جامعة الملك خالد
KING KHALID UNIVERSITY

Faculty Research Focus

Chemical Engineering Department

College of Engineering, King Khalid University
Alfara'a, Abha, Kingdom of Saudi Arabia

Catalysis, CO_2 Capture, and Hydrogen Generation

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Interested Research Area

- Catalysis and catalytic processes
- Environmental Protection-Carbon capture and storage
- Extraction Process
- Renewable energy
- Computational fluid dynamics

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Synthesis and optimization of suitable catalyst for enhanced methane decomposition to hydrogen

Mathematical formulations for H_2 production and CH_4 conversion vs. time curve

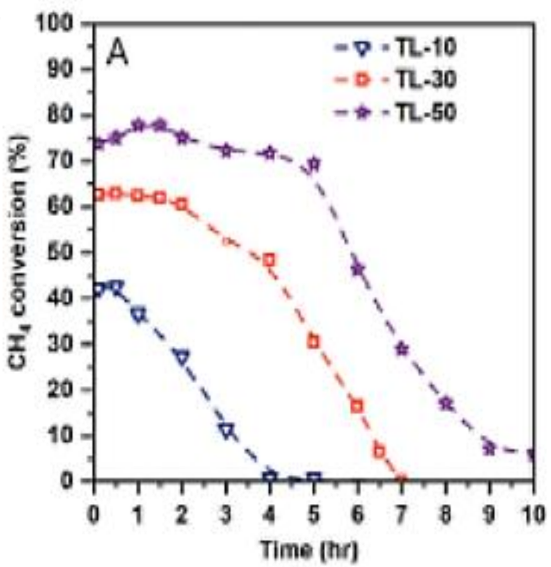
$$CH_4 = C(s) + 2H_2(g) \quad \Delta H^0_{298K} = 75.6 \text{ kJ mol}^{-1}$$

$$X_{CH_4}(\%) = \frac{\left(F_{CH_4 in} - F_{CH_4 out}\right)}{F_{CH_4 in}} \times 100$$

Hydrogen Productivity (HP, ml/g_{cat} h)

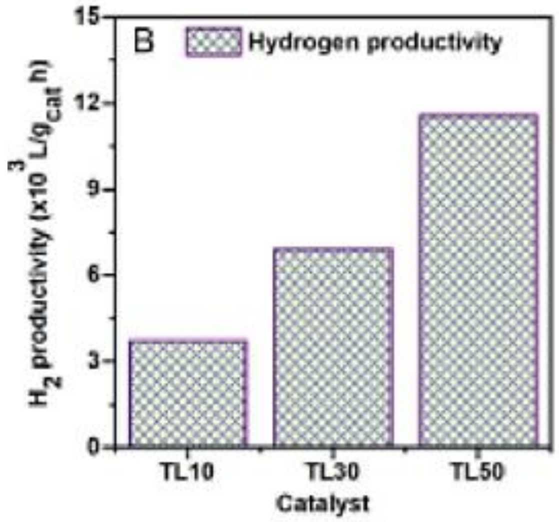
$$= \frac{\text{Hydrogen produced}\left(\frac{ml}{h}\right)}{\text{Wieght of catalyst}\,(g_{cat})}$$

$$\text{Total carbon yield} = \frac{g_c}{g_{cat}} \times 100$$

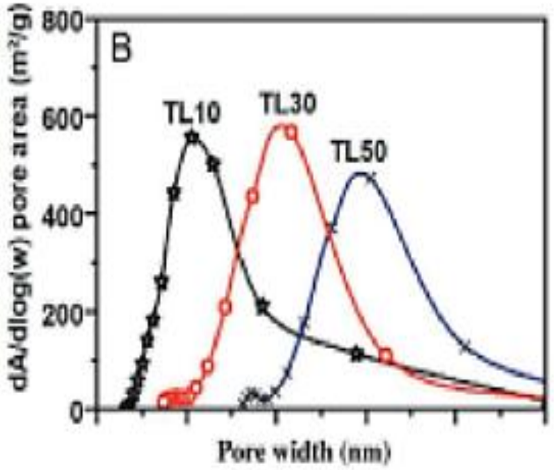


Hydrogen productivity and pore size distribution

Reported hydrogen productivity at 600 °C with 1 bar pressure and CH_4 : Ar = 1:1

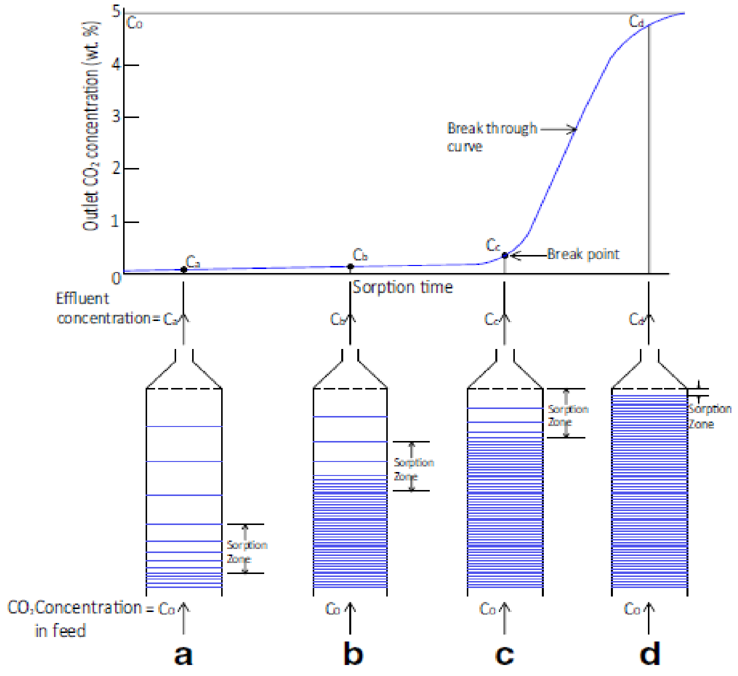


Pore size distribution for Co-based catalyst used for methane decomposition



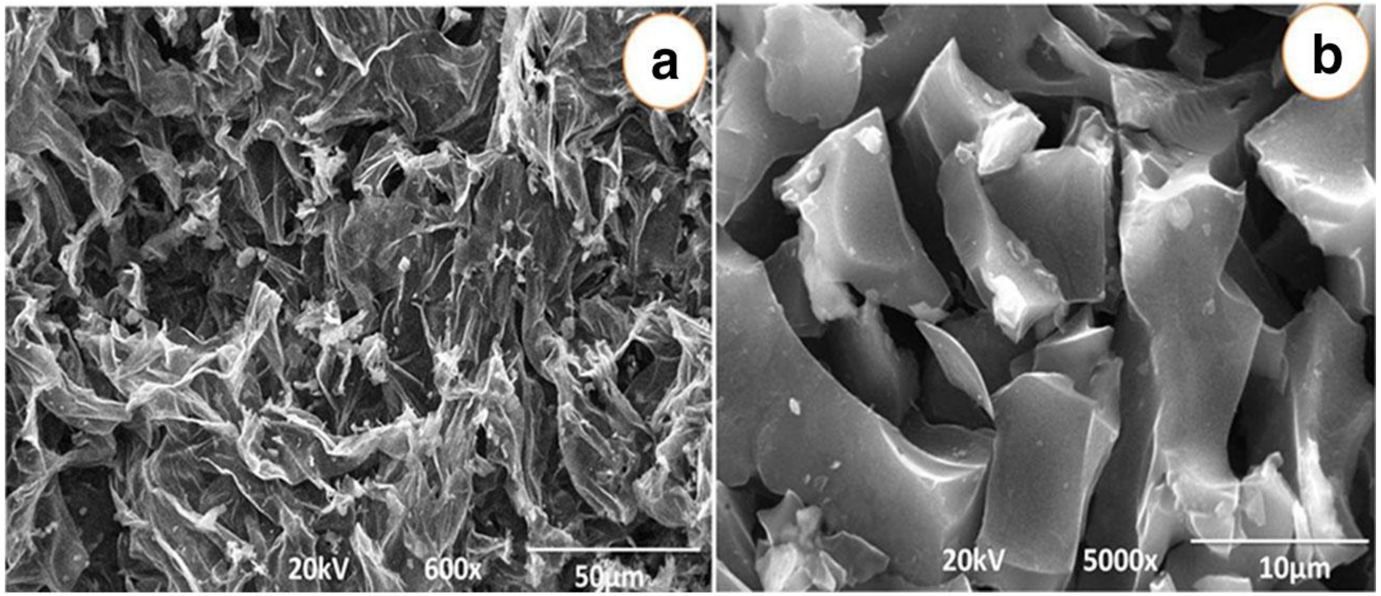
Mass transfer zone

The breakthrough profiles and movement of mass transfer zone during CO_2 capture process to reduce carbon emissions.



Morphology of biomass derived activated carbon

The enhanced surface morphological images obtained for an adsorbent prepared by proper activation technique. An adsorbent with improved surface and morphological properties results in increased adsorption capacity of CO_2. The SEM images of adsorbent produced from biomass at varied magnification level are depicted in Figures a-b



Main target are as follows:

- Synthesis of catalyst and optimizing the condition for hydrogen production from methane.
- Determining hydrogen productivity and total carbon yield.
- Production of biomass derived high performance activated carbon CO_2 capture.
- Characterization of adsorbent using suitable characterizing techniques for carbon capture.

Catalysts: Synthesizing or Modification and Their Usage

Interested Research Area

- Utilization of Loaded Cobalt onto MCM-48 Mesoporous Catalyst
- Applying MCM-48 mesoporous material
- Synthesizing and Characterizing a Mesoporous Silica Adsorbent.
- Using Polyelectrolyte and Palm

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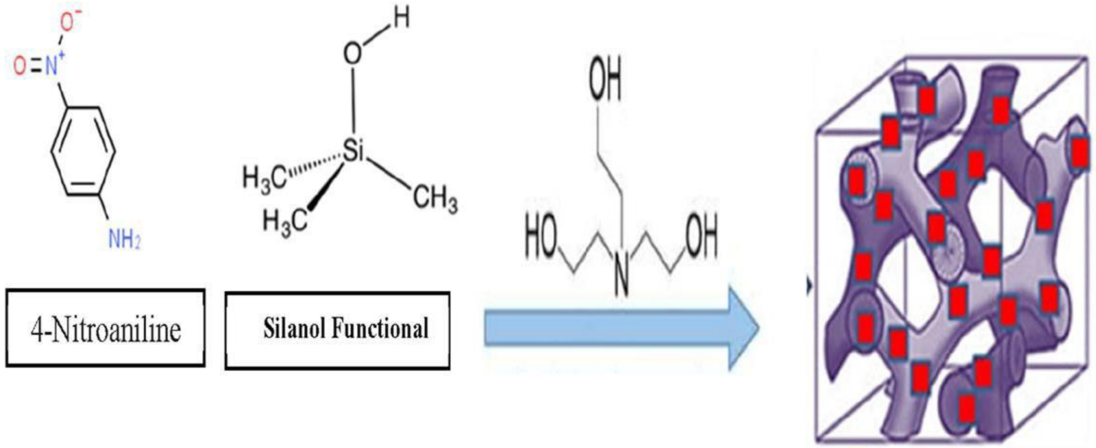
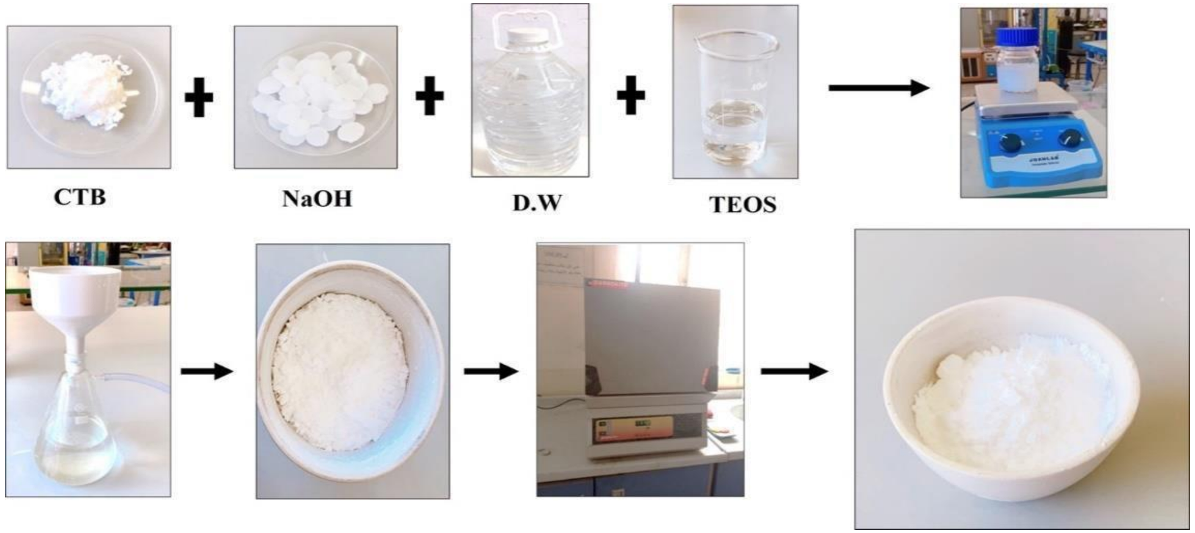
Applying MCM-48 mesoporous material

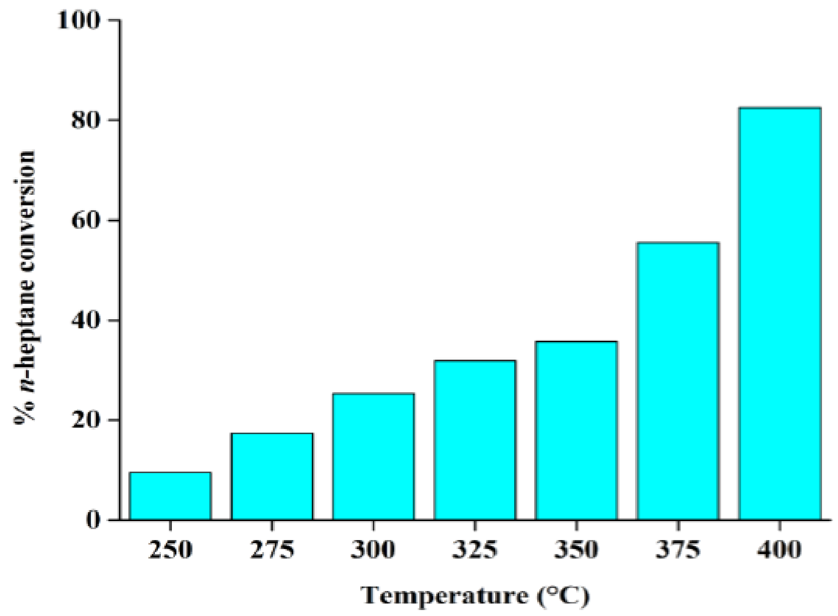
. The MCM-48 mesoporous material was prepared and characterized to apply it as an active adsorbent for the adsorption of 4-nitroaniline (4-Nitrobenzenamine) from wastewater.



Synthesizing Steps of Silica Adsorbent



Utilization of Cobalt onto MCM-48



Using Polyelectrolyte and Palm

Main target are as follows:

- ❖ - Utilization of Loaded Cobalt onto MCM-48 Mesoporous Catalyst to Produce Isomerization Product from n- Heptane
- ❖ -Applying MCM-48 mesoporous material for the effective adsorption of 4-nitroaniline from wastewater.
- ❖ -Synthesizing and Characterizing a Mesoporous Silica Adsorbent for Post-Combustion CO2 Capture.
- ❖ -Treatment of Fish-Processing Wastewater Using Polyelectrolyte and Palm Anguish

Catalysis and Catalytic Processes

Interested Research Area

- Catalysts Preparation
- Catalysts Characterization
- Catalytic Reaction Engineering
- Catalytic alkylation
- Catalytic oxidation , CO oxidation , ethane

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Catalyst synthesis

Catalysts preparation includes

- precipitation,
- co-precipitation,
- impregnation ,
- mixing and
- sol-gel techniques

Catalysts Characterization

Xay- diffraction technique, BET, SEM, TEM

Mixed oxides catalysts and its application

Mixed oxide catalysts syntheis using traditional and new methdadology and its application

Catalysis for cleaner technology

convert the methane and ethane into higher hydrocarbon.

Main target are as follows:

- Catalyst synthesis
- Physco-chemical catalysts characterization
- Catalysis for cleaner technology
- Catalysts Testing in hydrogen peroxide decomposing

Chemical Reaction Engineering

Interested Research Area

- Renewable Energy
- Biofuel Production
- H_2 Production
- All Solid- State Batteries
- Heterogeneous Catalysis

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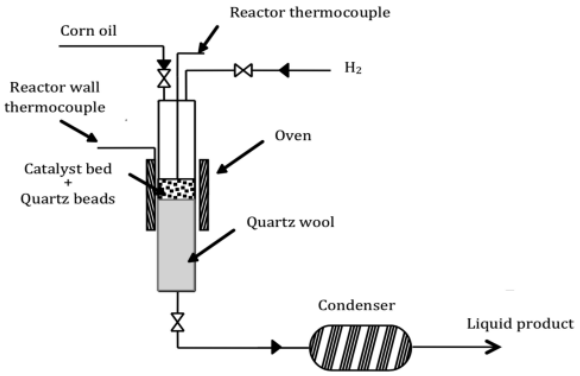
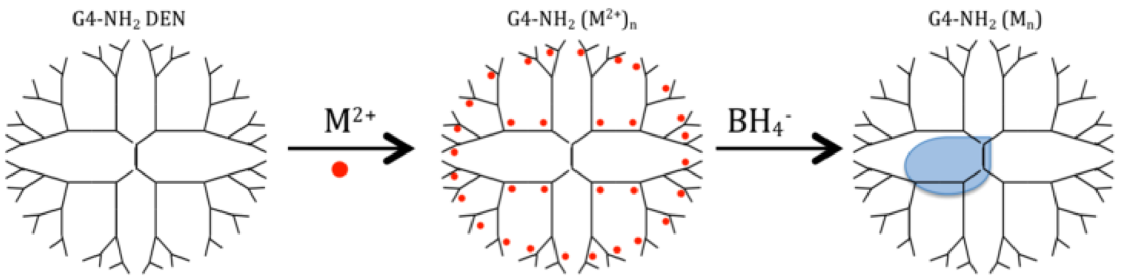
Green diesel production

The hydrocracking of distillers dried grains with soluble (DDGS) corn oil over bimetallic carbide catalysts was used for green diesel production. A catalyst composed of nickel−tungsten (Ni−W) carbide supported on Al-SBA-15 was designed based on the ability of nickel to adsorb and activate hydrogen and the potential of tungsten for hydrogenation reactions.



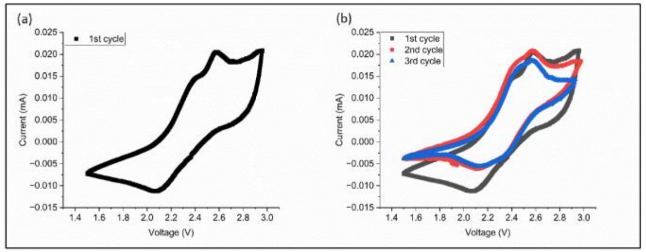
Synthesis of dendrimer-encapsulated nanoparticles

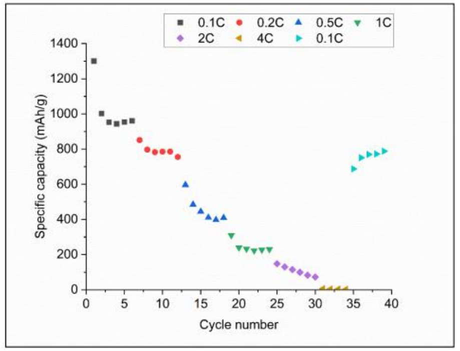
A dendrimer-encapsulated nanoparticle (DENP) method was employed to minimize alloy formation and increase the metal dispersion on the support. The catalysts prepared by the DENP method showed activity greater than that of the catalyst prepared by the impregnation method for the hydrocracking of DDGS corn oil.



All solid-state Li-S batteries

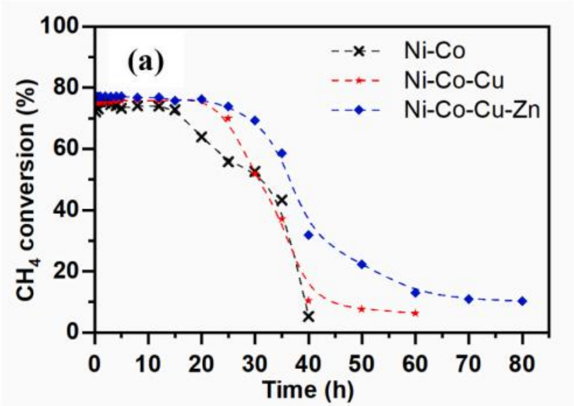
A novel composite solid-state electrolyte, which is nickel-tungsten carbides (NiWC) over mesoporous silica (SBA-15) filled polyethylene oxide (PEO), was developed and investigated folr Li-S batteries.

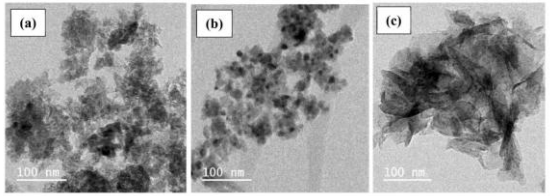




Methane decomposition for the production of COx free hydrogen

COx-free hydrogen production via methane decomposition was studied over bimetallic and trimetallic catalysts.





Main target are as follows:

- ❖ Synthesizing of solid electrolyte for Li-S and Na-S batteries
- ❖ Improving the ionic conductivity and stability of the solid electrolyte
- ❖ Developing metallic catalysts for methane cracking reaction
- ❖ Improving the activity and durability of the catalysts

Electrochemistry : Fuel Cell Technology and Hydrogen Generation

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Interested Research Area

- Renewable: H_2-O_2 Fuel Cell
- Microbial fuel cell Water Treatment cogeneration of Hydrogen
- PEM H_2 Generation
- Electrochemical Reduction of CO_2
- Photo electrochemical for hydrogen generation, CO_2 reduction and water treatment

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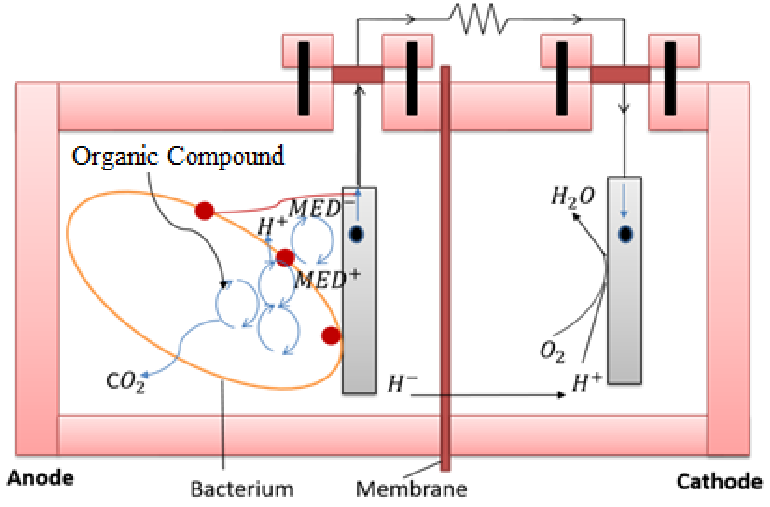
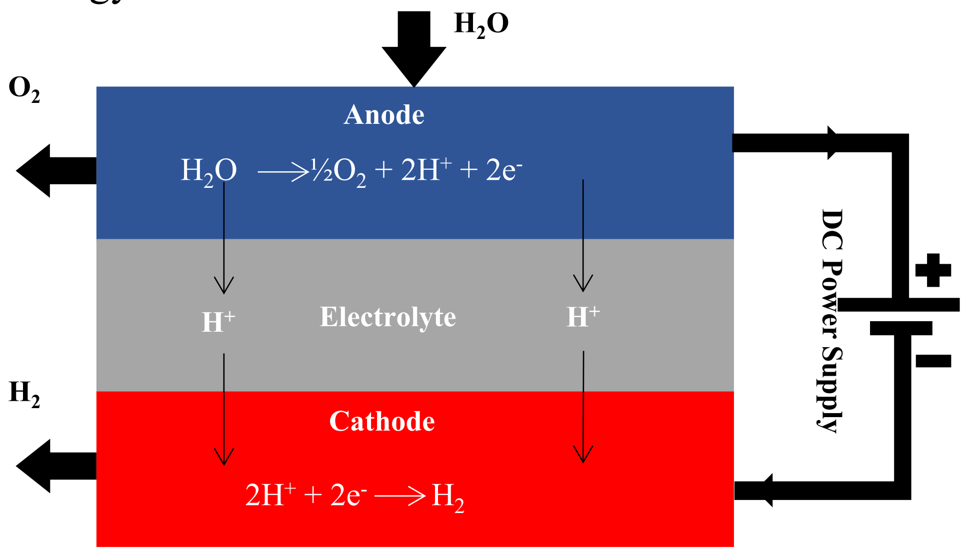
Water Treatment cogeneration of Hydrogen

A Microbial Fuel Cell (MFC) converts chemical energy, available in a bio-convertible substrate, directly into electricity. To do this, bacteria is used as a catalyst to convert substrate into electrons.



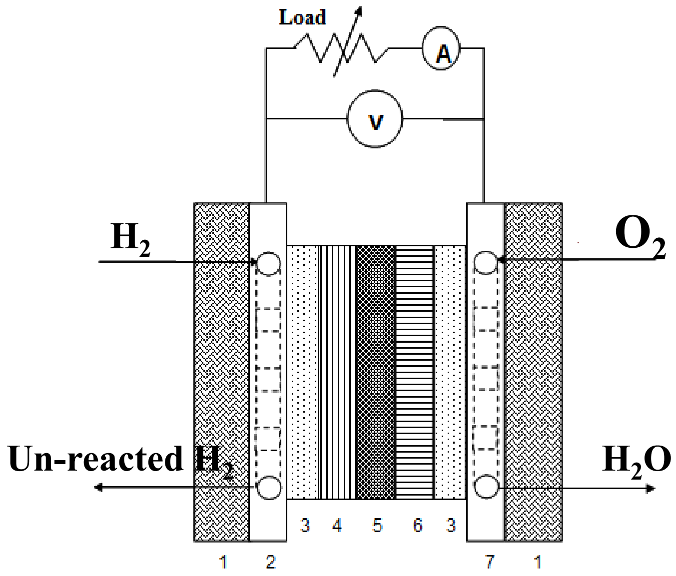
PEM H_2 Generation

Device used to split water electrochemically into pure hydrogen at the cathode and oxygen at the anode with the application of electrical energy.



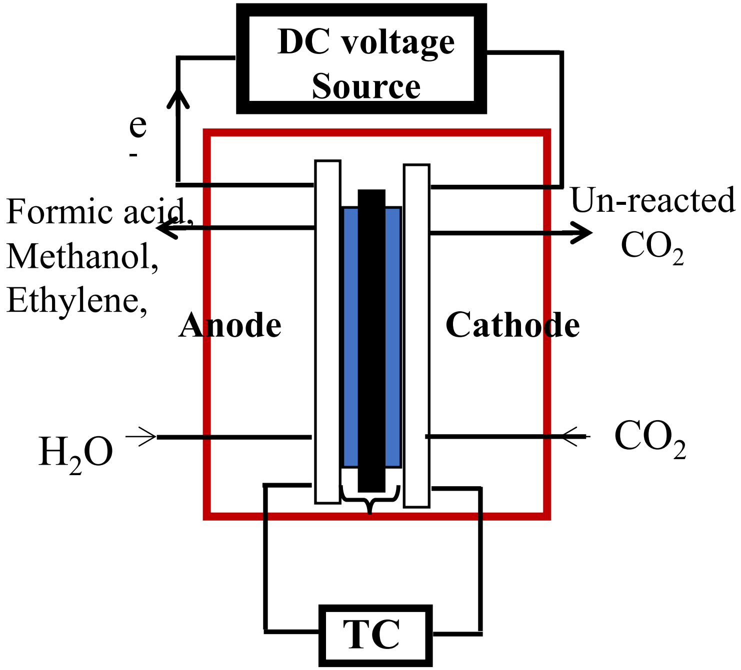
Renewable: H_2-O_2 Fuel Cell

Fuel Cell is a device converts chemical energy directly into electricity without causing any pollution to the atmosphere.



Electrochemical Reduction of CO_2

It's a device used to convert the CO_2 into higher hydrocarbon (say Formic acid, Methanol, Ethylene, etc.) with the help of power derived from the renewable energy sources (say solar, wind, tidal etc.,)



Main target are as follows:

- Electrocatalyst synthesis for the following reaction such as Oxygen Evolution, Oxygen Reduction, Carbon dioxide Reduction, Hydrogen Oxidation, Hydrogen Reduction
- Membrane and MEA fabrication
- Physical and Electrochemical Characterization of Electrocatalyst and Membrane
- Testing in respective electro cell

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Current Focus Area (Geoinformatics)
1. Exploring Rare Earth Metals in the Kingdom of Saudi Arabia
2. Investigation of Pollution through remote sensing

Interested Research Area

- Minerals Exploration
- Air Pollution
- Carbon sequestration Potential of Mangrove Forests
- Solid waste management
- Land surface temperature monitoring

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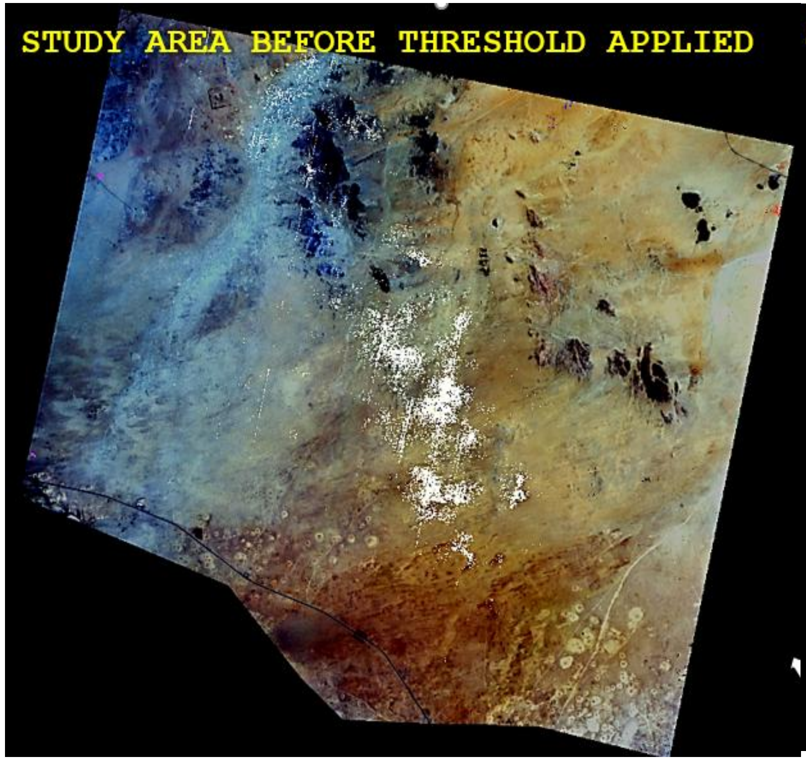

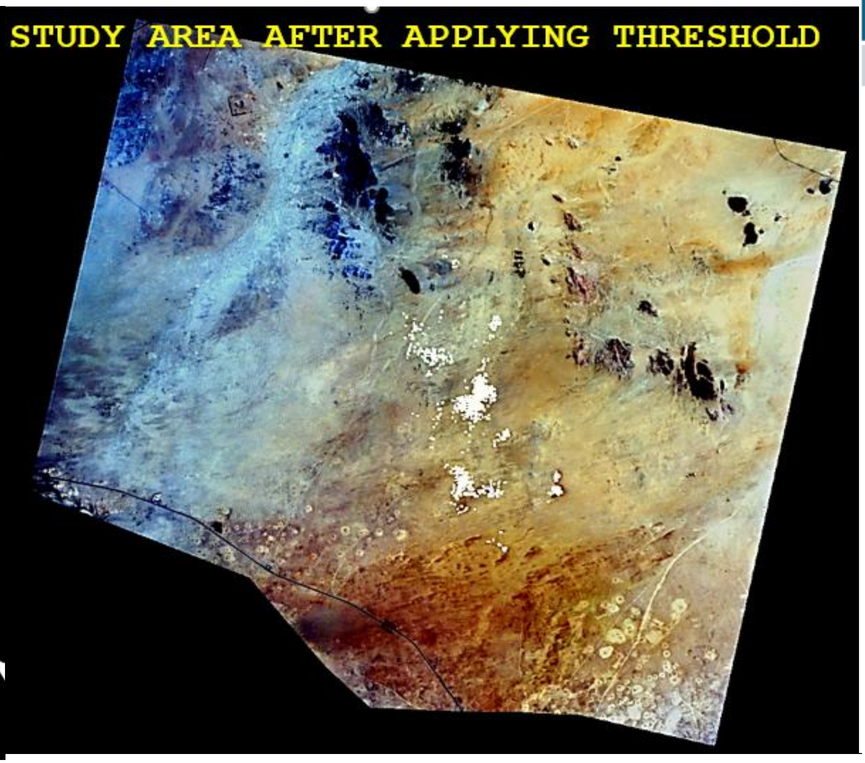

Basic Stats	Min	Max	Mean	StdDev	Pixel Count
Band Math (B1GT1.28)	0	1	0.0115	0.1067	1415979

ENVI Statistics

Mean = 0.0115; Pixel Count = 1,415,979

For a binary raster:

$$\text{Mean} = \frac{\textit{Number of carbonate pixels}}{\textit{Total pixels}}$$

So:

$$\text{Carbonate } \textit{pixel count} = 0.0115 \times 1{,}415{,}979 \approx \mathbf{16,283\ \textit{pixels}}$$

Area calculation

PRISMA SWIR pixel size:
30 m × 30 m
900 m² per pixel
Total carbonate area:

$$\text{Area } (m^2) = 16{,}283 \times 900 = 14{,}654{,}700\ m^2$$

Convert to km²:

$$= \boxed{14.65\ km^2}$$

Publications

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- Abd El-Hamid, H. T., **Arshad, M.,** & Eid, E. M. (2022). Theeffects of coastal development on the urbanheat island inthe mangrove ecosystem along the Jazan coast, KSA.*Journal of Coastal Conservation*, *26*(6), 70.
- **Arshad, M.,** Khedher, K. M., Eid, E. M., & Aina, Y. A.(2021). Evaluation of the urban heat island over Abha-Khamis Mushait tourist resort due to rapid urbanisation inAsir, Saudi Arabia. *Urban Climate*, *36*, 100772.
- Arshad, M., Hasan, M. A., Al Mesfer, M. K., Al Alwan, B. A., Qureshi, M. N., & Eldirderi, M. (2023). Sustainable landfill sites selection using geospatial information and AHP-GDM approach: A case study of Abha-Khamis in Saudi Arabia. *Heliyon*, *9*(6).
- Ali, I. H., Siddeeg, S. M., Idris, A. M., Brima, E. I., Ibrahim, K. A., Ebraheem, S. A., & **Arshad, M.** (2021). Contamination and human health risk assessment of heavy metals in soil of a municipal solid waste dumpsite in Khamees-Mushait, Saudi Arabia. *Toxin reviews*, *40*(1), 102-115..
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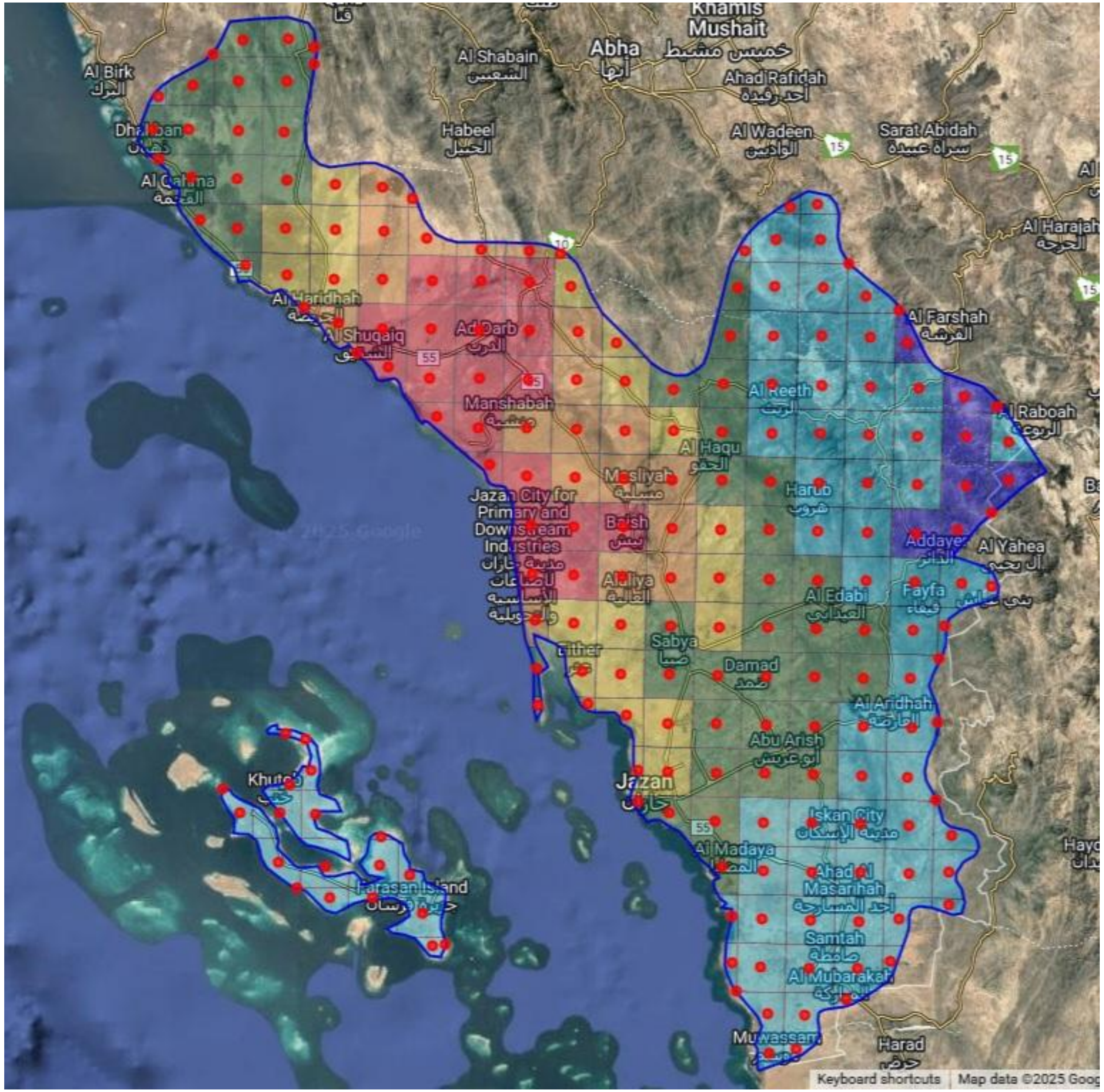
Jazan Economic City (JEC) SO2 Pollution



Corrosion Inhibition and Renewable Energy Material

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Interested Research Area

- Corrosion Inhibition
- Adsorption and Adsorbents
- Environmental Remediation
- Waste to Energy and Renewable Materials

Recent Publications

- Synthesis, characterization, and anionic azo dye adsorption by polyaniline/clay nanocomposite from artificial wastewater – Published in Processes – MDPI
- Efficient adsorption of hexavalent chromium ions onto novel ferrochrome slag/polyaniline nanocomposite: ANN modeling, isotherms, kinetics, and thermodynamic studies – Published in *Environmental Science and Pollution Research*
- Conductive Polymers and Their Nanocomposites as Adsorbents in Environmental Applications – Published in *Polymers*

Electrochemical Methods for Water Treatment

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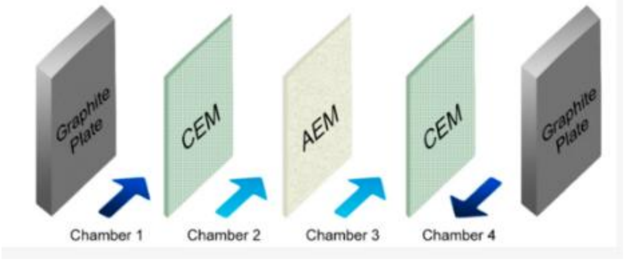
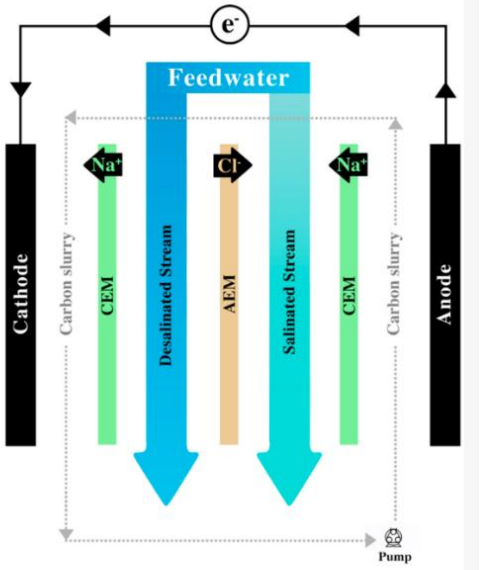
Interested Research Area

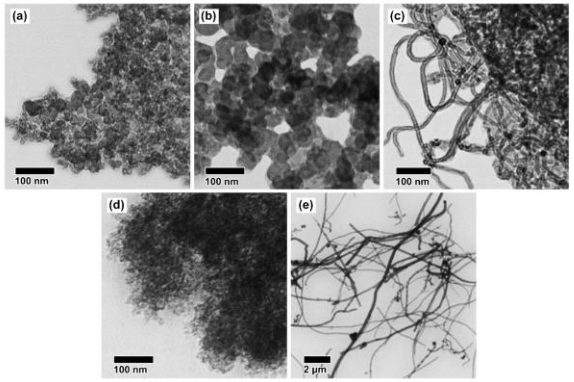
- Flow electrode Deionization Cells
- Water Desalination
- Water Softening
- Mineral Recovery

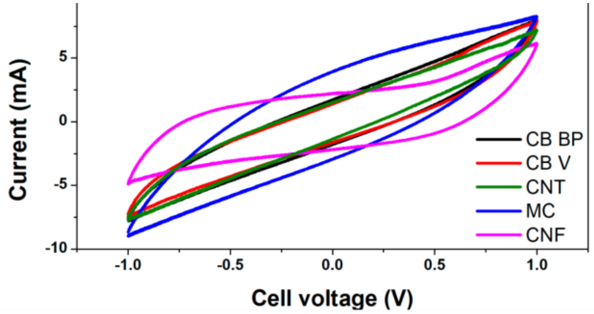
Flow Electrode Deionization Cells

Flow-electrode deionization desalinates and softens water by driving ions through membranes into a flowing electrode, where high-surface-area, conductive, pumpable electrodes store ions, enabling continuous hardness removal.









Renewable Energy Technologies

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❖ Interested Research Area:

- **Perovskite Materials and Solar Cells**
- **Polymer and Composite Materials for Energy Storage (Supercapacitors)**

Recent Publications

1- Jabbar, T., Almaymoni, N.K., **Sawwan, H.** ***et al***. Development of perovskite ($MgZrO_3$) decorated polyaniline for supercapacitors. *Chem. Pap.* (2025).

2- Jamil, M., Alrowaily, A. W., Alotaibi, B. M., Alyousef, H. A., Alzahrani, E., **Sawwan, H**., & Hassan, R. U. (2025). Enhanced electrochemical performance of innovative BaAl2O4/PANI nanocomposite for next generation supercapacitor applications. *Synthetic Metals*, 118053.

3- Zhang, X., **Sawwan, H**., Liu, L., Cao, Z., Wang, H., & Gong, X. (2025). Perovskite Solar Cells Incorporated with Urea Processing Additives. *ACS Applied Energy Materials*, *8*(3), 1838-1846.

4- **Sawwan, H.** ***et al***. Boosted device performance of perovskite solar cells via KI processing additives. *emergent mater.* **7**, 2457–2468 (2024).

Electrochemical Engineering

Interested Research Area

- Chemical and Process Systems Engineering,
- Corrosion Monitoring Systems and Machine Learning Techniques,
- Electrochemical Techniques and artificial intelligent (AI) applications,
- Materials analytical methods (SEM, EDS and Profilometry Measurements).

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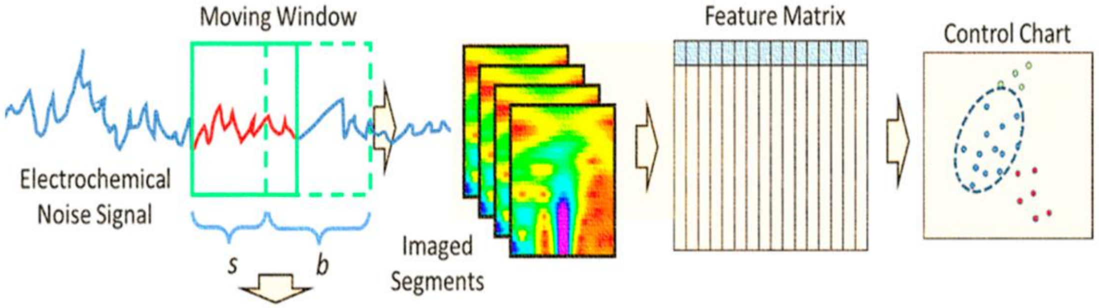
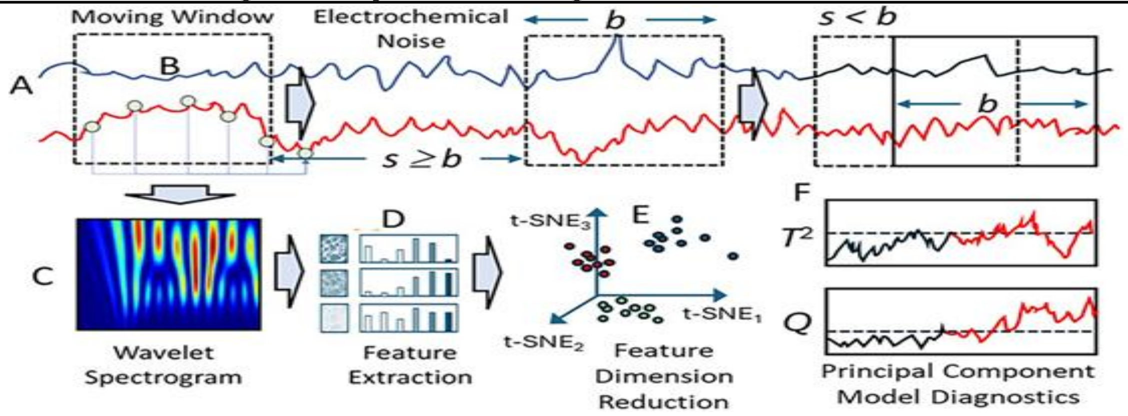
Corrosion analysis employs signal processing by mounting an electrochemical cell and an experimental instrument

Measuring electrochemical noise using an analog-to-digital (A/D) converter. Potential signals were recorded along with current signals obtained inferentially. With carbon steel electrodes, served as working electrodes in the cell used in this research to distinguish between different forms of corrosion

Unsupervised process monitoring

The general methodology for real-time (unsupervised) monitoring of corrosion is outlined in Fig.. Electrochemical noise signals representative of normal operational conditions are captured and pre-processed where necessary . The electrochemical noise signals are subsequently partitioned into smaller segments , which are encoded in wavelet spectrograms . Images of the object or material surfaces under surveillance can optionally also be captured.





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Water Treatment & Membrane Technology

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Interested Research Area

- Separation Processes
- Water/ wastewater Treatment and Desalination.
- Membrane Technology
- Essential oils Extraction
- Computational fluid dynamics and fluid flow simulations

Process Modeling optimization and control

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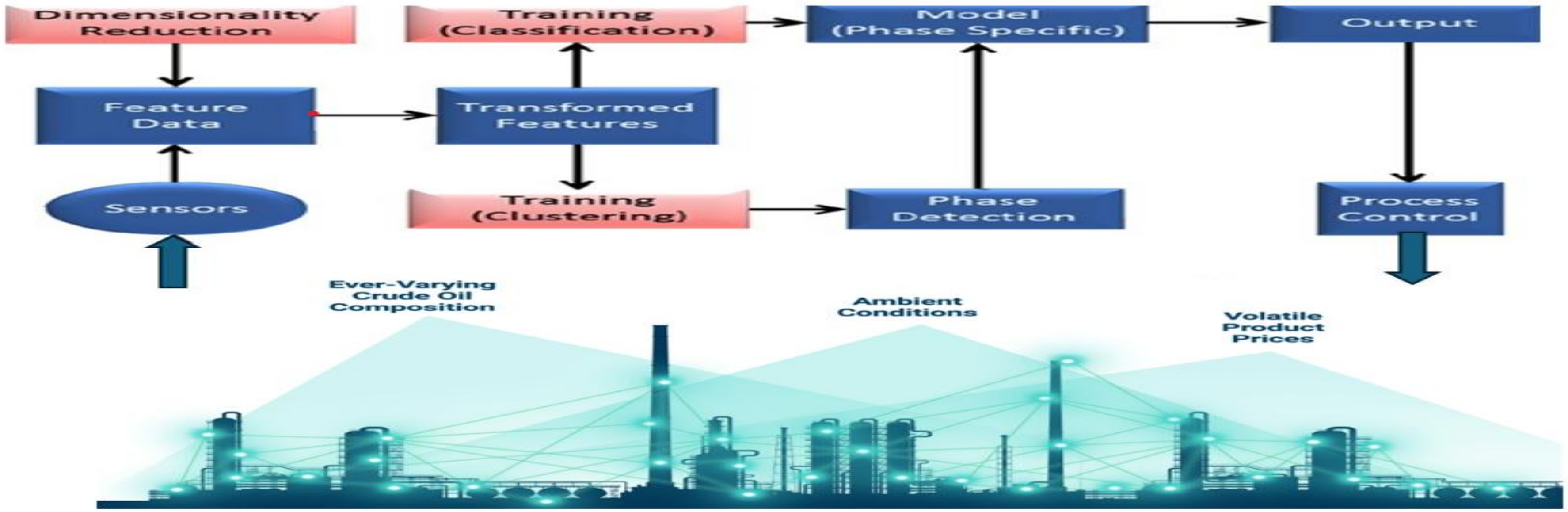
Interested Research Area

- Machine learning for Advanced Process Control (APC)
- Model design and optimization for lube oil recycling
- Remediation of Heavy Metals from Aqueous Solutions
- Solar still modeling and optimization.

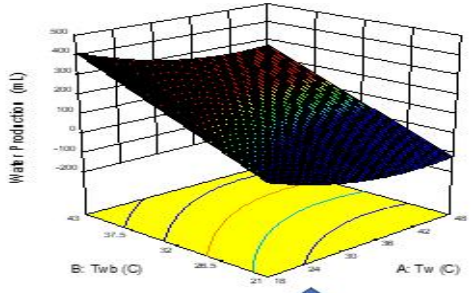
Machine Learning for Advance process control

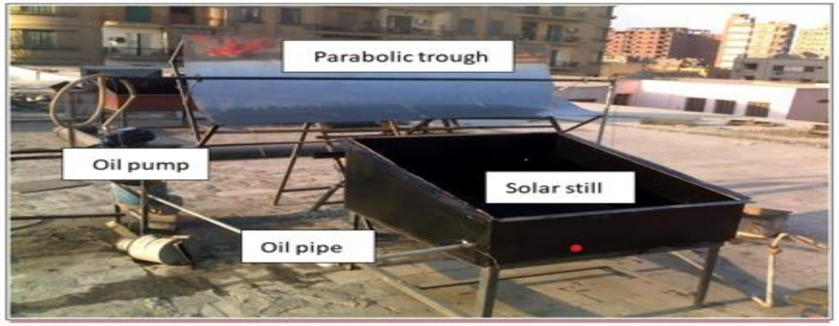
APC sensing large number of sensors in order to predict and control the process efficiently, Deep learning can be use to improve model identification from historical data , to identify models from operating data in real-time, and to dynamically identify and manage changes in the process state (for example, due to a different feed or operating mode)

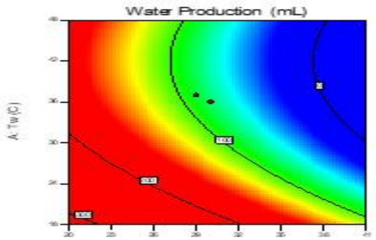


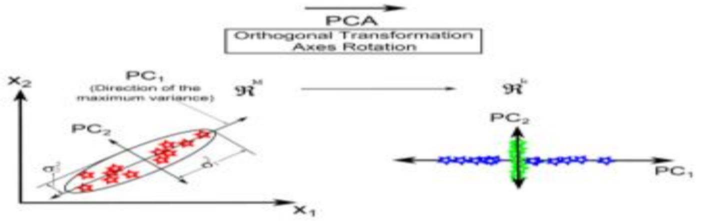
Solar still modeling and optimization

- Conventional single slope solar still integrated with a parabolic trough collector in addition to packaged glass ball layer was used in water desalination.
- Principal Component Analysis (PCA) reduced and categorized the number of effective parameters to three components.
- Effective System's Performance parameters modeled to predictive optimum operation conditions









Main target are as follows:

- ❖ To Develop advanced process control using deep learning to improve control robustness, performance, precision ,and stability.
- ❖ Using advanced modeling techniques for model prediction and optimization various chemical processes

Transport phenomena : Numerical simulation

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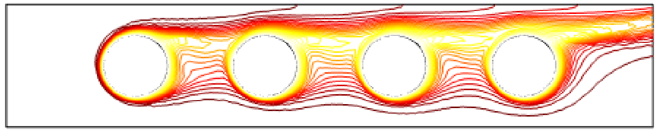
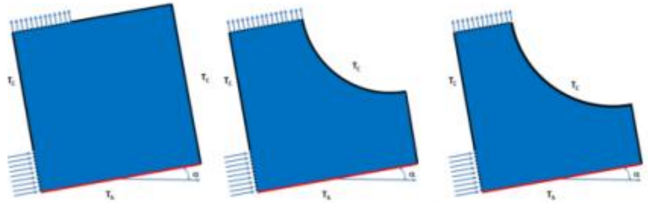
Interested Research Area

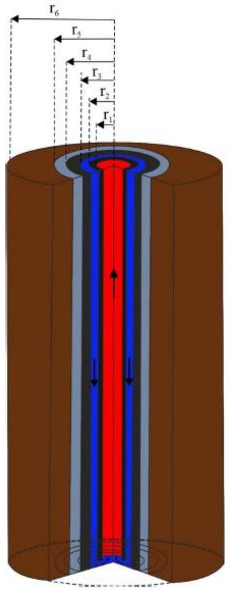
- Renewable energy
- Numerical simulation of coupled transport phenomena in continuous and porous media.
- Entropy production calculation
- Heat exchanger calculation
- Phytochemical characterization of essential oils

Renewable energy and heat transfer

Numerical simulation of hydrodynamic and heat transfer in a geothermal heat exchanger to obtain the optimal diameter of tubes with the lowest entropy using water and Al2O3/water nanofluid, also the study of coupled transport phenomena in continuous and porous media of nanoparticles or nar

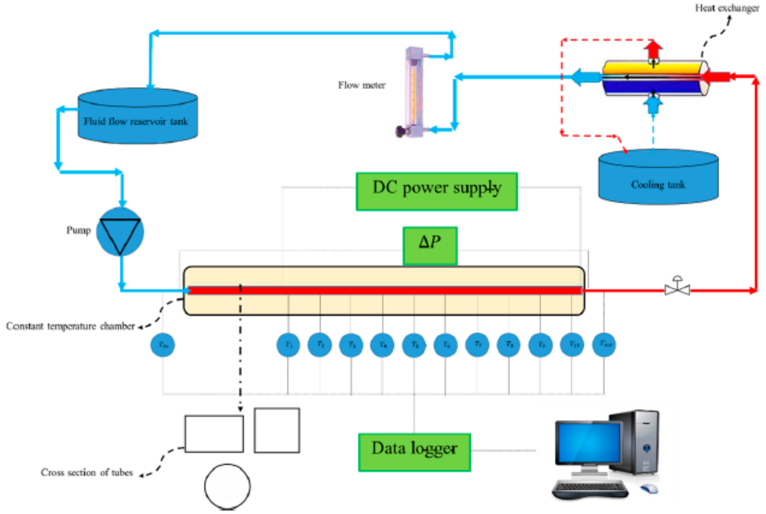






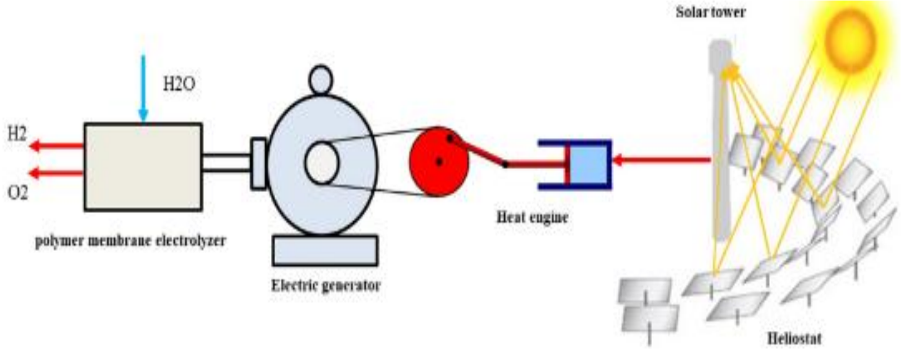
Entropy Generation

Sustainable Heat Transfer Management: Modeling of Entropy Generation Minimization and Nusselt Number Development in Internal Flows with Various Shapes of Cross-Sections Using Water and Al2O3/Water Nanofluid. Natural and mixed convection heat flow considered.



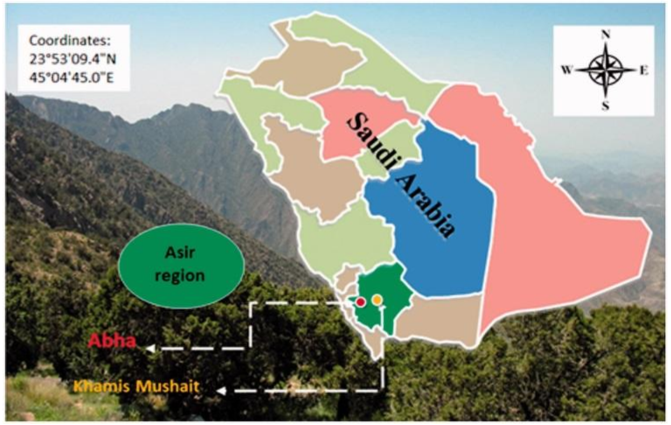
Thermodynamics investigation

Thermodynamics Investigation of Energy, Exergy, and Hydrogen Production from a Solar thermochemical Plant Using a Polymer Membrane Electrolyzer



characterization of essential oils

Phytochemical characterization, and antioxidant and antimicrobial activities of essential oil extracted by hydrodistillation of different parts of medicinal and aromatic plant from Abha, Saudi Arabia, and different cosmetics products produced.



Main target are as follows:

- Localization of the steam and isothermal lines for different various parameters and fluids through different enclosures geometries.
- Localization of the entropy production for different various parameters and fluids through different cavities or channel enclosures.
- Modeling and simulation of some prototypes, which, a thermodynamic irreversibility's under magnetic field should be done.
- Characterization of essential oils of different aromatics plants.

Reaction Engineering & Environmental Research

Interested Research Area

- Sorption and Transport Phenomena in Synthetic and Natural Porous Media
- Wastewater Treatment by physicochemical methods
- Treatment of liquid and gaseous effluents in chemical industries
- Valorisation of clay resources in the purification of water and air
- Research in environmental pollution

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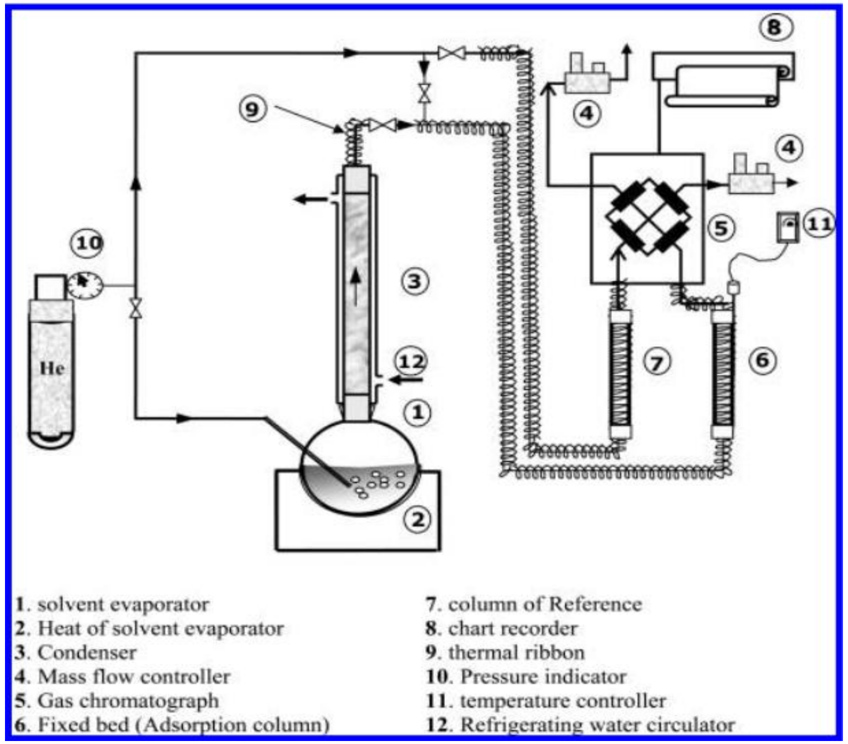
Adsorption of VOCs on Fixed Bed Reactor

Experimental setup used for the adsorption of VOCs on acid-activated bentonite in a fixed bed column.
A suitable adsorption model has been developed to simulate the measured data based on linear driving force approximation. The fourth-order Runge-Kutta method was used to integrate the partial differential equations, and the resulting functions were simultaneously solved to obtain the breakthrough profiles. Theoretical predictions from the model were compared with column adsorption data to ensure the validity of the model.



Mass Transfer

Interested Research Area

- Distillation
- Modeling and simulation
- Heat Transfer
- Extraction

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Modeling and Control of the Crude Atmospheric Unit in Khartoum Refinery

The work undertaken, lead to a mathematical model of the distillation column that can separate multicomponent systems in Khartoum refinery. Software was developed and might be used for research and development as well as at the stage of starting – up and shut down periods, A case study taking Distillation Column Units (DCU) of Khartoum Refinery was studied and investigated.

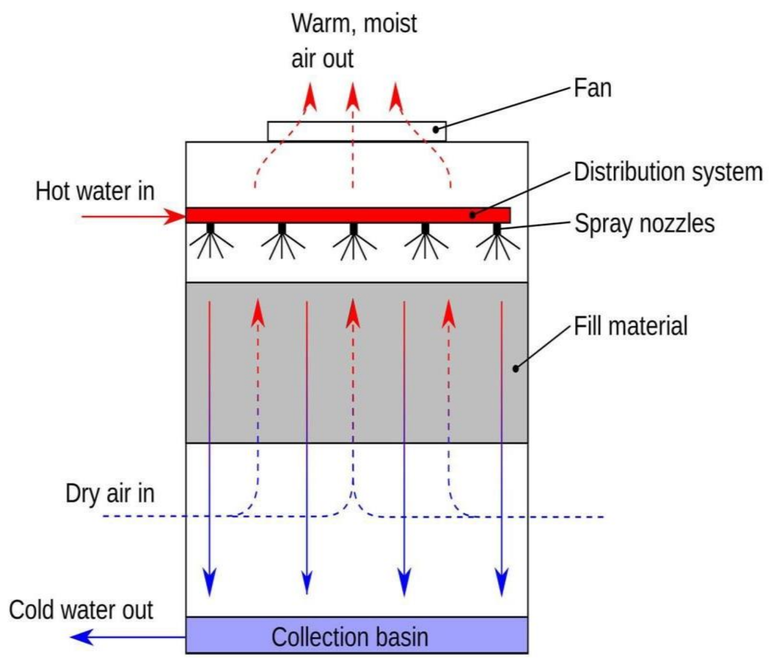
Gas Absorption

Absorption is a mass transfer process in which a vapor solute A in a gas mixture is absorbed by means of a liquid in which the solute more or less soluble. The gas mixture consists mainly of an inert gas and the soluble.

A typical example is absorption of the solute ammonia from an air-ammonia mixture by water.

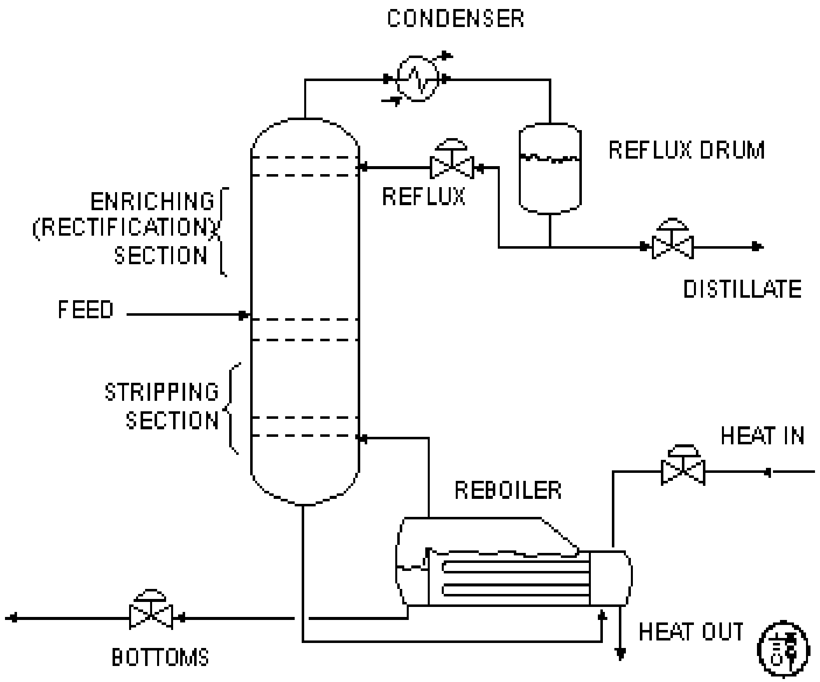
Cooling Tower

A cooling tower is a heat removal device that uses water to transfer process waste heat into the atmosphere. All cooling towers operate on the principle of removing heat from water by evaporating a small portion of water that is recirculated through the unit.



Distillation

Process in which the of components a substance or liquid mixture are separated by heating it to a certain temperature and condensing the resulting vapors. Some substances (such as crude oil) have components that vaporize at different temperature and thus can be separated by condensing their vapors in turn. Distillation is also used as a purification process in which non-volatile components are separated from volatile



Main target are as follows:

- ❖ Using software in designing of chemical engineering equipment
- ❖ Phase transition of mass transfer

Biomass, Renewable Energy and Advanced Material Processing

Interested Research Area

- Advanced characterizations and materials processing
- Renewable energies; biomass and wind energies
- Conventional and microwave heat treatment
- X-ray computed tomography, 3D imaging analysis (ImageJ and simpleware softwares).
- Natural and synthetic polymers and composite materials
- water treatment and water desalination

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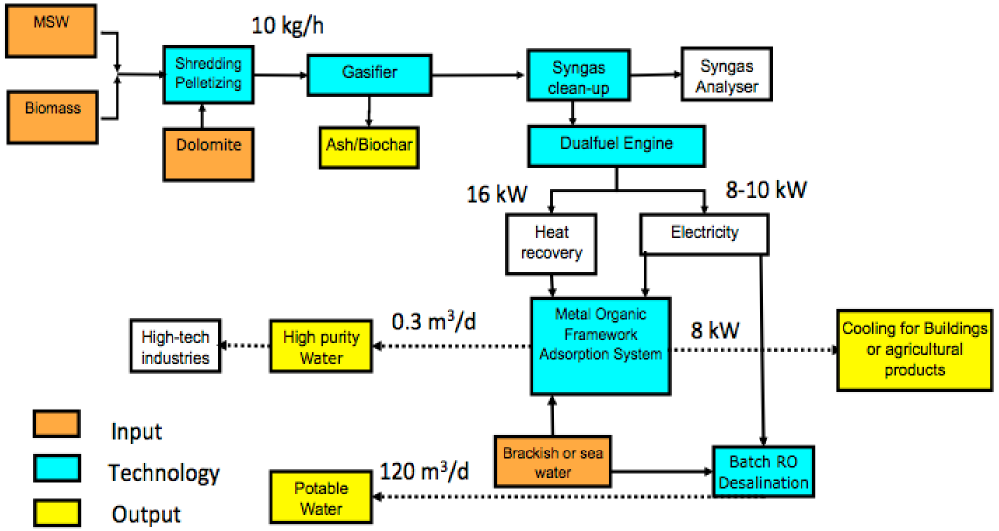
Integration of renewable (gasification and pyrolysis routes) energies with water desalination systems

- Renewable energy: using low to high-grade biomass for producing energy.
- Developing a novel and efficient approach to integrate waste management for energy conversion for electricity, water desalination, using gasification or pyrolysis



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Polymer Nano Composite Materials synthesis Characterization and Applications

Interested Research Area

- Characterization of polymeric composite materials
- Gas sensors
- Polymer nanocomposite synthesis
- Adsorption Techniques
- Waste water treatment
- Energy storage

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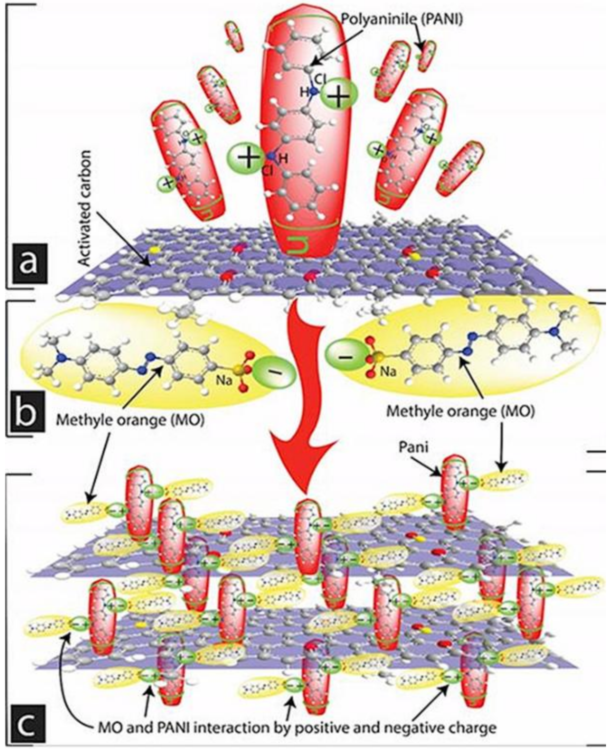
Novel Synthesis of Graphene/ZnO Nanomaterial Composite Using Hot Solvent Method for Enhanced Light Absorption

White light-absorbing materials are in high demand for catalysis and energy harvesting. Due to the UV (ultraviolet) light absorption capacity of graphene and zinc oxide (ZnO) nanoparticles, the light harvesting of the whole range of visible and near-IR (infra-red) light by utilizing these materials is a significant barrier. In this study, a graphene-ZnO nanoparticle composite was prepared from graphene and ZnO powder through a simple and novel hot solvent process at low temperatures without a catalyst or expensive instrumentation.



Renewable Energy, Biofuels, Energy Storage, Adsorptive Separations

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Interested Research Area

- **Pyrolysis:** Convert biomass/organic matters/plastic wastes into hydrocarbon rich oil
- **Adsorption:** CO_2 capture and liquid phase adsorption
- **Cavitation:** Cracking of crude oil and wastewater treatment
- **Catalysis:** Bio-oil upgradation
- **Energy Storage Materials:** Supercapacitors

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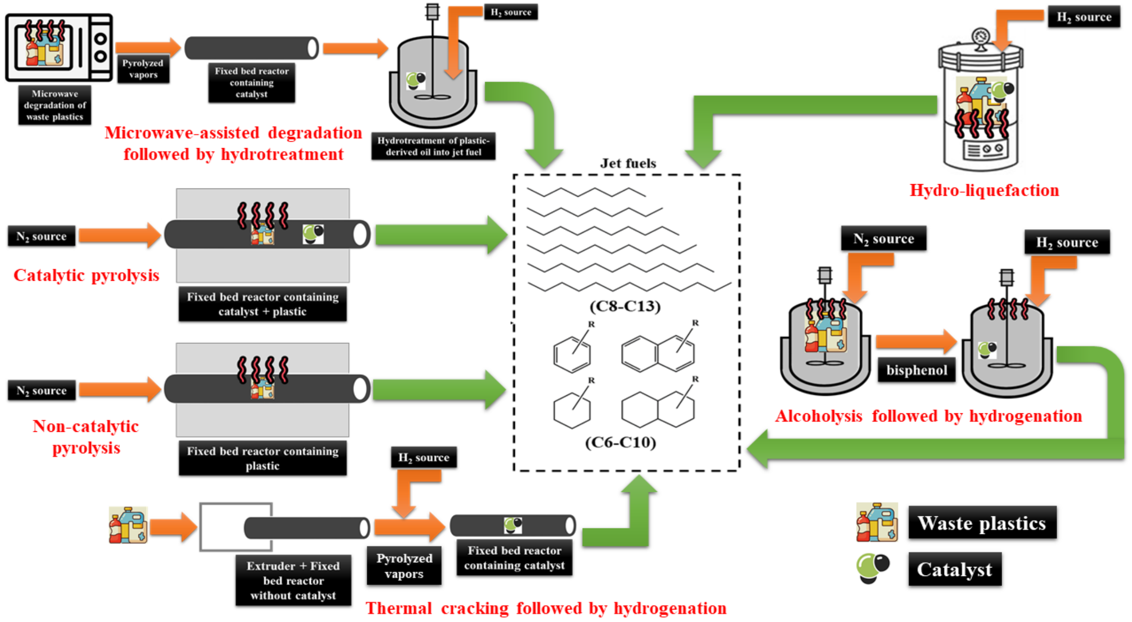
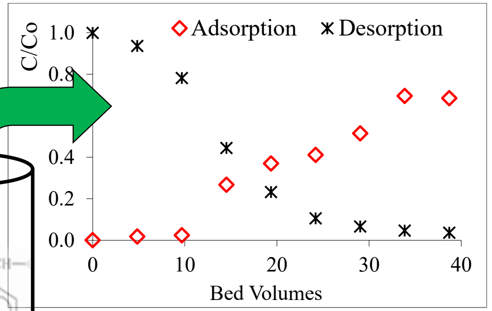
Pyrolysis and Thermochemical Conversions

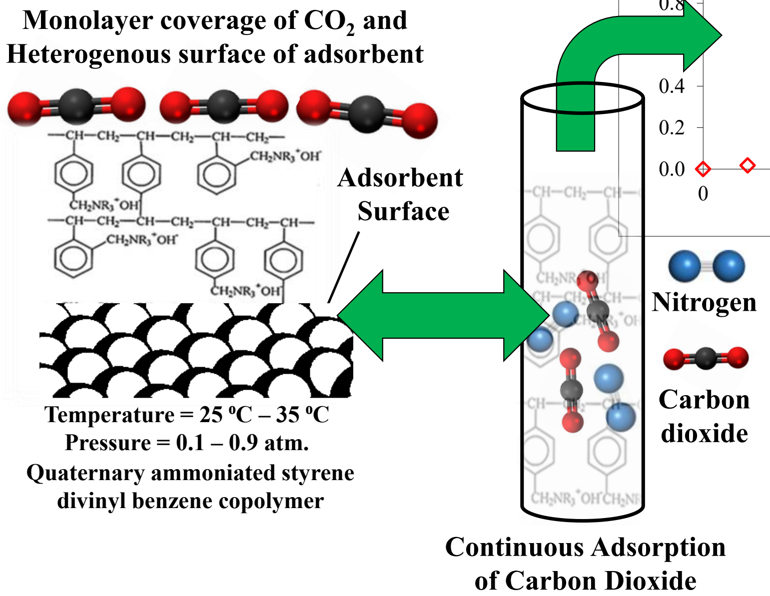
Thermochemical conversion of biomass/organic wastes/plastics into gases, hydrocarbon rich oil, and, char in the absence of air at elevated temperatures.



Adsorption

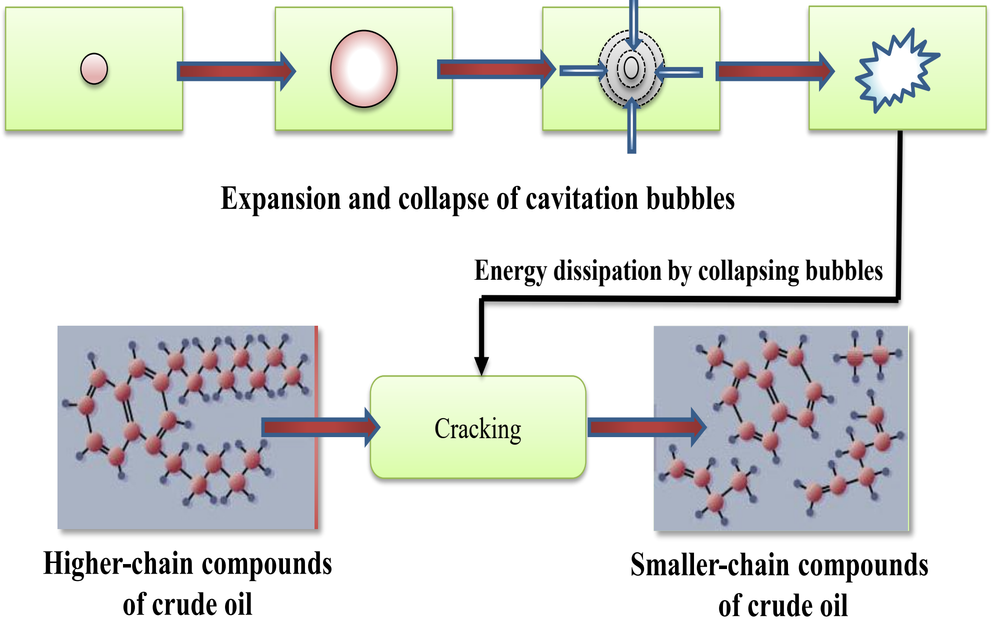
Separation of carbon dioxide from gaseous mixture using functional polymeric adsorbent. Separation of heavy metals from water using biosorbents.





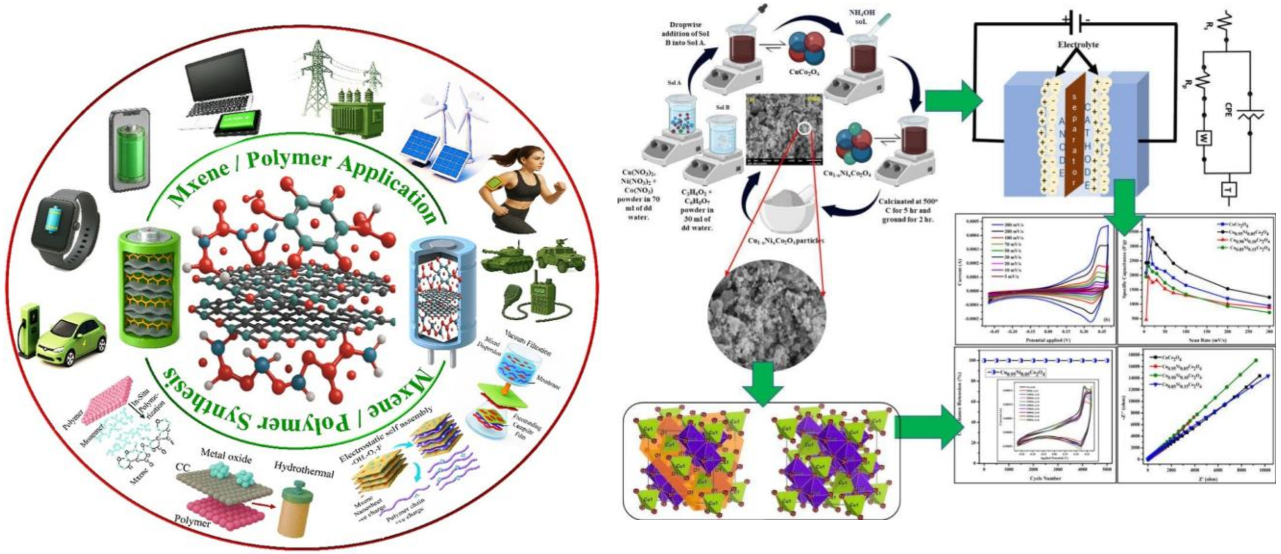
Cavitation

Cracking amongst crude oil compounds or dye compounds due to the formation and collapse of the cavities, generating localized temperature up to 1000 degree C.



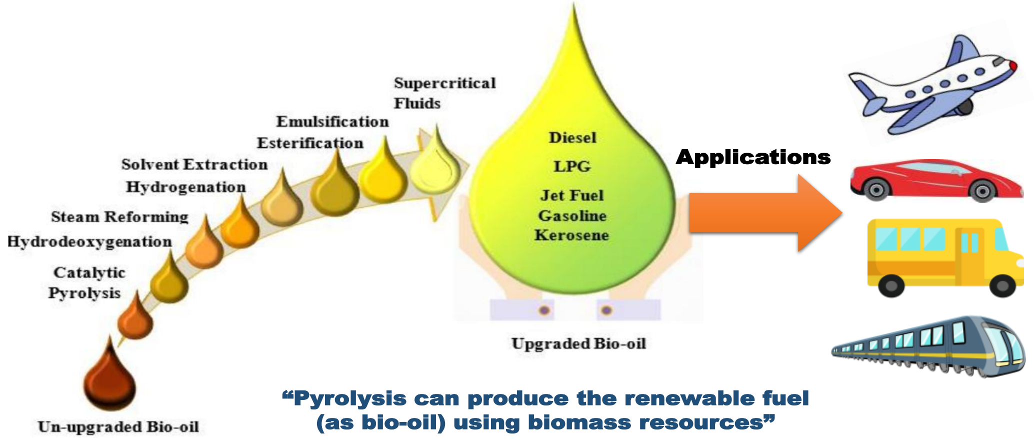
Energy Storage Materials

Necessity of energy storage had led to the development of new materials which can act like supercapacitor and provide immediately energy, especially in transportation.



Catalysis: Bio-oil upgradation

Pyrolysis derived oil is not suitable to be directly utilize in automobiles because of poor its fuel quality and hence it needs to be upgraded using a catalyst. Amongst various techniques, the catalytic upgradation of bio-oil is investigated.



Nano Materials: Energy and Environmental Applications

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Interested Research Area

- CO_2 capture and utilization for chemical synthesis
- Design of Nanomaterials, industrial catalysts, and supercapacitors
- Photocatalysis and nanomaterial design for wastewater treatment
- Modelling, Simulation and Design of Chemical Processes
- Life cycle assessment & sustainability analysis
- Biomass conversion processes
- Essential oil extraction and plant design

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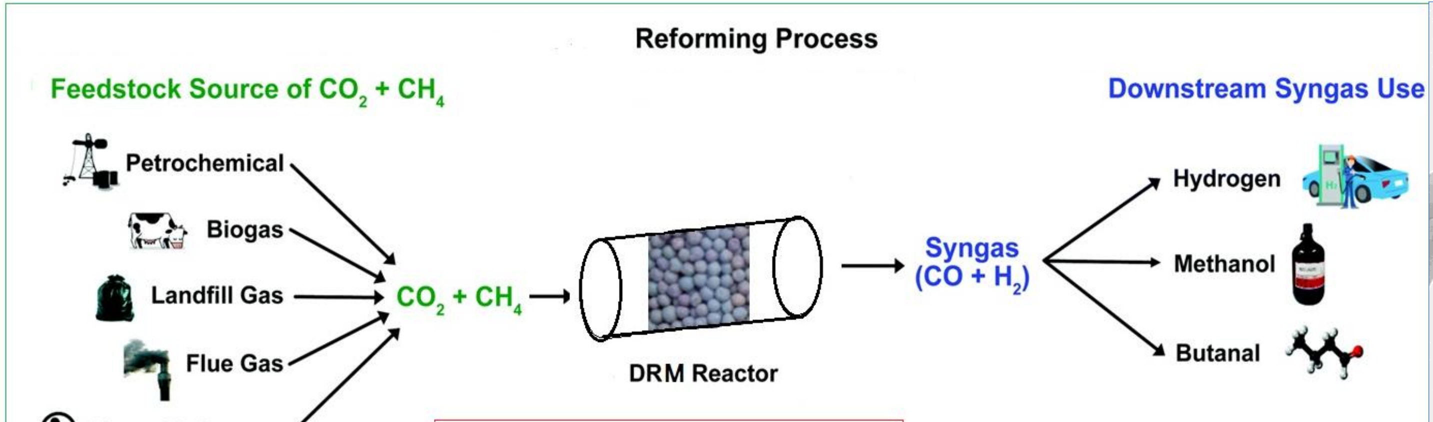
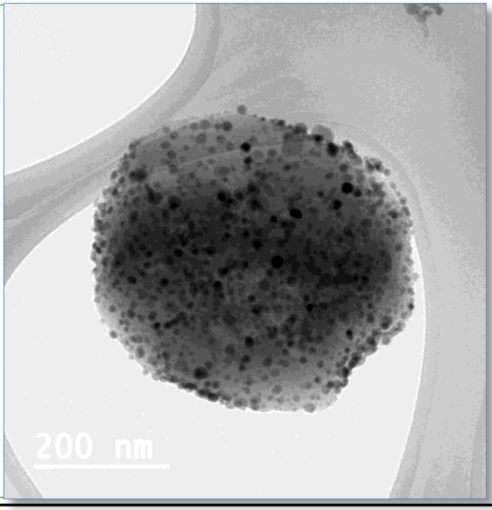
Catalyst and process design

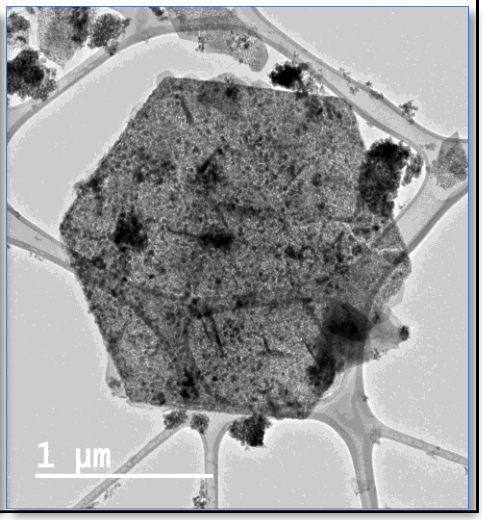
CO_2 capture and its utilization for the synthesis of syngas and other chemicals

Captured CO_2 from various industries is used to reform the natural gas and biogas into synthesis gas which can further be upgraded to a large number of chemicals, New nano-structured catalysts, and processes are designed for sustainable syngas production.



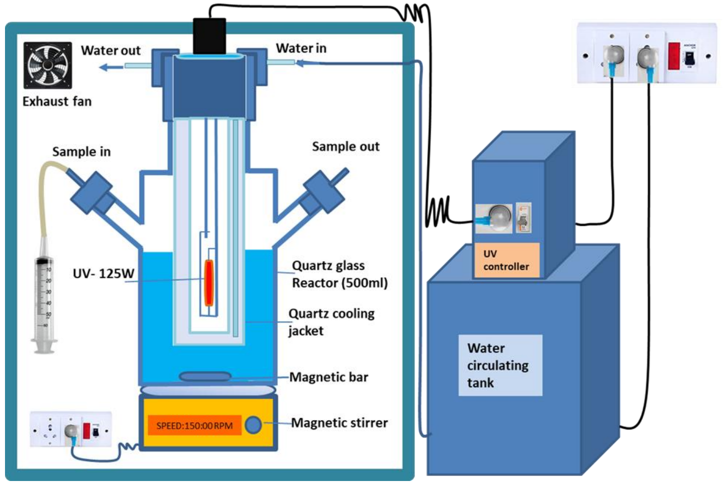
Nano Catalysis for CO2 Utilization





Wastewater treatment and photocatalysis

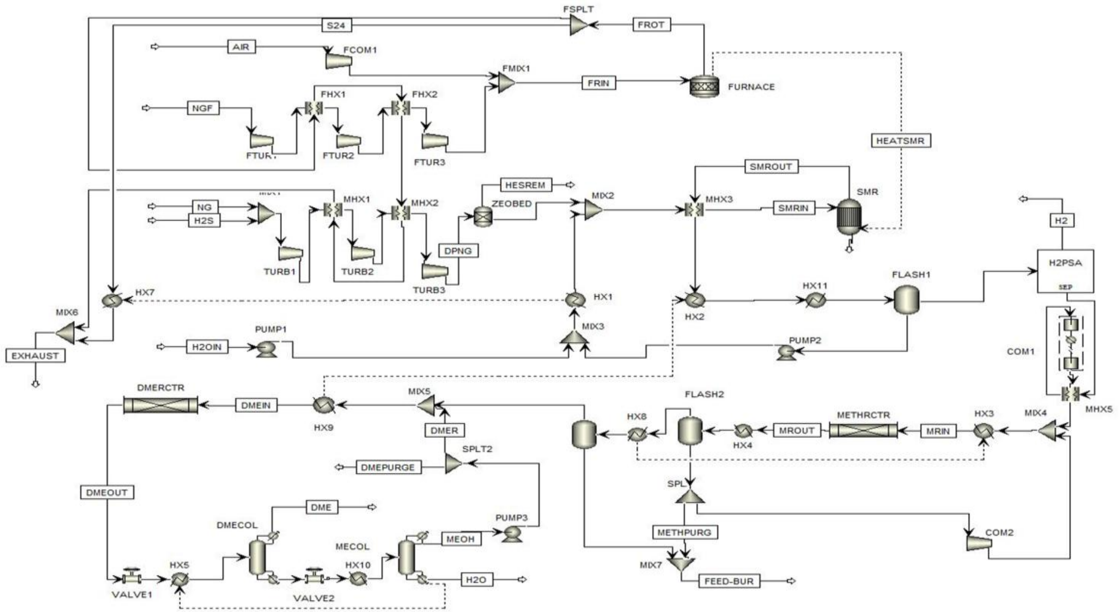
Adsorption of ionic contaminates from industrial wastewater and groundwater over biomass-based and metal oxide adsorbents is considered the greener water treatment method. The organic impurities can be treated using the photocatalytic methods.



Photocatalytic reactor

Modeling, Simulation, and LCA analysis

The flow sheeting using a commercial simulator like Aspen Plus is the first step in designing the New chemical processes. Sustainability and techno-economic analyses are critical in deciding on a greener chemical process.



Aspen Simulation of DME Production

The main targets are as follows:

- Design of green catalysts and processes for the production of methanol, and other higher alcohols.
- Development of green processes for industrial carbon capture.
- Process design for carbon-neutral cement, Iron & steel, and renewable energy generation processes.
- Design of industrial adsorbents for the sorption of waste gases and water contaminants.
- Green hydrogen production

Carbon Dioxide Capture and Catalysis

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Interested Research Area

- Carbon capture and storage to reduce carbon emissions
- Hydrocarbon conversion & catalysis
- Material synthesis and characterization
- Reduction of carbon emission by adsorption
- Mathematical modeling and simulation

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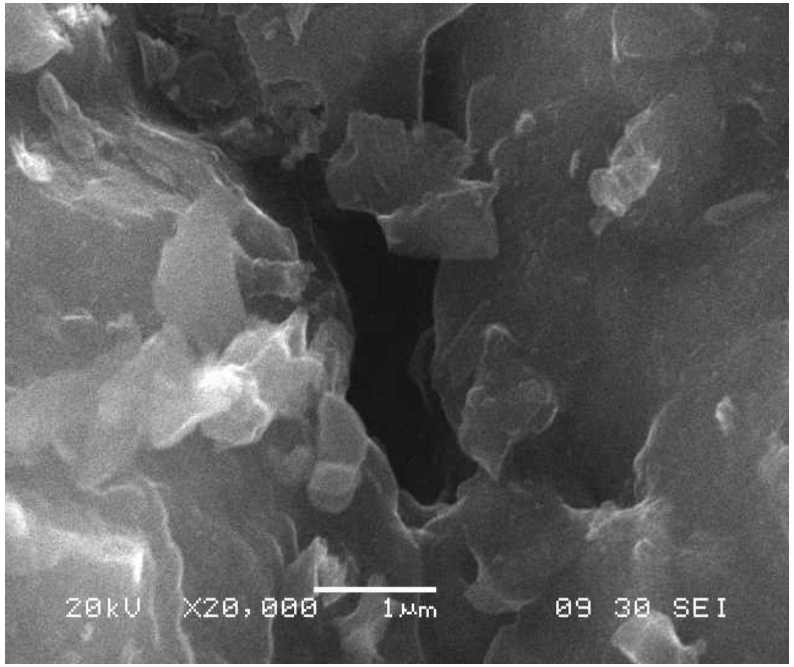
Date pits based biomass is converted to activated carbon using physical/activation technique

Activated carbon can be economically synthesised from vastly available date pits biomass.

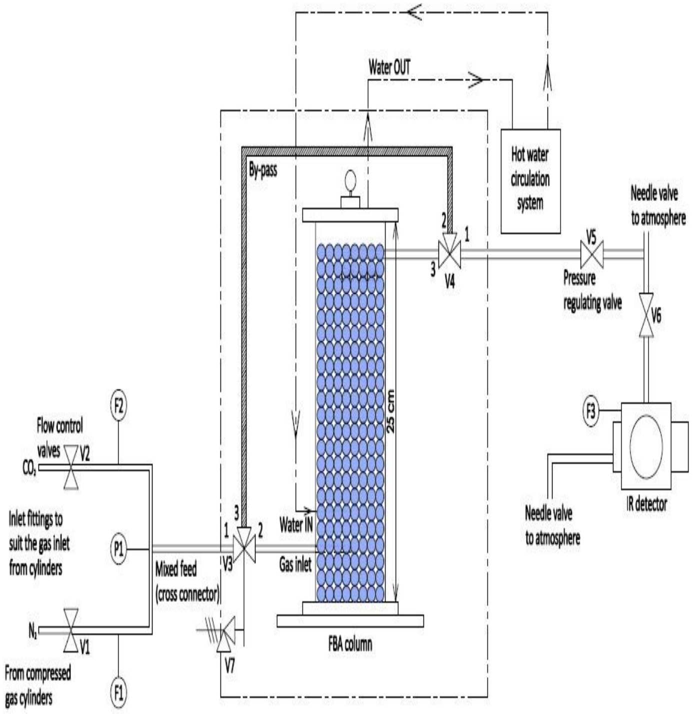
Surface morphology

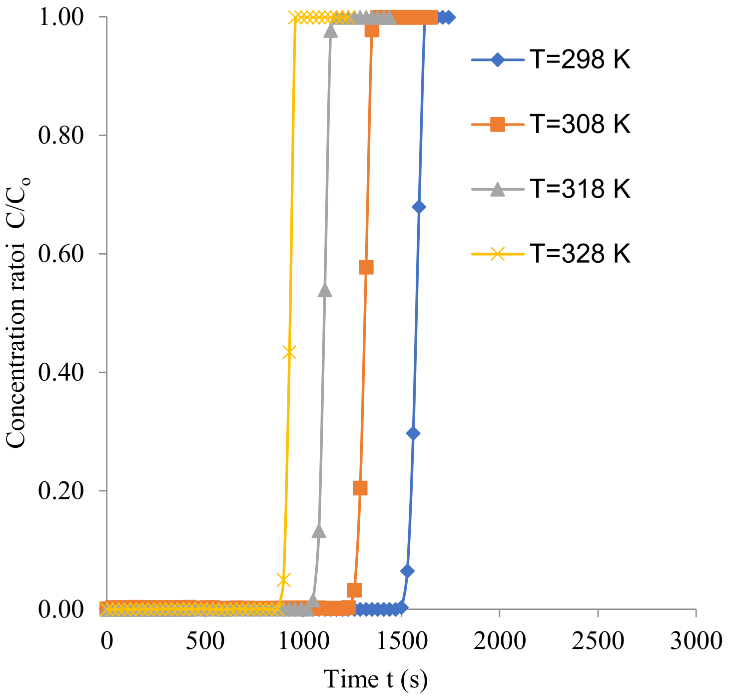
The produced activated carbon may be analyzed using SEM analyzer to study morphological characteristics.



CO_2 Capture unit & breakthrough profiles

The computer controlled CO_2 capture unit to study the carbon capture under varied conditions of temperature, feed rate, pressure and CO_2 mol%





Main target are as follows:

- Proper utilization of vastly available date pits based biomass by suitable activation technique.
- Investigation of CO_2 capture by adsorption using fixed bed continuous column.
- Estimating adsorption performances and characteristics of synthesized adsorbent.
- Fitting kinetics model and suitable adsorption isotherms.

Catalysis, Reaction Engineering and Process modelling

Interested Research Area

- ❑ Adsorbent & Adsorption Process
- ❑ Catalyst Synthesis and Catalytic Reaction
- ❑ Modelling and Simulation
- ❑ Computer Aided Design in Chemical Engineering

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Adsorbent & Adsorption Process

- Adsorbent Materials Development
- Kinetics, Isotherms & Thermodynamics
- Adsorption in Water Treatment
- Biological Adsorption
- Adsorption Process Optimization

Modelling and Simulation

- Multi-Scale Modeling
- Process Intensification
- Sustainable Process Design
- Bioprocess Modeling
- Digital Twins

Catalyst Synthesis and Catalytic Reaction

- Abundant material Heterogeneous Catalyst synthesis
- Catalyst Characterization
- Catalyst Optimization and Design

Computer Aided Design in Chemical Engineering

- Process Simulation and Modeling: Hysys, Aspen Plus, CHEMCAD, or COMSOL
- Process Optimization and Control: GAMS, MATLAB,
- Data Analysis and Machine Learning: Python, R

Conceptual design, modelling and simulation

Interested Research Area

- Modelling and Simulation of Petroleum Refining Processes
- Conceptual Design of Reactive Distillation system

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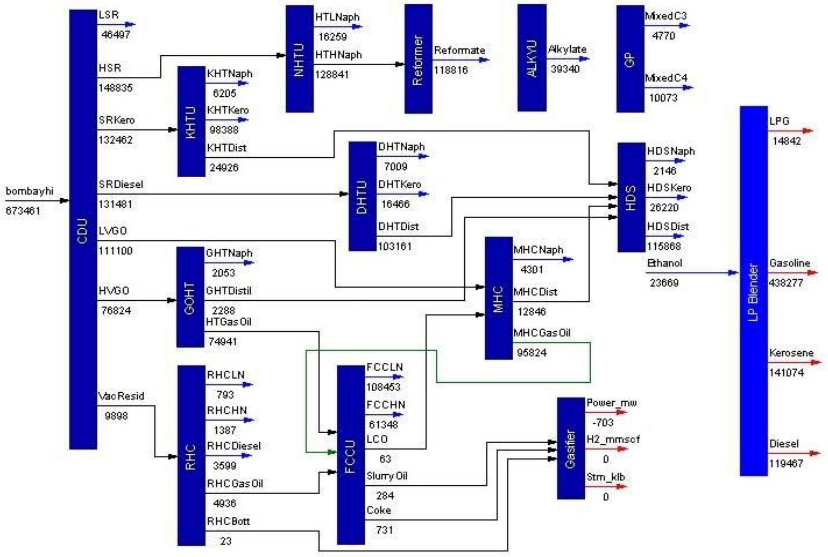
Modelling and Simulation of Petroleum Refining

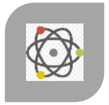
- ✓ Efficiently planning grassroot refinery projects
- ✓ Decide profit margins for processing opportunity crude oils
- ✓ Determine operating variables and product specifications



Conceptual Design of Reactive Distillation Systems

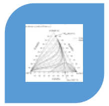
- ✓ Combining reaction and distillation for economic and efficiency advantages
- ✓ Determining feasible conceptual design options for reactive distillation
- ✓ Analysing complex interactions of reaction and V-L equilibrium and azeotropes formation

Material And Energy Balances



Physical Properties

Chemical Kinetics



Vapor-Liquid Equilibrium

Simulations

Waste Water Treatment

Interested Research Area

- Water and waste water treatment.
- Waste oil treatment (recycling and reprocessing).
- Seeds oils extraction.
- Adsorption.
- Analytical Techniques (ICP – AAS -UV).
- Water quality Assessment

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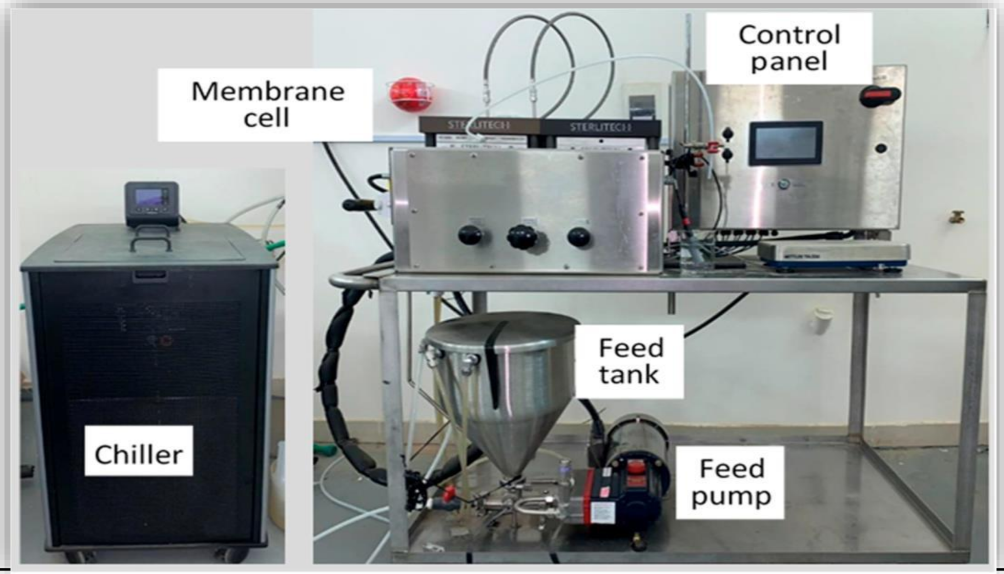
RO process lab scale setup



Waste Engine Oil Treatment Using Natural Adsorbents