2nd CONFERENCE ON SUSTAINABILITY IN PROCESS INDUSTRY (SPI-2014)

22nd MAY, 2014

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Book of Abstracts

Department of Chemical Engineering UET Peshawar

SPI 2nd - 2014

Sustainability in **P**rocess **I**ndustry

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ACKNOWLEDGEMENT

It is our great pleasure to welcome you to the SPI-2014 conference on **"Sustainability in Process Industry (SPI-2014)**". Putting together SPI-2014 was a team effort. We first thank the authors for providing the content of the program in the form of oral and poster presentations and all other participants. We are also grateful to the key note speakers from academia and various industries. These valuable and insightful talks can and will guide us to a better understanding of the **"Sustainability in Process Industry".**

We also thank the hosting organization, UET, Peshawar, and our generous sponsors PASTIC, NAYS. Technology Links (pvt) Ltd. And Rizvi and Co. (pvt) Ltd. without their great support it would not be possible to hold this conference. The support and funding they provided is greatly appreciated.

We are grateful to the program committee, who worked very hard in order to make this conference successful.

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PREFACE

Sustainability means "to maintain or endure." According to the work of the UN Brundtland Commission, sustainability in the context of development is to "meet the needs of the present without compromising the ability of future generations to meet their own needs." The sustainability in process industries has globally known from the last few decades. Sustainable development contains social, cultural, environmental and economic aspects. The country like Pakistan is facing various problems and energy is one of the main issues today. There are many reasons of energy crises in Pakistan and non- sustainable process is one of the major factors among them. This is the right time to address the sustainability and link it to the process industries to be sustainable and contribute to sustainable development in order to overcome the energy crises in Pakistan.

The Chemical Engineering Department of University of Engineering and Technology, Peshawar plays a crucial role in research areas of national interest. Our faculty is energetically involved in applied research at both national and international level.

The 1st conference on **"Sustainability in Process Industries (SPI-2012)**, held at UET, Peshawar on August 10, 2012, attracted prominent researchers from all over Pakistan which created a linkage and provided approaches to the application of sustainability in the process industry.

Continuing the same tradition, the Department of Chemical Engineering had again taken initiative to hold a 2nd conference on **"Sustainability in Process Industries (SPI-2014)**", on May 22, 2014 in collaboration with PASTIC and NAYS. The mission of the conference is to share and identify new directions for future

research and development regarding **“Sustainability in Process Industries**”.

We hope that you will find this program interesting and that the conference will provide you with a valuable opportunity to share ideas with other researchers.

Organizing Committee

PROGRAM

Time	22^{nd} May, 2014 **Main Hall**
08.00-09.00	***REGISTRATION***
INAUGURATION CEREMONY	
09.00-09.05	**Recitation from the Holy Quran**
09.05-09.20	**Welcome address:** **Dr. Saeed Gul, Conference Chairman**
09.20-09.45	**Opening remarks:** **Engr. S. Imtiaz H. Gilani (Vice Chancellor, UET Peshawar)**
09.45-10.30 **Plenary lecture 1** **Prof. Dr. Arshad Hussain (HOD, SCME-NUST Islamabad)** **Application Of Membrane Technology For CO_2 Capture From Natural Gas**	
10.30-11.00	**Tea Break and Poster Exhibition**
Technical Session 1A (Main Hall-I) **BIOPROCESSES**	
Session Chair: **Dr. Arshad Hussain** Session Co-Chair: **Dr. Jamil Ahmad**	

11.00-11.20	**Keynote 1**	**Prof. Dr. Suleman Tahir *(UOG Gujrat)***	**Bio-Refinery: An integrated and sustainable alternative to fossil fuel**
11.20-11.35	BP-1A-1	Dr. Sher Jamal Khan *(IESE-SCEE NUST Islamabad)*	Anaerobic Baffled Bioreactor for on-site domestic waste water treatment
11.35-11.50	BP-1A-2	Dr. M. Bilal K. Niazi *(SCME-NUST Islamabad)*	Melic acid a plasticizer for bio degradable food packaging thermoplastic starch films
11.50-12.05	BP-1A-3	Dr. Yousaf Jamal *(IESE-*	Treatment of inland brackish water using Capacitive Deionization

		SCEE NUST Islamabad)	
12.05-12.20	BP-1A-4	Engr. Suneela Sardar (*NFC IE&FR, Faisalabad)*	Extraction of byproducts of hydrogen peroxide working solution using solvent
12.20-12.35	BP-1A-5	Engr. Asmat Ullah *(UET Peshawar)*	Effect of CO_2 on the growth rate of microalgae in a photo bioreactor
12.35-12.50	BP-1A-6	Engr. Zaib Jahan (*SCME-NUST Islamabad)*	Fabrication and Characterization of cellulose acetate membrane for homo dialysis
Technical Session 1B (Hall-II) **ENERGY ENGINEERING-1**			
Session Chair: **Dr. Noor Ul Amin** Session Co-Chair: **Dr. Waqar Ali Khan**			
11.00-11.20	**Keynote 2**	**Prof. Dr. Shahid Raza Malik** *(NFC IE&FR, Faisalabad)*	**Energy Crisis in Pakistan and its Solution**
11.20-11.35	EE-1B-1	Dr. Gul e Rana Jaffri *(Fuel Reserch Centre , PCSIR,Karachi)*	Simulation for release Alkali species of Pakistan coal under pressurized combustion at elevated pressure and temperature
11.35-11.50	EE-1B-2	Dr. Shahid Hussain Ansari *(SCME-NUST Islamabad)*	Process Analysis and Production Potential of Synthetic Crude Oil by FTS Technology from Natural Gas and Solid Carbon Sources
11.50-12.05	EE-1B-3	Engr. Amjad Ali *(Cherat Cement Nowshera)*	Sustainability and Economical Development of Cement Process by Replacing the Fossil Fuels Through Alternative Fuels and Energy Recovery from Flue Gases
12.05-12.20	EE-1B-4	Engr. Yasir Zia *(PARCO)*	Retrofit of pre-heat train of a crude distillation unit in a refinery in Pakistan
12.20-12.35	EE-1B-5	Engr. Shoaib Ahmad *(CASE, UET Taxila)*	Development of Renewable Energy (RE) Technology Management Framework for Pakistan
12.35-12.50	EE-1B-6	Muhammad Abubaker *(CASE, UET Taxila)*	Effect of Vapour Velocity on Condensate Retention on Enhanced Tubes

Technical Session 1C (Hall-III) MODELING AND SIMULATION			
Session Chair: **Prof. Dr. Siraj Ul Islam** Session Co-Chair: **Dr. Irshad Ali**			
11.00-11.20	**Keynote 3**	**Dr. Ishaq Ahmad** ***(UET Peshawar)***	**Determination of Empirical Modeling Parameters for the Processing of Bauxite Ore**
11.20-11.35	MS-1C-1	Zaheer Uddin ***(UET Peshawar)***	Meshfree method for 2D highly oscillatory Fredholm integral equation
11.35-11.50	MS-1C-2	Masood Ahmad ***(UET Peshawar)***	Solving two-dimensional Poisson equations with nonlocal boundary conditions by meshfree method
11.50-12.05	MS-1C-3	Muhammad Ihsan ***(UET Peshawar)***	Numerical Simulation of Pure Diffusion Model by Haar Wavelets
12.05-12.20	MS-1C-4	Tariq Mahmood ***(UET Peshawar)***	Meshless Method for the Numerical Solution of 1D Highly Oscillatory Integral Equations of the Second Kind
12.20-12.35	MS-1C-5	Uzma Nasib ***(UET Peshawar)***	Meshless Based Complex Quadrature Solution For Highly Oscillatory Integrals Andthe Integrals Having No Stationary Points
12.35-12.50	MS-1C-6	Saeed Ullah Jan ***(UET Peshawar)***	Numerical solutions of SIR model by meshless and finite difference methods
12:50 - 13:05	MC-1C-7	Amir Afridi (UET Mardan Campus)	Micro-strip Patch Antenna
12.50-14.00 **Lunch/Prayer Break – Poster Exhibition**			
14.00-14.25 **Plenary Lecture 2 (Main Hall-I)** **Dr. Michael Harasek (TU Wien Austria)**			
Session 2 A (Main Hall-I) **MATERIAL ENGINEERING**			

Session Chair: **Prof. Dr. Sahar Noor** Session Co-Chair: **Dr. M. Imran Ahmad**			
14.25-14.45	**Keynote 4**	**Dr. Noor Ul Amin** ***(AWKU Mardan)***	**Designing of building material from locally available material in KPK Pakistan**
14.45-15.00	ME-2A-1	Dr. Iftikhar Ahmad *(SCME-NUST Islamabad)*	Soft sensing technology in process industries: designing hybrid soft sensors to realize efficient process operations
15.00-15.15	ME-2A-2	Engr. M. Iftikhar Ahmad *(UET Peshawar)*	Effects of Solid Loading on Rheological Behavior of HTPB- Based Polyurethane Composites
15.15-15.30	ME-2A-3	Engr. Habib Ur Rehman *(UET Peshawar)*	A comparative study on the mechanical behavior of polyurethane silica and carbon black composites
15.30-15.45	ME-2A-4	Engr. Atta Ullah *(UET Peshawar)*	Development of acrylonitrile butadiene based conductive polymer composite by using transition metal doped tin oxide
15.45-16.00	ME-2A-5	Engr. Iftikhar Ahmad *(UET Peshawar)*	Effects of Particle Size of Reinforcement Filler on Rheological Properties of HTPB-Based Polyurethane Composites
Session 2 B (Hall-II) **ENERGY ENGINEERING-II**			
Session Chair: **Prof. Dr. Shahid Raza Malik** Session Co-Chair: **Dr. Ishaq Ahmad**			
14.25-14.45	**Keynote 5**	**Prof. Dr. Suhail A. Soomro** ***(MUET Jamshoro)***	**Prospects of bioprocess industry and Chemical Engineering**
14.45-15.00	EE-2B-1	Dr. Shafiq R. Qureshi *(NUST-PNEC Karachi)*	Synthetic Rubber Based solar collector for Low to Medium temperature Industrial/Domestic Solar Heating
15.00-15.15	EE-2B-2	Engr. M. Fahad Khan *(ARL R/Pindi)*	ARL's Energy Management System & Sustainability
15.15-15.30	EE-2B-3	Engr. Imran Khan *(IIU Islamabad)*	Investigation of SEIG in renewable energy
15.30-15.45	EE-2B-4	Engr. Abdul Hai *(GIKI Topi)*	Solar Energy Utilization for the treatment of Produced Water for Oil & Gas Fields

15.45-16.00	EE-2B-5	Engr. M. Owais Ashraf *(NFC IE&FR, Faisalabad)*	Solar-Water Heating System for Domestic Use
Session 2 C (Hall-III) **PROCESS AND PRODUCT ENGINEERING**			
Session Chair: **Prof. Dr. Suleman Tahir** Session Co-Chair: **Dr. Gul e Rana Jaffri**			
14.25-14.45	**Keynote 6**	**Engr. Waheed Ur Rehman *(PCSIR Peshawar)***	**Forward osmosis and emerging separation Techniques**
14.45-15.00	PPE-2C-1	Engr. Muhammad Nawaz *(SCE-UOF-Faisalabad)*	Removal of Congo Red from aqueous solution using Saw Dust as an Adsorbent
15.00-15.15	PPE-2C-2	Engr. Abdul Hannan Zahid *(UOG Gujrat)*	Potential of Hydrogen Production in Microbial Fuel Cell for Ammonia Industry as Application of Waste Water Treatment
15.15-15.30	PPE-2C-3	Agha Danish Ilyas *(DCE Karachi)*	Production of biofuel combined with wastewater treatment through algae
15.30-15.45	PPE-2C-4	Engr. M. Noman Khan *(SNGPL)*	Cost Effective Approach for Risk Analysis of Natural Gas Pipelines
15.45-16.00	PPE-2C-5	Engr. S. Riyaz Uddin *(OGDCL Islamabad)*	Sustainable development and the chemical industry
16.00-16.15	PPE-2C-6	Engr. Amir Muhammad	CFD Simulation of Non-Dispersive Solvent Extraction in Membrane Contactors
16.15-16.30	PPE-2C-7	Engr. Shoaib Jadoon	Review of Process Simulation and Simulation Software-Open Source Software Development
16.30-16.45	PPE-2C-8	Engr.Iftikhar Ahmad	Simulation of HFMC for Heavy Metal (Cu) Extraction With Chelating Extractants
16.45-17.00	PPE-2C-9	Engr. Sher Ahmad	Modeling and Simulation of Osmotic Distillation Process of Fruit Juice Concentration

Session 3 (Main Hall-I) **PANEL DISCUSSION: UNIVERSITY-INDUSTRY** **1700-1720**	
Chair: **Dr. Saeed Gul** Co-Chair: **Dr. M. Younas**	
1. How can University-Industry linkages be enhanced? 2. Why Industry is hesitant to sponsor Research Grants to Academia? 3. Whose responsibility is to develop sustainability in process industry?	
CLOSING CEREMONY (Main Hall-I)	
16.05-16.15	**Wrap-Up (Dr. Mohammad Younas)**
16.15- 16.30	**Award Distribution**
16.30-16.45	**Closing Remarks by Chief Gust**
16.45-16.50	**Vote of Thanks**
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ABSTRACTS

Application of Membrane Technology for CO_2 capture from Natural Gas

Arshad Hussain

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Removal of CO_2 from crude natural gas by amine absorption is a well known and implemented industrial process and is still considered a state of the art technology. Likewise, there are quite a few membrane plants installed around the world, but these membranes do not have optimum performance with respect to flux and selectivity, and therefore require fairly large membrane areas. This work is focused on optimizing the membrane separation performance thus reducing both membrane area and CH_4 loss. Membrane processes are considered as a promising alternative for offshore production processes. Since there will always be a little loss of amine solution to the atmosphere during the process, membrane processes also offer an environment friendly alternative. Two different feed gas streams are considered in this study. For each stream a technical and economical analysis is done to assess the optimal process conditions, required capital investment and the resulting gas processing cost for amine absorption and different membrane configurations, respectively. Aspen Hysys has been used to simulate the amine absorption and membrane separation process. For amine absorption process and membrane application the property packages of Amine and Peng-Robinson are used, respectively. For amine absorption, a CO_2 concentration of less than 0.5 vol.% in the sweet gas and a concentration above 90% CO_2 in the acid gas stream is assumed. For single stage membrane processes the aim was to match the pipeline conditions, and to minimize the loss of CH4 in the permeate stream. In multi-stage membrane processes a similar goal for CO_2 purity and recovery

was set as in amine absorption; less than 2% CO2 in the product stream and a CO2 concentration around 90% within the permeate stream.

The simulation results show that purity of the achieved gas streams is for instance lower when using a membrane process, while the higher purity of sold and vent gas in amine process is paid by high total capital investment and a potentially more harmful environmental process. The membrane process yields lower purity than the amine process with respect to CO2 in the sweet gas, but meets the sales gas standards according to spec. (<2% CO2 in the sales gas). It is an environmental friendly and compact process which will require smaller footprint when an optimized membrane system is used.

Theme -1 Biotechnology and Biochemical

Bio-refinery: An integrated and sustainable alternative to fossil Fuel

M. Suleman Tahir[a], Muhammad Saif Ur Rehman[a], Sajjid Mehmood[b] Muhammad Sajjid[a]

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Pakistan is an agriculture economy that produces four major crops such as wheat, cotton, sugarcane and rice. These crops generate huge volumes of residue after harvesting. These lignocellulosic biomasses have been mainly investigated to produce bioethanol to date within the country which is not an economical pathway. Bioethanol can be economically produced from sugar industry waste in Pakistan, thus, this pathway is not so economical. Rather, lignocellulosic biomass (which is composed of cellulose, hemicellulose and lignin) can be used as a sustainable feedstock to produce multi-products such as furfural, hydroxymethyl furfural, levulinic acid, acetic acid, beneze compounds, lignosulfunates, biochar and bio-oil, exploiting all of the components of biomass. The production of various biochemicals and biomateirals from lignocellulosic biomass has surfaced the concept of lignocellulosic biorefinery that is more economical and likely to be commercialized in the country. It will not only provide a sustainable supply of energy as well chemical/material resources within the country, but it will also boost the rural economy of Pakistan

Anaerobic Baffled Bioreactor for On-site Domestic Wastewater Treatment

Vardha Komel[a], Rehan Mustafa[b], Tehmina Kausur[c], Sana-e-Sakina[d], Baseer Ahmed[e], Sher Jamal Khan[*]

[*]*Institute of Environmental Sciences and Engineering, School of Civil and Environmental Engineering, National University of Sciences and Technology (NUST), Sector H-12, Islamabad, Pakistan*

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Adequate sanitation is a global issue with effects on well-being, health, food production, and the environment. Over 884 million people around the globe suffer from the poor water and sanitation conditions. The situation gets worsen in the poorer areas of the world including developing countries like Pakistan. Pakistan being a victim of poor water and sanitation situation is losing 4% if its economy to worse sanitation and water supplies. The urban (36%) and rural (64%) population has 72% and 34% access to water and sanitation respectively. Although there is an ongoing effort from government and non-government organizations (NGOs) in Pakistan to improve public hygiene but still no cutting edge solutions have been developed so far. Therefore, there is a need for collaboration between government, NGOs, and academia which can prove to be fruitful in finding way out to handle and improve the water, sanitation, and hygiene (WASH) sector. In this regard, the National University of Sciences and Technology (NUST) and WaterAid UK in Pakistan have collaborated. The objective was to determine cost effective, easy to install and maintain, sustainable WASH technologies for peri-urban and rural areas of Pakistan. NUST in collaboration with Water Aid, developed an improved and modified form of septic tank with anaerobic filter, termed as anaerobic baffled bioreactor with peat filter. The objective of the study was to provide an onsite domestic wastewater treatment system capable of treating domestic wastewater to meet the National Environmental Quality Standards (NEQS) of Pakistan and the effluent could be reused safely for horticulture,

landscaping, and/or irrigation. The bench-scale setup was tested with and without the peat filter and the results showed an average removal of 80, 75, 80, and 70% in terms of COD, BOD_5, TSS and VSS respectively without filter while 90, 88, 94, and 90% average removal in terms of COD, BOD_5, TSS, and VSS, respectively. As this technology showed promising results for treatment of low to medium strength domestic wastewater both in terms of high removal efficiency, and low capital and maintenance costs, the next logical step would be up scaling of this prototype and replicated in the field in the peri-urban and rural areas of Pakistan.

Keywords: Sustainable WASH technologies; Academia and NGOs coordination; Septic tank, Anaerobic filter

Malic acid: a plasticizer for biodegradable food packaging thermoplastic starch films

Muhammad B. K. Niazi*[,a,] and Antonnius A. Broekhuis[b]

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Retrogradation of amorphous thermoplastic starch (TPS) films obtained by compression molding of spray dried potato starch was investigated. The aim was to investigate the influence of plasticizers with similar molecular weight but different functionality, i.e. isoleucine, asparagine and malic acid, on the performance of powder and TPS films. Combinations of malic acid with glycerol, urea, and maltodextrin were also evaluated. Except for isoleucine formulated starch, all samples were obtained as amorphous powders and films. Malic acid was identified as a strong retrogradation agent as it inhibited recrystallization of starch over the full range of humidity levels. Malic acid was also found to inhibit the retrogradation of formulations containing urea, glycerol and maltodextrin. The converse of the strong inhibition implied strong moisture absorption and high strain at break values, and low tensile strengths. Malic acid was also identified as a potential cross-linking agent to control swelling of starch-based products.

Treatment of inland brackish water using Capacitive Deionization

Hussain Kamran[a], Aitzaz Ahsan[b], Aamir Khan[c], Muhammad Ahmad[d], Fawad Ahmad[e], Yousuf Jamal*

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Capacitive Deionization (CDI) for desalination of brackish water is used in this research work to meet WHO drinking water standards of 1000 mg/L total dissolved solids (TDS). CDI is based on the concept of electro-sorption. An electro-potential difference is applied across two oppositely charged surface electrodes. System optimization is studied in this work on parameters like absorbent selection, adsorbent surface treatment, surface regeneration, applied voltage and retention time of water in contact with carbon electrodes. A parallel flow of water is adjusted against electrodes in a batch tank arrangement.

An increase in salts removal is observed with applied voltage from 1.4 to 1.8v. Increase in residence time has also shown remarkable removal of salts up to drinking limits. Desalination results were further improved with carbon electrode surface treatment with titanium oxide nano-particles. However, this study does not validate surface improvement by potassium hydroxide as reported in literature. All surface treated and untreated carbon electrodes have shown regeneration up to 90%.

Output of this research has the potential of providing safe drinking water in remote areas of Pakistan where groundwater has high salinity.

Keywords: Desalination, Capacitive Deionization, Electro-sorption, Process Optimization, Regeneration.

Effect of CO_2 on the growth rate of microalgae in a photo bioreactor (Pbr)

*Asmat Ullah, Mohammad Younas[a]

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For the past few years algae haven studied considerable as a research tool because of their nutritional value and their effective use in environment cleaning. Nowadays, algae are also considered as an alternate source of energy. High growth rates of algae are the focus of researchers in current era which lies in the efficient design of photo bioreactors. However CO_2 is also an important restrictive factor in micro-algae growth. The advantage of use of CO_2 in the growth of microalgae is that it can counteract the adverse affects of CO_2 production by industrial activities on environment. CO_2 is the major specie of green house gases which caused global debates concerning climate alteration. One of the options to mitigate the adverse affects of CO_2 emission is to utilize CO_2 aquatic microalgae growth. Other advantage of use of CO_2 in the production of microalgae is to convert the CO_2 into algal biomass, which can in turn used in many applications, such as biofuels, organic fertilizers, stock feeds and pharmaceuticals products.

The aim of current study is to determine the optimum flow rate of CO_2 for high growth rate of microalgae biomass. In this research a photo bioreactor (PBR) was fabricated and installed for microalgae cultivation. Pure CO_2 was injected into Photo bioreactor (PBR) under various flow rates (30 ml/min, 40 ml/min, 50 ml/min, 60 ml/min) while keeping other factors such as temperature, light intensity, PH and growing medium composition constant. Results showed that the growth of microalgae increased significantly by increasing CO_2 flow rate. Growth rate (cells/ml) of microalgae was analyzed verses different CO_2 flow rate. The operating conditions

will be considered for the developing of operational strategies and in projects of photo bioreactors for carbon-dioxide mitigation through microalgae.

Keywords: Microalgae, CO_2 mitigation, biofuels, photobioreactor.

Fabrication and characterization of cellulose Acetate membrane for hemodialysis

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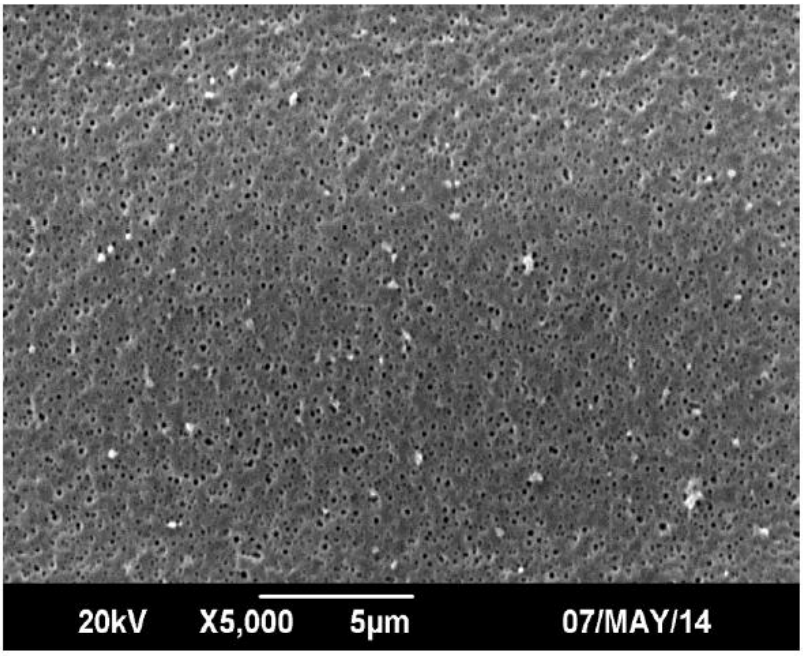
Dialysis membrane play vital role in the treatment of patients with renal failure. The indigenous development of dialysis membrane is therefore very important to get insight into the membrane fabrication process and reduce its production cost. The preparation of dialysis membranes requires the optimum adjustment of several variables, mainly the composition of polymer and the type & concentration of additives used. In this work, cellulose acetate membrane is fabricated by using solution cast method and tested for hemodialysis application.

Cellulose acetate (CA) has been used as basic polymer while distill water has been used as non-solvent phase. Acetone, acetic acid and formic acid were used as solvent phase. Different types of membranes were synthesized by changing the weight percent of CA, solvent phase and the non-solvent phase. The fabricated membranes were characterized by using SEM and AFM techniques. The membrane fabricated by using formic acid as solvent showed the best results with the addition of PEG as additive. The effect of changing percentage of CA on pore sizes and surface morphology was observed.



In order to quantify the flux through the membrane a membrane testing apparatus has been designed and fabricated locally. This apparatus consists of mainly a membrane cell, and can operate for both batch and continuous process conditions. It has the provision to adjust and control the feed/dialysate flow rates, feed/permeate for specific membrane area. Pure water flux has been measured through CA-Formic acid membranes with and without the addition of PEG for same membrane area, by using Fick's law. The permeability of sugar and urea molecules will be measured across the -Formic acid membrane.

Extraction of byproducts of hydrogen peroxide working solution using solvent

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Working solution comprising anthraquinone and its derivatives, used for preparation of hydrogen peroxide, leads to the formation of byproducts. These byproducts contain highly complex mixture of degradation products, which cannot take active part in the production of hydrogen peroxide, and cause higher viscosity and density of working solution. The low viscosity is important for mechanical reasons in cycling of the working solution through the equipment and density must be substantially different from the density of the water hydrogen peroxide solution resulting from water extraction of the hydrogen peroxide from the organic phase, in order to facilitate the extraction. The degradation products must be extracted from the working solution to prevent deteriorating the crude hydrogen peroxide color, smell, dissolved organic compounds and increase in density and viscosity of the working solution. A decrease in surface tension of the working solution promotes the formation of an emulsion during extraction degradation products decrease the activity and life time of the hydrogenation catalyst. Regeneration of the working solution for bringing it back to the good health a solvent Tetra Butyl Urea (TBU) is added in degraded working solution in a different proportion.

Keywords: Regeneration, Anthraquinone, Tetra Butyl Urea, Degradation.

Theme -2 Energy Engineering-1

Renewable Energy Concepts - Integrated Pathways from Biomass to Energy, Fuels and Chemicals

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Increasing use of renewable energy from biomass has become an important contribution to the transition of energy supply systems towards more sustainability. Among other renewable energy sources such as wind, hydropower and photovoltaics, biomass continues to play an important role in this field. However, biomass is more than energy – research and development activities in the last years have led to successful demonstrations of exciting routes for the integrated production of fuels and chemicals in addition to energy. In this presentation, the author will give an overview about these activities at the Institute of Chemical Engineering of Vienna University of Technology addressing biomass gasification, methanation, Fischer-Tropsch synthesis as well as biogas upgrading and the production of renewable hydrogen through various pathways.

Simulation for release alkali species of Pakistani coal under pressurized combustion at elevated pressure and temperature

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Energy demand is driving due to global economic development and lack of fossil fuel resources. According to world energy outlook, 2012 the World energy demand will rise about 30% in 2040 as compared to 2010. The additional capacity 4800 Gw is required to meet the crises of energy. Coal is an important fossil fuel and playing increasing role for electricity generation.

Coal based integrated gasification combined cycle power generation system are under development with aim to increase the efficiency of coal combustion and gasification but it requires a reliable gas cleaning to provide the gas turbines and prevent them to hot corrosion caused by Na-,Cl- and S- containing species.

Unfortunately these species are released during thermal conversion process but major depends on the condition of thermal utilization process and the composition of minor elements of coal moreover these species are highly volatile and lead to several problem of fouling, slagging and corrosion when they reach the colder part of plant. Therefore the comprehensive knowledge is required prior to carry out experiment.

The objectives of present study to simulate the combustion environment under elevated pressure and temperature and predict the release of SO_2, H_2S, NaCl, KCl and HCl in soft Pakistani coal using equilibrium calculations by Factsage.

Three soft Pakistani coal such as Lakhra (V_{ad} < 41.44%), Thar (V_{ad} < 42.02%) and Sor-range ((V_{ad} < 21.11%) belong to Lignite

and sub-bituminous coal were selected because especially high content of Na in Thar (<39.68%), Lakhra (<3.4%), Sor-range (<8.38%) and also Al, S, Cl, Ca elements. The direct use of such coal may be harmful for power plant. So this problem may be overcome by prediction their release behavior using equilibrium calculation during pressurized combustion under elevated temperature and Pressure or suitable amount of biomass and biomass char as additive can be used with coal to reduce the hot gas emission.

In this study the thermodynamic calculations were performed by Fact Sage 5.2, a common program using the Principle of Gibbs free energy minimization. This program based on Chem Sheet and able to calculate equilibrium in complex multi-component-multiphase system.

The initial model composition has been based on the data of coal analysis and has been related to 1 gm of coal. C, H, S, O, N, Na, K, Mg, Ca, Cl, Al and Fe were included into computation. The results were calculated by plotting mole fraction of each species vs Pressure (5 to 15 bar) at 1000°C and Temperature (1000°C to 1600°C) at 1 bar pressure for combustion process. The results for thermodynamic calculation for release species were predicted in order of sequence for pressurized combustion at elevated pressure and temperature as follows.

Releasing order of species at elevated Pressure

Lakhra coal = SO_2>H_2S<NaCl>KCl<HCl

Thar Coal = SO_2>H_2S<NaCl>KCl>HCl

Sor-range coal = SO_2>H_2S<NaCl>KCl<HCl

Releasing order of species at elevated temperature

Lakhra coal = SO_2>H_2S<NaCl>KCl>HCl

Thar Coal = SO_2>H_2S<NaCl>KCl>HCl

Sor-range coal = SO_2>H_2S<NaCl>KCl>HCl

On the basis of predicted order the SO_2 is the most stable species for combustion at elevated pressure and temperature. The high released amount of SO_2 and H_2S was predicted in Lakhra and Thar coal at 5~15 bar and 1400 ~ 1600°C while high released of NaCl was observed in Sor-range and Thar coal at 15 bar & 1600°C. The highest amount of KCl and HCl was obtained in Thar and Sor-range Coal at 5 bar & 1000°C.

Comparing with high pressure the predicted release of SO_2, H_2S, NaCl, and KCl is lowest but HCl release is highest than high temperature predicted results. The predicted results agree well with the literature reported for the case of Chinese soft coal.

The above available predicted information is valuable for development of hot gas cleaning technology.

Keywords: Equilibrium calculations, Predicting, FactSage, Soft coal, Combustion, Release of Sodium, Potassium, Chlorine, Sulphur species.

Effect of vapor velocity on condensate retention on enhanced tubes

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Static (non-condensing) data is reported on a set of pin-fin tubes and their equivalent integralfin tubes. Three fluids namely water, Ethylene glycol and R141b were tested to carry out this investigation. Longitudinal pin spacing and height were the only geometric parameters varied. It was founded that with the decrease in longitudinal (pin or fin) spacing, the effect of vapour velocity on retention angle seemed to be less effective in case of pin fin tubes when compared with equivalent integral fin tubes. The effect of vapour velocity on retention angle was almost negligible in case of pin fin tubes when the retention angle was greater than 90 degrees for all the fluids tested, longitudinal pin spacing only effect the retention angle for free convection data.

The effect of pin or fin height on retention angle was found to be less effective parameter within the vapour velocity ranging from free convection to 18 m/s.

Sustainability and economical development of cement process by replacing the fossil fuels through alternative fuels and energy recovery from flue gases

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Cement production processes are highly energy and cost intensive operations. Thermal energy accounts for 40–60% of the total production cost. Modern cement plants with state-of-the-art technology require 2.9 GJ per ton of cement produced. The energy consumption for older plants could exceed 5.5 GJ per ton of cement produced. In the present investigation, case studies are presented for 3200 tons per day Cherat cement factory, situated in Nowshera, Pakistan.

In cement plants, there is a great potential of heat recovery from hot flue gases emitting from pre heater and clinker cooler. In the first case study, waste heat recovery has been investigated. A thermodynamic analysis for cogeneration using the waste heat streams is not easily available. Data from Cherat cement factory of capacity 3200 tons per day were used to obtain an energy balance for the system. It was found that a lot of the input energy was being lost with the waste heat streams. A steam cycle was selected to recover the heat from the streams using a waste heat recovery steam generator and it was estimated that about 7 MW of electricity can be generated. Three water tube boilers along with turbine consider and pump assembly were installed generating 4.5 to 5.7 MW of electricity which is about 32% of the total electrical consumption of the plant.

The large utilization of coal and furnace oil in cement kilns for clinker production makes cement factories sensitive to rising prices

of fossil fuels; therefore, alternative fuels are investigated for reducing fuel costs. In the second case study, the utilization of carbon black, tier derived fuel (TDF) and refuse derive fuel (RDF) as alternative fuels for clinker production are investigated. The mixed fuel of carbon black and coal are used in kiln and precalciner which produce cement clinker. Two shredders for tier and RDF were installed in the plant. TDF and RDF were used in precalciner which reduced the required amount of coal for clinker production and hence plays the role of constituent to coal in cement process. The effects of the fuels on the quality of clinker and cement were checked and the saving was studied. It was found that the fuels did not affect product quality. Clinker and cement composition tests were made to quantify the values of tri calcium silicate C3S, di-calcium silicate C2S and tetracalcium alumino ferrite C4AF and the compositions were found to be in acceptable ranges. Two physical tests used on the product cement were the setting times and compression tests. The initial and final setting times were within standards. It was found that by adding carbon black and TDF into coal as a co-combustion fuel, 1–3% saving of fuel cost can be achieved. The great challenge, which is faced in the use of RDF, is its moisture content which is about 40 to 50%, which cause an increase of energy consumption per kg of clinker production. If it is controlled to a value of 15 to 20%, it may be an economical and sustainable replacement of coal for cement clinker production in cement plant.

Retrofit of pre-heat train of a crude distillation unit in a refinery in Pakistan

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In this paper retrofit of heat exchanger network (HEN) of a crude distillation unit, known as pre-heat train, of the largest refinery of Pakistan is investigated to determine the scope of improvement. Targeting is carried out employing the problem table algorithm for the operating scenario in which Arabian light crude is processed. The current crude heater duty is found to be higher than the minimum heater duty obtained through targeting indicating scope of improvement, i.e. reduction in heater duty. A suitable method would be adapted for retrofit of the heat exchanger network.

Keywords: Retrofit; crude pre-heat train; heat exchanger network.

Process analysis & production potential of synthetic crude oil by FTS technology from natural gas & solid carbon sources

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Fischer Tropsch Synthesis-FTS technology is addressed with catalytically production of raw syncrude oil from natural gas and solid carbon sources like coal, biomass, municipal solid waste and petroleum coke which proves a new alternative energy route for liquid fuels and various oxygenates. In order to meet increasing global energy needs, production of renewable fuels, such as gasoline, diesel and jet fuel, using the natural gas and solid carbon sources to liquid via Fischer–Tropsch Synthesis, it has been gaining strong attention during recent years. Renewable fuels are usually much cleaner and environment friendly. Syncrude oil is not a single product whose composition principally depends upon the active metal ceramic supported catalyst and conditions of FTS conversion. Catalysis plays a vital role for production of clean, environment friendly and carbon neutral fuels for sustainable growth as an alternative option other than fossil fuels. This paper will deliberately describe all possible technical and economic factors which are essentially prerequisite to check the performance of FTS technology network. The in-house developed meso-porous ceramic supported metallic catalyst was characterized by means of characterization techniques like SEM, XRD, TG-DTA, BET-area analyzer and FTIR. Furthermore, hydrogenation of carbon monoxide within micro fixed bed reactor highly dependent on the selectivity of metallic supported catalyst which will portrays the product distribution of carbon number in the range of C5-C22.

KeyWords: Fischer Tropsch Technology, Clean liquid fuel, Syncrude, Alternative energy and meso-porous.

Development of renewable energy (RE) technology management framework for Pakistan

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Renewable energies are an option for Pakistan to fulfil her energy needs, realize developmental goals and overcome environmental issues. Previous efforts to develop these in the country remained short of expectations; therefore, Pakistan fell behind in use of these technologies. It has necessitated a quick, cost-effective and ingenious management of all future deployments. So that, Pakistan not only covers up her past deficiencies; but also benefits in future.

In this research work Pakistan's energy needs are analyzed; possible contributions of renewables are determined; deep understanding of different commercially mature RE technologies is developed; the technologies are ranked in suitability order; success stories of China, India and other countries are reviewed; in-country current status and past efforts are analyzed; and a strategic and technological framework for future has been proposed.

Determination of suitable technologies for Pakistan is original and central in this work. Suitability was determined by assessing eleven fully mature and commercially available technologies, using Multi Criteria Decision Analysis technique. Two decision matrices were drawn for centralized as well as distributed deployment options. Each matrix used detailed assessment criteria, based on 106 variables, to rank the technologies for utility scale and small deployments in Pakistan.

First five technologies suitable for utility scale deployment are; small hydro, solar PV, bio ethanol (from molasses), biomass combustion (sugarcane bagasse), and wind. In small scale

deployment first five technologies are; biogas, small hydro, solar PV, solar water heating and wind.

Based on potential of renewables in Pakistan, realistic analysis of Pakistan's past performance, learning from mistakes and successful experiences of others countries (especially, China and India); a framework is outlined based on the technologies ranked suitable for Pakistan. This includes the conceptual approach, objectives to be achieved, policy instruments, implementation strategy, recommendations to overcome existing barriers and other essentials. The framework addresses both deployment modes of renewables. This research work is expected to be useful in decision and policy making for future deployments of RE technologies in Pakistan.

Theme – 3 Modeling and Simulation

Determination of empirical modeling parameters for the processing of bauxite ore.

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Clay impurities associated with bauxite creates lot of problems in Bayer process of alumina production and therefore it is normally removed by washing before sending the ore as a feed to the Bayer refinary. Bauxite washing is characterized by the removal of the fine silica (in the form of clay) from the surface of bauxite and hence its particle size distribution (PSD). Industrial washing of bauxite is a complex phenomina which involves a lot of process units e.g. trommel screens, application of water jets, vibratory screens, cyclones etc and it's difficult to apply the phenominological modeling to correctly estimate the products PSD. Therefore, the bauxite washing was investigated in laboratory. No models are available in the literature for the bauxite washing process and therefore, in the current investigation, empirical modeling techniques were used to determine the Gates-Gaudin-Schuhmann (GGS) distribution function parameters in order to estimate the PSD of the washed products.

Mesh free method for 2D highly oscillatory fredholm integral equation

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In this paper, a modified Levin's quadrature method is put forward for numerical solution of two-dimensional highly oscillatory Fredholm integral equation of the second type. The Fredholm integral equations are widely used in the field of Engineering and physics. These integral models are used in the formulation of scattering problems, optics, acoustics, quantum mechanics and electromagnetic waves. The new method focuses on the highly oscillatory kernel having phase function free of stationary phase points. Fredholm integral equations can be obtained from boundary value problems with given boundary conditions. The two-dimensional Fredholm integral equation model of the second kind where the unknown function appears inside and outside of the integral sign is presented by the form:

$$\varphi(x,t) = h(x,t) + \int_a^b \int_c^d k(x,t,u,v)\,\varphi(u,v)dudv\,, \quad \varphi(x,t) \in [a,b]\times[c,d]$$

Where $k(x,t,u,v)$ is the kernel function and $\varphi(x,t)$ is the unknown function. The above integral equation can be written in the oscillatory form as

$$\varphi(x,t) = h(x,t) + \int_a^b \int_c^d f(x,t,u,v)e^{i\,\omega\,g(x,t,u,v)}\varphi(u,v)dudv\,.$$

The above model is highly oscillatory Fredholm integral equation (HOFIE) having kernel with phase function $g(x,t,u,v)$, while f,g h and φ are considered smooth functions. The parameter ω represents the frequency of oscillations. Increasing ω will results into highly oscillatory kernel. This is really a competitive problem which needs a special attention to handle. The literature is inadequate on subject of solution of two-dimensional HOFIE. This aspect has not being watched and the researchers have to contribute to find efficient algorithm for numerical solution of Fredholm integral equations having highly oscillatory kernels. Different methods have been developed in the past which are primarily concerned the case where the integral equations have non-oscillatory kernel functions. Very accurate algorithm for solution of one-dimensional HOFIE has been provided by J. Li et al. based on his work done for two-dimensional highly oscillatory integrals(HOIs) .

Recently Leven's based multi quadric RBF method have been developed by Siraj ul Islam et al to find numerical solution of one and two-dimensional HOIs. The quadrature suggested here in this paper is efficient and accurate. The numerical examples provided at the end demonstrate its effectiveness.

Solving two-dimensional poisson equations with nonlocal boundary conditions by meshfree method

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Various mathematical models that described real-world processes consist of partial differential equations (PDEs) with nonlocal boundary conditions. Second order parabolic PDEs with nonlocal boundary conditions have important applications in chemical engineering, heat transfer phenomena and thermoelasticity. Therefore, interest in solving such PDEs numerically with nonlocal boundary conditions has been growing fast. In this paper we considered two-dimensional Poisson equation with nonlocal boundary condition. We used meshless method based on Radial basis functions collocation technique along with operating splitting scheme based on inverse multiquadric (CTWSPIMQ) for its numerical solution. We consider two examples of nonlocal boundary condition. One is two-point boundary condition and another is integral boundary condition. We paid attention to the influence of nonlocal boundary condition on the accuracy and condition number of the matrix arising in the numerical method.

Numerical simulation of pure diffusion model by haar wavelets

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In this paper we present a new collocation method based on Haar Wavelets for the numerical solution of the Pure Diffusion Model (PDM). This method is the extension of the Haar wavelet method with same accuracy. In the present method the time discretization is performed by forward difference operator and the spacetial derivatives are approximated by Haar Wavelets. The advantage of the present method to Haar Wavelet method is the time efficiency. As well as this method can also be applied to Partial Differential Equations (PDE) with Neumann and Robin boundary conditions easily as compared to Finite Difference Method (FDM). The numerical results of simple diffusion equation with Dirichlet jump boundary conditions also favorably match with the exact solutions.

Keywords: Haar wavelets, Pure Diffusion Model (PDM), Dirichlet jump condition, Collocation method.

Meshless method for the numerical solution of 1D highly oscillatory integral equations of the second kind.

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A new numerical method is put forward for the solution of Fredholm and Volterra integral equations of the second kind with highly oscillatory kernels using Multiquadric Radial Basis Functions (MQRBF). The method is based on the Levin's theory of converting integration problem in to a differential equation. The differential equation is then solved by a Meshless method.

Meshless based complex quadrature solution for Highly Oscillatory Integrals and the integrals having no stationary points

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The exact solution of High Oscillatory Integrals (HOIs) and integral having no stationary points is di_cult to obtain. So, an alternate way is to use numerical techniques, for such problems. In

this paper an e_cient method, based on Modi_ed Levin approach is employed for such problems. In the proposed technique multiquadric radial basis function (MQRBF) is replaced by Bessel radial basis function (RBF). In this scheme the integration problems are first transformed into their corresponding ODEs or PDEs form, and then the numerical simulations of the corresponding ODEs or PDEs are performed.

Numerical solutions of SIR model by meshless and finite difference methods

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In this paper, the whooping cough (SIR) model which consists of susceptible (S), infected (I) and recovered (R) classes, is being considered along with diffusion term.

Equilibrium points of the model have been determined i.e. disease free equilibrium point and endemic equilibrium and their stability has also been discussed. The effect of diffusion has been studied in the model. The basic reproduction number of the model is also derived. A finite difference operating splitting, meshless operator splitting and a one step meshless explicit methods are being considered for numerical solutions of the model with diffusion (WD) and without diffusion (WOD). As the exact solution is not available, the numerical outputs obtained are mutually compared and their correctness is being verified by the theoretical outputs as well.

In this paper, our focus is on the numerical simulation of the SIR model by three types of numerical methods. They include explicit meshless method (EMM), operator splitting meshless method (OSMM) and operator splitting finite difference method (OSFDM). This helps us to analyze the disease dynamics in a better way.

Micro-strip Patch Antenna

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Microstrip antennas are simple antennas with a dielectric medium $2.2 \leq Є r \leq 12$ sandwiched between a radiating patch and a ground plane. Lower the value of the dielectric constant, better the efficiency. The substrates with higher thickness have lower coupling and minimize undesired radiations therefore, they are mostly used in microwave circuitry. Electrically, the patch size looks greater than the physical dimension because of the fringing effect. Therefore, the patch size is increased by an amount of ΔL. The radiating patch can be of different shapes but rectangular and circular patches are common. There are different techniques to feed the microstrip antenna such as proximity coupling, coaxial probe, aperture coupling and microstrip line. The main advantage of microstrip antennas is that they are small in size, light, easy to install, cost effective and low profile. They are majorly used in aircrafts, medical sciences, rockets and satellites. The bandwidth and gain of these antennas is low. The problem of narrow bandwidth and low gain can be overcome by using different techniques such as single slot technique. A simple rectangular patch antenna can be designed to operate at a resonant frequency having the dielectric constant $Є r$, length L and width W. The length of the patch is less than the size of the ground plane by an amount of six times the height of the substrate. Circular polarization in microstrip antennas can be obtained by exciting two orthogonal modes at 90 degree time-phase difference between them. There are number of ways to achieve circular polarization in microstrip antennas such as by trimming the edges the opposite sides of the patch, by single feed arrangement, by 90 degree hybrid method, by power divider method and by cutting a rectangular slot in the patch having width (c=W/2.72) and height (d=c/10) of the slot. Such a circularly polarized antenna is designed in CST

Microwave Studio software at resonant frequency of 2.71GHz, Єr=4.3. The results show that the axial ratio (AR) of the designed microstrip antenna was found to be 2.64dB, which shows that the antenna is circularly polarized (since AR<3dB). The maximum directivity of the microstrip antenna is 6.58dB.

Theme 4 Material Engineering

Designing of new binding material from locally available material in Khyber Pakhtoon Khwa Pakistan

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A new alternative for Portland cement has been developed from the locally available clay in khyberpakhtoon khwa and studied for different physical and chemical parameters. Clay containing kaolinite has been chemically activated with strong alkali solution. The alkali activated clay has been studied for studied for compressive strength at different conditions. It has been found out that the activated clay cured at 80 °C for 48 h has a compressive strength of 44 MPa which is far greater than Portland cement. The newly formed phases may be sodium zeolite which is directly proportional to the compressive strength. The newly designed binding material is prepared at ordinary pressure without the evolution of CO2 thus making the cement industry more sustainable and environment friendly.

Soft sensing technology in process industries: designing hybrid soft sensors to realize efficient process operations

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In the global market, each industry faces a stiff competition and hence strive to realize stable and efficient operation and produce high quality products satisfying various customer demands. In realizing stable and efficient operation, uncertainties in equipment characteristics, operating conditions, and raw materials have been a big concern. Soft sensing technology has been very helpful in overcoming such hurdles. The hybrid/ gray-box soft sensors has attracted researchers' attention by its capability: known linear/nonlinear phenomena can be embedded in the first-principle model, and an unknown relationship among variables can be embedded in the statistical model by extracting such a relationship from the data. My presentation comprises an overview of state of the art in soft sensing technology followed by a systematic development of hybrid soft sensors for a real operation of a steel making process. The hybrid modeling strategy is explained into three sequential phases. In phase 1, gray-box model (soft sensor) is shown for prediction of molten steel temperature in tundish, TD temp. In the 2nd phase, a new gray-box model namely combined gray-box model to control the TD temp using temperature at Ruhrstahl-Heraeus degassing process (RH temp) as a manipulating variable is described. In phase 3, quantitatively modeling of the uncertainties in steel making process through the combination of gray-box model and bootstrap filter are explained. Finally, future challenges and prospects of soft sensing technology are summarized.

Effects of solid loading on rheological behaviour of HTPB-Based polyurethane composites

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Polyurethane is widely used in manufacturing of polymer composites. Various additives including fillers are added during its manufacturing processes. Re-inforcement fillers are added to improve the mechanical properties and reduce the cost effects. Fillers have a large influence on the rheological properties of composites as its particle size, particle size distribution, modality i.e. monomodal or polymodal sizes, particle shape, density, chemical nature and loadings. Rheological properties are determined to control the process conditions and parameters during manufacturing operations like mixing, extrusion, casting, rolling and calendaring etc. In current experimental study, polymer composites were prepared by filler at various solid loadings. The apparent viscosity was determined by using inner cylinder rotation type viscometer. The experimental data was utilized to determine the rheological properties like shear stress, shear rate, flow behaviour index and consistency factor. The application of rheological model showed that Power law best fits the computed data. The study also revealed that the apparent viscosity of polymer composites increases with increase in percentage of filler and decreases with increase in shear rate.

Keywords: Polyurethane, Composites, Rheology, Reinforcement, Shear Rate.

A comparative study on the mechanical behavior of polyurethane silica and carbon black composites

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The paper presents the mechanical behavior of polyurethane, reinforced with silica and carbon black fillers. The influence of each filler on the microstructural and mechanical behavior has been studied using both fillers in varying weight percentages (2~10%). Both fillers have different particle size, silica (~13µm) while carbon black (~29µm) was incorporated in the polyurethane matrix, which was synthesis by reacting hydroxyl terminated poly butadiene and toluene diisocyanate. Thin films (thickness: 0.6~0.8 mm) of polyurethane carbon and silica composites were prepared by solution technique. Structural properties have been studied by Fourier Transform Spectroscopy. The mechanical properties were tested on universal tensile testing machine. The results shown that tensile strength and modulus of polyurethane composites increased with filler contents, while strain values decrease relatively as filler contents increased. By comparative study of the mechanical behavior of two polyurethane composites, it has been revealed that silica composites have better mechanical properties than its competitor carbon composites. This behavior of silica is attributed by the following reasons: a) better dispersion of silica in dry solvent as compared to carbon black and b) hydrogen bonding offered by the oxygen on the silica surface. This comparative study has shown that both reinforced fillers offered better mechanical properties than pure polyurethane samples.

Keywords: Polyurethane reinforced composites; mechanical properties; structural properties; Fourier Transform Spectroscopy.

Development of acrylonitrile butadiene based conductive polymer composite by using transition metal doped tin oxide

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Acrylonitrile Butadiene rubber has poor electrical properties. To improve the electrical properties of NBR, transition metal doped Tin oxide was added to the Acrylonitrile Butadiene rubber matrix. For the preparation of samples, mastication and rubber mixing process was carried out by using open roller rubber mixing machine. Samples were prepared by verifying the ratio of doped Tin oxide (2% to 8%). During the mixing process rollers temperature was controlled at $\leq 50^{o}C$. Prepared samples were vulcanized in double platen hydraulic press machine. The thickness of vulcanized samples was 2mm. At the same time neat rubber sample was also prepared with the same procedure.

The prepared samples were characterized for their electrical properties. Surface and volume resistivity was measured at 500 DC voltages. Results of both neat sample and Tin oxide reinforced composite samples have been studied. This comparative study has shown that, Incomparison to the neat rubber sample, transition metal doped Tin oxide composite showed a remarkable improvement in the electrical properties. Moreover, by increasing the ratio of doped Tin oxide in the polymer matrix increasing trend in electrical (conducting) properties has been observed. Samples were also characterized to study the mechanical properties as well. Tensile strength, elongation and modulus of doped tin oxide samples were significantly amplified

Effects of particle size of reinforcement filler on rheological properties of HTPB-Based polyurethane composites

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Rheology of polymer processing is an art rather than science. Polyurethane (PU) is main constituent in preparation of polymer composites. In modern life, there are much applications of polyurethane especially in aerospace industry. The fillers are usually added to reduce cost and improve the thermo-mechanical properties; however it affects the rheology of matrix and offered difficulties in mixing, casting and molding operations. Polymer composite rheology is affected by various process parameters like shear rate, process conditions (processing time, temperature, and humidity), solid loadings, particle size of filler and its distribution.

In present work, polyurethane composites were prepared by using filler (Na_2CO_3) having different particle sizes to study their effects on rheological behavior of HTPB based polyurethane composites. The experimental data of apparent viscosity was used to determine the different rheological parameters like shear stress, shear rate, flow behavior index, consistency co-efficient. The application of rheological model showed that Ostwald-de-wale Power law best fits the intended data. The study also revealed that the apparent viscosity of polymer composites increases with the decrease of particle size of filler due to better dispersion which strengthen the filler-polymer network.

Keywords: Polyurethane, Composites, Rheology, Reinforcement, Shear Rate

Theme 5 Energy Engineering-2

Synthetic rubber based solar collector for low to medium temperature industrial/domestic solar heating

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Heating process is an energy extensive sector for both industry and domestic utilities. In most of the developed countries, the industrial heat-demand constitutes about 15% of the overall demand of final energy requirements. The temperature requirements of heating process in these sectors range from 60^{O}C to 260^{O}C generally, which is medium and medium high regime of the temperatures. Solar energy has a vast potential in process heating of industrial and domestic applications. Medium high and high temperature applications are normally not considered cost effective due to capital costs involved but still being used due to environment advantages. But Low and medium temperature applications are better candidates for solar heating. This work describes a novel cost effective method for low to medium range temperatures heating. In conventional solar heating systems metallic collector tubes i.e. copper, are used which are expensive and need special absorbent coating is also required. Use of EPDM synthetic rubber instead of metallic tubes is many times cheaper but has similar thermal performance. EPDM being flexible material have lesser chances of scaling and it also does not require any additional coating to increase its absorptivity due to its natural black color. Analytical and experimental study was undertaken for performance comparison of both copper and EPDM tubes. Transient thermal analysis has shown Temperature of fluid increases more quickly in EPDM tube than copper at atmospheric ambient conditions however performance is quite similar at increased ambient temperatures for both tubes . This is a critical conclusion of the study which suggests EPDM as a strong competitive candidate for solar thermal collectors for a temperature

range of up to 170^{O}C. In developing a more efficient design of collector, a detailed optical study was also carried to propose an optimum angle of collector's cover glass sheets. It is proposed that to minimize the reflection losses from glass plates an angle between 35-40O will give the best output.

Comparison of pin-fin and equivalent integral fin tubes, effect of vapor velocity

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Effect of vapor velocity on condensate retention was studied by systematically varying the circumferential thickness in a range from 0.5 mm to 2.0 mm. Three fluids namely water, ethylene glycol and R-141b were tested to carry out this investigation. Static retention measurement was achieved by changing vapor velocity from low approaching zero velocity to 19 m/s in a vertical wind tunnel. Photographic and pin counting methods were used to measure retention angle.

Retention angle (an angle measured from top of the tube to the point where tooth flanks becomes flooded by the condensate) in case of pin-fin tubes was found to be greater than equivalent integral fin tube for all cases. On the upper half of pin-fin and integral fin tubes, vapor shear effect showed an increase in retention angle with the increase in vapor velocity. On the lower half of pin-fin tubes vapor velocity had almost no effect on retention angle, while it markedly decreased for low surface tension fluids in case of integral fin tubes.

Investigation of SEIG in Renewable Energy

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Presently Renewable Energy sources are the most attractive sources for generation of Electrical Energy. Renewable Energy sources Solar, Wind, Hydro, etc are environmental friendly; as they do not produce toxic gases such as CO_2, CO, NO_x etc unlike as in Thermal power generation. They also do not contain Sulfur as in some coal fired power plant. Beside many other advantage of renewable energy sources over non renewable energy sources; per unit cost of the energy produces from renewable energy sources is less than the energy produces form non renewable energy sources.

The way of extraction of electrical energy from the renewable and non renewable energy sources is almost same. Turbine is used to convert the kinetic energy of Steam/Fluid (in non renewable) or Hydro/wind (in renewable) into mechanical energy. This mechanical energy is converted into electrical energy by means of generator. Most of the time Synchronous Generators are used for the extraction of Electrical Energy but induction generator got a special attention in the last few decades. Induction generators have the advantage of its simplicity, small size, low operation and maintenance cost and etc. Different configurations of induction machine are being used in the literature by researchers in many countries such as Doubly Fed Induction Generator (DFIG),

Separately Excited Induction Generator, Self Excited Induction Generator (SEIG) and etc.

This paper presents the comparison of different generators with Self Excited Induction Generator (SEIG); for the extraction of Electrical Energy from renewable Energy sources. Self Excited Induction Generators do not need external sources for the excitation of the windings. A capacitor bank is connected to provide the required reactive power to the SEIG and load. Various problems in using SEIG for Power generation and the some of the suggested solutions to those problems are presented here.

Keywords: Renewable Energy sources, Hydro Energy, Wind Energy, Self Excited Induction Generator (SEIG).

Solar energy utilization for the treatment of produced water for oil & gas fields

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Energy crisis is becoming a major problem in Pakistan. Renewable energy sources are used to overcome this crisis. As in oil and gas fields, gas is purified from water (produced water) and crude. Most of oil and gas fields are at those regions of the world in which there is scarcity of water, so a better choice is that to treat this produced water and use it for different purposes. In this paper a method for the treatment of produced water by using solar energy is introduced which is economical as well as environmental friendly. In this new method the work planned for our project is aimed to tackle such a situation where the saline water is made potable by the application of heat source from solar energy. By this, the problem of potable water in the oil and gas field is also diminished.

A detailed process, along with the result and conclusion is discussed in this paper.

Key words: Produced water, solar energy, and potable water.

Solar-Water heating system for domestic use

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Fossil fuels are the main sources that are being used to produce energy today in Pakistan. They are not only being depleted, but also polluting the environment, and affecting our economical stability. As oil prices continue to escalate to levels that threaten our economy, alternative energy sources are starting to play an important role in our society. Out of the available alternative energy resources, solar energy has emerged as one of the most powerful ,clean, safe and virtually inexhaustible source of energy, world can depend on it, in the years to comePakistan has a very good overall solar-energy potential. The average daily isolation rate in Pakistan is approximately 5.3 kWh/m^2 and average daily isolation rate in Faisalabad is approximately 5.65 kWh/m^2.Solar energy can be used directly or indirectly. In the indirect method solar energy is converted into heat energy for efficient utilization. Here design of solar water heating system, the indirect mode of conversion of solar energy is discussed in detail. We studied temperature change and sensible heat vs. time with different arrangements in storage vessel only, storage vessel with lenses and reflective mirror. No. of experiments have been performed and results of solar water heating system have been discussed in this paper.

***Keywords**:* SWH (Solar water heating), inexhaustible.

Theme 6 Processes & Product Engineering

Forward osmosis: An emerging separation technique

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Forward osmosis is an emerging technique in many areas of separation processes. Compared to the conventional techniques of reverse osmosis and ultra/nano filteration, forward osmosis utilizes the natural osmotic pressure gradient between feed and draw solutions to perform separation. A number of studies have recently been conducted to evaluate the performance of forward osmosis in various areas of separation sciences. In the present study, potential applications of forward osmosis are reviewed in detail to emphasize its importance as a prospective separation technique in industry. Largest area of application is desalination where forward osmosis is used as pre-treatment technique to obtain potable water from highly saline water resources. Forward osmosis has also been successfully employed in the treatment of stable oil-water emulsions where no other separation technique works satisfactorily. Osmotic Membrane Bioreactor (OSMBR) is another promising application of forward osmosis in municipal waste water treatment. OSMBR combines the advantages of conventional activated sludge process and forward osmosis membrane bio reactor in a single plant with reduced foot prints, lower energy consumption and higher effluent quality. Forward osmosis is equally useful in the treatment of land fill leachate where it efficiently removes the Total Dissolved Solids (TDS). Hydration bags are an example of the most significant applications of forward osmosis where an edible draw solution like sugar or beverage powder is packed in a sealed bag made of a semi-permeable FO membrane. When the bag is immersed in an aqueous solution, water diffuses into the bag and dilutes the initially solid draw solution. At the end of the process the diluted draw solution can be utilized as a sweet drink that contains nutrients and minerals. So,

hydration bag is an ultimate treatment process rather than a pre-treatment process. Many areas of research in forward osmosis are still open to uncover utilization of this novel technique in various segments of industry.

Keywords: Forward Osmosis, Desalination, Osmotic Membrane Bioreactor, Hydration Bag

Removal of congo red from aqueous solution using saw dust as an adsorbent

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In this study the use of low cost sorbent has been studied as an alternate of activated carbon for the adsorption of Congo Red (CR) from aqueous solution. Saw dust was used to remove CR from aqueous solution by batch sorption techniques. Effect of sorption time, dose of adsorbent, initial concentration of dye, temperature of the solution and pH of the solution were studied. It was seen that maximum dye removal was reached at 90 min. Removal of CR increased with increasing sorbent dose (0.25 to 1.0 g/50 ml), initial dye concentration (25 to 100 mg/l), solution temperature (25 to 70 °C) solution pH (5.7 to 10). The equilibrium sorption isotherms have been analyzed by Freundlich and Langmuir models at different initial concentrations of 25, 50, 75 and 100 mg/l, and the results were discussed in detail. The results showed that saw dust could be used as an effective and low cost sorbent for the removal of dyes from aqueous solution.

***Keywords*:** Congo red, Saw dust, Dye removal, Sorption isotherm, Thermodynamic parameters.

Potential of hydrogen production in microbial fuel cell for ammonia industry as application of waste water treatment

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Hydrogen production can be achieved from fermentation of sugar present in food industry wastewaters. In this study we are demonstrating the production of hydrogen from wastewater using microbial fuel cell and its potential in the production of ammonia for fertilizer industry in place of hydrogen form natural gas. This could not only help in the independency of natural gas but also saves energy, required in hydro-desulphuriser, reforming and shift conversion reaction of natural gas for hydrogen extraction. In addition more effective wastewater treatment can be achieved using microbial fuel cell (MFC). Assuming a maximum theoretical yield 4 mole of H_2 per mole of glucose, hydrogen yield is about 2-3 mole H_2 per mole glucose for food industry wastewater. These results propose that it is practicable to link biological H_2 production with ammonia using microbial fuel cells in order to achieve both independency of natural resources and wastewater treatment.

Production of Biofuel Combined With Waste Water Treatment through Algae

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Sustainable economic and industrial growth requires safe, sustainable resources of energy. For the future re-arrangement of a sustainable economy to biological raw materials, new approaches in research and development, production, and economy are necessary. The biofuels appear to be good renewable energy source to fulfil energy demand and controlling depletion of fossil fuel reserves by providing alternate source for energy. Next is a environmental pollution, changing concentration of gasses in atmosphere due to anthropogenic CO_2 and causing increasing green house gases which cause global warming, Renewable, carbon neutral, fuels are necessary for environmental and economic sustainability. Biofuel as work on a process of photosynthesis it acts as carbon neutrals sequestrate anthropogenic CO_2 and produceO_2. Apart from the harmful effects of air pollution waste water also cause many diseases and problems when discharge in large bodies of water and conventional wastewater treatment is expensive so not usually followed by under develop countries. Algal biofuel can easily grow in wastewater which has organic compounds and eutrophication from waste water can be removed, so that contamination of wastewater can be reduce to minimum by algae production.

Plants and algae seem to be efficient way to sustain environment. Microalgae are the most common and fastest growing species in this world whose carbon fixing rates are higher than those of land-based plants by one order of magnitude. Algae are a very promising solution to diminishing oil reserves, escalating oil prices and climate change caused by greenhouse gas emissions Algae by

means of Photosynthesis has the capacity to sequester anthropogenic CO_2 and also producing ofO_2. It does not require agricultural land. Fresh water is not essential and nutrients can be supplied by wastewater and CO_2 by combustion gas. Moreover microalgae can be used for feed for animals and other useful products like a number of other valuable pharmaceutical products. Thus algae have a clear potential to be used as a source for the production of renewable energy.

Environmental applications, production of biodiesel and other bio-products from microalgae can be more environmentally sustainable, cost-effective and profitable, if combined with processes such as wastewater and flue gas treatments. In one hand, the CHEMICAL REACTION-BASED WASTE REDUCTION approaches are energy-consuming, use costly processes, and have disposal problems. In other hand, the WASTE REDUCTION TECHNIQUES USING MICROALGAE is very attractive since it leads to the production of biomass energy in the process of CO_2 fixation through photosynthesis. Production of biofuel combined with waste management will be efficient process as Algae Biotechnology transforms Carbon Management from a Cost into Revenue. This process can be adopted by industries for treating their waste water and reducing flue gases as well as getting a biofuel for their use which reduce their cost of managing waste and buying of fuels from outside.

Cost Effective Approach for Risk Analysis of Natural Gas Pipelines

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Pipelines carrying natural gas are not on secure industrial site as a potentially hazardous plant, but are routed across the land, i.e., busy city or a network of superhighways. Consequently, there is the ever-present potential of incidents due to third party intervention, corrosion defects and ground movement to interfere with the integrity of these pipelines. In addition, the combination of third-party interference and pipeline route might suggest that people around the pipelines are subject to significant risk from pipeline failure. Therefore there is always a need to improve the level of safety of the pipeline. If the natural gas is accidentally released and ignited, the hazard distance associated with these pipelines to people and property has been found to range from under 20m for a smaller pipeline at lower pressure, up to over 300m for a larger one at higher pressure. In this study, an approach will be developed to express the risk for a gas pipeline in terms of cost. Total cost consists of cost of repair, supply interruption, material loss and damage to humans and buildings. Data analysis of each incident category will be carried out by which the risk of city gas pipelines can be assessed. This study present data on loss of gas incidents to present a safety performance and a broad basis for statistical use. This helps natural gas company to analyse impacts of each incident category and optimize the resources and devise more effective preventive maintenance programs.

***Key words*:** Risk, hazard, Integrity, Corrosion defects.

Sustainable development and the chemical industry

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Sustainability refers to the forward movement in term of economics, environmental and societal related to their services, products and environmental conditions and their advancement followed by proper research and development and new energy resources with alternatives. The chemical industries are to adopt the strategy of providing new products and services to meet the market requirements with customer's satisfactions without harming our eco-system.

The chemical industries are to handle the materials properly with checking and monitoring. Integrate the system for the use of raw materials, products and wastes in the industry. For handling wastes the approach of "CASCADING"-the waste of one industry can be Raw material of other industry. This technique is not only helpful for the environment, but also for the revenue generation as well i-e the economic sustainability and environmental sustainability. The chemical industries are working on research and development and for new innovations for handling of wastes to secure our eco-system.

The chemical industries are a major source of services, products and jobs for people in a society. Theses chemical industries are linked with society in term of products, services and their social links like jobs. For sustainability these chemical industries have to introduce new products, more acceptable to their customers.

For sustainability, the chemical industries are working on;

- Economic Policy assessment in chemical industries

- Environmental Policy assessment for sustainability in chemical industries
- Societal Policy assessment for sustainable in chemical industries

The sustainability in term of economics may involve new designs of processes, products and their services and their implementation. These processes, products and services are to be designed on the basis of customer satisfactions- based on customer feedback, market knowledge, the waste handling, and the new researches based on the transformation of one product to other valuable product. Working out new technologies for present and future sources of energies used in chemical industries. Good relations between different chemical industries are key to advancement and sustainability. Minimizing the energy cost by setting policies to the economically and environmentally optimized.

Environmental standards must be set to serve a benchmark according to the market for an economy, the responsibility of each chemical industry is to make policies to meet the standards.

Every chemical industry has to follow the following parameters;

Chemical industries must be able to properly monitor the environment scientifically

Their waste management system must be effective for protection of our eco-system and waste reduction.

CFD Simulation of Non-Dispersive Solvent Extraction in Membrane Contactors

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In this study is presented a 2-D axial-radial steady-state numerical model for dispersion free liquid-liquid extraction in a hollow fiber membrane contactor. Axial-radial convection and diffusion mass transfer is considered in both tube and shell sides of the contactor, while only diffusion through membrane. Momentum balance equations have been coupled with mass transfer continuity equations to study the concentration and velocity profiles across the membrane contactor, e.g. in shell and tube sides and through pores of membrane. The model equations have been solved with Computational Fluid Dynamics (CFD) techniques using finite element method in COMSOL Multiphysics™ Software. The effects of process parameters on solute extraction efficiency of contactor have been studied and it was confirmed that these devices are efficient for solute removal under liquid-liquid extraction mode. Furthermore, it was also observed that CFD study gives a detailed and clear analysis of dispersion free liquid-liquid extraction process in membrane contactors.

Keywords: Solvent extraction, Mass transfer, Hollow fiber membrane contactors, Modeling and simulation, Computational fluid dynamics

Modeling and Simulation of Osmotic Distillation Process of Fruit Juice Concentration

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The demand for fruit juices with high quality rather than the whole fruits has been increasing day by day. Fresh fruit contains more than 80 % of water which makes the transportation and storage uneconomical.Concentration of liquid foods in general and fruit juices in particular to high concentration up to 70-80%, will remove high amount of water. This will reduce packing and transportation costs. Storage and handling will be reduced as well. And more importantly concentrates will be preserved for longer period of time.

Conventional Techniques used for fruit juice concentration have disadvantages in one way or another. Another emerging technique for juice concentration is osmotic distillation process. It gives high concentration with better quality than other conventional techniques, like reverse osmosis and evaporation.

In this research work, the model for water transport flux prediction is developed in hollow fiber, hydrophobic membrane, using resistance in series approach. Feed (sucrose) was taken in fibers while osmotic agent (CaCl2) was taken in shell side. In this study Knudsen flow was dominated because of the pore size of the membrane**.** The developed model was then simulated using MATLAB. In this study CaCl2 Concentration was varied from 2M-6M and the effect of varying concentration on water flux was studied. The flux obtained was from 1.5kg/m^2hr-3.5kg/m^2.hr. The Predicted water flux obtained from the simulation results was then

validated with experimental data from literature. Finally, the effect of different parameters on water flux was studied.

Keywords: Osmotic Distillation, Osmotic Agent, Membrane Contactor, Hydrophobic, Microporous

Simulation of HFMC for Heavy Metal (Cu) Extraction With Chelating Extractants

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In the current study recovery of copper (II) from aqueous waste streams has been studied theoretically through hollow fiber membrane contactor. Copper (II) reacted with an organic extractant Trifluoro-acetyacetone (TFA) at the membrane interface and thus copper complex molecules was transferred from one side of membrane to other side of membrane. Mathematical model describing mass transfer phenomena, Poiseuille flow and design equations were integrated. The integrated process model algorithm was scripted in MATLAB® 8.1.2. The model analysis incorporate reaction kinetics of the copper with extractant, conservation rate equation of copper ion and extractant incorporating transfer of copper across the membrane pore as depicted by Fick's law of diffusion. Simulations have been performed for a wide range of different operating conditions in order to determine the optimum set of conditions for a particular operation. The model results were found to be in good agreement with the experimental work available in literature. It was found that the model predicted the data reasonably well, proving the model to be a useful tool for evaluating the potential applications of the technology.

Keywords: HFMC, Copper extraction, Simulation, Modelling

Review of Process Simulation and Simulation Software-Open Source Software Development

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Process simulation has been emerging as a growing field and inevitable demand of process industry in 21st Century. In the shadow of this ultimate need, several options are emerging to be useful in this regard. Among various simulation software there also are emerging open source freely available software to aid the existing proprietary ones in this regard. The development of these software and the CAPE-OPEN standards that lay down the principles of their application and usage are the parts of this study.

Keywords: Simulation, Simulation Software, CAPE-OPEN Standard

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