva, Ahmedabad

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Two different sludge management techniques i.e., Composting and anaerobic digestion Implemented on secondary sludge of CETP Vatva. These two different techniques for sludge management pursue two goals; handling of the sludge in a harmless way for the environment and producing more biogas. The produced compost can be used as a fertilizer. In-Vessel composting method was implemented and secondary sludge was taken in different proportion with Vegetable Waste (VW) as well as with Cow Dung (CD) in different vessels. To check the made compost quality and the best compost among all, Pot study was carried out by using the made compost as a fertilizer in plants. Compost, which is made by using 10 to 30 % of secondary sludge and 70 to

90 % of Cow Dung gave the best results. Usage of secondary sludge more than 30 % does not give good results. Further, to investigate possible ways to increase the methane production from sludge digestion the digestion of secondary sludge with addition of sewage and vegetable waste (to adjust C:N ratio) was investigated. The procedure adopted for measuring the methane production from the sludge was based on the theoretical calculation, which depends on the Chemical Oxygen Demand (COD) difference of Feed and Outlet of Anaerobic Digester. The methane production is expressed as volume of produced methane per kg COD removed (L CH₄/kg COD). In AD, the observed reduction was 73 % of Total Solids (TS) and 69 % of Volatile Solids (VS) averagely. Also maximum of 96.26 % and minimum of 58.50 % of COD removal has been obtained in AD. Secondary sludge along with continuous feeding of green waste and sewage gave maximum volume of methane gas generation i.e., 217.03 L CH₄/g COD on thirteen day after initiation of AD on the basis of COD reduction. During the entire study, average 91.00 LCH₄/g COD of cumulative methane gas generation was obtained. After 13 days, Average, 40-50 % of methane gas yield was obtained through Anaerobic Digestion of secondary sludge of GESCSLCETP, Vatva which was ensure through gas chromatography. Moreover, at site methane generation was ensure by burning of collected gas taken in bladder and continuous flame was observed, which is indication of presence of 40- 50 % of methane gas in generated biogas.

5. Mathematical Model for Molecular Masses of Amino Resins (UF)

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Amino resins are water soluble oligomers and obtained by methylolations/condensation reactions between Urea and formaldehyde. It is used for producing molded materials, adhesives, wood agglomerates, laminates etc. The aim of this work is to study mathematical models that can be used calculate molecular masses of urea formaldehyde resin by mathematical modeling. In this work, Mathematical model has been developed on the basis of methylolation and condensation of UF at different values of temperature, pH and F/M ratio. The kinetic constants were taken by

tomita, is a system of first order ordinary differential equations. The model developed was then solved numerically by MATLAB (ode45s solver). The model predicts, (1) Number average molecular weight(2) Average functionality of reactive H's (3) Methylene bridge (4) Ether bridge (5) Methylols. Final products contains thousands of different molecular species 30 of them contain more than 90 % of total weights, so model gives final distribution of molecular weight that is moderate with experimental demand. It reduces the number of iterations in Research and development department for requirement of low conversion product.

6. A Study on Maximization of Naphtha & Diesel Yield in a Hydrotreater Using Combined Refinery Streams

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Today's refiners are facing a number of challenges to maximize their product at existing condition. Hydro treating of Diesel is one of the most important process in crude oil refineries in which compounds such as sulfur, nitrogen, oxygen and metal are removed and government standards are met. In this work a study is done on how to maximize diesel & naphtha yield in an existing Hydrotreater by using combined refinery feedstock. Process simulation of existing Hydrotreater as well as of post maximization Hydrotreater is carried out by using CHEMCAD simulator (Chemstations). From the result of simulation Diesel and Naphtha yield is increased in terms of production. Comparison of production of pre & post maximization is done. Feed tray is optimized in Stripper column on the basis of three parameter i.e. H₂S, H₂O content and Diesel component in overhead of Stripper column. Additional one column is required for maximizing product yield from combined feed. To eliminate bottlenecks some approaches are also described. The required operating variables and data is obtained from ESSAR oil ltd. Vadinar, laboratory analysis.

7. Isobaric Vapour-Liquid Equilibrium Determination of a Binary System Comprising Cyclopentyl Methyl Ether and Methanol

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The importance of green solvents cannot be ignored because traditional solvents play an important role in the environmental performance of the chemical process industries. But most of the solvents cause the hazard to health and safety. Cyclopentyl methyl ether (CPME) is considered as one of the green solvents. During its production, it is required to be separated from methanol. The vapour-liquid equilibrium data of CPME/Methanol binary system is available for the isothermal system but it is not available for the isobaric system. So during this project, isobaric vapour-liquid equilibrium data was determined. The VLE data determination was carried out by the prediction using group contribution method as well by measurement using experimental apparatus. It was followed by thermodynamic consistency test and data regression by various excess Gibbs energy models.

8. Membrane separation processes

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Concentration polarization and membrane fouling are the two major limitations for the pressure-driven membrane filtration processes. They lead to the severe flux decline and that need to be controlled for the better process efficiency. This paper examines the flow reversal and pressure pulsation techniques for the flux enhancement in nanofiltration of reactive yellow 160 dye

synthetic wastewater in flat sheet membrane module with HPA 150 membrane. Nanofiltration with pulsation of 100 ppm reactive yellow 160 dye solution at 3, 5 and 7 kg/cm² pressure with frequency of 2 min intervals increases the permeate flux as 2.58, 5.12 and 8.80 % respectively. Similar observation were found in reversing the feed (1 min reverse after every 5 min forward feed) at different pressure. Flux alleviation was nearly 3.02, 6.9 and 10.2 % at 3, 5 and 7 kg/cm² pressure with flow reversal. Resistance-in-series model was applied to quantify the relevance of the flux enhancement and decrease in concentration polarization resistance (R_{cp}). The value of R_{cp} for forward flow is 1.04 m⁻¹ at 3 kg/cm² which is reduced to 0.84 m⁻¹ for flow reversal at same conditions. Similarly, during pressure pulsation (after 1 min interval) at 3 kg/cm² R_{cp} is varied from 1.02 m⁻¹ to 0.92 m⁻¹. Thus, there is no appreciable reduction in R_{cp} in case of pressure pulsation technique but significant reduction in R_{cp} observed in case of flow reversal.

M.E / M.Tech (Environment Engineering)

1. Successful application of River Water Quality Model QUAL2K for Mindhola River

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The study was carried out to apply “QUAL2K - A Modeling Framework for Simulating River and Stream Water Quality” on Mindhola River, which is Minor River of South Gujarat. The scope of study was thirty km long stretch from Amalsadi to Kapletha. The stretch was monitored for three cases; Average-Flow-Period, Peak-Flow-Period, and Lean-Flow-Period. The model was calibrated and confirmed in accordance with nine monitoring locations. Fifteen physico-chemical parameters taken in consideration were Temperature, pH, DO, cBOD, Species of Nitrogen, Species of Phosphorus, Conductivity, Alkalinity, and ISS. The model depicted monitored data reasonably well. Root Mean Squared Errors were calculated for main parameters DO, ucBOD, TN, TP and pH; which were 13.2%, 9%, 12.97%, 8.8% and 3.27%, respectively. As QUAL2K efficiently predicts water quality parameters for river that receives multiple discharges, it is a valuable tool for regulatory authorities to set discharge norms and develop river conservation policies accordingly.

2. Treatment of a real Dye wastewater using Anaerobic Sequential Batch (AnSBR) and Anaerobic Sequential Batch Biofilm (AnSBR) Reactors

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This study demonstrates treatment of real wastewater from manufacturing of Solvent Black 46(SB46) dye in Anaerobic Sequential batch Reactor (ANSBR). The performance of ANSBR was compared with ANSBR containing immobilized biomass i.e Anaerobic Sequential Batch Biofilm Reactor (ANSBBR). In acclimatization phase Organic Loading Rate (OLR) was ranging from 0.633-1.008 g COD/L d, percentage of COD removal in ANSBBR was in range of 60-90% whereas in ANSBR it was 50-70%. During operational period, OLR and COD concentration were ranging from 1.152-2.88 g COD/L d and 3500-10,000 mg/L in which removal in ANSBBR was ranging from 93-84% and in ANSBR it was ranging from 86-55% respectively. Biogas production was in range of 500-3000 mL/d in ANSBBR and 100-2500 mL/d in ANSBR. GC-FID analysis confirmed the presence of methane. Inlet pH of the feed was in range of 4.8-5 which increased to 7-7.9, indicating degradation of acetate in wastewater. Results of this study suggest that anaerobic treatment can be employed advantageously for SB46 wastewater, resulting in outstanding COD removal without any energy input and producing useful methane.

3. Treatment of Food-Processing Industry Wastewater by Vermi filtration

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Food processing industries consume huge amount of water for processing of food. A major portion of water is potential wastewater to be treated for safe disposal to the environment. Wastewater generated from food-processing can be characterized as nontoxic and it contains very few hazardous and persistent compounds. Wastewater from food-processing industries is mainly organic and can be treated by conventional biological technologies. Vermifiltration is a new low cost treatment technology for liquid waste treatment. It is a wastewater treatment process biofilter or trickling filter but with the addition of earthworms to improve treatment efficiency. The present work has been done to determine the treatment efficiency of vermifiltration for food-processing industry wastewater on a laboratory scale basis. Laboratory scale model was designed and fabricated based on some research works. *Eisenia fetida*

earthworm species was used for treatment purpose. Hydraulic loading rate and hydraulic retention time were $1.5 \text{ m}^3/\text{m}^2 \text{ day}$ and 6-7 hours selected, respectively. Experimental trials were conducted and compared with both control reactor (without earthworm) and UASB treatment. In vermifiltration, removal efficiency for COD, BOD, TSS and TDS were 77-86%, 77-84%, 62-68% and 52-59%, respectively.

M.Sc (Environmental Science)

1. Assessment of Carbon Footprint & Estimate Carbon Sequestration in HNG University, Patan

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Carbon sequestration refers to the natural and deliberate process through which carbon is removed from the atmosphere and that carbon is stored in environment which is known as "Carbon Sink". The present study has been carried out to know some potential native trees occurring in the campus of HNG University and their carbon stock. The study show that total organic carbon stock estimated in all the 1914 trees reaches up to around 20 tons in the campus, which reveals 20 tons/sq. meter carbon stock in the university was estimated. We have also estimated GHG emission using carbon calculator during February 2017 to January 2018. Present study may help to reveal the carbon footprint in the university campus and the opportunity of similar study in the industrial areas so that we can balance the atmospheric carbon through planting the native tree species. This will again help to conserve the native biological diversity and minimizing CO₂ in the atmosphere.

2. Sugarcane Bagasse as a Plant Activated Charcoal to Remediate Nutrients and Heavy Metals from Industrial Effluents: An Alternative Cleaner Technology.

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The Plant Activated Charcoal - a cheap and eco-friendly adsorbent has been prepared as an alternative source for Powdered Activated Charcoal for the remediation of nutrients and heavy metals from industrial wastewaters. In current investigation, utilization of local agricultural waste - sugarcane bagasse is prepared as plant activated charcoal acts as a adsorbent, characterized for size by SEM, elemental composition(EDAX), optimization at different contact time, PH, agitation and amount of adsorbent and eventually removed nutrients like PO_4^- , SO_4^- , NO_3^- , Hardness, Iron and Chromium (ICP Analyser) from the industrial wastewaters-Textile, Dye industrial effluents, Common Effluent Treatment Plant wastewater, Nandesari, Baroda and fisheries wastewater ranging from 60 to 95 percent.

B.E / B.Tech (Chemical Engineering)

1. Seebeck effect for pollution prevention and waste minimization of heat

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In today's era, we have more focused on sustainable renewable energy that produce very less carbon emission and eco-friendly energy. We know that conventional sources are limited and may be in future it has not remaining for our future generation. These sources are pollution causing so we need to find other method for producing energy with no pollution. We believe a thermoelectric generator that can use waste heat energy to produce electricity. The major advantage of seebeck effect phenomenon is the machinery that built using this principle is clean, safe and user friendly.

2. Emulsion of water in diesel

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The standard of living, quality of life & development of a nation depend on its per capita energy consumption. Global energy supply that mainly depends on fossil fuel is decreasing day by day. Emulsification process and behaviors of an emulsified diesel will be investigated. The influence

of stability of emulsion & RPM of agitator of emulsified diesel samples & product of emulsification process will be studying. The primary objective of this work will be to demonstrate the manufacturing of emulsified diesel by use of Tween 20, Span 20 and agitation. The analysis describes stability checking, flash & fire point checking, smoke point checking will be investigated at the end it will be study that it will be possible to use emulsified fuel in diesel engine by comparing the properties of pure diesel.

3. Biodiesel production from Dairy scum waste

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Biodiesel is more expensive than conventional diesel fuel because of cost of raw material. To reduce cost of biodiesel there is a need to search for the alternative sources which are not useful and go as waste. This lead to search for excavation of biodiesel feed stocks from unconventional, non-edible oil and fats like, waste grease, waste cooking oil, disposed automobile tyres, etc. The present work is explores the potential of dairy waste scum as a feed stock for bio-diesel production. The study optimized the parameters involved in transesterification process of Dairy Waste Scum Oil. The yield of bio-diesel reached 90.6% when 1.5 wt.% of Potassium hydroxide, reaction temperature of 65 °C, 45 min of time and 6:1 Methanol oil ratio at 400 rpm. The present analysis confirms that biodiesel from dairy waste scum is quite suitable as an alternative to petroleum diesel with recommended fuel properties as per ASTM standards. This new way for using dairy waste scum reduces the cost of production of bio-diesel and the problem related to the disposal of Dairy scum.

4. Achieving Cleaner Production Aims By Improving Resource Efficiency By Means Of Proposed Design of Leaching Equipment

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Solvents have been classified under the Hazardous waste category and cannot be disposed of without following proper norms. Therefore operations which require the use of solvents have majorly been decreed to follow end of pipe treatment or recovery techniques. Leaching is used for purpose of separation wherein particle size, solvent, temperature, energy, efficiency and yield are the major considerable factors. Leaching operation uses more energy to carry out operation so less energy consuming process is more preferable. The conventional leaching equipment have several limitations like higher power consumption, large equipment sizing, stage by stage transportation slurry and leached solution, separation of slurry and solution on each stage and cleaning process after leaching. To solve above problems, the new design of leaching equipment is generated. The proposed design may solve some of the problem like stage by stage transportation, separation of slurry and solution on each stage and cleaning process after leaching. The design proposed is in adherence to the concept of Process Intensification thereby enabling a better prospect of improving resource efficiency and waste minimization which satisfy our broader concept covered under Cleaner Production technologies.

5. Comparative study of processing and application of precipitated silica from agricultural waste (Rice husk) and industrial waste (glass)

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Silica being one of the most abundant substances on earth due to its versatile applications as fillers for paints and rubber, in ceramics, in construction, and in preparation of other substances it has been procuring attention since past few years. On the commercial scale precipitated silica is manufactured by the fusion of the high purify caustic soda and silica sand in furnaces at temperature of 1000-1500 °C, In spite of that precipitate silica can also be recovered from industrial and agricultural waste material (rice husk and borosilicate waste glass) which is more eco-friendly and greener method. In addition, the study elucidates the comparison of precipitate silica recovered from agricultural waste (rice husk) and industrial waste (glass) based on: method implemented for recovery, the characterization of precipitate silica produced from rice husk and waste glass, and how the precipitate silica (Rice husk & waste glass) have different affinities towards different applications. To the least, as analytical auditing being a mandatory core subject to be studied by every industry to prohibit going over the limits stated by government norms, hence laboratory test; pH, COD, TDS, Cl, Hardness, etc. are performed on the effluents obtained during the synthesis. To examine all the parameters being studied accord optimism towards sustainable development. In addition we have broadly worked on the application of these different silica towards different applications that include: deterring the affinity of different precipitate silica towards absorbance capacity, checking on the binding enhancement and fastness during dying of different dyes on fabric, checking on the reinforcement in mechanical strength of ceramic bricks etc. This study also concludes that how these different silica suits for precise area of application.

6. To Decrease Chemical Oxygen Demand (COD) In Waste Water in ETP

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This technology comes at different configuration and setups from direct crystallization to indirect and at promising cost reduction compared to conventional thermal and RO processes. The process involves nucleation, crystal growth washing and melting. There is still much to learn on the nucleation and crystallization aspects of the process. Recent CFD development enables to shed more light on the overall crystallization.

7. Solar Drying System

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Now a day's many water resources are polluted by industrial processes. Public concern over the environmental impact of wastewater pollution has increased. The different types of contamination of wastewater require a variety of strategies to remove the contamination. In industries, after treating waste water, there is the problem of sludge disposal. That sludge has so many liquid contaminants so that sludge is go through drying process but that process is open sun light drying. By this kind of drying, the moisture contents is remain in sludge, so the weight of that is more for dumping. It increases the cost of dumping and also the further purification of leached liquid of that sludge is very complicated. Using this Solar drying system the cost of dumping is decreased and the requirement of purification of leached liquid is less. Any drying

process is based on fact that water molecules changes from liquid in to gas called vapour. When sunlight enters into Dom with dry air the green house effect is caused and thereby water is evaporated by solar radiation and moisture is removed by dry air and moist air is removed from top of the Dom and sludge is dried.

8. Waste water generation & management in chemical industries

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Now a day there is a continuously increasing worldwide concern for development of alternative water reuse technologies, mainly focused on industries. In this context, Advanced Oxidation Processes (AOPs) are considered as a highly competitive water treatment technology for the removal of those organic pollutants not treatable by conventional techniques due to their high chemical stability and/or low biodegradability. Although chemical oxidation for complete mineralization is usually expensive, its combination with a biological treatment is widely reported to reduce operating costs. This project reviews recent research combining “Fenton process” and Membrane Bio-Reactor for the industrial wastewater. The main conclusions arrived at from the overall assessment of the literature are that more work needs to be done on degradation kinetics and reactor modeling of the combined process and also dynamics of the initial attack on primary contaminants and intermediate species generation. Fenton treatment with recycling through UF RO system by stream segregation is the good treatment for waste water in industries for high COD.

9. Textile Waste water Treatment using Reverse Osmosis Membrane Process

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The textile industry contributes significantly to the overall economic growth of developing countries such as India. The textile industry is among the few large industries that consumes considerable amount of water at different stages of processing, which leads to a wide variety of waste-water characteristics. For these reasons, the effluent/wastewater streams from textile industries must be treated before discarding to the environment. In addition to the already existing traditional treatment methods, the efficiency and effectiveness of the treatment methods are increased by advanced treatment methods such as Nano filtration, ultra-filtration, micro filtration and reverse osmosis. Membrane plays a significant role in any advanced dye waste-water treatment system. RO amongst all other membrane technology is more effective and getting more practiced.

10. Development of Heterogeneous Metal Catalysts for Oxidation Reactions

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Oxidation reactions may be considered as the heart of chemical synthesis. Heterogeneous catalysts with various supports are brought to the spotlight because of their excellent capabilities to accelerate the rate of chemical reactions with low cost. They also minimize the use of chemicals in industries and thus are friendly and green to the environment. The green chemistry approaches must meet health and environmental safety and use very little chemicals reducing both cost and time. Heterogeneous Catalytic approaches might be considered as green since specific chemical transformation could be achieved within very short time with the addition of very little catalysts, significantly reducing production cost as well as health and environmental risks. To enhance selectivity and reduce catalyst separation cost, recently many heterogeneous catalytic processes have been developed. Objective of the present work will be synthesize heterogeneous catalysts and to test them for oxidation reaction. Suitable catalysts will be proposed for characterization. To have easier separation from reaction mixture and better selectivity with higher conversion, such research work focuses to develop heterogeneous Metal catalysts for oxidation reactions.

11. Catalytic pyrolysis of Waste Plastics into Fuels

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Plastic is an indispensable part of our daily life. Its production and consumption has been rising very rapidly due to its wide range of application. Due to its non biodegradable nature it cannot be easily disposed off. So, now a day's new technology is being used to treat the waste plastic. One of such process is pyrolysis. Over a 100 million tones of plastics are produced annually worldwide, and the used products have become a common feature at overflowing bins and landfills. Though work has been done to make futuristic biodegradable plastics, there have not

been many conclusive steps towards cleaning up the existing problem. Here, the process of converting waste plastic into value added fuels will be developed for recycling of plastics. Thus two universal problems such as problems of waste plastic and problems of fuel shortage are being tackled simultaneously. The waste plastics are subjected to depolymerisation, pyrolysis, catalytic cracking and fractional distillation to obtain different value added fuels such as petrol, kerosene, and diesel, lube oil, furnace oil traction and coke. Different catalyst will be used here is a mixture of zeolite, clay, alumina, activated Carbon and silicates in different proportions. Converting waste plastics into fuel hold great promise for both the environmental and economic scenarios. Thus, the process of converting plastics to fuel has now turned the problems into an opportunity to make wealth from waste.

12. Design of Bio-mass gasifier using saw dust as a feedstock

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As a result of global warming harmful gases released into the atmosphere combined with continual depletion of fossil fuel resources at unpredictable rate which lead to put effort in developing alternative energy technologies from agricultural waste like saw dust, rice husks and sugar cane bagasse to meet up the future energy demand. Biomass gasification has been identified as one promising technology for converting carbonaceous materials into a clean, renewable and sustainable energy carrier gas known as Producer Gas, which is also called as Syn-Gas. This Biomass gasifier can be used for operating pumps in remote rural areas, lift water, operate saw mills, flour mills and for generating electricity.

13. Removal of Ni (II) ions from Industrial Effluents using Agricultural waste

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The pollution of heavy metals in water bodies has gained worldwide attention due to their toxicity, difficult degradation, and accumulation in the living organisms. Nickel is selected as an adsorbate because its compounds have widespread applications in many industrial processes such as non-ferrous metal, mineral processing, paint formulation, electroplating, and many more leading to relatively high concentrations in aquatic environment. Many conventional methods including oxidation, membrane filtration, etc. have been reported in the literature to remove heavy metals from waste water. These techniques are not so economical. The utilization of agro-wastes as adsorbent is currently receiving wide attention because of their abundant availability and low-cost owing to relatively high fixed carbon content and presence of porous structure.

14. Photo Degradation of the Pharmaceuticals Waste of Paracetamol by the Modified Solar Photo-Fenton Process

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Photo degradation of the pharmaceuticals like Paracetamol (PCT) in aqueous solutions via the photo-Fenton process using different catalyst was investigated under solar irradiation. Which helps in deduction COD of effluents. Pharmaceutical industry uses conventional method such as

adsorption, aeration, etc for effluent treatment which is not to degrade recalcitrant organic contaminants. Hence some alternate methods should be developed to treat such effluent. Fenton's reaction is used to treat a large variety of water pollutants such as Phenols, Formaldehyde, Pesticides, chemicals etc. Fenton process is an Advanced Oxidation Process (AOP) which is used for mineralization of organics. The influences of iron source, initial H₂O₂ concentration and matrix (distilled water and sewage treatment plant effluent) on degradation efficiency were discussed in detail., the oxidation of waste is faster than under conventional processes like coagulation, oxidation. All these pharmaceuticals can be efficiently degraded employing the process evaluated. So this process can be employed as a treatment of pharmaceutical waste water.

15. Study on Preservation of Sugarcane Juice by using Various Additives and Recovery of Furfural Aldehyde from Bagasse

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The variety Cop 92226 was selected for preparing sugarcane juice beverage. Sugarcane juice beverage samples were prepared by pasteurizing the sugarcane juice and adding citric acid, ascorbic acid and sodium metabisulphite. Samples of sugarcane juice beverage were stored at room and refrigeration temperature in pre-sterilized glass bottles and analyzed for physico-chemical, microbiological and sensory attributes at every 15 days interval for 90 days. Bagasse is a waste product from the sugar industry, which is usually used as energy source in factory at present. However, the amount of bagasse left is still high enough for more value-added product for example furfural. Bagasse is a good source of pentosan. The main objective of the research

was to produce furfural from bagasse. The main raw material used for the production of furfural was bagasse and some chemicals/ingredients used were H₂SO₄, water, NaCl, etc.

16. Study of Applications of Waterborne Epoxy Resins & Advanced Curing Techniques

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Epoxy resins have been commercially available for more than sixty years and are used in one of the most diverse range of applications in the modern world. The epoxy resins applications are not limited to surface coating industry but also in thermal and ambient cure applications in industries such as aerospace, civil, automotive, chemical, electrical, marine, leisure and many others. If modifications in the properties of epoxy resins can be done by improvements in weathering characteristics, scratch hardness, etc. then a great deal of value addition is achieved. The improved curing techniques such as ultraviolet and electron beam (UV/EB) can bring revolution in coating industries. The aim of this project is to study epoxy resins and improvement in their properties for specific applications.

17. Waste water purification and improve the quality of membrane

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We focus on increasing the life of membranes in use and making it effective for multiple times use. Our second aim is to reduce the rejected water coming out of RO. Efficiency of Membrane is low. We have to Change the membrane frequently. Manufacturing cost of membranes are high. We always get the high amount of rejected water.

B.E / B.Tech (Environment Engineering)

1. Design and Development of Fresnel Film Based Concentrating Solar heating system

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Major concerns, today are the rapidly depleting natural resources and rising pollution As the world is growing and also due to modernization there is increase in the demand of power, so it is need of the hour to reduce the dependency on non-renewable sources. The objective of the project was to device a solar thermal system for heat application to suit temperature up to 250 °C to promote eco friendly production in the industries. The system consists of Fresnel film aluminum an iodized reflector sheet; stand for heat application, manual tracking system and a common frame to house all these components. The UV stabilized Fresnel film focuses incoming beam solar radiation at its focal point; the well placed reflector reflects the concentrated high intensity solar beam onto the conducting bottom of vessel which creates temperature as high as 250 °C. The system works on the principle of Fresnel lens and concentrated solar power (CSP). Fresnel film having several concentric rings, each rings is slightly thinner than the next and focus the light towards the center. CSP is basically a solar thermal technology; here the light energy of the sun is concentrated by using reflecting surface to generate heat, which can be used for variety of heating application. Results revealed that the bottom of the stand attained 109 °C, higher than boiling temperature in just 10 minutes of time during experiment conducted on 8th, January, 2018. Maximum temperature of 204°C was found at 13.14 hrs. Instantaneous insolation recorded by pyranometer was in the range of 650982 Wh/m². Fresnel film based concentrating solar

system permits no cost heating, it is eco friendly, noise less and emission free option to save environment.

2. To eliminate the higher amount of “Ibuprofen” drug from pharmaceutical Industries effluent by using piezoelectric generator

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Pharmaceutical wastewater is one of the complex water to treat as it contains complex drugs traces. There are variety of drugs present in pharmaceutical waste water and one of them is ibuprofen an inflammatory drug, we are dealing with in this project. Available conventional treatment techniques to reduce the concentration of drugs into natural sinks and reduce the damages it can cause are not efficient enough to deal with the situation and also sometimes it may lead to formation of toxic end product, which makes it important to design a new treatment technique which is efficient and economical. In this project Hydrocavitation with the help of Piezoelectric Generator is use to eliminate ibuprofen from waste water. Ultrasonic cleaner power driver board transducer is used to produce ultrasonic wave due to which the micro Cavitation bubbles are formed. When these bubbles rises from bottom to top it increase in size and ultimately it collapse which lead to breaking of complex drug compound into simpler end Products which are not toxic in nature and residuals of ibuprofen are adsorb in a separate sand filter.

3. Techno-economic comparison of different electrodes for the removal of Ibuprofen (IBU) in pharmaceutical wastewater

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Effective treatment of pharmaceutical wastewater is a great challenge because of the large quantity, complexity and its hazardous nature. Lack of implementation of efficient treatment technologies worsen the situation in countries that faces the problems like rising population, rapid urbanization and industrialization which adds on to the enormous quantity of industrial waste generated. Electro coagulation and Electro oxidation process may be a possible approach for the pre-treatment of pharmaceutical residue which contains Ibuprofen in its wastewater. The motive of experiment is the comparison of Fe, Al, and Stainless steel electrodes used to treat wastewater containing Ibuprofen. Also, the influence of detention time, voltage, and distance are being studied during the experiment.

4. Storm water management and electricity generation

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India being a tropical country, receives uncertain amount of rainfall in different regions throughout the year. In today's scenario the world is facing a huge problem of availability of freshwater. Most of the precipitated water is lost as runoff due to the concrete trees the world have these days and poor management of this runoff poses high risk to situations like floods. Hence, to develop better resilience, a system has been evolved which manages runoff and further generates electricity. The Storm water is captured and allowed to pass through a specially designed riparian channel where water receives phytotreatment. Then it encounters a multi-sintered screen in order to remove the minute contaminants that may be left out. Small droplets of this treated water are utilized for electricity generation with the help of hydroelectric cell and rest of the water is stored. As a result, this water can be put to use for domestic, agricultural and industrial purpose, thereby preventing overuse of underground aquifers and aids in reducing the heavy storm water loads on sewer lines as well as sewage treatment plants. Hence, this model can be a mitigatory step towards flood management and better resource provider.

5. Identification, Characterization and Fate of Pollutants from Personal Care Products (PCPs)

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Personal care products (PCPs) have received growing attention in recent years as emerging contaminants for their possible threats to environment and human health. The global Cosmetic market was 460 billion USD in 2014 and is estimated to reach 675 billion USD by 2020 growing at a rate of 6.4%. Personal care products which contain diverse organic groups, such as Disinfectants, Fragrances, Insect repellents, Preservatives, Sunscreen UV filters, toothpaste, shampoo etc. India is a large country with high production and consumption of PCPs. These all

diverse organic groups have diverse effect on ecological environment and human health. India is second largest country in population so consumption of personal care products is high. This review summarizes the current identification and characterization of pollutant from PCPs in different environment media including, surface water sewage, sludge and air. This review also summarizes Chemical composition of 31 PCPs and investigates seasonal variations of PCPs in surface water sewage etc.

6. No_x Reduction Using Concrete Pavement

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This project investigated the potential for passive cleaning of outdoor air using Photocatalyst, which have been shown to photo catalyze the oxidation of atmospheric pollutants such as oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Photocatalyst has been of considerable interest due to its new technology for environmental pollution. Among the photocatalyst semiconductors, titanium dioxide is known as a photocatalyst for the removal of environmental contaminants. A clean TiO₂ layer on the surface of concrete porous pavement in the presence of sunlight therefore enables the removal of harmful NO_x gases from the atmosphere by oxidation to nitrates.

7. Assessment of Ground Water for Water Supply in Bhuj City

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The complete analysis of 4 drinking water samples was carried out to develop a data base on the quality of water being consumed in different areas of Bhuj city. The qualitative and quantitative analysis of water samples of different locations was conducted to determine Physico-Chemical parameter of water. The drinking water samples were taken from the main water sources which are distributed to city, where water is used for drinking and other domestic purposes.

8. Under Vacuum Collection of Solid Waste in Railway (Coaches)

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Solid waste Collection in rail compartment may be challengeable for waste handling operatives. In this developed plan is presented for vacuum waste collection system for the all Indian railway together with its feasibility and opportunities. The main goal is to clean the Rail compartment.

This optimal solution is following the models of other Indian railways. The system is designed for the all railway and the total waste amount is calculated; moreover the number of population served is correlated with seasonal tourist flow. The following research is provided as an example to be followed by other railways facing the same challenges.

9. Vermi Composting of Spent Mushroom Substrate and Paper Waste

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Municipal solid waste (MSW) is one of the major areas of concern all over the world. In developing country like India there is rapid increase in MSW due to urbanization and population growth. Effects of MSW are surface and ground water contamination, bad odour, hazardous gas emissions. Several waste management method have been investigated, including open burning, sanitary landfills, incineration, pyrolysis, composting, and vermicomposting. Out of which vermicomposting appear to be the most promising and ecofriendly for municipal waste management. Vermicompost is the product of the composting process using various species of worms usually red wigglers, white worms and eisenia fetida to creat a mixture of decomposing vegetable or food waste, bedding materials and vermicompost. In this study mushroom substrate and paper waste have been used as energy material in vermicomposting. Study shows that compost prepared after 50 days through vermicomposting has N:P:K Ratio= 1.26:0.04:0.1853 for paper waste and N:P:K Ratio= 1.008:0.0281:0.0531 for mushroom substrate. The study result shows a little variations with result of N:P:K Ratio= 0.36:1.18:0.36 for paper waste in research paper prepared by Muddasir Basheer and O. P. Agrawal, 2013 and N:P:K Ratio= 1.90:0.57:2.74 for mushroom subsrate in research paper prepared by Nik Nor Izyan, Noor Zalina Mahmood, Adi Ainurzaman Jamaludin, 2009.

10. Domestic RO Reject Management in Urban and Rural Area

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The technological advancement in applications of membrane processes was efficiently explored in recent decades due to huge demand for potable water. However relatively little improvements have been reported in the management and handling of the major by-product, called reject water or brine. The disposal or management of desalination brine is expensive and faces major environmental challenges. In spite of the scale of this economical and environmental problem, the options for brine management have been limited. This brief review presents an overview of existing methods on brine treatment, minimization, and disposal practices based on the newest and most updated technologies. In addition, the review outlines the advantages and disadvantages of most common treatment and disposal methods from an environmental perspective.

11. Development of Scrubber for Removal of CO₂ from Biogas

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Energy supply is a crucial issue in the world in the last few years. Renewable energy sources are one of the solutions to get rid of energy supply problem. Biogas energy is widely adopted by rural people as well as by industries. However, until now the use of biogas has not yet been maximized because of its low methane content. The research work was carried out to improve the quality of biogas (in terms of methane content) using the scrubbing method using water. Farmers and rural community can adopt this method as it is very cheap and easy. Therefore, their economy and productivity can be increased. This study includes the absorption of CO₂ gas present in biogas by water scrubbing method. The water scrubbing method has a good potential of improving the quality of biogas and has advantages as it is low cost and easy to operate.

12. Design and Development of Solar Powered Lawn Mower

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Burgeoning price of fuel and rising emissions of greenhouse gases have compelled the world to use the abundant solar energy as a source of power to drive technologies. A solar powered rotary lawn mower was designed and developed to promote use of green energy. The solar powered lawnmower comprises of main frame, 48 V, 15 Ah direct current (D.C) motor; 48 V 26Ah rechargeable battery bank; array of three solar modules (50 W, 2 x11W) , cast iron blade and control system. The special feature which makes the solar lawn mower unique is orientation of the solar modules. The 50 W solar module was oriented on the handle and two 11 W modules are placed on two sides of motor cover making them part of mower envelope. The arrangement gives the modules exposure to direct sunlight without any shading effect irrespective of direction of operation of the lawn mower. The array of three solar modules produces about 49 W of power in hour under clear sunshine to recharge battery bank which in turn operate DC motor. Charge controller of 48 V and 26 Ah is provided to protect the battery bank from over charging and deep

discharging. The solar array delivers synchronous power to battery bank to ensure uninterrupted lawn mowing operation. Lawn Mowing is achieved by the stainless steel rotating blade directly coupled to the shaft of the 1 hp D.C motor, which provides the required torque to drive it. Main on/off switch of 20 ampere is provided to operate lawn mower. Results obtained from field test revealed that the battery bank takes about 12 to 15 hours (at 50 % depth discharge) to attain full charging condition under solar insolation of 4.5 to 6 kWh/m²/day. The solar array feeds battery even while lawn mower is in operation. The lawn mower works for 45 to 50 minutes at full Charge of Battery Average field capacity of the lawn mower was found to be 0.069 ha/hr.

B.Sc. (Environmental Science)

1. The Stinking Drains!

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The Acid in our current toilet pot cleaner [the blue one] does a good job. The job of cleaning the stains and disinfecting. But what about the protection and hygiene factor in between the cleaning cycles? Well, nothing. The germs and odour simply start building up as you use. We put this Air Freshener and believe “All is well”. No its worse. It’s an irony that something designed to improve indoor air quality by making it smell better winds up making your home more toxic. An internet search will show sufficient research papers on the subject. The cost of masking the odour is huge and still the source “germs and odour creating bacteria” keeps growing there until your next cleaning cycle. With this toilet & bathroom manager we solve it from the core. It does not stop at cleaning and disinfecting. It goes several steps ahead and creates a layer of Bio-Film for Active Protection. It stops the growth of foul odour creating bacteria and germs, keeping your washroom odourless. Everyone dislikes and will be more than glad to see it disappear without a trace. We blame the municipal corporation and the government for the mess. We blame everyone, except us. Let us have a look at the problem with a scientific lens and work out a solution. We all create organic waste – Washrooms, Kitchen etc. Naturally occurring microorganisms (tiny bacteria, fungus etc) converts them into simple essential substances. For these microbes the organic waste is the source of food & energy. In fact when the sewage waste goes into a Sewage treatment plant (STP) it employs the same technique for cleaning. Now, let me take back to the source – Your Washroom, Kitchen etc. Herein we use conventional cleaners and detergents. They are all acids, alkali or bleaches. They are bad for microbes and they end up killing these microbes thus disrupting this natural process and accentuating the problem. We call it the Dead Sewage.

We introduce cleaning alternates – especially for Washrooms & Drains, made with Microbes and Microbe friendly solutions.

- For the user it offers a stain free, odour free & unclogged clean drainage system.
- The beneficial microbes thrive on this Organic Waste and bring life back into the Sewage. It keeps cleaning itself as it flows.

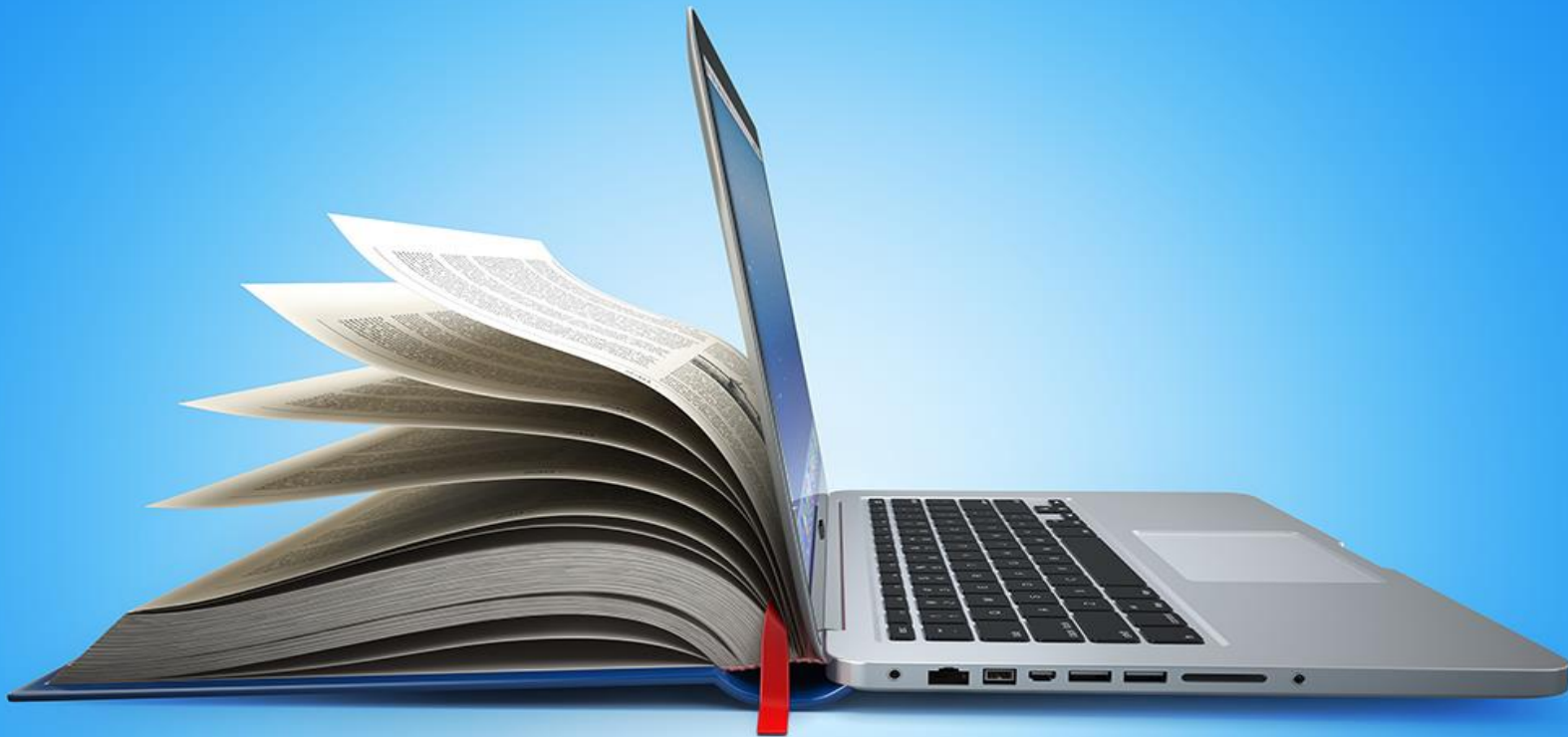
With this life back into the Sewage we can see a gradual reduction in drainage and of course lesser load on Sewage Treatment Plants. Reduce pollution in water bodies and so on. It does so, by providing several additional benefits to your health & hygiene, while giving you the joy of being environment friendly. It does all the above, without even burning a hole in the pocket.

2. Ecofriendly Biodegradation of Malachite Green Dyes by an Isolate Bacillus Subtilis.

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Textiles and dye industries contribute to water and soil pollution in a major way. These industries discharge large volume of color effluents due to the presence of synthetic dye, which pose major environmental problems. Many physical and chemical methods are used in treatment process, but they are economically expensive. Biological methods are being simple to use and low cost. This study is done to isolate and enrich bacterial strain capable of decolorizing some commercial dyes. The Bacillus subtilis culture is screened and is tried for biodecolorization studies. The isolated bacterial strain which can degrade Orange 2R, Turquoise blue, Reactive yellow MERL, Golden yellow, Malachite green, Methylene blue, Crystal violet. Among these dyes, Malachite green dye was decolorized at highest percentage. So we are utilizing this dye as model dye and further physical parameter such as pH, temperature, inoculum load, process condition. Enrichment studies by replacing carbon and nitrogen source exhibit some notable results. Sucrose (1gm %) in place of glucose and use of cheaper Urea (organic nitrogen) and NH₄cl (inorganic nitrogen) in place of peptone are concluded as better alternatives and double

efficiency in biodecolourization is observed. HPTLC studies proved that the malachite green dye has been completely degraded by this isolate after 24 hours. These results along with spectrophotometric data prove the efficiency of bacteria suggesting its possible use in treating dye containing effluents. This strain can be further studied for pilot experimentation at dye-industry effluent plant.



GUJARAT CLEANER PRODUCTION CENTRE

(ESTABLISHED BY: INDUSTRIES & MINES DEPARTMENT, GOVERNMENT OF GUJARAT)

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