"Integration of Research to Industrial Application"

सत्यमेव जयते

Forests & Environment Department
Government of Gujarat

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GUJARAT CLEANER PRODUCTION CENTRE & ENVIS CENTRE

Gandhinagar

FOREWARD

The world is fast converging into a global village. The accelerated pace of development has posed greater challenges to the environmentalists. Industrialization is the driving force and index of progress of a country. To surge ahead at all levels, India needs to train its huge reservoir of human resource into competent, knowledge intensive workforce to take up the challenges in upcoming era with sustainable development.

Gujarat is one of the fastest developing States in India. In the recent years the major focus has been sustainable development of the state for which effective management and cleaner production are essential elements. There have been many development in different parts of the State in building and strengthening of infrastructure as well as application of better environmental technologies. A need therefore has been felt for which dissemination of information to the industries, professionals, students in general on various as aspects of environmental technologies.

Contributions of GCPC over the years towards promotion of Cleaner Production in the state of Gujarat to improve the productivity and the environmental problems faced by SMEs have been significant. GCPC had also played active role in framing Industrial Policy 2003, 2004 and 2009 and also supported in developing many schemes pertaining to CP/CT. Several success stories of implementation of CP have been documented. In appreciation of the efforts of GCPC, though GCPC is a regional CP Centre, UNIDO has recognized it at par with National CPC and included in RECP (Resource Efficiency and Cleaner Production) networking membership.

Under the project on Capacity Building of Academicians and students, supported by the Department of Forests and Environment, GCPC had conducted successful training programme for students and academicians. To carry forward further, GCPC had invited abstracts of thesis/dissertation of final year UG, PG & Ph.D students of Chemical and Environmental Engineering L.D. of Engineering college , Nirma Institute of Technology, Vishwakarma Government Engineering College, Gandhinagar, Dharamsinh Desai University (DDU),Nadiad Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat , Sarvajanik College of Engineering and Technology (SCET), Surat responded and total 95 abstracts have been received. These abstracts have been compiled and will be distributed to the industries which can implement some work done by students where-ever it is feasible. With this GCPC makes an efforts to fill gap between industries and academia.

We are confident that this effort will go a long way in inspiring the younger generation of entrepreneurs, technocrats, academia and decision makers.

We are thankful to our panel of experts Dr. P.A. Joshi, Professor, Department of Chemical Engineering, Dharmsinh Desai University, Dr. C. B. Upasani, Director Jyoti Om Chemical Research Centre Private Limited, Ankleshwar, Shri A. N. Trivedi, Pidilite Industries Ltd, Vapi, Shri Syamal De, General Manager – Technology Projects & Operation, Atul Ltd, Ankleshwar , Shri Paresh Mevavala, Director, ENPRO, Surat and Shri Vatsal Nayak, MD, Mahavir Synthesis , Surat for selecting best abstracts.

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Gandhinagar

Bharat Jain
Member Secretary
GCPC

ABSTRACT TITLE

1. "Process design of Sodium Sulphate crystallizer"

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In the industrial crystallization, ammonium sulphate crystallizers are most often used. The applications of sodium sulphate are widely used at dying industry as cathartic and in solar systems. Sodium sulphate is the bi-product of most of the companies. The reason is high acidity level in generated effluent. This is the very best option and it has its own cost. People were using Oslo type crystallizer before and then atmospheric centrifuge crystallizer, now adiabatic vacuum is very cost effective and high performance giving crystallizer. It is combination of a crystallizer, a condenser and an ejector. At the outlet of crystallizer we get glauber salt, a hydrated form of sodium sulphate salt. But after centrifuge and drying we can get pure dehydrated sodium sulphate. In this study of Sodium Sulphate crystallizer, Material balance and Energy balance is very important to get process design data. The paper discusses in detail material and energy balances and thereby designs aspects for sodium sulphatecrystalliser.

2. "Spent FCC catalyst: Potential anticorrosive and anti-bio fouling material"

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To combat corrosion and biofouling in chemical and marine industries with green and cheap material many efforts are put. Efficacy of spent FCC catalyst coating was studied for these purposes. Its corrosion resistance against corrosive media was examined up to 80 8C and 6 h by two methods. They indicated high corrosion inhibition efficiency. Antibacterial and antibiofouling activity of zeolite was studied for bacteria isolated from seawater. Zeolite coating was subjected to cooling water to observe antifouling behaviour and the performance was found to improve upon some modifications. The metal deposited on zeolite did not leach away in stagnant and flowing waters.

3. "Practical Application of Vermi-Biofiltration for the treatment of Industrial Effluents"

Kevin Savsani, Akash Patel, Akash Limbachiya, Rochish Modi
Prof. Rakhi Mehta, Head, Chemical Engineering Department, Surat.

The aim of the study is to assess the potential of an Integrated Vermi-Biofiltration system with vertical surface flow constructed by using earthworms and a wetland weed cyprus rotundus undera small scale laboratory experiments. The work provides a preliminary idea of using earthworms in wastewater treatment system. The wastewater is treated through this system for a total of eight respective cycles and after each cycle the changes in pH, TDS, TSS, COD, BOD of water are measured. Vermi Biofiltration caused significant decrease in level of TSS (88.6%), TDS (99.8%), COD (90%), BOD (90%) of wastewater from detergent industries.

4. "Reactive Distillation - A Technological Alternative for a Safe and Clean Future"

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In the present age of technological innovations and developments, we tend to compromise on various aspects to obtain a product which is highly listed in terms of its yield, quantity as well as the net profits. Environmental and safety factors are usually in a state of neglect owing to such increased competitiveness in the market. This has thus led us to take up Process Intensification (PI) which aims at achieving

significant benefits in economic, ecologic and social efficiency of any process. This technology comprehends with the idea of Cleaner Production(CP) which aims at the continuous application of an integrated preventive environmental strategy; applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment.Monochloroacetic acid (MCA), the product under consideration here is a popular intermediate in the dye, pharmaceuticals, anaesthetics and herbicides industries. India itself is a significant contributor in the production scenario in the world (>65,000 tonnes/year), employing the conventional method of chlorination of acetic acid. It involves a series of equipment which deploys methods encompassing maximum exposure to a hazardous set of chemicals.The implementation of cleaner production technology in the process will eliminate the no. of equipment used conventionally, especially the crystallizer which proves to be the source of maximum exposure to the hazardous effects of the chemicals involved. MCA, being a highly hazardous product requires proper handling to safeguard the personnel as well as the environment. Other than this, conventional production also fails to achieve a high conversion of the reactants.All this has encouraged us to think of some technological alternative under the safe haven of CP to ensure that least casualties occur due to the hazardous nature of production, as well as the chemicals involved. This paper focuses on the production of MCA by a relatively new and highly popular PI technique Reactive Distillation, ecological benefits associated with it and its simulation studies depiction using CHEMCAD.

5. "The Role of Polymer Bound Chemicals in Manufacturing of Rubber Product with Economic and Environmental Benefits"

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Rubber chemicals are substances which are added to rubber compounds to allow vulcanisation to occur, to control the course of vulcanisation and to influence the properties of the vulcanisates. Rubbers chemicals are usually powders which may not be readily incorporated homogeneously into rubber compounds and usually give rise to dust during processing. The use of powders has its inherent disadvantages in terms of dusting, creation of fines, environmental problems etc. Cleaner production technology provides a solution to this problem by implementation of the option of substitution of the raw materials and other auxiliary materials. Polymer bound chemicals are used as a replacement solution to this problem. It plays a major role in improving mixing quality; productivity and consequently final products quality with economic as well as environmental benefits are obtained. The main objective of this paper is to focus on the formulation of the above described form of polymer bound chemicals and to check its effect on the mechanical, chemical and other such properties of rubber products. Safety parameters as well as the environmental effects of these are also studied and depicted.

6. "Recovery of Acid From Effluent Via Freeze Crystallization"

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In the process industry, separation technology is a key enabler in medical, mining, food, paper, chemical, pharmaceutical and biotechnological processes. Handling aqueous salt-bearing streams, either for the recovery of the salt, or for the reduction of waste streams via a concentration process, is energy intensive and thus costly. For mixtures with high solute concentrations, crystallization-based separation processes can be applied. In the past, most chemical process industry freeze separation processes have been batch operations. They have been labor intensive, inefficient and limited to low-throughput operations. But, continuous process equipment is now on the market - equipment that makes available more of the inherent capabilities of the technology. Freeze crystallization is an efficient separation process that can potentially

be used in any application. Freeze crystallization is a high energy efficiency separation process that can be applied to a wide variety of industrial requirements. Although the vapour-liquid equilibrium is generally employed to separate the components of a solution, use of solid-liquid equilibrium should be considered - it may be cheaper. Complete recovery of acetic acid and formic acid from acetic acid-water and formic acid-water solution respectively by ordinary distillation is nearly impossible, because of very low relative volatility and azeotrope formation respectively. But the same separation is possible by freeze separation technique. This paper will include stage wise separation data by freeze crystallization for very dilute aqueous solution of acetic acid and formic acid. Also it is shown that energy required for recovery of acetic acid is much lower than that of distillation. Freeze crystallization has been used historically in those applications where other separation processes are incapable of effecting the separation. Although freeze crystallization has been used to fractionate solution in specialized applications, the technique has never been adopted on a large scale. In some applications, freezing can perform a separation with 75-90% reduction of the energy required by conventional distillation. Effect of addition of salt on the acetic acid - water and formic acid - water mixture for separation will be studied.

7. **"Technological alternative for synthesis of urea-formaldehyde resin"**

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Urea-formaldehyde resin is a clear thermosetting synthetic resin used in various ways as textiles, adhesives, surface coatings, molding resins, laminating resins. It is made by condensing urea with formaldehyde in presence of a catalyst under controlled conditions of heat;pH and molar ratios.Urea formaldehyde resin is in class of strong, odorless, colorless, water soluble and transparent type resins. Conventional urea-formaldehyde resin productionis done by using acid catalyst. In this paper a new route has been developed for the production of urea-formaldehyde resin, using ion exchange resin. A lab scale production of urea formaldehyde resin has been carried out. Kinetic study of the new route illustrates the considerable reduction in free formaldehyde by using ion exchange resin which reduces the odour problem. Free formaldehyde affects people in various ways so it is required to reduce the loss so as to make the surrounding area cleaner and pollution free. When present in the air at levels at or above 0.1 ppm, acute healtheffects can occur including watery eyes; burning sensations in the eyes, nose and throat; nausea; coughing; chest tightness; wheezing; skin rashes; and other irritating effects. The World Health Organization recommends that exposure should not exceed 0.05 ppm. Formaldehyde has caused cancer in laboratory animals and may cause cancer in humans; there is no known threshold level below which there is no threat of cancer. The risk depends upon amount and duration of exposure. The new route suggested for the manufacture of urea formaldehyde will not only reduce the free formaldehyde but will also improve the product quality.

8. **"Cleaning operation of various type of sludge by peristaltic rubber tube pump technology "**

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Eco friendly peristaltic rubber tube pump is blessing for sludge treatment plant. Viscosity of fluid is very high which content chemicals and abrasive solid particles. It is very difficult to pump and also difficult to transport by other pumps for example, in leather treatment plant, effluent content fatty acid, organic substances, and soap and leather fibers. This fluid is highly viscous. Other pumps failed to transport this sludge from one places to other pumps. In many small industries, this transportation can be done by labor.

Many times it dumps by illegal way which will be harmful for environment, natural resources and human health. When drainages (gutter lines) are chocked up, they are cleaned by using human, which is dangerous for their health. Using this rubber tube pump .We can eliminates this type of risks and achieves easy transportation of hazardous and viscous chemicals. It can provide higher employee's safety, better working condition at dump sites and sewage farm of municipal cooperation which will result in reduction of pollution. Transportation and various processing of sludge can be possible by using peristaltic rubber tube pump. By using this pump we can utilize sludge for producing drinking water and solid sludge content can be used as raw material for brick. This way we can save energy , resources and water and possible to convert waste into best.

9. "Implementation of Cleaner Production in Dyes Manufacturing Plant"

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The Reactive Turquoise Blue Dye is manufactured by sulphonation process using CSA, CPC(Copper Phthalocyanine Crude Blue) and PCL3 as raw materials. A large quantity of vent gases containing SOx gases is released as a effluent from the top of reactor. These gases are considered to be very hazardous; if accidently it comes in contact with human. There could be an acute effect to human health which can ultimately lead to fatal. Such annoying condition can be reduced by passing SOx gases through graphite condenser/cooler which is placed in between reactor and scrubber, instead of passing these gases directly to scrubber. Condenser will liquefy organic vapor and send it back to reactor as a reflux. This alternative route decreases the prospects of hazard in plant as well as increases product quality with reduction in water effluent. This paper will include the design data of this graphite condenser, advantages of this graphite condenser in terms of reduction in effluent quantity and improvement in product quality. Modification in the existing scrubbing system for SOx are also suggested.

10. "Study on antimicrobial property of silica supported silver for water purification"

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Water is one of the essential enablers of life on earth. Beginning with the origin of the earliest form of life in seawater, it has been the centre to the evolution of human civilizations. A number of chemical and biological contaminants have endangered the quality of drinking water .My project entitled "Study on antimicrobial property of silica supported silver for water purification" is about the study in the field of water purification and my aim in this semester is to carry out a comparative study on supported silver as an antimicrobial activity. In this study, silver nanoparticles and silver ions in supported form (on silica, thiol functionalize silica, amino functionalize silica) were tested for antimicrobial activity. Silver nanoparticles were synthesized by a chemical reduction method and silver ions were implanted by wet impregnation method using silver nitrate aqueous solution. Silica gel was modified with thiol functional group & amino functional group. Silver nanoparticles and silver ions were directly created on the surface of silica or modified silica by impregnating with their solutions. The prepared materials were characterized by Fourier Transform InfraRed (FTIR), Thermal Gravimetric Analysis (TGA), Dynamic Light Scattering (DLS), Zeta potential, UV-vis spectrophotometer, etc. The supported silver samples were examined for their antibacterial properties against Escherichia-coli (E.coli) by zone of inhibition and test tube test. In the zone inhibition and test tube analysis, we analyzed Ag supported amino functionalize silica give good results compared to thiol functionalize and Ag directly created on the surface of silica. Hence from the study it can be concluded that Ag supported amino functionalized silica is good antibacterial agent.

11. "Concept of Waste Water Quality Index for substitution of General standards for Discharge of treated effluents"

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In India, Effluent Standards are followed for disposal of wastewater where limits are given for different parameters for discharge in to different Environmental Sinks. It is difficult for authority to make any decision based on these different parameters. To take the steps against the industries which are violating the discharge standards, there is a need of some effective measuring tools. So it is proposed to develop WasteWater Quality Index (WWQI) on the line of the Water Quality Index (WQI). WWQI is expected to be more practical in implementing the standards and decision making tool for authority. WWQI indicates a single number like a grade that expresses the overall waste water quality. This paper is discussing the various methods of the WQI and the advantages over the present system of the effluent standards.

12. "Heat Insulation in Rubber Paint"

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The main objective of this review is to describe some of the important topics related to the use of rubber paint for heat insulating purpose. The term "Heat insulation" refers to the process of reducing the heat transfer between the surfaces using special paint. The review aims at providing a thorough picture of state-of-the-art in improving heat insulation property in rubber paint. While many other forms of insulation, including fiberglass and cellulose, are not as effective in protecting against radiant heat, most insulating paints offer this protection. Traditional insulations absorb and slow down the travel of heat, but insulating paint actually reflects it. The refractive index of the paint plays an important role in reflecting sun light rays. The higher refractive rubber paint can be resulted in high heat insulating paint. By using refractive binders and pigments, the overall refractivity of rubber paint can be increased. By using such paints, heat insulation can be done just by applying coats of paint instead of using many others heat insulations. Summer heat increases interior temperatures placing a huge load on your air conditioning system, and winter heat loss results in higher heating bills. Insulating the walls by paint resulted in a much lower rate of heat transfer through the walls when the outdoor temperature exceeded the indoor temperature, but the added insulation also increased the retention of heat generated within the house when the outdoor temperature fell below the indoor temperature. Insulating paint will help in reducing the energy consumption for insulating purpose and it is economically beneficial too. This application route will be advantageous in preventing adverse effects of environment, by not adding more adverse effects to the environment. Thus how it can be a best green route for heat insulation purpose.

13. "Grafting Mechanism On Recycle Rubber Powder Interphase"

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In this present Era Each and Every country is in the race of enhancing Economy. With the development decrement in the level of pollution is much more important for the sustainable growth. In recycling of

crushed rubber materials, which is achieved by recycling process of the Waste Tyres/Rubber which formed the new rubber matrices, a slight drop is noted in the mechanical value level of elastomer. This drop is due to deficient grafting of the recycled rubber with the fresh rubber matrix. It is the Green process in the direction towards the adopting green technology for cleaner production. To improve grafting quality, the particle surfaces are modified chemically in different ways following a comprehensive morphological and chemical characterization of select types of rubber powder. Grafting with maleic anhydride has shown them self to be the most promising method. The criterion applied to evaluate the suitability and effects of the surface modification with grafting mechanism of reclaim rubber powder interphase is the level of or the observable changes in the material's mechanical properties, such as Tensile strength, dynamic modulus, ultimate elongation, and other properties like ageing resistance, abrasion loss etc.

14. "River Flow Augmentation By Using Tertiary Treated Sewage During the Dry Season in Sabarmati River, Ahmedabad"

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Many studies have been done to assess the degradation of stream due to human impacts. The potential of using tertiary treated sewage during dry season is discussed in this paper. The use of tertiary treated sewage reduces the volume of wastewater discharged to receiving body and increases the fresh water available for use. River Sabarmati (Ahmedabad, Gujarat) is taken as a case study. For this purpose the Riverfront water quality, quantity and volume of Sabarmati Riverfront are studied. The sewage discharge from Dandibridge Dafnala, sahibag dafnala and secondary treated sewage from 60 MLD STP Pirana are studied as a source of water for Sabarmati Riverfront. In order to choose the suitability of related sewage for recreational use of river have been taken as a reference since the secondary treated sewage from STP is not likely to satisfy these norms. It is proposed to provide tertiary treatment to the sewage. Different tertiary treatment shall be discussed in the paper. The benefits of tertiary treated sewage for Sabarmati Riverfront will be highlighted in this paper.

15. "Wastewater Treatment by Ozone"

Jimit Buddhdev , Prof. Sandip Sharma, Nirma University , Ahmedabad

Dyes and pigments released to the environment in the form of effluents by textile, leather and printing industries cause severe ecological damages. Wastewater from these industries is highly colored and contains organics which contaminate ground water. Due to the inhibitory nature of many compounds for biological oxidation, the need for pretreatment by advanced oxidation process (AOP's) has become essential. One of the AOP's processes is ozonation, which is versatile and environmentally sound.

Ozonation of water is a well known technology and the strong oxidative properties of O3 and its ability to effectively oxidize many organic compounds in aqueous solution have been well documented. Ozone treatment of several types of wastewater has resulted in considerable COD reduction and has been used for treatment of dyes, phenols, pesticides, etc. In recent years, ozonation is emerging as a potential process for color removal of dyes, since the chromophore groups with conjugated double bonds, which are responsible for color, can be broken down by ozone either directly or indirectly forming smaller molecules, thereby decreasing the color of the effluents.

Reactive Red 195 (RR195) and Acid Yellow 23 (AY23) synthetic textile dye bath effluent were treated with ozonation process. The operating parameters are Dye concentration, Ozone flow rate, Agitation provides in

reactor. pH is maintained 7 ± 0.5 almost same in all experiments. Experiments were evaluated to find the optimum conditions for the ozonation processes.

Ozone is mainly used in the Advanced Oxidation Processes (AOP's) refers to a set of chemical treatment procedures designed to remove organic and inorganic materials in dye industry wastewater by ozonation process. According to decolorization efficiency it can be inferred that effect of OHo radical present in the synthetic dye bath as well as radical formation promoter (e.g. OH?) was probably hidden due to complexity of the synthetic dye bath matrix. The contaminant materials are converted to a large extent into stable inorganic compounds such as water, carbon dioxide and salts, i.e. they undergo mineralization.

The effect of ozonation on the Decolorization, Degradation, and Mineralization of a dye(Acid yellow 23 and Reactive Red 195), perform in a laboratory scale bubble column batch reactor. In Experiment Decolorization, Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Ozone Demand was analyzed. The effect of operational parameters on decolorization such as ozone dosage and dye concentration is study.

The present study demonstrated that nearly completely decolorization of Acid yellow 23 and Reactive Red 195 could be accomplished by ozonation. The time required for the complete decolorization gradually increase with increase in the initial dye concentration. The COD removal efficiency gradually increased with an increase in the initial concentration of dye solution. The TOC removal efficiency gradually increased with an increase in the initial concentration of dye solution. The ozone demand is gradually increased with an increase in the initial concentration of dye solution. The cost for removal of COD using ozone varies from 1.5 to 3.5 Rs. /lit.

16. "New Material Synthesis For Carbon Dioxide Capture From The Flue Gas"

Rajvi Mehta, Dr. Satyanarayana Reddy and Dr. A. P. Vyas, , Nirma University , Ahmedabad

Carbon dioxide generated from fossil fuel-fired power plants is a major contributor to global warming approximately 30% of gaseous CO2 emitted to the atmosphere comes from the fossil fuel plants. Among the approaches used, amine based chemical absorption have been used commercially for CO2 capturing plant. However, the liquid amine based processes pose operating difficulties due to the challenge of keeping the solvent clean and operating within the process constraints of the system. This process also suffers from high regeneration energy, large equipment size, solvent leakage from piping system and also equipment corrosion problem. regenerable solid sorbents will be a promising alter- native that can potentially offer several advantages over liquid amine systems such as ease in handling of solids, reduced toxicity and corrosiveness. Various porous supports impregnated with liquid amines have been reported. The key issue for adsorption separation is to develop an adsorbent with high CO2 adsorption capacity and high CO2 selectivity which will be the main objectives of this study. The purpose of this research is to develop a simple, cost effective technology to remove CO2 as an essentially pure stream from flue gas using a regenerable amine-based sorbent. There are different technologies like membrane separation, cryogenic separation, absorption by liquid amines and various solid adsorbents used to functionalize for CO2 capture by means of physical and chemical adsorption. In this research project we mainly focus on the solid adsorbents like MCM-22, Alumina and SBA-15 which will be functionalized by different amines like Tetraethylpentamine and Polyethylenimine for carbon dioxide capture capacity. The result shows that as the concentration of amines increased the surface area and pore volume decreases. Amongst all the samples 50% TEPA functionalized SBA-15 shows the maximum CO2 adsorption Capacity i.e. 2.4 mmol/g. All the sorbents prepared for this work are regenerable at 130oC. The adsorption capacities showed good correlation with well ordered porous structure, amine loading and type of amine.

17. "Synthesis and Applications of Metal-Organic Frameworks in Adsorptive Separations"

Yogesh Patil , Dr.Pradeep Kapadia and Dr. Milind Joshipura , Nirma University , Ahmedabad

Metal-organic frameworks (MOFs) are a recently-identied new class of hybrid porous material, consisting

of metal ions or cluster linked together by organic bridging ligands. MOFs have shown tremendous potential in adsorptive separation applications and gas storage owing to some of their extraordinary features in terms of specific surface area, pore volume, low to moderate heat of adsorption and fairly uniform pore size distribution. MOFs have frequently been investigated for storage of permanent gases like hydrogen, methane, or carbon dioxide.Adsorption of larger organic compounds currently is a rarely explored field.Many MOFs are available now with sufficiently large pore windows and cages, and in most of them an important fraction of the pore walls consists of aromatic rings. For these reasons, we focused on adsorption of Alkene-alkene and aromatic in the pores of MOFs. This project work is focused on the synthesis and characterization of different MOFs and their application in adsorptive separations.

MOFs are crystalline compound consisting of metal ions/cluster coordinated to often rigid organic molecules to form one, two, three dimensional structures that can be porous. The pore size and surface properties of these materials can be tuned to a great extent with relative ease by choosing appropriate metal centers and organic ligands. MOFs have got advantages over ex-isting porous materials and zeolite. They possess a wide array of potential applications including materials for gas storage, gas/vapor separation, catalysis, luminescence, and drug delivery.

Firstly, In this exploratory kind of project work synthesis of varriuos MOFs using different metal precursor and ligand have done based on solvotheraml method except for RMOF -3. 1,4 - benzenedicarboxylic acid ligand based ve (RMOF-1,RMOF-2,RMOF-5,RMOF-6,RMOF-11), and 1,3,5 benzenetricarboxylic acid based three (RMOF-3,RMOF-7,RMOF-10) MOFs were synthesized. RMOF-3 was synthesised by crystallization method. Various characterization techniques were applied to study the properties of these MOFs. X-ray powder diffraction (PXRD), BET surface area, deferential scanning calorimetry analysis(DSC) and thermogravimetric analysis (TGA) were extensively used.

Adsoptive separation studies using MOFs as a ansorbent and various liquid organic compounds as a adsorbate were performed. Among the eight MOFs were synthesised, all MOFs shows pos- itive results towards adsorptive separations for selected guest compunds. RMOF -5 and RMOF-3 proved prominent adsorbent among all MOFs synthesized. The adsorption was found to be dependent on concentration of adsorbate by keeping adsobent consatant.

18. "Studies on Trans-Fat with Reference to Alternate Green Process for Production of Trans Free Vanaspati"

Videh Singh Parihar, Dr. Parin D. Shah, Nirma University , Ahmedabad.

Fatty acids are the building blocks of lipids Typically, common vegetable oils low in saturated fats and the double bonds within unsaturated acids are in the cis-configuration. To improve their oxidative stability and to increase their melting points, vegetable oils are hydrogenated. The chemical process and hydrogenation is intended to add hydrogen atoms in presence of sodium methoxide or nickel catalyst, cis-unsaturated fats, eliminating a double bond and making them more saturated. Full hydrogenation would produce exclusively saturated fatty acids containing trans fat that are too waxy and solid to use in food production. But these hydrogenated and chemical interesterified oils and other product are contains trans fat which occurs at high temperatures and creates three by-products like sodium soaps, fatty methyl esters and monoglycerides in addition to the interesterified fats this trans fat is very harmful for health and causes various disease like Cancer, Obesity, Dibities etc. To avoide this trans configuration in fats, green enzymatic interesterification process is very beneficial. In this process Enzyme reacts with oil molecules by changing the fatty acid positions and made trans free configuration that we required. Different types of enzymes can be used basis on the type and origin of oil. On above basis the selection of enzyme is selected. For study purpose total five samples of Vanaspati Ghee are collected of different brands from Indian market and marked named as Sample A,B,C,D and E. Vanaspati or we called dalda ghee is a result of hydrogenation of vegetable oil. Vanaspati is widely used in every hard food product like biscuits, namkeen

, snacks, pastries, toasts, chocolates and margarine etc. consist of different vanaspati ghee. Vanaspati Ghee is used to make all these products because it make harder and harder product as increasing of melting point of fat remain for long time at room temperature. To determine the amount of trans fat, fatty acid methyl ester is prepared and using this FAME, American oil chemist's society (AOCS) having standard method for analysis of trans fat in vanaspati ghee. This method is adopted for preparation of FAME. According to this method fatty acid methyl ester (FAME) is prepared for the particular sample for the GC analysis of trans fats trans fats in vanaspati and other hydrogenated food can be analyze by Gas Chromatography with BPX-70 cynopropyll column. Chemical interesterification using sodium methoxide is also carried out for different oils like Palm oil, Cottonseed oil and soyabean oil all samples got good results about about their hardening properties but adverse effects are also there that is mainly Trans fat configuration observed in this process and also process problems like waste generation oil loss and harmful chemical used in this process. The capital investment costs are low because the enzymatic process requires only one simple column/tank as special equipment. A specific melting profile of the fat is achieved by passing the oil once through the enzyme column.Unlike both hydrogenation and chemical interesterification, the enzymatic process requires no chemicals. Using different oils individuals and several blends of palm oil, cotton seed oil, coconut oil and soyabean oil are prepared with different ratio and enzymatic interesterification is carried out under bacteria free environment using autoclave and laminar air flow using biocatalyst immobilised Lipase, from Mucor michei named Lipozyme TL IM (1,3 specific) which is purchased by Sigma Aldrich Limited, Bangalore. Experiments are performed under laboratory batch scale and analysis of Trans Fat and Fatty acid composition, change in melting point of enzymatic interesterified fats are also carried out. This all enzymatic interesterified fat gives good results in melting point difference and these products are having zero trans fat which is our aim of the entire project which is achived. After comparision of all three process modification of fats is achived by all three process but with respect to human health and environmental benifits, enzymatic interesterified products are very good benifits in current scenario. In this process enzyme is reused till four times after the first reaction good results obtained that shows the cost benefits in this process.

19. "Production Of Hydrogen From Glycerol Via Steam Reforming Process"

Kartik Avasthi, Prof. R.N. Reddy, Nirma University, Ahmedabad.

The depleting fossil fuels with their ever increasing prices have paved ways for alternative fuels. Biodiesel is one of these alternative fuels which have picked up keen interest of the people due to its similar properties to diesel. However due to biodiesel being costlier than diesel in the present scenario, it has not been preferred to diesel. However if the cost of biodiesel is reduced then its effective usage can be made, either by blending with conventional diesel or by utilizing its by-product (glycerol) effectively. One way is to use glycerol to produce hydrogen. Hydrogen, being another source of renewable energy, is also seen as a clean fuel for transportation purpose. Hydrogen can be prepared through glycerol via various routes namely steam reforming, auto-thermal reforming, partial oxidation, etc. The report here focuses on the steam reforming process. This process is used widely used in the industries and it would not require much change in the system if the feedstock is changed to glycerol from naphtha or natural gas. However like every process this process also has some limitations which hinder the effective production of hydrogen. The report, here discusses the thermo dynamical study of the reaction using Aspen Hysys along with the experimental study of the reaction using Ni based catalysts and pure glycerol, the experimental work here focuses on the understanding of activity of Ni based catalysts, based on the different base metal loading under the one reaction condition. The report discusses the analysis of gaseous and liquid product obtained from the reaction. The thermodynamical analysis is carried out using Gibbs reactor in Aspen Hysys 2004.2. The Gibbs Reactor works on the principle of minimization of Gibbs free energy. Thermodynamical analysis discusses about the effect of temperature, pressure and water to glycerol ratio on the reaction of steam reforming using pure glycerol. For the experimental study Ni based catalysts were prepared using

wet impregnation method, the activity of catalysts are taken in atmospheric gas solid reactor at a particular temperature range. The gas and liquid products generated are analyzed in GC. After the gas analysis the catalyst with the best result is again tested in the reactor for a smaller range of temperature. The used catalyst is regenerated and again tested to see if the regenerated catalyst gave the same result as the fresh catalyst. The liquid products are analyzed in the GC and an attempt has been made in order to understand and find the liquid compounds in the liquid sample.

20. "Separation of Propylene from Propane by adsorption".

Bidyadhar Sahoo, Dr. Swapan Ghosh , Dr. R. K. Mewada, Nirma University , Ahmadabad.

Propylene is the second most important starting product in the petrochemical industry after ethylene. It is the raw material for a wide variety of petrochemicals. Global propylene demand grew from 37.2 million tons in 1995 to approximately 52 million tons in 2000, corresponding to an average annual growth (AAG) of 5.5 percent. Demand grew at an average rate of 4.6 percent per year from 2000 to 2006, reaching almost 67 million tons. Demand of propylene is expected grew at almost 4.7 percent annually for the period 2007 to 2012. The peak value achieved was US$ 90 billion in 2008.

Cracked unsaturated LPG from LPG merox unit is fed to the de-propaniser where C4 and heavier components are removed from the bottom. The de-propaniser overhead containing propylene & propane is fed to the C3 Splitter where propylene and propane are separated. The separation of propane and propylene is an energy intensive process due close boiling temperature. The boiling point of propylene is -47.8°C and propane is -42°C. Separation of polymer grade propylene (purity >99.5%) need high pressure (22-24 Kg/cm2), low temperature (250 K) and distillation column height 82m and no. of trays 188. So, both capital and operating cost is high. In C3 splitter polymer grade propylene separated as overhead product. But 4 - 6 % of propylene cannot recovered and transferred to LPG sphere along with propane as bottom product. LPG is a low valued product than other derivatives of propylene. The aim is to separate propylene from C3 splitter bottom stream.

Non-conventional methods like physisorption by 4A, 5A, 13X zeolites, MOFs, and chemisorption by Ag+ and Cu+ solution shows suitability for propane propylene separation. In chemisorption adsorption occurred by both Van der Waal's force as well as covalent bonding. Experiments carried out by addition of stabilizing agent (pyridine) to the copper salt solution. Additionally this solution is lees corrosive than other anhydrous system. From the experiments it is found that 2.0M CuNO3o2.1 pyridine shows best results during separation of propane and propylene. Propylene loading is 23 cm3/cm3 of adsorbent propane loading is 1 cm3/cm3 of adsorbent. The increase in ligand (pyridine) concentration beyond 2.0M decreases propylene loading. Because pyridine adsorbed on the crystal surface and inhibits chemisorption. From the experiment carried out by taking unsaturated LPG as feed, it was found that the copper pyridine complex can be used for the separation of olefin and paraffin of C4 hydrocarbon with less severity.

From the experiments with silver nitrate solution and propane propylene mixture it was found that, silver nitrate is more suitable for the separation of propane propylene mixture than copper pyridine complex. Propylene loading is 5.6 mmol/g of silver nitrate salt. The separation factor of propane propylene achieved 92 by silver nitrate solution. The separation factor is more than cuprous pyridine complex. 61% pure propylene achieved from adsorbed stream of the experiment carried out with C3 splitter bottom and aqueous silver nitrate. So, after single recycle polymer grade propylene can be achieved. The selectivity of propylene increases with increase in mol fraction of propylene in the feed. The propylene loading also increased with increase in partial pressure propylene in feed. The desorption temperature found to be 70-80°C. The impurity in the adsorbed phase is due to the solubility of propane with the aqueous solution.

Adsorption of propylene carried out by silver nitrate impregnated on highly porous silica (MCM-41). MCM-41 is used as adsorbent because there is less number of acid sites available on the surface. The acid sites affect the adsorption activity. From literature it was found that at 3.3 atoms /nm2 monolayer of silver

nitrate achieved. Based on surface density data monolayer dispersed silver nitrate on MCM-41 prepared by wet impregnation method. The adsorption activity study carried out in a fixed bed reactor in atmospheric pressure. The feed flow rate was controlled by rotameter. From experiments it was found that propylene loading decreases as temperature increases. The propylene loading found 1.7 mmol/g of adsorbent and 3.54 mmol/g of silver nitrate. The propane loading is 0.3 mmol/g of adsorbent. From C3 Splitter bottom propylene recovery achieved is 22% with purity 65%. The impurity in the adsorbed gas phase is the propane adsorbed on the surface as well.

21. "Metal-organic frameworks: A new class of hybrid materials for catalytic application"

Swaroop Rayaroth, Dr. Sanjay S. Patel ,Dr. Pradeep Kapadia, Nirma University, Ahmedabad

Metal-Organic-Frameworks (MOFs)belong to class of crystalline compounds consisting metal ions or clusters coordinated to often rigid organic molecules to form one-, two-, or three dimensional structures that can be porous. A metal-organic framework is composed of two major components: a metal ion or cluster of metal ions and an organic molecule called a linker. This collection of compounds has been variously termed metal-organic frameworks, coordination polymers, hybrid organic-inorganic materials and organic zeolite analogues with unavoidable overlap. MOFs have wide variety of potential industrial applications. It can be used as the replacement for some of the conventional industrial operations since it is more economical and highly efficient.

MOFs, the new and emerging class of porous materials have a characteristic properties like reasonable thermal stability (typically ~400°C), High micropore volume, Large pore sizes, well characterized pores , Crystallinity and a high metal content offering potentially valuable active sites, Gas absorption properties, Magnetic behaviours etc. MOFs may be produced to act as highly selective molecular sieves, sensors, or catalysts. Sensor capabilities become realizable when the optical, electronic, or magnetic properties of the framework are altered by guest interactions.

MOFs have wide variety of potential industrial applications. It can be used as the replacement for some of the conventional industrial operations since it is more economical and highly efficient. MOFs are widely used in storage of hydrogen and methane gases. It can also be used in gas separation, gas detection, catalytic reaction etc. There is lot of research work going on to elucidate whether the metal centers, the ligands, particle size, or some combination of these can engender MOFs with unusual catalytic properties. MOF has wide variety in catalytic application since it can act as catalytic center as well as support. Presence of more than two ligands in certain MOFs results in selective reactions and Post synthesis modification can alos be done on MOFs it. Series of reaction can happen in a single MOF since both ligand and metal center has the catalytic activity.

There different methods of MOF synthesis. In this project work mainly solvothermal (parr reactor and reflux) and crystalization methods were followed. RMOF-1and RMOF-3 was synthesized based on parr reactor and crystalization methods respectively. Remaining six MOFs were synthesized by solvothermal reflux method. Four characterizations namely PXRD, TGA, DSC and BET were carried out. PXRD shows all the MOFs are crystalline in nature, thermal and structural stability were identified. Surface area values obtained from BET surface area analysis

Catalytic application study of each RMOFs synthesized were carried out to identify the catalytic activity. Since the project was an exploratory in nature objective was to identify the catalytic application rather than detailed study. Alkylation studies were carried out with RMOF-2, RMOF-5, RMOF-6and RMOF-7 in which RMOF-2 and RMOF-7 shows catalytic activity. Comparative study of RMOF-2 and RMOF-7 were carried out for alkylation reaction. Acylation reactions were studied using RMOF-5, RMOF-6 and RMOF-7 in which RMOF-7 exhibits catalytic application. Oxidation was another reaction tried for catalytic

application. RMOF-1, RMOF-2, RMOF-6, RMOF-7 were used for oxidation reactions. RMOF -1 was used for photo oxidation in presence of UV light other RMOFs were study carried out using excess quantity of oxidizing agents.

RMOF-2 and RMOF-7 were separated from reaction mixture by filtration and PXRD was carried out after basic purification and activation. Result shows that crystallinity of both the catalysts wereretained. Surface area similar to reported value can be achieved with better synthesis technique and purification methods.

22. "Selectivity Engineering of a Cyclohexane Oxidation Reaction using Solid Acid Catalyst"

Anand Upadhyay ,Dr. R. K. Mewada, Nirma University, Ahmedabad.

In chemical industry selective oxidation of hydrocarbons are of great importance. In most of the oxidation reactions, complete oxidation results into undesirable products. Oxidation of hydrocarbon to more valuable organic compound such as alcohol, ketone, and aldehyde requires selective oxidation of strong C-H bond. Cyclohexane oxidation represents a typical example of this kind of reactions, which became an interesting subject from academic and industrial point of view.

On a commercial scale most of the cyclohexane produced is used for the production of cyclohexane and cyclohexane, which is also known as KA-(Ketone-Alcohol) oil. KA-oil is an important intermediate in the in the production of Nylon-6 and Nylon-66. In the present commercial process for cyclohexane oxidation, reaction is carried out at 150 ^{o}

C, and 1-2 MPa pressure which affords 4% conversion and 70-85 % selectivity to cyclohexane and cyclohexane over metal cobalt salt or boric acid. This shows tremendous scope for improvement in conversion or selectivity for KA-oil production.

Objective of the present work is to develop heterogeneous catalytic system to enhance the conversion and selectivity for KA oil. Various catalysts were synthesized and activity of the same was tested for cyclohexane oxidation reaction using molecular oxygen. Ag-SBA-15 catalyst has shown about 10.5 % conversion with 86 % selectivity for KA-oil. Catalyst was characterized to correlate with its activity for cyclohexane oxidation.

Selectivity is a crucial task for hydrocarbon oxidation reactions. For cyclohexane oxidation reaction, commercial production is restricted to 4-6% conversion due to sharp decrease in selectivity for K-A oil. Due to its commercial importance, cyclohexane oxidation reaction has been studied by numerous researchers and industrialist.

Out of all catalysts prepared, 2% Ag-SBA-15 has shown about 10.5 % cyclohexane conversion with 86% selectivity for K-A oil. However silver loading can be increased to 4% to 10% of SBA-15 and activity can be tested. Characterization of the Ag-SBA-15 was carried out. XRD peaks confirm the structure of SBA-15 and presence of silver in catalyst. Dynamic light scattering test methods confirms size of catalyst particles.

Silver doped SBA-15 gives best results, kinetic study with parametric analysis can be carried out for cyclohexane oxidation reactions. Scale up aspects to process development can be considered for future work.

Future works to be done in the thesis are

- Preparation of Ag-SBA15 with various amount of silver loading (3%, 5%, 7%, 10%) and study of its activity.

- Variation in the reaction parameter like Temperature, Pressure, Solvent etc. and its effect on the product selectivity.

- Kinetic study of the reaction

- Process development

23. "Upscaling of Longifolene Isomerization In Continuous Flow Reactor Over Solid Acid Catalyst".

Chirag B. Mehta, Dr. Amish Vyas, Dr. Beena Tyagi, Nirma University, Ahmadabad.

Isomerization, is the chemical process by which a compound is transformed into any of its isomeric forms & Longifolene is the common (or trivial) chemical name of a naturally occurring, oily liquid hydrocarbon found primarily in the high-boiling fraction of certain pine resins & Isomerization of longifolene with solid acid catalyst such as sulphated zirconia gives Isolongifolene. Isolongifolene and its derivatives, which extensively used in perfumery industry due to their woody and floral odour. The acid catalysed and hydroformylated products of this isomerized isolongifolene have also woody amber odour and are used as a flavour in many pharmaceutical industries. isomerisation of longifolene with Nano-crystalline sulphated zirconia (SZ) solid acid catalyst and obtained 95-97% conversion of longifolene and 100% selectivity of isolongifolene at 180°C within 15-30 minutes under stirred batch reactor. It is noteworthy that SZ exhibited similar catalytic activity over a wide range of longifolene to SZ weight ratio, i.e., 10:1 to 100:1.

So now for industrial production of isologifolene we need to up scaling this process by using the continuous flow fixed bed reactor.so we transfer this isomerization process lab scale to industrial scale. The up scaling of the process for the said reaction will be carried out in continuous flow reactor: so in this up scaling us Design and modification of existing continuous flow reactor. We also study Different forms of the catalyst such as beads, granules and powder studied using different binders and their effect on the activity and life of the catalyst and we also study the various reaction parameters such as temperature, time and substrate to catalyst weight ratio. So and optimized this parameters we can achieve maximum conversion and selective formation of the product from lab scale to large scale.

24. "Manufacturing of phthalonitrile by Ammoxidation of o-xylene"

Akshaysinh Magodara, Dr. C.B. Upasani ,Dr. J.P. Ruparelia, Nirma University, Ahmedabad

Phthalonitrile is an organic compound with the formula C6H4 (CN) 2. It is a crystalline powder having a faint greyish yellow colour and a slightly aromatic odour, similar to benzonitrile. Phthalonitrile is used in organic synthesis (such as phthalocyanine pigments, paint), flame retardant and as an insecticide. In India 80% production of copper phthalocyanine is done in Gujarat. The manufacturing procedure is mixing phthalic anhydride, urea and cuprous chloride in presence of ammonium molybdate catalyst and trichlorobenzene as solvent. This is an old technology giving environmental issues like generation of ammoniacal nitrogen in the effluent also excess of urea is used which results in decomposition of ammonia and carbon dioxide. In search of green technology it was thought of to make copper phthalocyanine pigment using phthalonitrile as starting material. If phthalonitrile is produced first then use of excess urea could be avoided and environmental issues specifically ammoniacal nitrogen can be taken care off.

In a single stage continuous process o-xylene is converted to phthalonitrile by reaction with ammonia and oxygen in the gas phase in a fluidized bed reactor. A mixed metal oxide catalysts comprising varying fractions of Bi,Sb,Mo and V were prepared in laboratory and activity test of all catalysts using a lab scale fixed bed reactor made of stainless steel was performed. Results of the activity test showed that when the reactants, i.e., o-xylene, ammonia and air are fed at flow rates of 3 ml/min, 6 ml/min and 43 ml/min respectively, conversion of o-xylene is very low for all the catalyst. However when the reactants i.e., o-xylene, ammonia and air were fed at flow rates of 1 ml/min, 2 ml/min and 13 ml/min respectively, o-xylene conversion increased which resulted in increase in phthalonitrile yield. Also, from the results it has been noted that catalyst in which antimony has been used has shown less conversion as compared to those in which antimony is not used.

Though the yield of phthalonitrile reported here is not much high for commercial application, the investigations revealed several interesting features, which would certainly be helpful for the future course of study. An overview of the current status of the results indicates that there is still an ample scope for

further improvement of catalytic performance and, therefore, future work should aim greatly towards the discovery and development of highly active and selective catalysts for producing phthalonitrile in higher yields. It has been noted that catalyst in which antimony has been used has shown less conversion so it is suggested to prepare metal oxide catalyst consisting varying proportion of Vanadium, Molybdenum and Bismuth on alumina support. Apart from the type of catalyst it has been observed that space velocity plays a major role in reactant conversion, therefore, it is advised to vary the space velocity and the molar feed ratio while performing the activity test of the prepared catalyst.

25. "Manufacturing of Phthalonitrile by ammoxidation of o-xylene".

Manish hariram bhanushali, Dr. J.P. Ruparelia, Nirma University, Ahmedabad.

Phthalonitrile is an organic compound with the formula C6H4(CN)2. It is a crystalline powder having a faint grayish yellow color and a slightly aromatic odor, similar to benzonitrile.

Phthalonitrile is used in organic synthesis (such as phthalocyanine pigments, paint), flame retardant and as an insecticide. In India 80% production of copper phthalocyanine is done in Gujarat. The manufacturing procedure is mixing phthalic anhydride, urea and cuprous chloride in presence of ammonium molybdate catalyst and trichlorobenzene as solvent. This is an old technology giving environmental issues like generation of ammoniacal nitrogen in the effluent also excess of urea is used which results in decomposition of ammonia and carbon dioxide. In search of green technology it was thought of to make copper phthalocyanine pigment using Phthalonitrile as starting material. If Phthalonitrile is produced first then use of excess urea could be avoided and environmental issues specifically ammoniacal nitrogen can be taken care off. In a single stage continuous process o-xylene is converted to Phthalonitrile by reaction with ammonia and oxygen in the gas phase in a fluidized bed reactor. Vanadium based catalyst are widely used for Ammoxidation reaction. Here vanadium phosphate based catalyst was developed and tested for the activity towards desire reaction. Efforts were also made to find out the non vanadium based catalyst for same reaction and test their activity for same.

26. "Kinetic study of cyclohexane oxidation reaction using heterogeneous catalyst".

Priyank Khirsariya, Dr. R.K. Mewada, Nirma University, Ahmedabad.

Selective oxidation of cyclohexane is continue to be a most difficult and most challenging reaction for researchers. Industrial processes suffer from very low conversions (about 4 to 6%) and poor selectivity for K-A oil (about 80-85%). Cobalt and manganese salts have commonly been employed as catalysts for this reaction. This shows the tremendous scope for improvement in conversion and/or selectivity for KA-oil production.Objective of the present work is to develop heterogeneous catalytic system to enhance the conversion and selectivity for KA oil. Various catalysts were synthesized and activity of the same was tested for cyclohexane oxidation reaction using molecular oxygen or air as oxidant agent.Even thermodynamically 100% conversion of cyclohexane is feasible, practically cyclohexane conversion is kept about only 4-6 % in industrial operation and about 20% conversion of cyclohexane at laboratory scale is achieved due to severe selectivity problem. Due more reactive nature of intermediate desired products, large amount of byproduct formation takes place as conversion increases. This can increase product separation cost substantially. In current work, silver loaded alumina and SBA-15 shows about 5% conversion and 80% selectivity for K-A oil. Different silver loading will be carried out to increase the conversion and selectivity Detail kinetic study with all parametric analysis will be carried out in future.

27. "Determine VLE data for system containing CPME".

Modi Chintan K., Dr. M.H. Joshipura, Nirma University, Ahmedabad.

Conventional solvents used in industries create so many problems like environmental, health and safety. Green solvents provide an attractive alternate to the conventional solvents. Cyclopentyl methyl ether is one of the green solvents. Temperature dependent physical properties like vapor pressure, heat of vaporization, heat capacity is not available in the literature for CPME. These properties play an important role in

designing the processes involving CPME. One of the routes to produce CPME is the cyclopentanol. In this present work purpose for CPME, Cyclopentanol and Dimethyl sulphate and their binary mixtures is proposed. In first phase pure component properties are determined.

Vapor pressure is an important property for many reasons. It provides the idea about handling and storage of the chemicals as well as it can be used for predicting other thermo-physical properties. The report lists the experimentally measured vapor pressure data of CPME. The experiments were carried out using Ebuilliometer. The experimental vapor pressure data was fitted to Antoine equation, Prediction of vapor pressure of CPME, Cyclopentanol were also done using CEOS.

28. "Polybutadiene Rubber Nanocomposites"

Bhavin patel, Dr. S.S. Patel, Nirma University, Ahmadabad.

Extensive research work has been carried out in past to overcome the limitation of using hydrophobic polymers such as polypropylene, polybutadiene and polyethylene for preparing nanocomposites without a compatibilizer. However, in this study, polybutadiene rubber (BR, hydrophobic polymer) nanocomposites were produced using 1, 3, 5, 8 and 10 phr (per hundred gram of rubber) nanofiller successfully without a compatibilizer with a melt compounding method. X-Ray Diffraction (XRD) data showed an intercalation and exfoliated nanofiller morphology in the polymer matrix, which led to increase physico-mechanical properties. Rheological study was carried out on these nanocomposites at temperature 145°C for 1 hr. The cure time (t90), Scorch time (t2), and their difference (t90 - t2) of the BR/ nanofiller hybrids were much reduced than those of BR. The tensile strength of BR/ Cloisite-20A and BR/ Cloisite-30B hybrids (at 3% filler loading) were 166% and 153% respectively and for BR/ CNT hybrid (at 5% filler loading) was 153% higher than those of BR. Other than that 100% and 300% modulus, hardness and crosslink density were also significantly improved.

Keywords: elastomer, nanocomposites, polybutadiene rubber (BR), nanofiller, carbon nanotubes, Cloisite-20A, Cloisite 30 B, Pargel B20, nanosilica.

29. "Biodiesel Production from Jatropha oil using Microwave-assisted Technology".

Sayali Jawale, Dr. Sanjay S. Patel, Nirma University, Ahmadabad.

Adverse environmental impacts of fossil fuels, dearth of crude oil reserves and escalating demand for energy has led to the search for alternative fuel which is inexhaustible and imperishable. Biodiesel is the best substitute to Petro-diesel. Biodiesel could be used as pure fuel or as blend with petro diesel, commonly known as biodiesel blends. Among all methods of producing biodiesel; transesterification is widely adopted. Biodiesel can be produced under various novel techniques such as ultrasound-assisted transesterification and microwave-assisted transesterification. Here in this project work a novel technique "Microwave-assisted Technology" for production of biodiesel is used. It is produced both from edible and non-edible oils, among which using non-edible oils is fruitful to avoid the issue of fuel v/s food, moreover edible oils are expensive than non-edible oils. There are various non-edible oils but among them jatropha oil is widely used as it is found locally and can be easily cultivated on waste lands. Experimental work is carried out and discussed extensively for jatropha oil feedstock. This technique offers a trouble-free and fast route for the production of biodiesel. Through studies, it is reported that this technique enhances reaction rate and reduces reaction time from hours to few minutes. However, this technology has a wide application and needs to be further investigated for scale up for industrial application.

30. "Mechanistic studies on dimerization of olefins and subsequent alkylation of phenol".

Shakti Bhardwaj, Prof. Parag Saxena, Nirma University, Ahmadabad.

Production of less toxic detergents has been a topic for extensive research since adverse effects of detergent toxicology have been seen on aquatic life as well as it's propagation in our entire food cycle through means of water, soil and air has led to ban on various detergents in several countries. Olefin like Nonene is used

conventionally in the formation of surfactants world-wide. Aim of this project is to work with olefins such as 1-Octene, 2-Octene and Decene for the production of non-ionic surfactants with better surfactant properties and reduced toxicology levels to a greater extent. Dimers of these olefins have shown a good reactivity pattern towards phenol thereby producing para substituted alkyphenols which are known to possess the excellent detergent properties. The dimerization reaction is carried out by cationic mechanism in the presence of zeolite catalyst. From the experimental results conclusions can be derived about the best catalyst, optimum reaction conditions and kinetics of the reaction. Regenerative capacity of the catalyst is also analyzed through experiments and characterization of catalysts at several stages.

31. "Process improvement in steam cracking of Naphtha".

Sudeep Wadia, Dr. A.P. Vyas, Nirma University, Ahmadabad.

Steam cracking of naphtha and light hydrocarbons such as ethane, propane and their mixtures is a major process for production of ethylene, propylene, butadiene and the aromatics. Coke formation and deposition is a major problem associated with this process. This report presents the results of the base runs established in a new coil made of Incoloy 800H and new furnace. Previously base run was established out in a reactor made of Incoloy 800 that was subjected to more than 6000 hours of repeated cracking and decoking cycles.Numerous runs were carried out in the bench scale naphtha cracker unit with different operating conditions to optimize operating conditions that would simulate commercial plant performance with respect to yields. The optimized operating conditions are; COT-830oC, Dilution Ratio= 0.32, Residence time = 0.5 sec, Naphtha flow rate= 63.49g/h, Water flow rate=20.32g/h.

32. "Automotive Exhaust Emission Control Using Perovskite Catalysts Prepared By Mechanochemical Synthesis".

Hardik Gandhi, Prof. (Ms.) Femina Patel, Nirma University, Ahmadabad.

Air pollution generated from mobile sources such as automobiles contributes major air quality problems. Automobile market has been increased exponentially day to day. About 50 million cars are produced every year and over 700 million cars are used worldwide which has resulted in serious concerns about urban air quality caused by engine exhaust gas emissions which contains poisonous gases like hydrocarbons, carbon monoxide, nitrogen oxides and particulate matter. Engine modifications alone were not sufficient to control them, so catalytic systems were introduced to do this. This catalytic chemistry involves activation of small pollutant molecules that is achieved particularly effectively over platinum group metal catalysts. Catalytic emissions control was introduced first in the form of platinum-based oxidation catalysts that lowered hydrocarbon and carbon monoxide emissions. Reduction of nitrogen oxides to nitrogen was initially done over a platinum/rhodium catalyst prior to oxidation but platinum group metal catalyst face limitations like sintering at around 10000C, it easily get deactivated. Being noble metal they are very costly and according to norms the catalyst must have lifetime of 80,000 km and selecting its support is quite difficult .So we have been investigating on other substitute catalyst "Perovskite" to overcome all drawbacks.

Perovskite have general formulae ABO3 where A and B both are cations where A is larger than B cation , and O is an anion. The ideal cubic symmetry structure has the B cation in 6 fold and A has 12 fold coordination surrounded by anions. The major drawback of perovskites is the low specific surface area (usually several m2/g) due to their preparation that involves a rather high temperature (often as high as 800 0C) to ensure the formation of the crystalline phase.

A new preparation method called reactive grinding is developed for its synthesis at room temperature by high energy ball mill which result in relatively high surface area that overcome limitation of conventional method of perovskite.

The project is to illustrate the technology for abatement of exhaust emissions by analysis the current understanding ofTWCs, the speci?c role of the various components, the achievements and the limitations.

It also discusses Perovskite, occurrence, various synthesis methods, their characterization, usage of perovskite in automobiles, advantages over conventional catalyst.

Keywords : Perovskite, Reactive Grinding, Mechanochemical synthesis, CO oxidation

33. "Treatment Of Wastewater From Dye Industries Using Electrochemical Technology".

Ami Bhatt, Dr. J. P. Ruparelia, Nirma University, Ahmadabad.

As technological changes take place numerous compounds are generated from industrial processes and are difficult and costly to treat by conventional wastewater treatment processes. The amounts of heavy metals and synthesized organic compounds generated by industrial activities have increased, and new organic compounds are added each year. Using electricity to treat water was first proposed in UK in 1889. Because of the relatively large capital investment and the expensive electricity supply, electrochemical water or wastewater technologies did not find wide application worldwide then. But now a day electrochemical technologies have reached such a state that they are not only comparable with other technologies in terms of cost but also are more efficient and more compact. For some situations, electrochemical technologies may be the indispensable step in treating wastewaters containing refractory pollutants. Electrooxidation is effective in degrading the refractory pollutants on the surface of a few electrodes. The electrooxidation of the organic compounds can occur by two different oxidation mechanisms. One mechanism is direct oxidation or direct anodic oxidation, where the compounds are degraded at the anode surface. Another mechanism is indirect oxidation, where oxidizing agents are electrochemically generated and they operate the oxidation. The removal of dyes from textile wastewater prior to its discharge or reuse is a challenging task. This report focuses on the treatment of synthetically prepared Reactive Black 5 dye wastewater. Experimental runs were conducted at room temperature in batch mode using Dimensionally Stable Anode (DSA) type electrodes were prepared by depositing oxide layer on Ti substrate using the thermal decomposition method and Stainless Steel as cathode. Electrodes were kept 8 mm apart. D.C. power for constant current density of 50 mA/cm2 was supplied by means of a D.C. power supply. Stirring was maintained using a magnetic stirrer. Sodium Chloride (NaCl) was added to the solution as electrolyte. High extent of pollutant degradation was observed in terms of Colourand Chemical Oxygen Demand (COD) removal efficiencies.

34. "Production of bioalcohol - study of various roots using non edible renewable resources".

Khyati Bhatt, Dr. R. K. Mewada, Nirma University, Ahmadabad.

One set of promising alternatives to petroleum derived fuels are bioalcohol, especially those are produced via fermentation process from renewable sources ,such as butanol(bio butanol),ethanol etc. Biobutanol can be a liquid fuel from waste/ nonedible biomass is a promising approach for securing energy and resource. Butanol as a potential second generation biofuel,is a better alternative for the gasoline fuel, from the view points of combustion characteristics, engine performance, use of widely available biomass of low cost without competing with food and feed production.Fornon edible/waste lignocellulosic biomass, cost-effective fermentation can be achieved by the consolidation of saccharification and fermentation process. Solventogenic clostridia are particularly well suited for fermenting sugars derived from cellulosic feedstock. The major problem associated with the production of bio butanol are, inhibition of microorganism due to toxic nature of butanol, resulting in a low yield of butanol. Due to low concentration of butanol product recovery cost increases which provides economical limitations.In this work studied clostridium fermentation of stress assisted-acid hydrolyzed rice straw that exhibited a typical trend of acidogenesis followed by solventogenesis. Acid hydrolysis of 5% (w/v) mixture of rice straw in water with simultaneous application of shearing stress resulting in release of total sugar ,reducingsugar.Glucose formed major fraction of the reducing sugar. Anaerobic fermentation of rice straw hydrolyzate using clostridium acetobutylicum NCIM 2337 resulted in acetone, butanol and ethanol production.

35. "Color Removal From dye wastewater using Perovskites".

Darshankumar H. Joshi, Prof. F. J. Patel, Nirma University, Ahmadabad.

La0.5Ca0.5NiO3 adsorbent was prepared by Sol-Gel Method (using distilled water and nitric acid) and Co-Precipitation Method (using Distilled Water) in the presence of nitrate-metal-ethylene glycol (EG) polymerised complex. Experimental results indicated that the adsorption kinetic data follow a pseudo-second-order rate for the tested dye. The isotherm evaluation indicates that the Freundlich model fits the experimental data better than the Langmuir model. The La0.5Ca0.5NiO3 adsorbent showed excellent adsorption efficiency towards reactive black 5 (RB5) as a reactive dye in aqueous solution. The adsorption studies were carried out at different pH values, dye concentrations, various adsorbent dosages and contact time in batch experiments. The dye removal efficiency was found to be decreased with increase in initial pH of dye solution, and La0.5Ca0.5NiO3 adsorbent exhibited good dye removal efficiency at acidic pH specially 1 pH.

36. "Process design for advance biological treatment of petrochemical wastewater".

Rima Joshi, External guide: Dr. A.J.A. Sophia, Internal guide: Dr. S.S. Patel,
Nirma University , Ahmedabad

Semiconductor photocatalysis has been intensively studied in recent decades for a wide variety of application such as hydrogen production from water splitting and waste water and air treatment. The majority of photocatalysts are, however, wide band-gap semiconductors which are active only under UV irradiation. In order to effectively utilize LEDs and UV light, this thesis investigates various types of visible-light active photocatalysts including various catalyst like ZnO, TiO2 and metal ion-doped TiO2 for the waste water of the Reliance Industries.

Many different metal ion-doped TiO2 nanoparticles are synthesized. I compare the effects of individual dopants on the resulting physicochemical properties and corresponding photocatalytic activities with respect to the catalysis of several reactions under visible-light irradiation. I found several metal ion-doped TiO2 nanoparticles such as Bi, Ag, and Ce had visible-light photocatalytic activities and the presence of anatase phase in these metal ion-doped TiO2 may affect their photoreactivities.

To get the more degradation many optimizations (eg., pH optimization, Catalyst weight Optimization, etc.) are performed under lab scale reactor and try to make the reaction economically viable.

By using coating technology the mobilized catalyst is try to make into immobilized form so catalyst can be reuse more and more time. The kinetic study is done by Langmuir-Hinshelwood (L-H) rate equations. The Reactor degrades variety of pollutants and effectively control the parameters like pH, COD and Turbidity. The Reaction is environmental friendly and economically cheap.

Additionally the case study is taken to treat the waste water from Reliance Industries and use the treated water as a cooling water and further treatment for use the water as a Demineralized water. Also convert the batch reaction into the continuous reaction.

37. "Design & Development Of Photo Catalytic Water Treatment Technology For The Degradation Of Waste Water Production At Ril Manufacturing Plants"

Rushi Kansara, Dr. A.P. Vyas, Nirma University, Ahmedabad.

Semiconductor photocatalysis has been intensively studied in recent decades for a wide variety of application such as hydrogen production from water splitting and waste water and air treatment. The majority of photocatalysts are, however, wide band-gap semiconductors which are active only under UV irradiation. In order to effectively utilize LEDs and UV light, this thesis investigates various types of visible-light active photocatalysts including various catalyst like ZnO, TiO2 and metal ion-doped TiO2 for the waste water of the Reliance Industries.

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Additionally the case study is taken to treat the waste water from Reliance Industries and use the treated water as a cooling water and further treatment for use the water as Demineralized water. Also convert the batch reaction into the continuous reaction.

38. "Catalytic Ozonation of Wastewater".

Patel Tarak Sureshbhai, Prof. Sandip Sharma, Nirma University, Ahmadabad.

Water pollution and its scarcity are the main problems that humankind is facing nowadays. In this regards, great attention is being given to the removal of these pollutants from wastewater by using an advanced oxidation processes (AOPs) that are based on generation of highly reactive species, especially hydroxyl radicals and other reactive mechanism. Among them, ozonation and catalytic ozonation are operating at room conditions of pressure and temperature, are of special interest involving some other operational costs. There are many different types of catalyst are used into the catalytic ozonation of waste water treatment at using the different operating condition like pH, time for the reaction, catalyst quantity, concentration, ozone flow-rate etc. The reaction will be occurred at different operating condition and remove the organic and inorganic pollutant from the waste water and also remove the color and like COD, TOC and other pollutants.

Reactive Red 120 (RR 120) and Reactive Yellow 145 (RY 145) these all dyes are treated with the ozonation and catalytic ozonation. The all process are occurred with the different operation condition like different pH, ozone flow-rate (30 & 50 LPH), different dyes concentration (500 ppm, 1000 ppm) and using different catalyst. After the completion of the experiment to check the color removal concentration in UV Spectophoto meter, COD in COD incubator and TOC concentration in TOC analyzer and also calculate the ozone demand required for the reaction and the operation cost. The time, COD, TOC, Color and Ozone Demand is gradually increase with increasing the initial concentration of the dyes solution. During the process of the simple ozonation reaction color is 100 % removal from the wastewater and TOC up to 20 % and the catalytic ozonation process time TOC reduction is up to 40 to 45 % which is depend on the time for the reaction.

39. "Removal of refractory COD and ammonical nitrogen from effluents"

Swapnil Singala, Dr. J. P. Ruparelia, Nirma University, Ahmedabad.

Electro-oxidation provides sustainability, energy conservation, automatisation and environmental friendliness. It is an advanced technology used for treatment of high COD bearing water and ammoniacal nitrogen. Refractory wastewater is the complex form of effluent containing numerous organic and inorganic compounds dissolved in it which has to be removed up to certain level before it is set free to make their way to water bodies. A major producer of the refractory wastewater includes dye industries, pharmaceuticals industries and the company's manufacturing inorganic compounds. Final discharge effluent from CETP is processed in this experiment for the period of five hours. There is an experimental

decrease in the value of COD by 5-8% and that in ammoniacal nitrogen by 50%.This paper introduces the concept of electrochemical oxidation, its mechanism, and applications. It investigates electrochemical oxidation using different types of electrodes. It includes case study and practical based on Stainless steel electrode. The paper provides an overview on the current developmental status of Stainless steel for electrochemical applications. An attempt has been made to summarize a comparison of different anode materials for removal of refractory organics from wastewater by electro-oxidation.

40. "Production of Hydrogen from glycerol by steam reforming process".

Narasimha Reddy Ravuru, Dr. Sanjay. S. Patel, Nirma University, Ahmedabad.

The development of alternative sources of energy is becoming important in this era of diminishing petroleum reserves and increased environmental awareness. Hydrogen production from biomass has attracted great interest because of the potential application in fuel cells. Significant amount of glycerol is produced as a by-product during bio-diesel production by trans esterification of vegetable oils, which are available at low cost in large supply from renewable raw materials. With increased production of biodiesel, a glut of glycerol is expected in the world market, and therefore it is essential to find useful applications for glycerol. Finding alternative uses for glycerol is important. Using glycerol as a source of producing hydrogen is a good possibility. Steam reforming is a promising way to utilize the diluted glycerol aqueous solution to produce hydrogen.Glycerin is a potential feed stock than ethanol for hydrogen production because one mole of glycerin can produce up to four moles of hydrogen.For the experimental study Ni based catalysts were prepared using wet impregnation method, the activity of catalysts are taken in atmospheric gas solid reactor at a particular temperature range. The gas and liquid products generated are analysed in GC. After the gas analysis the catalyst with the best result is again tested in the reactor for a smaller range of temperature. The used catalyst is regenerated and again tested to see if the regenerated catalyst gave the same result as the fresh catalyst. The liquid products are analysed in the GC and an attempt has been made in order to understand and find the liquid compounds in the liquid sample. An attempt will me made to identify catalyst by adding promoters with results in high selectivity towards hydrogen and sufficient reaction rate at mild conditions. The effects of the process variables such as temperature, contact time, and water to glycerol ratio, metal loading on hydrogen yield will be investigated. Other considerations such as catalyst activity, catalyst lifetime and operating conditions will be studied for over all process economics. On the experimental obtained data kinetic studies and development of kinetic model will be done.

41. "Synthesis and Characterization of Perovskite based Catalysts for Automotive CO Oxidation"

Prof. Femina Patel, Dr. Sanjay S. Patel, Nirma University, Ahmedabad.

Air pollution generated from automobiles has been a burning issue because of poisonous gases like carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx) and particulate matters (PM) emitted by automobiles. These pollutants create adverse effect on human health, air quality and the environment that lead in stringent regulations in the form of emission norms. To control tail pipe emission from two/four wheelers, three way catalytic converter based on Pt-Pd-Rh have been used successfully however it has some limitations. Perovskite oxides (with general formula ABO_3 where A and B are rare earth, alkaline earth, alkali metal and transition metal cations respectively) can be alternative catalytic material to this noble metals based three way catalytic converter for automotive CO oxidation because of their low cost, thermal stability at high temperature, high mechanical stability and excellent redox properties.

Perovskites are mainly prepared by ceramic and wet chemical methods. These methods produce low specific surface area perovskite, they are complicated and relatively expensive to put into practice. To overcome the limitations of above conventional methods used for preparation of perovskites an improved high energy (planetary) ball mill has been designed and developed for reactive grinding. The reactive

grinding method using improved planetary ball mill produces perovskites in an efficient, simpler and economical manner.

In the present study, perovksite catalysts (LaCoO3, LaMnO3, LaFeO3, LaCo0.8Cu0.2O3, La0.8Sr0.2CoO3, La0.8Sr0.2Co0.8Cu0.2O3, La0.8Ce0.2CoO3 and LaCo0.95Pd0.05O3) were prepared by citrate complexation, co-precipitation and reactive grinding methods. Prepared catalysts were characterized by various characterization techniques such as TG-DTA, XRD, BET, SEM, EDX, TEM, particle size analysis, H2-TPR and O2-TPD. The catalytic performance of the perovskites for automotive CO oxidation was carried out using atmospheric gas-solid fixed bed catalytic reactor with simulated gas mixture containing 1% CO, 1% O2 and balance N2.

The parameters were optimized based on physicochemical properties and the catalytic activity. The optimized operating conditions for reactive grinding method using planetary ball mill are recommended as jar speed: 350 rpm (clockwise), sun wheel speed: 200 rpm (anti-clockwise), ball to powder weight ratio: 15:1, milling time 11 h.

The effect of preparation method on LaCoO3perovskite catalyst for CO oxidation studied. The performance was almost similar for all perovskites prepared by various methods. LaCoO3perovskite catalyst prepared by co-precipitation method exhibited marginally higher catalytic activity compared to all catalyst compositions. LaCoO3perovskite catalyst prepared by reactive grinding method, milled for 11 h without heat treatment exhibited minute lower activity for CO oxidation due to dislodging of iron impurities through MOC of grinding jars and balls which contaminated the catalyst surface. Substitution of 20% Cu in LaCoO3perovskite catalyst (LaCo0.8Cu0.2O3) prepared by reactive grinding method, milled for 11 h with heat treatment at 600 0C for 5 h enhanced the catalytic activity for CO oxidation. The LaCoO3perovskite catalyst prepared by reactive grinding method, milled for 11 h without heat treatment exhibited 90% CO conversion at temperature 260 0C and high space velocity of 60,000 Ncm3/g h (GHSV). This perovskite catalyst subjected to time-on-stream activity test for 24 h at 300 0C during which it remained stable and exhibited 100% CO conversion. CO conversion rate increased with contact-time and temperature. The CO oxidation was a first order reaction with activation energy 11.94 kcal/mol.

42. "Catalytic Carbon Dioxide Reforming of Methane to Synthesis Gas".

Ganchi Sanjay Pratapbhai, Dr. Sanjay S. Patel, Nirma University, Ahmedabad.

The reforming of methane with carbon dioxide for the production of synthesis gasis appealing because it produces synthesis gas with higher purity and lower H2 to CO ratio than either partial oxidation or steam reforming.

Lower H2 to CO ratio is a preferable feedstock for the Fischer-Tropsch synthesis of long-chain hydrocarbons. On the environmental perspective, methane reforming is enticing due to the reduction of carbon dioxide and methane emissions as both are viewed as harmful greenhouse gases.

Commercially, nickel is used for methane reforming reactions due to its inherent availability and lower cost compared to noble metals.

However, nickel also catalyses carbon formation via methane decomposition and CO disproportionate. Thus, notable efforts have been concentrated on exploring new catalysts, which are resistant to carbon formation. Sulphurpassivated nickel catalysts and noble metals have been shown to exhibit resistance to carbon formation. But the low activity of sulphurpassivated nickel and the high costs and limited availability of the noble metals have limited their application. There has been considerable interest in the catalytic properties of metal carbides.

The production of metal carbides is abundant and their price is cheap compared to noble metals. It has been suggested that they can replace the rare and expensive noble metals in catalysis.

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