ORAL PRESENTATION

OP-01

OPTIMIZATION OF ANALYTICAL PARAMETERS TO ENHANCE THE EFFICIENCY OF NITRATE REDUCTION FROM GROUNDWATER USING CARBOXYMETHYL CELLULOSE-STABILIZED ZERO-VALENT IRON (CMC-ZVFe^0) NANOPARTICLES

Devsharan Verma* and Narashiman Varadaraj
E-mail address: debuverma@gmail.com (Devsharan Verma)

Nitrate (NO_3^-) contamination in groundwater poses a significant hazard to water quality and public health, especially in regions where groundwater is a prime source of drinking water. Nanoscale zero-valent iron (nZVFe^0) has proved to be an effective tool in environmental nanotechnology for the removal of NO_3^-, but it is still suffering from aggregation, surface passivation, and low reactivity in the reaction system. We use a green approach to synthesize ZVFe^0 particles with 20 to 45 nm dimensions, using food-grade carboxymethyl cellulose (CMC) as a stabilizer, which not only increased the specific surface area of the nanoparticles (NPs) but also increased the reactive particle surface. The chemical reduction of NO_3^- by highly reactive ZVFe^0 NPs stabilized with CMC is a preferred option for reducing NO_3^-contamination from groundwater due to their environmentally benign nature, high efficiency, and cost-effectiveness. The product distribution indicated that almost all NO_3^- was reduced to NH_4^+ and N_2 without accumulation of intermediates after reaction. The allocation between the two reduction products, NH_4^+ and N_2, can be controlled by varying the ZVFe^0-to-NO_3-molar ratio. We studied the effect of various analytical parameters on the reduction process, such as the initial concentration of NO_3^-, contact time, initial pH, and ZVFe^0-to-NO_3-molar ratio. We found that greater CMC-to-ZVFe^0 ratios lead to faster NO_3^- reduction. Analytical parameters were optimized for rapid and precise determination of NO_3^-in groundwater based on the analytical peak selection at 1384 cm^{-1}. The findings of the research showed that CMC-to-ZVFe^0 provided better reactivity and reusability than ZVFe^0, which can guide the optimal design of robust CMC-ZVFe0, and nano-scale particles displayed a rapid and high NO_3-removal capacity from water.

Keywords: Nitrate, Groundwater, Abatement, CMC-ZVFe^0, SEM, DRS-FTIR,

OP-02

A SIMPLE AND EFFICIENT ELECTROCHEMICAL SENSOR FOR FOLIC ACID DETERMINATION BY USING TiO_2 NANOPARTICLES MODIFIED CARBON PASTE ELECTRODE

Shaila G. Sanjeevagol and J. Manjanna*
Department of Chemistry, Rani Channamma University, Belagavi – 591156 Karnataka
E-mail- sanjeevagolsg@gmail.comE-mail- jmanjanna@gmail.com

Folic acid (FA, Vit B9), plays an essential role for pregnant women and anemic patients. Having adequate FA prior to and during gestation can protect the brain of the child and spine from significant birth abnormalities [1]. It reduces the risk of stroke, heart diseases and some type of cancers etc. Thus FA is now employed as a reliable biomarker in the early identification of various disorders [2]. In the present study, TiO_2 NPs were synthesized by precipitation method and the final product was heated at different temperatures (100 °C as TiO_2-1, 400 °C as TiO_2-2, 600 °C as TiO_2-3, and 800 °C as TiO_2-4) which are used to modify carbon paste electrode (TiO_2/MCPE) to detect FA. The TiO_2-1/MCPE revealed high sensing for FA when compared to bare and TiO_2-2, TiO_2-3, TiO_2-4 NPs modified carbon paste electrode through CV, DPV and EIS was used to study the conductivity of TiO_2/MCPE. The TiO_2-1/MCPE showed the lowest detection limit (46 to 49 nM) within the concentration range of 0. 4 30 M by DPV in phosphate buffer pH 6. Moreover, the TiO_2-1/MCPE was successfully used for voltammetric detection of FA in real samples such as orange, banana, spinach and tablet samples. The developed sensor has excellent stability and reproducibility.

Reference:

[1] A. Di Tinno, R. Cancelliere, L. Micheli, Determination of folic acid using biosensors—a short review of recent progress, *Sensors,* 2021, ***21,*** 3360.

[2] M. Yang, C. Wang, Y. Yan, E. Liu, X. Hu, H. Hao, J. Fan, Visual detection of folic acid based on silica coated CdTeS quantum dots in serum samples, *Mater. Res. Bull,* 2021, ***144***, 111509.

OP-03

PLANT-MEDIATED SYNTHESIS OF n-ZnO@Cs FOR ENHANCED REMOVAL OF REMAZOL BRILLIANT BLUE R DYE

P. J. Doondani*, R. M. Jugade

Department of Chemistry, RTM Nagpur University, Nagpur-440033, India

*Corresponding Author's Email: priyankadoondani7897@gmail.com,

Contact No.: +91 7030102484

The improper disposal of organic dyes into aquatic ecosystems can lead to heightened toxicity levels, and have detrimental effects on both human health and ecosystem. This study addresses the challenges associated with biopolymers, such as instability and poor mechanical properties, by introducing an eco-friendly nanocomposite composed of chitosan (Cs) and nanomaterials extracted from water lily leaves (n-ZnO). The nanocomposite aims to combine the benefits of biopolymers and nanomaterials to enhance stability and increase the removal efficiency of organic dyes. Characterization of the synthesized nanomaterials was conducted using various techniques, including FESEM, EDAX, XRD, BET, TG-DTA, and pH_{pzc} confirming their successful preparation. The developed bio-nanocomposite (n-ZnO@Cs) was then employed for the removal of Remazol Brilliant Blue R dye (RBBR). Experimental investigations considered optimization of key parameters such as pH, n-ZnO@Cs dose, contact time, RBBR concentration, and temperature. Results revealed that more than 95% of the dye was effectively removed from 100 mg/L dye solution by 50 mg of n-ZnO@Cs within a short 90-minute interaction time at pH 5.0. Kinetic and isothermal studies provided insights into the adsorption mechanism, indicating a pseudo-second-order mechanism and adherence to the Langmuir isotherm model, respectively. Thermodynamic analysis disclosed an enthalpy-driven, spontaneous, and exothermic nature of the adsorption process. Additionally, the reusability study demonstrated the successful application of the synthesized n-ZnO@Cs for up to five cycles without a significant decrease in removal efficiency. This finding underscores the economic and sustainable aspects of the proposed nanocomposite for organic dye removal in aquatic environments.

Keywords: Remazol Brilliant Blue R; Plant extract; Bio-nanocomposite; Chito

OP-04

COMPARATIVE STUDY OF IRON AND COPPER METAL OXIDE NANOPARTICLES FOR THE REMOVAL OF HEXAVALENT CHROMIUM FROM WATER

Dr. Vivek Bhusari, Ms. Amruta Yadao
Bajaj Institute of Technology Wardha
E mail : vnbhusari@gmail.com

Chromium has a wide range of applications in the metal, alloy, electroplating, chemical, and leather processing industries. It is mainly found in wastewater discharges from different industries. The hexavalent form of chromium is considered to be a human carcinogen due to its mutagenic and carcinogenic properties. This study compares iron and copper metal oxide nanoparticles that were synthesized and evaluated for their ability to remove hexavalent chromium from water. Both the adsorbents were thoroughly characterized using techniques like X-ray diffraction, SEM, and TEM. The adsorbent capacity was determined using Langmuir and Freundlich adsorption models. The study revealed that copper metal oxide nanoparticles showed better removal compared to iron oxide nanoparticles

OP-05

ROLE OF LINEAR ALIPHATIC BIOPOLYESTERS IN SCAFFOLD: A REVIEW

S. M. MESHRAM[1*], A. V. BHARATI[1]
Department of Chemistry [1]
Shri Ramdeobaba College of Engineering and Management, Nagpur
*meshramsm@rknec.edu

Linear biodegradable polyesters serve very important role as a biomaterials in tissue engineering and regeneration. Tissue engineering aims to create functional and viable biological substitutes to repair or replace damaged tissues. These biodegradable polyesters exhibit excellent properties such as bio compatibility, biodegradability, tunable mechanical properties and versatility in processing. These properties make them valuable components in the development of scaffolds and implants for various tissue engineering applications. The scaffolds used in either tissue engineering or regeneration are to provide support for cellular attachment and subsequent controlled proliferation into a predefined shape or form.

The use of biodegradable polymers as the temporary scaffolds either to grow cells/tissues in vitro for tissue engineering applications or to regenerate tissues in vivo has very recently become a highly important. Scaffolds have been used for tissue engineering such as bone, cartilage, ligament, skin, vascular tissues, neural tissues, and skeletal muscle and as vehicle for the controlled delivery of drugs, proteins, and DNA. A biodegradable scaffold would be preferred because of the elimination of chronic foreign body reaction and the generation of additional volume for regenerated tissues.

In this review paper, we are focusing about the use of different types of scaffolds made up of biodegradable polyester and their applications in the biomedical Implants, wound healing, tissue engineering and regenerative medicine, drug delivery Systems.

Keywords: Scaffold, Biodegradable, drug delivery, bio compatible.

References :

[1] Dhandayuthapani B., Yoshida Y., Maekawa T. , and Sakthi D. Kumar *International Journal of Polymer Science , 2011, 2011,1-19.*

[2] Baolin G. Ma. P., *Sci. China Chem*. 2014, 57(4), 490-500

OP-06

PHOSPHORYLATED ZIRCONIUM CROSS LINKED BIOPOLYMER FOR EFFICIENT SEQUESTRATION OF URANIUM FROM WATER

Dhanya V[a] and Rajesh N[a]
Department of Chemistry, Birla Institute of Technology and Sciences-Pilani, Hyderabad Campus, Telangana, 500078,India.
p20190103@hyderabad.bits-pilani.ac.in, Contact No.: *+919700155877*

Heavy metal contamination of water is a global environmental concern. Chemical and radiological toxicity of uranium renders it a potential hazard when present beyond permissible limits in water. Adsorption techniques prove to be effective in remediation of uranium [1]. Suitable functionalization of environment friendly biopolymer materials as adsorbents is a sustainable approach towards decontamination [2].

In the present study, zirconium cross linked phosphorylated guar gum composite (GG@ZrP) was used as an adsorbent for removal of uranium. Adsorption was maximum at pH 6, followed Langmuir model and pseudo- second order kinetics. The presence of uranium on the adsorbent has been confirmed by the SEM and EDAX data as depicted in Figure 1. The good selectivity observed for uranium in the presence of concomitant metal ions is attributed to hydroxyl and phosphate moieties on the adsorbent. The adsorbent was applied effectively to remove uranium from natural ground water samples. With good regeneration capacity, this ecofriendly adsorbent is a promising candidate for remediation of uranium from water.

Keywords: Adsorption; uranium; guar gum; zirconium; remediation.

References

[1] Dhanya V, Arunraj B, Rajesh N. RSC Adv. 2022;12:13511-13522.
[2] Usman M, Barbar TM, Carabineiro SAC, Environ. Sci. Pollut. Res. 2023; 30: 102027–102046.

OP-07

SENSING POTENTIAL OF HYDROT HERMALLY SYNTHESIZED NiO DOPED YSZ

R. R Purandare [a], M. Y Khaladkar [b]

a Department of Chemistry, Modern College of Arts, Science and Commerce, Ganeshkhind, Pune- 411016, India

b Department of Applied Science, Government College of Engineering & Research, Avasari Khurd, Ambegaon, Pune - 41240, India

[a] Corresponding Author's Email: abhirucha@gmail.com, Contact No.: +91 98234778164

Doping of NiO in YSZ solid solution is a subject of great interest. The doping in YSZ has been extensively studied due to the property of the solid solution to act as solid oxide fuel cell. In the present paper, NiO was doped in YSZ solid matrix in 5, 10 and 15 mol%. One more sample without yttria was also studied. The samples were synthesized hydrothermally by wet chemical route using hydroxide as the precursor. The synthesized samples were sintered at 600C and were characterized using TG/DTA, XRD and SEM. The sensing potential of all the samples for acetone, NO and H2S was carried out in vacuum using an assembly made in-house.

Keywords: YSZ, Nickel oxide, hydrothermal synthesis, doping, sensing assembly

References :

[1] Kanan M. *, El-Kadri Oussama M., Abu-Yousef Imad A. and Kanan Marsha C.; *Sensors* 2009; 9, 8158-8196

[2] Korotcenkov, G. *Mater. Sci. Eng. B* 2007; 139, 1–23.

[3] Moseley, P.T., Norris, J.O., Williams, D.E., Eds.; *Techniques and Mechanisms in Gas Sensing*; Adam Hilger, Bristol, UK, 1991.

[4] Madou, M.J.; Morrison, S.R. *Chemical Sensing with Solid State Devices; Academic Press, Inc.*/Harcourt Brace Jovanovich Publ.: Boston, MA, USA, 1987.

[5] Sberveglieri, G., *Gas Sensors-Principles Operation and Developments;* Ed.; Kluwer Academic Publishers: Dordrecht, The Netherlands, 1992.

[6] Korotcenkov, G., *Sens. Actuat. B: Chem.* 2005; 107, 209–232.

[7] Lu, Z.; Kanan, S.M.; Tripp, C.P., *J. Mater. Chem*. 2002, 12, 983–989.

[8] Williams, D., *Sens. Actuat. B: Chem.*, 1999, 57, 1–16.

OP-08

KERATIN: A VERSATILE BIOPOLYMER FOR BIOTECHNOLOGICAL AND INDUSTRIAL ADVANCEMENTS – INSIGHTS INTO STRUCTURE, EXTRACTION METHODS, AND DIVERSE APPLICATIONS

Mohd Amin Sk Husain, Atul V. Wankhade*
Department of Chemistry, Visvesvaraya National Institute of Technology, Nagpur, India
E-mail: ds22che016@students.vnit.ac.in, avwankhade@chem.vnit.ac.in

In recent years, keratin has garnered widespread attention owing to its remarkable biocompatibility and biodegradability. Its versatile applications span across diverse industries such as poultry, textiles, agriculture, cosmetics, and pharmaceuticals. Keratin, as a multifaceted biopolymer, has been instrumental in the fabrication of fibrous composites, and through strategic modifications, it can be adapted for use in gels, films, nanoparticles, and microparticles.[1] Its inherent stability against enzymatic degradation and exceptional biocompatibility have positioned it prominently in biomedical applications and regenerative medicine. This comprehensive review delves into the intricate structure of keratin, its classification, and the array of properties that make it an attractive material for various applications. It further explores the diverse methods employed for keratin extraction, encompassing chemical hydrolysis, enzymatic and microbial treatment, dissolution in ionic liquids, microwave irradiation, steam explosion techniques, and thermal hydrolysis or superheated processes.[2,3] The focus extends to the utilization of keratin in different forms such as hydrogels, films, fibers, sponges, and scaffolds across a spectrum of biotechnological and industrial sectors. For researchers delving into natural proteins and their applications, this review serves as a valuable resource, providing insights into the structural nuances of keratin, its extraction methodologies, and its versatile applications in various fields.[4] Moreover, it sheds light on the evolving landscape of keratin-based materials and their implications for both scientific and industrial communities.

Keywords: Keratin · Sheep wool · Feathers · Proteins · Amino acids.

References:

1. Barba C, Méndez S, Roddick-Lanzilotta A et al (2008) Cosmetic efectiveness of topically applied hydrolysed keratin peptides and lipids derived from wool. Ski Res Technol 14:243–248. https://doi.org/ 10.1111/j.1600-0846.2007.00280.
2. Bertini F, Canetti M, Patrucco A, Zoccola M (2013) Wool keratinpolypropylene composites: properties and thermal degradation. Polym Degrad Stab 98:980–987. https://doi.org/10.1016/j.polym degradstab.2013.02.011.
3. Brown EM, Pandya K, Taylor MM, Liu C-K (2016) Comparison of methods for extraction of Keratin from waste wool. Agric Sci 07:670–679. .. https://doi.org/10.4236/as.2016.710063.
4. Cataldi P, Condurache O, Spirito D et al (2019) Keratin-graphene nanocomposite: transformation of waste wool in electronic devices. ACS Sustain Chem Eng 7:12544–12551. https://doi.org/10.1021/ acssuschemeng.9b02415.

OP-09

ENVIRONMENTAL FRIENDLY APPROACH FOR CHEMICAL CHARACTERIZATION OF MAGNESIUM METAL BY GD-OES

Y Balaji Rao[a]*, S NVMS Gupta[a], P V Nagendra Kumar[b], Dinesh Srivastava[a]
[a] *Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India*
[b] *Assistant Professor, Dept. of Chemistry, GITAM University, Hyderabad-502329, India*
**Email:* ybrclabnfc@gmail.com / ybr@nfc.gov.in

Zirconium alloys are widely employed in the manufacture of various reactor core components for BWRs and PHWRs due to superior properties under reactor operating conditions. Reactor grade Zr-metal is the starting material for production of various grades of Zircaloys at Nuclear Fuel Complex (NFC). This reactor grade zirconium (RG Zr) metal is produced at NFC through a well-known Kroll's Reduction Process. The RG Zr metal thus produced is taken for manufacturing different types of Zirconium alloys which are used for fabricating various reactor components. In view of its applications in reactor, stringent specifications are laid down for Zr metal and to produce Zr metal of desired quality, it is essential to monitor the content of impurity elements in all materials used for making Zirconium sponge. Magnesium (Mg) is an essential in put metal used in RG Zr metal production and therefore, it has become mandatory to carry out chemical characterization of magnesium metal before its use in Kroll's reduction process. Different analytical techniques like Flame-AAS, DC-Arc OES and ICP-OES are cited analysis of Mg metal. DC-Arc OES method is cumbersome and generates lot of NOx fumes and therefore, is not a preferable choice in view of the hazardous effects of NOx fumes to the environment. Flame-AAS does not help because of its low sensitivity since the elements are to be quantified at trace level. Where-as ICP-AES requires sample to be in liquid form and dissolution of Mg samples generates lot of NOx fumes as well and also generates analytical liquid waste. In view of this, a systematic study has been carried out to develop an analytical protocol for estimation of impurities Al, Cu, Fe, Mn, Ni, Si and Ti in high pure Mg metal samples directly, without any dissolution, using Glow Discharge Optical Emission Spectrometry (GD-OES) technique. Single parameter alternative method has been used to optimize analytical conditions like Pre integration time, Integration time, Ar Pressure inside GD source, RF power applied to GD Source. Effect of Argon pressure& RF power on signal, background intensities is studied and discussed in the paper. Interference free wavelengths have been selected for calibration of equipment using CRM's. Comparison of analytical results obtained using direct calibration and Internal Standard (IS) calibration modes are given in the paper. All the calibration curves have been found to be linear with co-relation coefficient (R^2) ≥ 0.99.The developed method is compared with regularly employed ICP-AES method for its validation.% RSD of the developed method found to be less than 3% for most of the elements.The developed method not only simple in terms of direct solid analysis but also environment friendly as it does not generate any analytical waste or hazardous NOx fumes.

References:

T.S Krishnan; Technical note on 'Analytical Quality control in the production of nuclear grade zirconium and its alloys'; BARCpresented in 'Recent developments in Non-ferrous metals technology'; Dec 4-7, 1968, NML, Jamshedpur;

OP-10

ETHYLENE SCAVENGING PROPERTIES FROM HALLOYSITE NANOTUBES LOADED NATURAL RUBBER LATEX/BUTYL STEARATE COATING ON PAPER FOR FOOD PACKAGING APPLICATION

Armaanjot Singh[1] , Pradeep Kumar[2] , Preetinder Kaur[3] , Kirtiraj K Gaikwad[4]

[1] B.Tech student, College of Agricultural Engineering & Technology, PAU, Ludhiana.

[2] PhD Scholar, Department of Paper & Pulp Technology, IIT, Roorkee.

[3] Principal Scientist, Department of Processing & Food Engineering, PAU, Ludhiana.

[4] Asstt Professor, Department of Paper & Pulp Technology, IIT, Roorkee.

With increasing environmental concerns and human health, paper and biobased food packaging materials have gained significant interest and area to research. Using natural rubber latex and natural clay, we developed an easy and green method to prepare active paper-based packaging material having hydrophobicity and ethylene scavenging properties, which is coated with a solution containing halloysite nanotubes (HNTs), butyl stearate, and natural rubber latex (NRL). The result shows that paper thickness improved by 22% and GSM by 56%. The tensile and burst strength of the paper increased to 11 and 8% compared to the control due to the coating of the solution. The contact angle of coated paper decreased from 48.9o to 55.9 o, showing the hydrophobicity of paper to restrict moisture. The SEM and AFM analysis of coated and control paper shows that the porosity and the surface structure of coated paper improved compared to control paper. The obtained result of active paper and improved physical, mechanical, and barrier properties effectively scavenges the ethylene. The coated paper shows 30 to 55% ethylene scavenging in seven days. Active This study provided a new insight into paper-based materials for fruit and vegetable packaging applications.

Keywords – Halloysite nanotubes; Ethylene; Natural rubber latex; Packaging; Fruits.

OP-11

FERROUS OXIDE NANOPARTICLE FOR ENHANCED CO_2 CAPTURE IN MONOETHANOLAMINE SOLUTION

Snehal Deshmukh[a], Samir Deshmukh[a], Swarda Mote[b]
[a]*Department of Chemical Engineering, Laxminarayan Institute of Technology Nagpur, Maharashtra-440023, India.*
[b]*Department of Chemical Engineering, Priyadarshini College Of Engineering, Nagpur-440019, India*
[a]*Corresponding Author Email:snehasdeshmukh@rediffmail.com*
Contact No.: +7218181716

As the industrial sector increasingly relies on machinery, the energy demand is escalating, leading to a significant release of greenhouse gases. The predominant contributor to climate change and the greenhouse effect is the substantial increase in atmospheric carbon dioxide (CO_2).Addressing this environmental challenge involves exploring solutionsand capturing CO_2 emerges as a viable option. Liquid sorbent materials, such as Monoethanolamine (MEA), are commonly used for CO_2 capture. However, MEA's volatility, and its oxidative and thermal degradation, present major limitations. In recent years, nanomaterials (NMs) have gained popularity as promising adsorbents for CO_2 capture due to their high adsorption capacity, cost-effectiveness, and widespread availability. The present work focuses on the use of ferrous oxide (FeO) nanoparticles for CO_2 capture. Experiments were conducted by employing a 30% concentration of MEA at different time intervals (ranging from 15 minutes to 60 minutes) for CO_2 capture with and without the addition of nanoparticles. The results indicate that, for the same absorption time, the incorporation of FeO nanoparticles into MEA significantly enhances CO_2 capture compared to using only MEA solution. The percentage enhancement ranges from 20% to 90% with the addition of merely 5% by weight of FeO nanoparticles with variations in time. This observation suggests that the introduction of FeO nanoparticles to MEA solution not only enhances CO_2 absorption but also improves mass transfer in gas-liquid systems by reducing resistance against mass transfer between liquid and gas phases.

Keywords**:** FeO nanoparticles, CO_2Capture, monoethanolamine (MEA)

References

[1] Kim W-g, Kang HU, Jung K-m, Kim SH ***(2008)*** Synthesis of silica nanofluid and application to Co2 absorption *Separation Science and Technology* ***43:3036-3055*** doi:https://doi.org/10.1080/01496390802063804

[2] Ali N, Teixeira JA, Addali A ***(2018)*** A review on nanofluids: fabrication, stability, and thermophysical properties *Journal of Nanomaterials* ***2018***

[3] Arshadi M, Taghvaei H, Abdolmaleki M, Lee M, Eskandarloo H, Abbaspourrad A ***(2019)*** Carbon dioxide absorption in water/nanofluid by a symmetric amine-based nanodendritic adsorbent *Applied Energy* ***242:1562-1572*** doi: https://doi.org/10.1016/j.apenergy.2019.03.105

OP-12

ANALYSIS OF SEASONAL FLUCTUATION OF FLUORIDE CONCENTRATION IN GROUNDWATER IN KORPANA TEHSIL, CHANDRAPUR DISTRICT, INDIA AND SUGGESTED PRECAUTIONARY MEASURES

Mrs.Dipti.G.Iyer a , Dr.Mrs.Vaishali.P.Meshram, Dr.Pravin.U.Meshram
Email address: diptig.iyer@gmail.com Contact No.: +91 9823034266

Groundwater is an important water resource in India for domestic, irrigation and industrial purposes[1].The chemical composition of groundwater is controlled by several factors that include composition of precipitation, anthropogenic activities, geological structure and geological processes within the aquifer medium[2].In order to evaluate the seasonal fluctuation of groundwater quality in study area for its suitability for drinking purpose. Groundwater samples were collected during pre and post-monsoon period of year 2023 and analyzed for various parameters. Residents of Korpana tehsil of Chandrapur district (MS) are using groundwater for drinking and irrigational purposes. Fluorides concentration in groundwater samples were determined in the selected villages of Chandrapur Dist. Various samples were collected twice from selected sampling locations and analyzed for fluorides content along with pH, TDS, Total hardness, COD, BOD and Dissolved oxygen. The concentration of fluoride in groundwater of these villages varied from season to season i.e 0.8 to 3.0 mg/l. Samples show high concentration of fluoride. Survey in these villages shows that population is affected by fluorosis. Dental fluorosis and deformation of bones in children as well as in adults were observed in the study area indicating the excess of fluoride concentration. It also shows good relation with TDS concentration as compared to other physico-chemical parameters.

Keywords: Groundwater; Korpana Tehsil; Fluoride; Seasonal Fluctuation.

References:

[1] S.M.Deshpande, K.R.Aher & G.D Gaikwad ,IJRT,2012,4,120 .
[2] Ander et al.Journal of hydrology,2005,305,40-62.

OP-13

CARBONIZATION OF CASIA FISTULA SEEDS: AN EXPERIMENTAL APPROACH FOR THE REMOVAL OF CRYSTAL VIOLET DYE AND REGENERATION STUDY BY GAMMA IRRADIATION

A. S. Bambal[a], R. M. Jugade[b]

[a]Department of Chemistry, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur-440033, India.

[b]Department of Chemistry, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur-440033, India.

[a]Corresponding Author's Email: apurvabambal1996@gamil.com, Contact No.: +91 9172284837

The widespread utilization of Crystal Violet (CV) dye in textile industries for coloring cellulosic fibers is of common practice. Cationic dyes are highly toxic with respect to anionic dyes, as their trinctorial values are very high. CV dye is carcinogenic and recalcitrant molecule due to its non-biodegradability and can be persistent in a variety of environment. Hence removal of CV dye from industrial effluent is therefore essential prior to their disposal to ensure the protection of the environment and human health.

For the efficient adsorption of CV dye, Casia fistula (CF) seeds were activated by using phosphoric acid and torrified at 400^{0}C to obtain biochar in inert atmosphere. BET analysis showed that the biochar has large surface area of 1120.6 m^2/g. Prepared CF biochar was then characterized by FT-IR, TGA-DTA, SEM, EDX and XRD. It was then used for adsorption of CV dye using batch adsorption studies and the maximum adsorption capacity was found to be 208.86 mg/g. Isotherm and kinetics study revealed that the CV adsorption obeyed Langmuir isotherm and pseudo-second order kinetics. Thermodynamic studies indicated that the adsorption was exothermic in nature.

The potential of adsorbent for regeneration was investigated by regenerating adsorbent in the presence of gamma radiations using Co^{60} source. After 30 KGy gamma dose, the adsorbent was regenerated with a marginal reduction in adsorption capacity by 8.3%.

Keywords: Casia fistula; biochar; adsorption; crystal violet dye; carbonization; kinetics

References :[1] Prabu G., Muthusamy S., Selvaganesh S., Sivarajasekar N., Rambabu K., Sivamani S., Sivakumar N., Maran J.P., Hosseini-bandegharaei A. Ecofriendly biopolymers and composites : Preparation and their applications in water-treatment, *Biotechnol. Adv.* 52 (2021) 107815.

[2] Biswas S., Pal A., Application of biopolymers as a new age sustainable material for surfactant adsorption : A brief review, *Carbohydr. Polym. Technol. Appl. 2* (2021) 100145.

[4] Chemistry P., Adsorbent biopolymers from tannin extracts for water treatment, 168 (2011) 1241–1247.

OP-14

NOVEL CHITOSAN-GLUTAMIC ACID MEMBRANE FOR EFFICIENT REMOVAL OF Cr (VI) AND DICLOFENAC: INVESTIGATIONAL AND STATISTICAL APPROACH

Tejaswini. A. Rathi[a], R. M. Jugade[a]
Department of Chemistry, R.T.M Nagpur University, Nagpur 440033, India
Corresponding Author's Email: tejaswinirathi1999@gmail.com,
Contact No.: +91 7028687175

In the era of increasing environmental concern, the presence of toxic contaminants such as Cr (VI), and diclofenac in water bodies poses significant harm to human survival and eventually whole ecosystem. Cr (VI), soluble form of chromium is highly hazardous to human as well as aquatic life. Chronic exposure to Cr (VI) has detrimental effect on human health such as respiratory, skin and allergic infection. It also increases the risk of developing certain type of cancer cells. Diclofenac sodium, a non-steroidal anti-inflammatory drug (NSAID) has been recognized as a persistent organic pollutant with adverse effect on aquatic life and whole ecosystem.

Removal of these toxicants, using high efficiency adsorbents is key solution to this problem. Chitosan is second largest available biopolymer with tendency to adsorb both Cr (VI) and Diclofenac. However, the efficiency is too low to be used in water treatment. To enhance the adsorption efficiency for both Cr (VI), and diclofenac, glutamic acid crosslinked chitosan (CsG) membrane was fabricated that have the favorable characteristics of chitosan with improved mechanicals strength and chemical stability, making it an ideal candidate for efficient contaminant removal. The adsorption process relies on the interactions between the functional groups present in glutamic acid crosslinked chitosan membrane (CsG membrane) and the targeted contaminants. The prepared CSG membrane underwent characterization through techniques such as FT-IR, TGA-DTA, SEM, EDX, XRD and BET surface area analysis. Subsequently, batch adsorption studies for Cr (VI) and diclofenac were carried out, demonstrating a maximum adsorption capacities of 410.7mg g^{-1} and 132.7mg g^{-1} respectively. Isotherm and kinetics studies unveiled adherence to the Langmuir isotherm and pseudo-second order kinetics, respectively. Thermodynamic assessments suggested an exothermic, enthalpy-driven adsorption process for both targeted contaminants. Response Surface Methodology (RSM) served as a statistical tool to validate parameters optimized through batch experiments.

Keywords: *Chitosan; glutamic acid; crosslinking; Chromium (VI); Diclofenac*

[1] Garg, R., Garg, R., Sillanpa¨a, ¨ M., Alimuddin, Khan, M.A., Mubarak, N.M., Tan, Y.H. Rapid adsorptive removal of chromium from wastewater using walnut-derived biosorbents. *Sci. Rep.* 2023. 13 (1).

[2] D'Souza, G.B., Kumar, A., Kamath, S.V., Maraddi, A.S., Nataraj, S.K. Designing engineered biopolymer mesh filter for robust sequestration of chromium (VI), fluoride and other emerging pollutants: a sustainable approach. *Chem. Eng. J* 2022. 443, 136462

OP-15

LYOPHILIZED Chitosan - Barbituric acid Hydrogel for Remazol Brilliant Blue R-19 Dye Adsorption: A Thermodynamic Study

Vaishnavi Gomase*, Ravin Jugade
Department of Chemistry, R.T.M. Nagpur University, Nagpur-440013, India
Corresponding Author's Email: gomasevaishnavi50@gmail.com,
Contact No.: +91 9730893170

The widespread utilization of Remazol brilliant blue R-19 dye in textile industries for coloring cellulosic fibers is a common practice. However, a significant portion of synthetic dyes exhibits a resistance to disintegration due to their intricate molecular structures, rendering them highly toxic. Some of these dyes even possess carcinogenic properties and can cause irritation of the eyes and skin. Consequently, dyeing industries often release these harmful dyes into water bodies. The primary aim of this research is to comprehensively assess and enhance chitosan by crosslinking it with barbituric acid to facilitate the removal of Remazol brilliant blue R-19 dye. The characterization of the resulting adsorbent involved the application of various analytical techniques, including FT-IR, XRD, SEM-EDX, TGA-DTA, and BET surface area analysis. In a series of batch adsorption experiments, the process was carried out at varying conditions, encompassing pH, dosage, concentration, temperature, and time. Chitosan-barbituric acid (CBA) was employed as the adsorbent to eliminate R-19 dye from aqueous solutions. Utilizing response surface methodology (RSM), the parameters were fine-tuned, leading to the achievement of more than a 90% removal of R-19 dye. The adsorption behaviour closely adhered to the Langmuir isotherm model and followed pseudo-second-order kinetics, a conclusion supported by both isotherm and kinetics studies. It was observed that the maximum adsorption capacity (q_m) exhibited an increment with rising temperature. At specific temperatures, such as 301 K, 313 K, 318 K, and 323 K, the q_m values were identified as 566.576 mg g^{-1}, 624.736 mg g^{-1}, 671.302 mg g^{-1}, and 713.503 mg g^{-1}, respectively, in accordance with the Langmuir isotherm model. Examining the thermodynamics of the adsorption process revealed its spontaneous nature across the entire temperature range. The potential of adsorbent for regeneration was investigated through five adsorption–desorption cycles, demonstrating the reusability of the adsorbents. An analysis of the sustainability of the adsorbent synthesis process indicated its eco-friendliness, as evidenced by the low value of the E-factor.

Keywords: *Lyophilization, R-19 dye, Response surface methodology, Chitosan, Barbituric acid, Thermodynamic study*

References:

[1] Nga NK, Chau NTT, Viet PH. Preparation and characterization of a chitosan/MgO composite for the effective removal of reactive blue 19 dye from aqueous solution. Journal of Science: Advanced Materials and Devices, 2020, p. 65-72.

[2] Ahmad AL, Hameed BH. Adsorption of reactive dye onto cross-linked chitosan/oil palm ash composite beads. Chemical Engineering Journal, 2008, p. 164-172

OP-16

ASSESSMENT OF PESTICIDE RESIDUE LEVELS IN THE EXPOSED DERMAL REGIONS OF FARM WORKERS: IMPACT OF USE OF PERSONAL PROTECTIVE EQUIPMENT

Summaiya Lari[1] and Padmaja Jonnalagadda[1]*
[1]Food Safety Division, ICMR-National Institute of Nutrition, Hyderabad, Telangana, India
Email: summaiyalari@gmail.com

Background: Unsafe pesticide handling practices and limited use of personal protective equipment (PPE) by Indian farming groups has increased the risk of pesticide exposure. However, limited epidemiological and analytical studies have assessed the impact of the use of PPE on the exposure to pesticides among Indian farm workers.

Material & Methods: A community-based follow-up study was conducted to evaluate dermal exposure to pesticides and to analyse the impact of PPE usage on minimizing pesticide exposure among 120 farm workers of Rangareddy district, Telangana, India. Dosimeters, wipes, and hand-wash technique was adopted to assess dermal exposure to pesticides using liquid chromatography with tandem mass spectrometry (LC-MS/MS). Safety analysis as margins of safety was also assessed.

Results: The farm workers had an average of 18 years of farming experience and demonstrated resistance to adopting good agricultural practices. A selective and sensitive method developed was validated in-house for the quantification of pesticide residues in dermal washing samples for their detection at the lowest possible levels using LC-MS/MS with satisfactory recovery, correlation, and intra- and inter-day precision. Ten pesticide residues were detected in concentrations ranging from 0.000 to 246 g mL^{-1} in hand-wash, 0.000 to 198.33 ng cm^{-2} in patch dosimeter, and 0.000 to 1,740 ng cm^{-2} in wipe samples collected from farm workers not using PPE. The intervention study results showed that there was a significant reduction in both concentrations and numbers of pesticide residues in the hand wash, patch, and wipe samples from the farm workers who have used PPE provided to them (p<0.01). The safety risk assessment based on the margin of safety suggested that farm workers adhere to risk-prone handling practices.

Conclusion : This study confirms the high pesticide exposure risk among farm workers and highlights the importance of the use of PPE and might help in developing databases for risk assessment through dermal penetration/absorption.

Keywords : occupational-dermal-exposure, hand-wash, patch-dosimeter, wipe-samples, safety-analysis

OP-17

PREPARATION AND ASSESSMENT OF POLYHERBAL FORMULATION FOR SYNERGISTIC ANTIOXIDANT ACTIVITY

Sheba Raju[a], Sugandha Shetye[a], Jonty Rodrigues[a]
[a]*Department of Chemistry, K J Somaiya College of Science and Commerce, Vidyavihar, Mumbai-400077, India*
[a]Corresponding Author's Email: sugandha@somaiya.edu, Contact No.: +91 9819500324

Background: Combination of different herbal plants has been used widely in Indian traditional medicine systems like in Ayurveda, Siddha, and Unani for the treatment of complex and multifactorial diseases like cardiovascular and neurodegenerative diseases, Rheumatoid arthritis, Metabolic syndrome, atherosclerosis etc[1,2]. The antioxidant properties of active phytoconstituents present in different medicinal plants will work together in enhancement of overall antioxidant capacity of the formulation which will induce in suppression of oxidative stress and its associated health problems.

Objective: This work aims to assess the synergistic antioxidant activity of four selected herbal extracts when mixed in different proportions.

Methodology: Plant materials were collected from the Somaiya Vidyavihar Campus and extracted using Ultrasound-assisted technique. Twenty Polyherbal formulations were prepared by mixing the ethanolic plant extracts in different % proportions which was generated by Design expert software[3]. Total phenolic content (TPC) of polyherbal formulations was determined spectrophotometrically using Folin Ciocalteau method. The Antioxidant potential of the formulations was estimated by DPPH free radical scavenging assay. Synergistic interaction was assessed using simple arithmetic method[4].

Result: Out of the twenty-formulation studied, three formulations showed synergistic activity. Formulation 1 showed the highest synergistic activity. The observed antioxidant activity of polyherbal formulation containing *C. longa* : *T. arjuna: M. parvifolia* : *M. elengi* was 74% with maximum synergistic effect in comparison with other formulations.

Conclusion: The formulations containing *C.longa*, *T. arjuna*, *M. parvifolia, M.elengi* can be used for the further optimization and potential therapeutic analysis for the treatment of neuro-inflammatory diseases. This method can be used to quantify the efficacies of many ayurvedic Polyherbal formulations, since most of them are not standardised.

References

[1] Ghasemian, M., Owlia, S. & Owlia, M. B., *Adv Pharmacol Sci* 2016; 2016, 1–11.
[2] Zhu, F., Du, B. & Xu, *Crit Rev Food Sci Nutr* 2018; 1260–1270.
[3] Suksaeree, J., Wunnakup, T. & Monton, C. *Adv Tradit Med* 2022;22, 547–556 .
[4] Hugo, P.C., Gil-Chávez, J., Sotelo-Mundo, R.R., Namiesnik, J., Gorinstein, S. and González-Aguilar, G.A, . *Molecules*, 2012; 17(11), 12657–12

OP-18

VISIBLE LIGHT ASSISTED BIODIESEL PRODUCTION FROM WASTE COOKING OIL BY PORPHYRIN PHOTOCATALYST

Bhairav Chandroday Mataghare and Pundlik Rambhau Bhagat*
Department of Chemistry, School of Advanced Sciences, Vellore Institute of Technology,
Vellore,
TamilNadu, India-632014
Email: bhairavmataghare23@gmail.com , drprbhagat111@gmail.com

The quantity of WCO generated from domestic waste can have severe environmental consequences. It has several disadvantages like, damage aquatic ecosystems, severely block pipes when drains in the sink, and may mix with other contaminants to form toxic substances which leads to water pollution. Some modification in the WCO has prodigious potential to yield green biofuel which can not only boost up production of biodiesel but also reduce the environmental snags. This study aims to convert the fatty acids (FA) in WCO to its corresponding ethyl esters (FAEE) by using the heterogeneous recyclable porphyrin-based photocatalyst. The porphyrin photocatalyst was synthesized and scrutinized by using FT-IR, NMR, and SEM/EDAX. The esterification process is optimized by using Response Surface Methodology (RSM) based on the Box Behnken Design (BBD) approach. The four independent variables photocatalyst (15-25 mg), time (10-20 h), molar ratio (05-15 mmol), and light intensity (3-7 W) were studied including their influence on the yield of biodiesel production. The highest yield achieved was 90.23% at room temperature, with 20 mg photocatalyst loading and ethanol to oil molar ratio (10: 01 mmol) in 15h, and by exposure of 5W LED light. The photocatalyst found very effective and was recycled six times in the process with a slight decrease in the esterified product yield. The composition of the oil was confirmed by GC-MS, ^{1}H NMR, ^{13}C NMR, DEPT 135 analysis, and its physicochemical properties were scrutinized with the ASTM standard methods. The protocol was applicable for gram scale (200 g) reaction with the similar yield under optimized reaction conditions.

Keywords: Porphyrin, Photocatalysis, Waste Cooking Oil, Box Behnken Design.

OP-19

A METHOD FOR ESTIMATION OF THORIUM IN THORIUM BEARING EFFLUENTS BY ICP-AES

Y Balaji Raoa*, S NVMS Guptaa, P V Nagendra Kumarb, Dinesh Srivastavaa
a Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India
b Assistant Professor, Dept. of Chemistry, GITAM University, Hyderabad-502329, India
*Email: ybrclabnfc@gmail.com / ybr@nfc.gov.in

Thorium Nitrate is the starting material for preparation of ThO2and indigenously designed Advance Heavy Water Reactors (AHWRs) utilizes thorium and low enriched uranium (LEU) in the form of (Th-LEU)O2 MOX as fuel [1]. In this connection, issues related to treatment & management of thorium bearing effluent solutions generated from the front end cycle of fuel fabrication facility are to be addressed. In view of the stringent measures laid down by the regulator body for disposal of thorium bearing solutions, suitable treatment and containment is essential before their disposal. Accordingly, the concentration of thorium in effluents has been fixed to a maximum level of 40 ng/ml and monitoring its level is mandatory as part of QA/QC program. Several methods are cited in literature for the determination of thorium and each one of them has its own advantage and disadvantages. For example, Spectro-photometry is a time consuming method, where-as Neutron Activation Analysis (NAA) demands the availability of nuclear reactor in the proximity for neutron source. Similarly, ICP-MS, being a most advanced instrument, suffers from operational related problems due to its complexities and hence, requires skill and expertise, which make it as un-preferred choice for an industrial lab to cater high analytical load. In view of the above, an attempt has been made to analyse thorium in thorium bearing solutions using Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES). The present paper discusses about the development of a simple analytical method to estimate thorium at trace levels in thorium bearing non process effluents generated from fuel fabrication facility project at NFC [2]. Several wavelengths for thorium are studied for their suitability to measure low level of thorium and spectral lines at 274.716nm, 374.118 nm are found to have adequate sensitivity and free from interferences. Therefore, these lines are selected for further studies. Plasma parameters like RF power, plasma gas flow rate, Nebulizer gas flow, Sheath gas flow rate and height of torch have been optimized to arrive at final conditions suitable for analysis. A synthetic standard of 1000 ng/ml is used for this optimization study. At constant plasma gas flow (10L/min) and nebulizer flow (1 L/min) and torch height of 15mm above the load coil, synthetic standard was aspirated into plasma for seeing its intensity at 274.716 nm line using different RF powers. At these optimized conditions, instrument was calibrated using synthetic standard solutions and calibration curves were found to be linear over a wide range of concentration with R2 ≥ 0.998 for both the lines. Standard recovery and method recovery were calculated and it is found that recoveries are near to 100% at different concentration levels which validate the method. Also, RSD of the method was calculated and found to be ±15% at 40 ng/ml level and ±3% at 200 ng/ml level in the samples.The developed method using ICP-AES can be used for the estimation of Thorium inthorium bearing non process effluents in the concentration range 40ng/ml to 1000ng/ml.

References:

[1]. AHWR300 – LEU Advanced Heavy Water Reactor with LEU – Th MOX fuel, BARC, Mumbai.
[2]. Baidurjyanath, Y.V Swaroopalakshmi, S.K Tiwari, D.S Setty, G. Kalyanakrishnan and N. Saibaba; International Thorium Energy Conference – ThEC15, Oct 12-15, 2015, Mumbai, India

OP-20

COMPARATIVE ANALYSIS OF SOLAR ENERGY OVER CONVENTIONAL POWER SUPPLY

P. G. Lokhande[a], K. G. Lokhande[b], S. S. Uparkar[c], P. D. Shobhane[d]

[a]*Cardiff University, United Kingdom*

[b]*Priyadarshini College of Engineering, Nagpur, India*

[c]*Shri Ramdeobaba College of Engineering and Management, Nagpur, India*

[d]*Symbiosis Institute of Technology, Nagpur Campus, Symbiosis International (Deemed University), Pune, India*

[c]Corresponding Author's Email: uparkarss@rknec.edu, Contact No.: +91 9923334030

Energy that is sustainable is defined as something that never runs out or is limitless, like solar. One of the most plentiful and readily available energy sources on our planet is sunlight. The quantity of solar energy that reaches the surface of the globe in a single hour exceeds the planet's whole annual energy needs. The quantity of solar energy we can utilize varies depending on the time of day, the season of the year, as well as our geographic location, despite the fact that it may seem like the ideal renewable energy source. The fact that renewable energy can stored and used as per our requirement irrespective of presence of sunlight, dynamic whether conditions and remote geographical location makes Battery enabled storage systems and solar energy a very sustainable renewable solution than can solve many energy consumption issues. This research study focuses on the calculation of solar energy and storage system and how carbon footprint can be reduced even with a small addition of solar energy into our daily lives as a primary source of energy. In additional a case study of comparative study of Solar Energy over Conventional Power Supply of a firm has been carried out using various statistical tools. The end results reflect the facts and figures of advantages of the solar renewable energy over the conventional energy.

Keywords: Renewable energy, Solar energy, Conventional power supply, Statistical tools, Battery enabled storage systems (BESS)

References

[1] Tarek Safwal Kabel, Mohga Bassim, “Literature Review of Renewable Energy Policies and Impacts”, European journal of Marketing anf Economics, Volume 2, Issue 2, May - August 2019, 28-41

[2] Kumar. J, C.R., Majid, M.A. Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities. Energ Sustain Soc 10, 2 (2020). https://doi.org/10.1186/s13705-019-0232-1

[3] Ghosh, P., Jha, A. and Sharma, R (2020), "Managing carbon footprint for a sustainable supply chain: a systematic literature review", Modern Supply Chain Research and Applications, Vol. 2 No. 3, pp. 123-141. https://doi.org/10.1108/MSCRA-06-2020-0016

[4] B. Mohandes, M. Wahbah, M. S. E. Moursi and T. H. M. El-Fouly, "Renewable Energy Management System: Optimum Design and Hourly Dispatch," in *IEEE Transactions on Sustainable Energy*, vol. 12, no. 3, pp. 1615-1628, July 2021, doi: 10.1109/TSTE.2021.3058252.

OP-21

ASSESSMENT OF WATER QUALITY IN AMGAON'S LAKES: IMPLICATIONS FOR BEAUTIFICATION AND RECREATION

Dipali Garghate[1] **Samruddhi Bawankule**[1] **Dr. Gajanan Khadase**[1]
dipaligarghate55@gmail.com ; samruddhi1595@gmail.com ; gk_khadse@neeri.res.in
[1]CSIR- National Environmental Engineering Research Institute, Nagpur-440020, M.S., India

This study evaluates the water quality of three lakes in Amgaon town, Gondia district, Maharashtra, India under the 'Amrut Sarovar' scheme, focusing on their suitability for beautification and recreational purposes. Water samples from Matabodi Lake, Padampur Lake, and Radhakrishna Temple Risama Lake were collected and analyzed for various physico-chemical, organic and bacteriological parameters following standard methods. The results indicate that the lakes exhibit compromised water quality due to various pollutants and contaminants. Notably, the presence of free ammonia found to be 3.9 to 4.5 mg/L which exceeds permissible limits, as defined by CPCB Class D standards. The lakes also show contamination with total coliform and fecal coliform, suggesting high levels of bacterial pollution. Phytoplankton analysis reveals the prevalence of cyanobacteria species, some of which can produce harmful toxins. The phytoplankton diversity index suggests moderately polluted waters. Three samples of water from three different lakes had Shannon Wiener Diversity Index (SWI) of 1.4 to 2.1 and Palmer Pollution Index (PPI) of 14, 7 and 6 indicating mildly to moderately polluted water. Zooplankton assessment shows the presence of rotifers and Daphnia indicating certain ecological disturbances. It is evident that additional efforts are necessary to restore and maintain the water quality of these lakes to meet the standards required for beautification and recreational purposes. The study proposes implementing effective control measures to revive the lake ecosystem.

Keywords**:** Cyanobacteria, Shannon Wiener Diversity Index (SWI), Palmer Pollution Index (PPI), Zooplankton assessment, Ecological disturbances, Water quality restoration, Environmental conservation.

OP-22

OPTIMIZATION OF USED COOKING OIL BIODIESEL PRODUCED IN NOVEL REACTOR: A FUTURE RENEWABLE ENERGY

A.V. Kurve[a], R. R. Gedam[b], V. N. Ganvir[c], P. N. Belkhode[d]

[a] Research Scholar, Laminarayana Innovation and Technological Institute, Nagpur-440010, India

[b] UG student, Priyadarshini College of Engineering, Nagpur-440001, India

[c] Associate Professor , Laminarayana Innovation and Technological Institute, Nagpur-440010, India

[d] Research Scholar, Laminarayana Innovation and Technological Institute, Nagpur-440010, India

[a] Corresponding Author's Email: anjalivkurve@gmail.com, Contact No.: +91 9860843628

In order to fulfill the increase in demand of fuel, there is no other alternative than to switch over the renewable energy resources. Replacement of petroleum diesel by used cooking oil (UCO) Biodiesel is an emerging future fuel. Optimization is a technique, which assures the safety with environmental standards, improve outcomes as well as economic viability. Hence, chemical processes function better overall after optimization.

In this experimental work, UCO biodiesel produced in Spiral Static Reactor via trans-esterification reaction. UCO biodiesel production optimized with the help of Minitab and LABFIT. The optimization study has considered Oil to Alcohol Molar ratio, Catalyst concentration as independent variables and yield of biodiesel as a dependent variable. This study investigated the oil to methanol molar ratio at 0.16667 and 2-weight % of catalyst concentration resulted into 90% yield of UCO biodiesel which are the optimized conditions for UCO biodiesel production.

The advancements of this research are the process intensification by using spiral static reactor and optimization of biodiesel production technology. It leads to promote sustainability and green way to environment.

Keywords : Optimizing Technique; Trans-esterification Reaction; Renewable Energy; LABFIT; Minitab;

References

[1] F. Ma and M. A. Hanna, "Biodiesel production: a review 1." https://doi.org/10.1016/S0960-8524(99)00025-5

[2] H. G. Abubakar, A. S. Abdulkareem, A. Jimoh, O. D. Agbajelola, J. O. Okafor, and E. A. Afolabi, "*Optimization of biodiesel production from waste cooking oil," Energy Sources, Part A: Recovery, Utilization and Environmental Effects*, vol. 38, no. 16, pp. 2355–2361, Aug. 2016

[3] P. D. Patil and S. Deng, "*Optimization of biodiesel production from edible and non-edible vegetable oils," Fuel*, vol. 88, no. 7, pp. 1302–1306, Jul. 2009

[4] T. Jin, B. Wang, J. Zeng, C. Yang, Y. Wang, and T. Fang, "*Esterification of free fatty acids with supercritical methanol for biodiesel production and related kinetic study,*" *RSC Adv*, vol. 5, no. 64, pp. 52072–52078, 2015

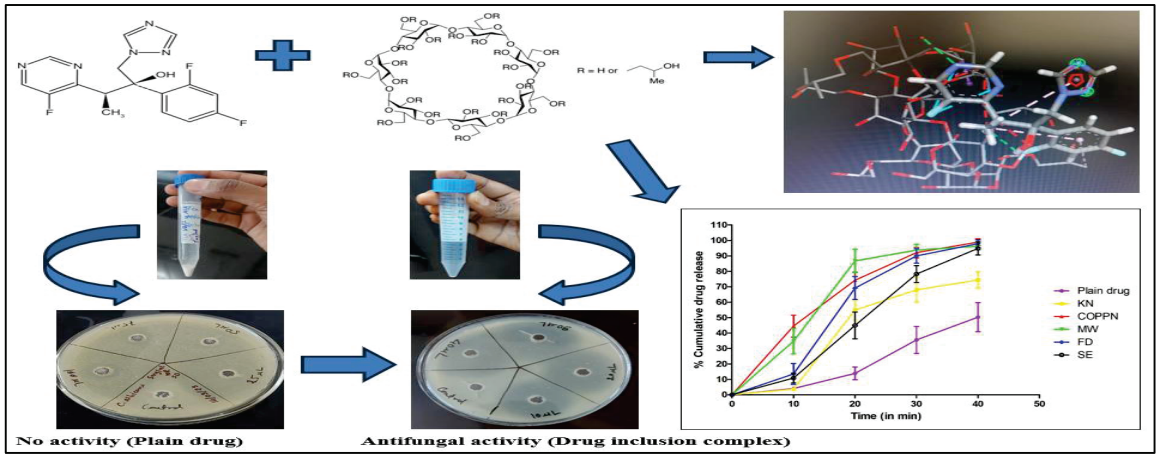
[5] A. N. Phan and T. M. Phan, "*Biodiesel production from waste cooking oils*," *Fuel*, vol. 87, no. 17–18, pp. 3490–3496, Dec. 2008.

OP-23

INCLUSION COMPLEX OF VORICONAZOLE WITH HYDROXY PROPYL BETA CYCLODEXTRIN: PREPARATION, CHARACTERIZATION, AND A STRUCTURAL INSIGHT

P.S. Kanojiya[a], **R. N. Wadetwar**[a], **A. P. Godbole**[a]
[a]*Department of Pharmaceutical Sciences, Rashtrasant Tukaodoji Maharaj Nagpur University, Amravati Road, Nagpur-440033, India*
[a]Corresponding Author's Email: pranita.kanojiya@gmail.com,
Contact No.: +91 9284296479

Voriconazole is an antifungal drug, however, it has poor aqueous solubility belonging to BCS class II. Hence, the inclusion complex of Voriconazole with hydroxyl propyl beta cyclodextrin by different methods was prepared such as kneading (KN), coprecipitation (COPPM), solvent evaporation (SE), freeze-drying (FD), and microwave irradiation (MW). The phase solubility study was performed and the molar ratio of Voriconazole to Hydroxy propyl beta-cyclodextrin was found to be 1:2.5. The solubility of the inclusion complexes was studied, and characterization of the inclusion complexes was carried out using FTIR, DSC, XRD, NMR, and SEM studies. All these studies confirmed the formation of the inclusion complex. The solubility studies showed a higher value for the COPPM inclusion complex. The *in vitro* dissolution studies resulted in higher dissolution from COPPM (98.928±2.17%) as compared to the plain drug (50.293±9.47%). The *in vitro* antifungal assay was carried out to check the efficacy of the inclusion complex which resulted in enhanced antifungal activity of the inclusion complex.



Keywords: Voriconazole, Hydroxy propyl beta cyclodextrin, Inclusion complex, in vitro dissolution, in vitro antifungal study

References

[1] Li J, Zhang S, Zhou Y, Guan S, Zhang L. J. Incl. Phenom. Macrocycl. Chem. 2016;84:209-17.
[2] Liu K, Liu H, Li Z, Li W, Li L. J. Incl. Phenom. Macrocycl. Chem. 2020;96:233-43.

OP-24

REMOVAL OF CRYSTAL VIOLET, AN EMERGING POLLUTANT FROM ITS AQUEOUS SOLUTION USING BIOCHAR PREPARED FROM COCONUT SHELL

Jonty Rodrigues[a], Sugandha Shetye[a], Sheba Raju[a]

[a]*Department of Chemistry, K J Somaiya College of Science and Commerce, Vidyavihar, Mumbai, 400077 India*

[a]Corresponding Author's Email: sugandha@somaiya.edu,
Contact No.: +91 9819500324

Introduction: Emerging pollutants (EPs) are chemicals that are not commonly monitored or regulated in the environment like antibiotics, synthetic dyes, personal care products (PCP), etc. Biochar, a material derived from the pyrolysis of biomass, has excellent surface properties such as high surface area, high porosity and ion exchange capacity [1]. Crystal Violet is a synthetic dye which is carcinogenic, genotoxic and mutagenic causing development of tumour in some species of fish if persistent in environment for long periods of time [2]. Biochar can be used as a good adsorbent due to its excellent surface properties to remove crystal violet from its aqueous solution.

Methodology: Coconut shell powder was subjected to pyrolysis at four distinct temperatures to obtain biochar samples. Proximate analysis was performed for all the biochar samples obtained. The sample were characterised using FTIR. Adsorption studies were carried out to determine the efficiency of the biochar samples for removal of an organic dye viz. crystal violet from its aqueous solution. Design Expert Software (Version 13) was used to perform a response surface methodology experiment for optimizing the dosage of biochar and concentration of the organic dye. The optimized parameters were used to perform kinetics and isotherms studies.

Results: As the temperature increase the pH and Ash content increased, the yield of biochar decreased and there was a decrease in the oxygen containing functional groups and increase in aromaticity and formation of unsaturated groups [3]. Response surface methodology suggested the optimum dosage of biochar required is 250 mg at a concentration of 10 ppm. The biochar sample produced at 700 °C displayed 63 % removal efficiency. The adsorption process adhered to second-order kinetics, and the maximum adsorption capacity, according to the Langmuir adsorption isotherm, was determined to be 124.41 mg/g [4].

Conclusion: In conclusion, biochar derived from coconut shells, pyrolyzed at 700 °C, exhibits an outstanding capacity for removal of the organic dye like crystal violet from its aqueous solution.

Keywords: Biochar, Emerging Pollutants, Synthetic Dyes, Design of Experiment.

References

[1]. Braghiroli, F. L., Bouafif, H., Neculita, C. M. & Koubaa, A., *Water Air Soil Pollution,* 2018; 229
[2] Mani, S., & Bharagava, R. N., *Review of Environmental Contamination and Toxicology*, 2012; 237,71–104.
[3]. Behrens, M., Cross, J. S., Akasaka, H. & Ohtake, N., *Biomass Bioenergy*, 2019; 122
[4]. Zhou, R., Zhang, M., Zhou, J. & Wang, J, *Scientific Reports*, 2019; 9.

OP-25

A SIMPLE METHOD FOR DETERMINATION OF NON-METALLIC ELEMENTS IN URANIUM BASED SAMPLES USING ICP-AES

Y BalajiRao[a]*, S NVMS Gupta[a], P V NagendraKumar[b], Dinesh Srivastava[a]
[a] *Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India*
[b] *Assistant Professor, Dept. of Chemistry, GITAM University, Hyderabad-502329, India*
**Email:* ybrclabnfc@gmail.com / ybr@nfc.gov.in

Nuclear Fuel Complex (NFC) is engaged in production of sintered UO_2 pellets as nuclear fuel for Pressurized Heavy water Reactors (PHWRs) operating in India. Sodium Di Uranate (SDU)/Heat treated Uranium Peroxide (HTUP)/Uranium Ore Concentrate (UOC) is the raw material for fuel production and stringent specifications have been laid down by the reactor designers for achieving the optimum performance of fuel. Phosphorous (P) and Sulfur(S) [1] are important non-metallic elements among other critical parameters to be monitored on regular basis as an integral part of QA/QC programme. Sulphur if present greater than 20 ppm in UO_2 powder may cause coring (differential microstructure) in UO_2 pellet during sintering process and P present in UNPS may affect the precipitation operation. Therefore, concentration of P and S is monitored in UO_2 pellets production stream. The stream samples include UNPS, UO_2 powder and UO_2 pellet. Several analytical techniques such as UV-Vis spectrometry, Graphite furnace atomic absorption spectroscopy (GF-AAS) [2] are cited for the determination of phosphorus and Gravimetry, Turbidimetry are cited for determination of Sulphur content in Uranium matrix. UV-Vis spectrophotometry, Gravimetry, turbidimetry being time consuming methods are not preferred choices for an industrial lab. Where-as GF-AAS suffer from poor precision. The combustion-NDIR method for determination of sulphur is restricted to solid/powder samples and cannot be used for liquid sample like UNPS. In view of this, successful attempt has been made to develop a single method for determination of P and S in all the samples from UNPS to sintered UO_2 pellets using ICP-AES. Prior separation of uranium matrix is carried-out to avoid spectral interference during ICP-AES measurements. Several solvents like Tri-n-butyl phosphate (TBP), Tri-n-octyl phosphine oxide (TOPO), Tris 2-ethylhexyl phosphate (TEHP) are choose to study their suitability for uranium matrix separation and the details are discussed in the paper. Effect of residual uranium (left-out after the separation) on determination of P and S is also discussed in the paper. Optimization of instrumental parameters like wavelength selection, RF power, Plasma gas flow, nebulizer flow, nitrogen purging time etc are also detailed in the paper. A 214.914nm line for phosphorous and 181.978 nm line for sulphur found to be suitable for the present purpose. Calibration of the instrument has been carried out at the optimized conditions using a set of matrix matching standards and correlation coefficient was found to be greater than 0.99. Standard recovery study was carried out to validate the developed method and in all the cases the recovery values found between 100 ± 10% for both the elements which shows the reliability of the developed method. Limit of quantification for this method found to be 10ppm for sulphur and 20ppm for phosphorous which meets the requirements laid down for the UO_2 fuel. A % RSD of the developed method found to be less than 3%.

References:

1. P. Balakrishna, etal., Transactions of the Indian Ceramic Society; *Vol. 46 (1987) 153-161*
2. D.M. Hughes, D.C. Gregoire, H. Naka, C.L. Chakrabarti; *Spectrochim. Acta,* B53, 1079(1998).

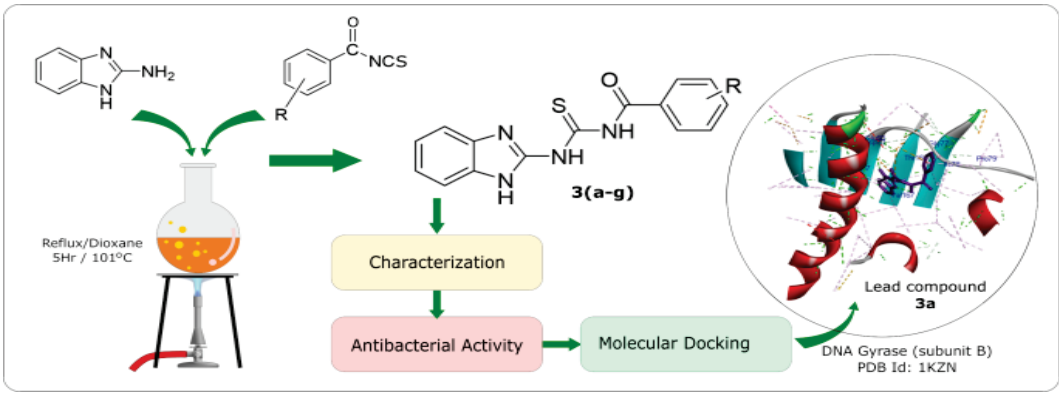
OP-26

EXPLORATION OF MOLECULAR PROPERTIES AND BIOLOGICAL ASSESSMENT OF NEWLY SYNTHESIZED N-(1H-BENZO[D]IMIDAZOL-2-YLCARBAMOTHIOYL)-2/4-SUBSTITUTED BENZAMIDES

P. M. Wanjari[a], A. V. Bharati[a], S. N. Mokale[b], V. N. Ingle[c],
[a]*Department of Applied Chemistry, Shri Ramdeobaba College of Engineering and Management, Nagpur, 440013, Maharashtra, India*
[b]*Y. B. Chavan College of Pharmacy, Dr. Rafiq Zakaria Campus, Aurangabad, 431001, Maharashtra, India*
[c]*P. G. Department of Chemistry, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur, 440033, Maharashtra, India*
[a]E-mail: poonamwanjari3@gmail.com, Contact No.: +91 8983987731

We synthesized novel l series of N-(1H-benzo[d]imidazol-2-ylcarbamothioyl)-2/4-substituted benzamides **3(a-g)** by reacting 2-aminobenzimidazole and different benzoyl isothiocyanates. The structural confirmation of all newly synthesized compounds was achieved through elemental analysis, along with comprehensive spectral studies (IR, ^{1}H NMR, ^{13}C NMR, and mass). Antibacterial activity assessment against both gram-positive and gram-negative bacterial strains revealed that these compounds exhibited moderate to potent antibacterial effects comparable to conventional medicines.
Notably, compounds **3a, 3b, 3c,** and **3e** have shown significant antibacterial action against a tested range of bacterial species. To further explore the binding interactions and affinity of the most promising ligands with proteins, a molecular docking study was conducted utilizing the binding pocket of DNA gyrase (subunit B).

Graphical Abstract



References

[1] Sridhar Babu G, Rajani N, Malathy PS, Srinivas B, Kulandaivelu U, Rao JV. *Der Pharma Chem* **2010; *2***, 196.
[2] Yadav S, Lim SM, Ramasamy K, Vasudevan M, Shah SA, Mathur A, Narasimhan B. *Chem Cent J* **2018**; ***12:*** 12.

OP-27

REVOLUTIONIZING PROTEOMIC VALIDATION: THE ROLE OF N-TERMINAL ACETYLATION IN ENHANCING PROTEIN IDENTIFICATION AND CHARACTERIZATION

M.V.Jagannadham [a,b], Deepika Chandra [a], Mudita Vats[a], M.K. Ray[a] and R. Nagaraj [a]
[a] *CSIR-Cente for Cellular and Molecular Biology, Hubshiguda, Hyderabad, India*
b School of Life Sciences, University of Hyderabad, Hyderabad, India
[b]Corresponding Author's Email: medicharlavj@gmail.com, Contact No.: +91 9490311294

In the realm of Proteomics studies, the imperative to expand the roster of identified proteins and fortify their validations cannot be overstated. The determination of peptide sequences in proteomics hinges on the exploration of tandem mass spectra through databases. An intriguing aspect lies in the elusive detection of b1 ions in a majority of peptides, although they play a pivotal role in discerning the amino-terminal amino acid of the peptide. Notably, amino acids featuring nucleophilic side chains, such as Histidine, Arginine, Lysine, and Cysteine, yield b1 ions. Complicating matters, the gas-phase reactions of MS reveal the cyclization of peptides, potentially generating scrambled b ions that confound accurate sequencing. Crucially, our investigations, aligned with broader studies, spotlight the efficacy of N-terminal acetylation in averting cyclization, amplifying the presence and intensity of b-ions, and facilitating the generation of the elusive b1-ions. Our exploration, encompassing acetylamino acids and the acetylation of tryptic peptides on a Proteome scale, has unearthed the formation of b1-ions and an enhanced overall MS/MS spectral quality. Applied to the proteome of the Antarctic bacterium *Pseudomonas syringae* Lz4W, acetylation emerges as a promising tool for validating identified proteins. Traditionally, western blot analysis employing antibodies has been the conventional validation method, albeit characterized by its time-consuming and expensive nature. Our laboratory's technological innovation underscores that acetylation presents an economical, swift (under 5 minutes), and scalable alternative at the proteome level, devoid of sample loss. Conducted in volatile solvents such as acetonitrile and methanol, with the aid of the base triethanolamine, acetylation was seamlessly integrated into the workflow. Following protein extraction, SDS-PAGE, and in-gel trypsin digestion, peptides were bifurcated for analysis— one part subjected to LC-MS/MS and the other post-acetylation. The amalgamation of both methods yielded a comprehensive identification of 1139 proteins, with acetylation proving instrumental in identifying an additional 69 proteins. Notably, 673 proteins were validated through this streamlined process, demonstrating the efficiency and efficacy of acetylation as a valuable tool in proteomic studies. This technology accelerates the research in Agriculture, health care, and Biotechnology and has a wide variety of applications.

Keywords: acetylation; b-ios; Mass spectrometry; proteomics; peptides; MS/MS spectra

References:

[1] Deepika Chandra, P Gayathri, Mudita Vats, R Nagaraj, MK Ray, MV Jagannadham. European J Mass Spectrom 2020; 26(1):36-45
[2] Harrison AG. J Am Soc Mass Spectrom. 2009; 20: 2248-2253. DOI: 10.1016/ j. jasms.2009.08.013.
[3] Harrison AG. Mass Spec Rev 2009; 28: 640–654.

OP-28

SPECTROPHOTOMETRIC ANALYSIS TO IDENTIFY POTENTIAL CONTAMINATION USING IMAGE PROCESSING ALGORITHM ON LEAFY VEGETABLES

V. S. Lande, S. L. Mudliar, S. V. Vyawahare*, E. P. Zanwar , S. R. Jaiswal
Shri Ramdeobaba College of Engineering and Management, Department of Chemistry & Electronics and Communication Engineering, Katol Rd, Gittikhadan, Nagpur,440013, India *
Author's Email: vyawaharesv@rknec.edu, Contact No.: +91 8411929114

This research addresses the critical issue of pesticide residue detection in agricultural produce, with a specific focus on the widely used organophosphate pesticide, Monocrotophos. The challenge lies in ensuring food safety and meeting consumer demands for pesticide-free products. The study employs a two-fold approach, combining chemical testing and image processing techniques to enhance the accuracy and efficiency of pesticide residue assessment.

In chemical testing phase, leafy vegetable i.e. spinach samples were meticulously collected , contaminated with Monocrotophos under controlled conditions, and analysed using a diazotized p-amino acetophenone reagent which reacts with Monocrotophos and shows colour change shown in Figure 1 and 2. UV-VIS Spectrophotometer is used to measure absorbance, facilitating in finding the maximum absorbance (facilitating in finding the maximum absorbance (λ(max) region which lies near 560nm shown in Figure 3. This biased sample then goes through Image analysis which evaluates food item edibility through diverse light sources, employing thresholding processes and image transforms with pseudo-colour image processing.

Figure 1 Before adding reactive agent 20 ml Monocrotophos with 100 ml water

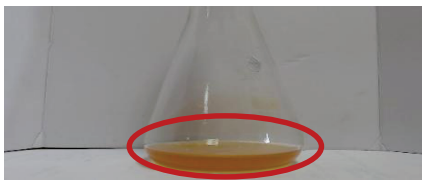


Figure 2 : After adding reactive 20 ml Monocrotophos with 100 ml water

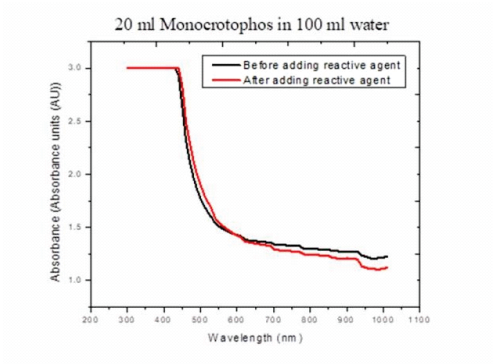


Figure 3: Absorbance vs Wavelength Graph

This methodology ensures a thorough assessment of potential contamination in leafy vegetables. The research contributes to innovative technologies aligning with consumer safety expectations, regulatory standards, and environmental sustainability. By leveraging Monocrotophos as the primary pesticide, the study presents a promising step towards bridging the gap between consumer demand for safe food and the limitations of current pesticide residue detection methods in the agricultural supply chain.

References

[1] Janghel, E.K., Rai, J.K., Rai, M.K., & Gupta, V.K. (2006); *A New and Highly Sensitive Spectrophotometric Determination of Monocrotophos in Environmental, Agricultural and Biological Samples*; Journal of The Chinese Chemical Society, 53; 343-347.

[2] Hemraj Sharma,Hari Prasad Sapkota,Kanchan Paudel,Anusha Raila, Sujata Kandel, Pramod Chaudhary and Kritika Bhattarai;*Green Spectrophotometric Determination of Organophosphate in Selected Fruits and Vegetables*, International Journal of Analytical Chemistry, vol. 2023, Article ID - 6691659, Jun. 2023; DOI: 10.1155/2023/6691659.

[3] L. Sun, X. Cui, X. Fan, X. Suo, B. Fan, and X. Zhang; *Automatic detection of pesticide residues on the surface of lettuce leaves using images of feature wavelengths spectrum*, Front. Plant Sci., vol. 13; 2022doi: 10.3389/fpls.2022.929999.

OP-29

LIQUID CHROMATOGRAPHIC APPROACH IN QUANTIFYING PHENYL PORPHYRIN, SUBSTITUTED PHENYL PORPHYRINS AND THEIR METAL COMPLEXES: NOVEL METHOD DEVELOPMENT AND VALIDATION

Ashish M. Ujagare[a], Matthew C. Uzagare, Bhausaheb N. Ghogare, Lokesh Kumar Gupta, Vishwanath Patil, Kamini Donde*[a]

Address: [a]Department of Chemistry, Ramnarain Ruia Autonomous College, L.N. Road, Matunga (East), Mumbai- 400 019, Email: kaminidonde@ruiacollege.com

The present research involves the development of a novel, efficient and accurate analytical method for in-process control, to determine the chromatographic purity and assay of phenyl porphyrin, substituted phenyl porphyrins and their metal complexes that were synthesized and characterized.

The crux of this innovation lies in the development of a novel HPLC method designed to assess the purity of phenyl porphyrins, substituted phenyl porphyrins, and their associated metal complexes. This method serves as a potent tool for online monitoring of the entire reaction process, encompassing both the formation of porphyrin and its subsequent transformation into the corresponding metal complex. This approach facilitates the optimization of reaction conditions, aiming to achieve maximal conversion of the starting material into the desired product. By minimizing the formation of undesired by-products, the method contributes to obtaining superior purity and yield of the final product. Remarkably, such an approach has not been explored previously for these specific molecules.

Utilizing this innovative analytical method, all porphyrin products along with their corresponding metal complexes were synthesized. This approach was employed for in-process quality control checks, as well as for assessing the purity and potency of the isolated product through HPLC analysis. The product yield is within the range of 25% to 40%, accompanied by HPLC purity ranging from 97% to 99% for porphyrins and yields ranging from 50% to 95% for metallo-porphyrins, with HPLC purity ranging from 95% to 98%. This study encompasses phenyl porphyrin, substituted phenyl porphyrins, and their metal complexes, including but not limited to Cu and Ni. These components are explored in the research for their versatile applications in diverse fields, including electronics, catalysis, and potential uses in harvesting solar energy and CO_2 conversion.

Keywords: Phenyl porphyrin, Substituted phenyl porphyrins, Metallo-phenyl porphyrins, Porphyrin HPLC method.

OP-30

XENOTIME : A SUITABLE PHASE FOR IMMOBILIZATION OF NUCLEAR WASTE, A CASE STUDY BASED ON PETROGRAPHIC OBSERVATION OF RADIOACTIVE LEUCOSOMES OF NANIYAGARH AREA, SINGRAULI DISTRICT, MADHYA PRADESH, CENTRAL INDIA

Pritam Karmakar[1], Satyaki Samanta[1], E Lingamurty[1], Priyatham Kumar[1], Junaid Ahmed[2], P.K. Gupta[1], Mayank Agarwal[3] , B. Saravanan[3]
Atomic Minerals Directorate for Exploration and Research, Nagpur[1], Delhi[2], Hyderabad[3]
Corresponding E-mail : pritamkarmakar.amd@gov.in

Rare-earth phosphates such as monazite, xenotime are presently being studied as glass-ceramic composites, having potential use in nuclear waste disposal applications considering the resistance of these materials to radiation-induced structural damage. Radioactive pegmatoidal leucosome of Chhotanagpur Granite Gneissic Complex (CGGC) intercepted in a borehole from Naniyagarh area, Singrauli district, Madhya Pradesh, contains U, Th and REE minerals such as uraninite, uranothorite and xenotime. Petrological study infers that xenotime occurs as inclusion within plagioclase and biotite (Fig.1). Xenotime grains show a wide variation of grain size (92µm to 1035µm, n=20). Xenotimes show high Y_2O_3 (43.04-44.56 wt.%), P_2O_5 (31.29-34.02 wt.%) and HRE_2O_3 (18.08-18.68 wt.%). Inclusion of uraninite, thorite and uranothorite have been documented within xenotime grains (Fig.2 & 3). Microscopic radial fractures surrounding uraninite, thorite and uranothorite noted within xenotime, which are delimited within minute distance and not affecting original properties of xenotime. Dimension of tiny inclusions of U, Th bearing phases varies between 5 µm to 25µm within coarse grained xenotime, possibly representing temperature controlled exsolution texture in a closed chemical system. Mineral chemical composition of uraninite shows appreciably high ThO_2 (4.28 & 4.48 wt.%), RE_2O_3 (2.28 & 2.83 wt.%) and Y_2O_3 (7.34 & 7.17 wt.%) implying high temperature origin. Inspite of having several inclusion of actinides with varying size, the xenotimes are not metamict in nature and maintaining their original characteristics over a wide geological time. It further depicts that, the xenotimes are able to retain actinides, which only causes micro radial cracks in the host xenotime. This study suggests that xenotime could be a phase suitable to be included in glass-ceramics composites designed for the immobilization of high level nuclear waste.

Keywords: Xenotime, uraninite, non-metamict, nuclear waste disposal

OP-31

EFFECT OF ELECTROLYTE CONCENTRATION ON DIFFUSION OF Fe^{3+} IONS IN AGAR GEL MEDIUM CONTAINING COPPER SULFATE

M. S. Gupte
Department of Chemistry, Modern college of arts, science and commerce,
Ganeshkhind Pune 411053, India
[a]Corresponding Author's email: mohinigupte@moderncollegegk.org
Contact No.: +91 8956601615

The present paper deals with studies on the diffusion of ferric ions in agar gel medium containing copper sulfate. The effect of electrolyte concentration and temperature on the diffusion of Fe^{3+} ions in copper sulfate was studied with a view to verify Wang's model of diffusion. The diffusion coefficients were measured using the zone diffusion technique and found to vary with the concentration of electrolyte. The activation energy (*E)* is found to decrease with increasing electrolyte concentration which is in agreement with Wang's model. This observation is explained on the basis of the distortion in the water structure caused by ions and agar molecules.

Keywords: Diffusion; agar gel medium; Ferric ions; supporting electrolyte; activation energy; tracer diffusion.

References

[1] Mohanakumar, S., Wiegand, S. Towards understanding specific ion effects in aqueous media using thermodiffusion. *Eur. Phys. J. E* 45, 10; 2022.

[2] Rajurkar, N.S., Kute, M.M. Determination of Activation Energy for the Diffusion of Fe^{3+} Ions in Agar Gel Medium Containing Various Transition Metal Sulfates. *J Solution Chem* 39, 2010, 87–95.

[3] Rajurkar, N., Kute, M.: Study of obstruction effect and activation energy for tracer diffusion of chromium ions in agar gel containing transition metal sulfates. J. Mol. Liq. 142, 2008, 6–9 .

OP-32

NATURAL INDIAN INDICATORS: AN ALTERNATIVE TO THE FOREIGN INDICATORS

M. S. Joshi[a], A. S. Rak[b], R. C. Uttekar[c], P. A. Dwivedi[d]
[a]Corresponding Author's Email: kmukula@gmail.com, Contact No.: +91 9822749483

The indicators used in chemical laboratories are mainly of foreign origin. The aim of our study is to develop an effective alternative to these indicators. In the present work, the preparation and application of few natural indicators of Indian origin are discussed. These indicators were found eco friendly, economical and equally competent.

Keywords: natural indicators, pH, colour change

References

[1] Aras Kooser, Judith L., Jenkins, Lawearence E. Welch; *J. Chem. Educ.*, 2001; 78, 11:15049.
[2] Rany Im, Toutomu Iwayama, Masashi Osa; *J. Chem. Educ.;* 2023, 100, 12, 4707–4713.

OP-33

COMPARATIVE STUDY OF UV SPECTROSCOPY, RP-HPLC AND HPTLC METHODS FOR QUANTIFICATION OF ANTIVIRAL DRUG LAMIVUDINE IN TABLET FORMULATION

Komal Somkuwar*, Prafulla Sabale, Vaibhav Sawale, Rina Ikhar and Priya Rahangdale
Department of Pharmaceutical Sciences, R. T. M. Nagpur University, Mahatma Jyotiba Fuley Educational Campus, Amravati Road, Nagpur-440033, Maharashtra, India.
*Corresponding author's Email: sweetsomkuwar@gmail.com

Lamivudine (LMU) is an antiviral drug used to treat hepatitis B and HIV (human immunodeficiency virus). It is effective against both HIV-1 and HIV-2. In the current study, UV spectroscopy, RP-HPLC and HPTLC methods were developed for quantification of LMU in tablets and comparative studies between the methods were investigated by analytical results and statistical test Analysis of variance (ANOVA). UV spectrophotometry was performed at 271 nm absorption maxima using methanol as the solvent. In the RP-HPLC method, Shimadzu C18 column (5 µ, 250 mm × 4.6 mm) was used for chromatographic separation. The mobile phase used was a mixture of methanol:water (70:30 v/v) at a flow rate of 1.0 ml/min in isocratic mode. The retention time of LMU was 3.1 min and the total run time of analysis was 5 min. In the HPTLC method, the chromatogram was developed on a precoated plate of silica gel 60 F254 using a mobile phase of chloroform:methanol (8:2, v/v). The quantification was performed at absorbance mode of 271 nm by densitometry. The R_f value of LMU was 0.49–0.62. The correlation coefficient for UV, HPLC and HPTLC were found to be 0.9980, 0.9993 and 0.9988 and the percent recoveries were calculated as 98.40-100.52%, 99.27-101.18% and 98.01-100.30% respectively with percentage relative standard deviation less than 2% showing that the developed methods were accurate and precise. Moreover, the shorter duration of analysis for LMU makes these reported methods suitable for routine quantitative analysis in Tablets.

OP-34

DEVELOPMENT AND VALIDATION OF RP-HPLC METHOD FOR QUANTITATIVE ESTIMATION OF RITONAVIR IN BULK AND PHARMACEUTICAL FORMULATION

Vaibhav Sawale*, Prafulla Sabale
Department of Pharmaceutical Sciences, R. T. M. Nagpur University, Mahatma Jyotiba Fuley Educational Campus, Amravati Road, Nagpur-440033, Maharashtra, India.

A novel was developed to estimate Ritonavir and its tablet formulation by Reverse Phase Chromatographic method. The chromatographic parameters were effectively optimized to achieve the separation of Ritonavir and tablet, employing a Shim-Pack Solar C18 column (4.6x250nm) with a 5µm particle size. The flow rate was adjusted at 1.0ml/min, and the mobile phase consisted of a mixture of acetonitrile and water in a ratio of 70:30%v/v. detection of Ritonavir was performed at a wavelength of 239nm. The HPLC system employed consisted of a Shimadzu HPLC Auto Sampler, a separation module DGU-20A5R, a photodiode array detector, and lab solution software. The retention time was determined to be 5.790 minutes, and the purity of Ritonavir was measured at 99.16%. System suitability parameters for Ritonavir, including theoretical plates (8358) and tailing factor (1.077), were also assessed. Additionally, the method was validated according to ICH guideline Q2 (R1) to assess accuracy, precision, specificity, linearity, and robustness as well as determine the limits of detection (LOD) and quantification (LOQ).

A developed method was simple, accurate, rapid, and precise and validated for determination of Ritonavir and its tablet formulation.

Keywords: Ritonavir, RP-HPLC, Shim-Pack Solar C_{18} Column.

OP - 35

GREEN ROUTE SYNTHESIS OF PMMA AND MgO COMPOSITE MATERIALS FOR INDUSTRIAL APPLICATIONS

Pranali P. Kharwade[a], Seema G. Rawat[b*], Tushar C. Borkar[c], Shubhangi V. Khapekar[d], Harsha N. Bhutada[e]

[a]Assistant Professor, Department of Applied Science and Humanities, Guru Nanak Institute of Engineering and Technology, Kalmeshwar Road, Dahegaon, Nagpur-441501, Maharashtra, India.

[b]Assistant Professor, Department of Applied Science, Priyadarshani College of Engineering, CRPF gate Hingna, Nagpur-440019, Maharashtra, India.

[c]Assistant Professor, Department of Applied Science and Humanities, Guru Nanak Institute of Technology, Kalmeshwar Road, Dahegaon, Nagpur- 441501, Maharashtra, India

[d]Assistant Professor, Department of Chemistry, L.A. D. College,

Shankar Nagar, Nagpur-440010, Maharashtra, India
[e]*Lecturer, Bharat Junior College, Hinganghat, Wardha, Maharashtra, India*
Corresponding Author's Email: seemagrawat@gmail.com,
Contact No.: +91 7743895234,
Pranali61196@gmail.com, Contact No.: +91 8855083373

This study investigates the synergistic potential of Poly(methyl methacrylate) (PMMA) and Magnesium Oxide (MgO) composite materials for advanced applications. The blend of PMMA and MgO offers a unique combination of properties, including improved mechanical strength, thermal stability, and optical clarity. The research focuses on the synthesis process, characterizing the structural and thermal properties, and exploring the material's performance in diverse applications. Key findings suggest that the composite exhibits promising attributes for fields such as optoelectronics, aerospace, and biomedicine. The study contributes to the understanding of composite material design and opens avenues for tailored solutions in cutting-edge technologies. This delves into the intricate realm of composite materials, focusing on the amalgamation of Poly(methyl methacrylate) (PMMA) and Magnesium Oxide (MgO). This study aims to unlock the potential synergy between these components, investigating their combined impact on mechanical, thermal, and optical properties. The synthesis process is scrutinized, elucidating the intricate structural transformations and thermal stability achieved through the integration of PMMA and MgO. Characterization techniques such as X-ray diffraction, scanning electron microscopy, and thermal analysis provide insights into the composite's unique microstructure and thermal behaviour. The research also explores the material's application in advanced fields, demonstrating its enhanced mechanical strength and optical clarity. In the realm of optoelectronics, aerospace engineering, and biomedicine, the PMMA and MgO composite exhibits promise as a multifunctional material. The findings contribute significantly to the evolving landscape of composite materials, shedding light on tailored solutions for diverse technological applications. This study not only advances our understanding of material science but also propels the development of innovative materials with potential transformative impacts across industries.

Keywords : Green Route synthesis; MgO; Polymethyl methacrylate; Thermal; Photoelectonics.

References

[1] Smith, A. B., et al. (2023). "Synthesis and Characterization of PMMA and MgO Composite Materials." Journal of Materials Science, 34(2),2023; 129-134.

[2] Mohsen Hajibeygi Johnson, C. D., et al. (2021). “Design and preparation of new polypropylene/magnesium oxide micro particles composites reinforced with hydroxyapatite nanoparticles” Material Chemistry and Physics, 258(15), 2021;123917.

OP-36

Estimation of MOX Fuel Homogeneity by Radiation Image analysis

Rajashree Dixit*[ab1], K. V. Vrinda Devi[a], S. Mukhopadhyay[b1], Amrit Prakash[a]
[a]Radiometallurgy Division
[b]Electronics and Instrumentation Group
Bhabha Atomic Research Center, Mumbai, India
[1]Homi Bhabha National Institute
* Email: rajashree@barc.gov.in

Radiation imaging finds its widespread relevance in several industries for being an effective nondestructive characterization technique for various elements and its constitution. In the nuclear industry this analysis can be done by exposing the nuclear fuel to external radiation sources as well as by its internal emissions. For characterization of plutonium bearing nuclear fuel which has strong internal emission namely α radiations , γ-rays, neutrons, etc; self-radiation images can be very useful. This imaging technique is commonly known as autoradiography. Gamma autoradiography (GAR) has been used as a non-destructive evaluation (NDE) technique for effective quality control of nuclear fuel elements [1]. Although GAR can reveal the details of the fuel inside the encapsulated pins, it is very complex to derive conclusions using conventional methods of evaluation.

To attend to the above issues analytical studies have been attempted to estimate the plutonium heterogeneity in fast reactor fuels from auto radiographs [2]. Conventional film based γ- autoradiography was used for the study and the auto radiographs were digitized at high resolution using a film scanner. Data matrix corresponding to the GAR images of (U, Pu)O2 of mixed oxide (MOX) fuel pins for the upcoming Prototype Fast Breeder Reactor (PFBR) were obtained and pixel analysis was done. The objective was to investigate the relationship between the grey levels obtained in the GAR images and the corresponding plutonium activity. Cesium-137 source was used as a calibration standard for the study. The GAR for cesium-137 source was obtained for varying durations of exposure from 9 hours to 72 hours. The images obtained were then analyzed using the data matrix obtained from this image by dividing it into grids. Activity of Cesium-137 was also calculated for each time period and a relationship between the grey values and its activity was established. This correlation was found helpful in identifying the gamma activity corresponding to any grey level value within the studied range. The amount of plutonium responsible for a given activity in this range could be found using the specific activity of the nuclide. This study has application in estimating the plutonium heterogeneity in nuclear fuels.

References

[1] D. Mukherjee et al (2008). Gamma autoradiography and x-ray gamma autoradiography for quality control of PFBR fuel elements. India: Indira Gandhi Centre for Atomic Research.
[2] K. V. Vrinda Devi et al (2019). Plutonium heterogeneity in MOX fuel: A quantitative analysis. Journal of Nuclear Materials. 518.10.1016/j.jnucmat.2019.02.048.

OP-37

MONTE CARLO SIMULATION OF GAMMA IMAGES OF MOX FUEL PELLETS AND THE MINIMUM DETECTION LEVEL OF Pu AGGLOMERATES

Biju Keshavkumar[1] and K.V. Vrindadevi[2]
[1]Health Physics Division, Health, Safety and Environment Group,
[2]Radio Metallurgy Division, Nuclear Fuels Group
Bhabha Atomic Research Centre, Trombay, Mumbai 400085
Corresponding author email: bijuk@barc.gov.in/bijusivolli@gmail.com

Autoradiography is the imaging technique using the radiations emitted by the object itself which is implemented for regular quality control inspection of mixed uranium and plutonium bearing nuclear fuels for homogeneity characteristics. Though the technique is very useful in detecting heterogeneity (the presence of concentrated plutonium agglomerates) in the mixed uranium-plutonium fuel, it is very difficult to infer the anomalies detected in the images due to absence of calibration standards. Monte Carlo method of radiation transport simulation by FLUKA code[1] has been used to generate virtual auto radiographic images of plutonium rich mixed carbide (MC) fuel and the minimum dimension of the agglomerates that can be observable in the a grey scale image and already published [2]. These values highly depends on the geometry and material composition of the fuel matrix.

Therefore similar study was made for oxide fuel (MOX) and the FLUKA simulated of the minimum detectable dimensions (MDD) of agglomerates in MOX images and presented in this paper. This is done by modeling spherical agglomerate of various diameter, say 100 microns to 500 microns at the surface of the fuel matrix near to the imaging plane (Geometry in Fig.1). The MOX fuel composition considered as 28% PuO_2 and 72% UO_2. The composition was chosen because of its relevance to Indian fast reactor program and also because it is challenging to detect even a pure plutonium agglomerates in this fuel due to the plutonium rich matrix. The transmitted photon fluence is scored at the imaging location MOX fuel without agglomerate (background) and with agglomerate.

The counts based detection analysis was carried out based on the following concept. The fluence/counts obtained from the pellet containing the plutonium agglomerate should exceed the background fluence from the rest of the fuel pellet; to ensure the detection. Photon fluence from a homogeneous pellet of nominal composition (with no agglomerate) was estimated with the statistical error bar to estimate the background ($X \pm \Delta X$). The fluence due to the presence of pure PuO_2 agglomerate was also estimated ($Y \pm \Delta Y$). The condition assumed for the agglomerate detection was $(X+Y) > (X+\Delta X)$, i.e. the photon fluence from the pellet with agglomerate should exceed the maximum possible upper bound of the background fluence. This analysis shows that pure PuO_2 agglomerates above 200 microns are only detectable if it is on the near surface (Fig. 2). The MDD of pure PuO_2 agglomerate varies as a function depth in the fuel matrix. It is found that the MDD is 300 micron as the agglomerate is placed at 100 micron depth.

The 2D plot of transmitted spatial fluence distribution forms the virtual images and the presence of agglomerate provides the visual indication in the form of higher darkness. The similar values of MDD is observable in the images as well as noted in the fluence analysis.

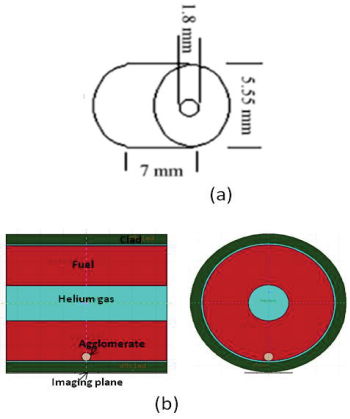


Fig. 1 Schematic of MOX pellet with dimensions (a) and the cross sectional view of the FLUKA simulated geometry (b)

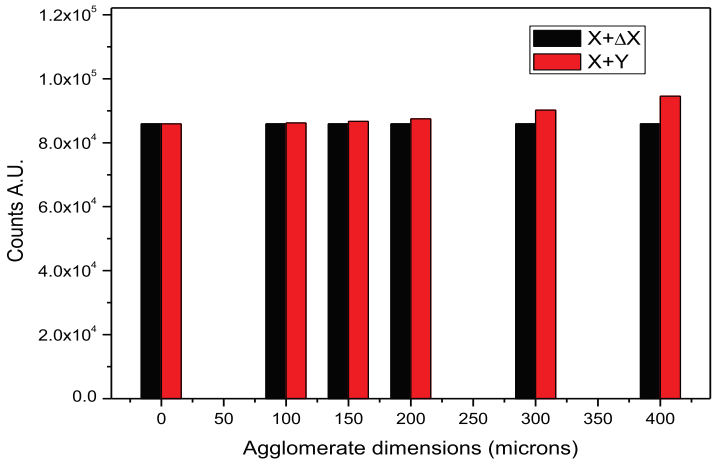


Fig. 2 Simulated values of photon fluence/counts obtained on the imaging plane as a function of the agglomerate dimensions

References:

1. G. Battistoni et al., Annals of Nuclear Energy, 2015 82, pp.10-18.
2. K. V. Vrinda Devi and K. Biju, Journal of Radioanalytical and Nuclear Chemistry, 2019, 319,167-173.

OP-38

DEMONSTRATION OF GLOVE BOX INTEGRATION OF CARBON & SULPHUR DETERMINATOR (C&S) AT FUEL FABRICATION PLANT/FRFCF

B Siva Kumar, G Eswar Rao, G Sivasankaran
Fast Reactor Fuel Cycle Facility, Nuclear Recycle Board, Bhabha Atomic Research Centre
E-mail id: bsk@igcar.gov.in

Fuel fabrication plant (FFP) as a part of FRFCF is designed for the production of MOX fuel pins.FFP houses Analytical and Certification Laboratory (ACL) to meet analytical requirements of radioactive samples received from FRP, FFP and RUP of FRFCF. Determination of Carbon in MOX fuel is essential as it may react with the clad material (SS) in Fast reactors and cause carburization by forming second phase particles $Cr_{23}C_6$. Therefore C&S Determinator is used for assaying carbon in MOX fuel samples as a part of quality control. Since the sample handled is radioactive in nature, the heating system (induction heater) is installed inside glove box keeping the oscillator and other sensors/controls outside glove box for ease of maintenace. This equipment works on the principle of Infrared absorption when the CO_2 and SO_2 in O_2 gas evolved from burnt sample passes through detector. Originally the system was a single integrated unit. For adapting to glove box environment, oscillator unit/sensor unit/control unit is separated from the induction heating system. The oscillator is installed closer to glove box panel in order to minimize power losses. RF coil leads are embedded in specially designed Teflon based leak tight feed-through (in-house design) which is mounted on glove box compartment at suitable location (Fig 1).

The functional test of glove box adaptable C&S determinator system is successfully demonstrated and validated with SS standards (92400-3040:0.053±0.002% C). The accuracy and precision obtained for Carbon is well within 5%.The analytical values obtained for Carbon in five determinations is 0.054±0.001%C.Using this calibration, the carbon content obtained in SS 304 L and SS 308L filler wire samples is 0.033% & 0.032 respectively.

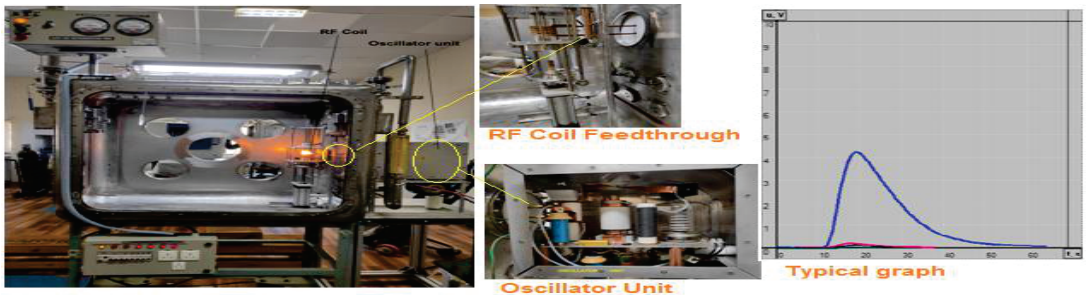


Fig 1 Glove Box adaptable Carbon Sulphur Determinator

Conclusion: Functional demonstration of the glove box adaptable C&S determinator is successfully demonstrated and validated.

OP-39

LED fluorometric technique for analysis of Uranium at ppb level in aqueous samples

Supriya Singh, Mousumi Singha, V. H. Rupawate, S. K. Satpati
Uranium Extraction Division
Bhabha Atomic Research Centre, Mumbai,400094
Corresponding Author's Email: mousim@barc.gov.in, Contact No.: +91 02225596391

ABSTRACT

Analysis of trace amount of toxic element like uranium in aqueous waste generated during mining, milling and refining and also during developmental work is important considering the increasing stringent environmental limits [1, 2]. Conventional methods of analysis such as, volumetric [3], gravimetry, spectrophotometry, ICPOES are time consuming, requires processing of sample and consumption of chemicals and mostly report uranium up to 1 ppm accurately and precisely. LED fluorimetry is a direct method for low ppm and ppb level U analysis in the range with substantial accuracy and precision [4, 5]. The method is convenient and cost efficient. Uranium present in solution complexes in aqueous medium and the complex emits fluorescence light, which can be measured by PMT detector. This fluorescence yield is proportional to the intensity of excitation source and concentration of uranium in sample. The present study was aimed at developing a method for analysis of trace U in waste water that contains high concentration of other species, anions like NO_3^-, F^- are in more than 1000 ppm, TDS and cations like Al^{+3}, Mg^{+2}, Fe^{+3} are in trace amount. U quantification was carried out over a wide range of samples and standard deviation values calculated. Initially the instrument was tuned to get consistent fluorescence values by carrying our analysis of around 100 samples. Standard solution of U was prepared in the range of 5 ppb to 500 ppb and the instrument calibrated. The calibration curve shows R2 value of 99.9%. Further, the standard values were measured against calibration and the deviation was found to be within 10%. Actual plant samples containing high TDS were analyzed in fluorimeter and parallelly carried out in ICPOES, and the results were found to be comparable. The study successfully establishes the use of LED fluorometer for the determination of Uranium in low concentration level in waste liquid and also treated water.

REFERENCES

1) R.C. Bhangare, M. Tiwari, P.Y. Ajmal, S.K. Sahoo, G.G. Pandit, *Radiation protection and environment,* ***2013, 36****, issue 3.*
2) Uranium from sea water report, issued by United Kingdom Atomic Energy Authority, ***October 1976.***
3) W. Davies, W. Grey, *Talanta*, ***1964, 11,*** 1203
4) Sanjukta A. Kumar, Niyoti S. Shenoy, Shailaja Pandey, Suvarna Sounderrajan, G. Venkateswaran, *Talanta,* ***2008, 77,*** 422
5) A. Rani, S. Singh, *Health phys*. LWW, ***2006***, ***91***, 101

OP-40

MICROWAVE-ASSISTED ACID DIGESTION OF METAL FLUORIDE FOR SAMPLE PREPARATION FOR TRACE ELEMENT ANALYSIS

R. Valsha, V. H. Rupawate, Pansare Madhavi S, Mousumi Singha, , S. K. Satpati
Uranium Extraction Division, Bhabha Atomic Research Centre, Mumbai 400094
Corresponding Author's Email: mousim@barc.gov.in, Contact No.: +91 02225596391

ABSTRACT

Metal fluoride dissolution is required to detect the presence of trace elements in laboratory. Metal fluoride dissolution is difficult due to high lattice enthalpy and dimer formation [1, 2]. For its dissolution, stringent conditions like concentrated acid, oxidizing agents (H_2O_2), high temperature and exotic material like platinum dish are required. Also, time required for dissolution is long requiring constant supervision which leads to exposure of the analyst to come in contact with volatile gases and air borne activity (if radioactive). In conventional method for 1gm sample, the dissolution takes 1.5 hour with 37mL of concentrated nitric acid and 5mL oxidizing agent (H_2O_2). In the present work, a Microwave Digester (MD) is being explored for dissolution of metal fluoride salt. Microwave digestion [3] is an extremely useful sample preparation technique for trace element analysis. The process uses microwaves to heat up the prepared sample that is combined with concentrated acid, breaking down solids into solutions for analysis. The present study is to optimize the consumption of hazardous acids, optimization of time and to prevent the use of exotic material during dissolution of fluoride salt. About 1gm of sample was digested in in three batches with 3mL, 5mL, 7mL of acid respectively. The digestion was done at a constant temperature (200°C) and pressure (50psi) in an enclosed environment of the digestor which also has an exhaust system. The digestion time was also optimized by carrying out the digestion for 20min, 30min, 40min, 60min. It is observed that complete dissolution is occurred in 30min with 3mL acid and without the requirement of any oxidizing agent. For trace element analysis, corrosive fluoride ion concentration needs to be controlled. It is found that the fluoride ion concentration in microwave digested and conventional method samples are comparable and in the range of 7g/L. This is acceptable for further processing of sample and a slight heating of the sample removes 90% of fluoride. Trace element analysis data is similar for samples prepared by microwave and conventional method within ±2% RSD. Thus, microwave digestion of metal fluoride can be carried out successfully which have the advantages of (a) Low chemical consumption, (b) Less digestion time, (c) No use of exotic materials, (d) No contamination of environment with hazardous material.

REFERENCES

1. BY albert, W. Jache, George H. Cady, *The journal of physical chemistry*, 1952, **56**, 1106.
2. Riane E. Stene, Tim Graubner, Sergei I. Ivlev, Antti J. Karttunen, Florian Kraus, *ZAAC*, 2022, *10,* 648.
3. J. Aldabe, Carolina Santamaria, David Elustondo, Jesus Miguel Santamaria*, Analytical methods*, 2013, *5(2),* 554

OP-41

EFFECT OF COMPLEXING AGENT ON UPTAKE BEHAVIOR OF NAFION MEMBRANE

Jayshree Ramkumar and S.Chandramouleeswaran
Analytical Chemistry Division, Bhabha Atomic Research Centre, Mumbai-85
Corresponding Author's Email: jrk@barc.gov.in

Ion exchange membranes with applications in various fields are always a topic of research due to their interesting properties. Ion exchange behaviour is due to the functional groups attached to the polymer [1]. The functional groups containing the fixed counter ion imparts the nature of the ion exchanger i.e the counter ion is negative in a cation exchanger and electroneutrality is maintained by H^+ ions which are labile and can be replaced by cations in solution. The mobile anions present in solution, known as co-ions are rejected from polymer matrix due to electrostatic repulsion. Ion exchange behavior is governed by various factors like the polymer matrix, functional groups, nature of cations in membrane as well as solution, interfering ions, pH of external solution etc [1]. Ion exchange membranes (IEM) are governed by factors similar to ion exchange resins but they allow the passage of ionic species through them. The selectivity of ion exchange membrane is governed more by Donnan equilibrium. The resulting selectivity towards the transport of ions of opposite charges is known as permselectivity. According to IUPAC, ionomer is a polymer of ionomer molecule [2], which is defined as a macromolecule with small but significant proportion of ionizable or ionic groups, or both. One of the most common ionomer with excellent applications is perfluorosulphonate based Nafion membranes discovered by Walther Grot E.I. du Pont de Nemours and Co [3]. It is a sulfonated tetrafluoroethylene based fluoropolymer-copolymer with unique properties leading to its large number of applications. The ion rich clusters in the polymer have a reversed micelle structure which depends on factors like water/ solvent content, counter ion, nature of polymer matrix etc. The permselectivity of Nafion is affected by various external parameters and has been used for achieving selective separation [4]. Based on the concept of permselectivity, the selective uptake or permeation of cations can be achieved. However studies showed that the property of permselectivity which allows the permeation of cations through it is found to be severely affected by various experimental factors. Hence it became important to understand the effect of complexing agents in solution which are at times added to mask interfering ions. Earlier studies showed difference in copper uptake by acid treated membranes [5] in presence of different complexing agents. In this study, water boiled membranes was used. It was seen that copper uptake in presence of ethylene diamine was quite different from that obtained using acid treated membranes. This indicates that the different pretreatments affect the structure of Nafion membrane to a different extent.

References:

1. Jayshree Ramkumar, T.Mukherjee, (2012). Principles of Ion Exchange Equilibria. In: Dr., I., Luqman, M. (eds) Ion Exchange Technology I. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-1700-8_2
2. A.D. Jenkins, P. Kratochvíl, R.F.T. Stepto, U.W. Suter, "Glossary of basic terms in polymer science (IUPAC Recommendations 1996)" Pure App. Chem. 68 (1996) 2287-2311.
3. Jayshree Ramkumar Book chapter 13, Nafion Perfluorosulphonate Membrane: Unique Properties and Various Applications, in Functional Materials (Eds S. Banerjee and A.K.Tyagi) 2012, Pg 549-577
4. Jayshree Ramkumar, K.S. Shrimal, B. Maiti, T.S. Krishnamoorthy, J. Memb. Sci. 116 (1996) 31-37
5. Jayshree Ramkumar, S. Chandramouleeswaran, MOJ Biorg Org Chem. 1 (2017) 245–247

OP-42

AATMANIRBHARATA IN FABRICATION OF CRITICAL SPARES AND CONSUMABLES AS IMPORT SUBSTITUTES

S NVMS Gupta, Y. Balaji Rao, A.K. Nayak, R.K.Chaube, Komal Kapoor*
Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India
**Email: corresponding author:* ybrclabnfc@gmail.com/ ybr@nfc.gov.in

Nuclear Fuel Complex (NFC), an industrial unit of Department of Atomic Energy (DAE) is engaged in production of nuclear fuel and reactor components for Pressurized Heavy water Reactors (PHWRs) and Boiling Water Reactors (BWRs) operating in India. Control laboratory, being centralized analytical facility, is catering to analytical requirements of all production plants at NFC with annual analytical load of around 1million of estimations from 0.1million of samples. For taking care of existing requirements and to meet ever increasing analytical demands in future, it has become essential to become self-reliant through indigenization efforts. Control lab has put efforts to indigenize in many areas, among them is fabrication of critical spares and consumables as an import substitutes. They includes Oxygen Free Copper (OFC) and Ceramic electrodes for RF GD-OES and high temperature insert tip, upper electrode assembly, lower electrode plate, collor tips, nickel baskets for elemental Oxygen-Nitrogen analyser & Hydrogen analysers. It has become challenging task to indigenize them due to non availability of complete details of these items and also not shared by the suppliers. Therefore, these spares and consumables are fabricated by following a systematic approach comprises of determination and selection of material of Construction (MOC), initial designing, freezing of technical specifications, finding suitable vendor for fabrication, carrying out necessary trails and testing the fabricated item for the intended purpose. These indigenous efforts have resulted in complete removal of dependency on import supplies which has increased the timely availability of all the equipments. This is very critical for an analytical lab where high sample load is encountered on routine basis for quick analytical feedback to production plants in meeting timely production schedules. Further to this, an average annual savings of 45 lakhs is resulted in these efforts to the department apart from saving the time by eliminating the purchase procurement process. The details of indigenized items are given below.

Table: Details of indigenously fabricated spares and consumables.

Item							
Name & Cost	Ceramic electrode	OFC electrode	Insert tip	Lower electrode plate	Upper electrode assembly	Collor tips	Nickel baskets
Import	1.1 lac	0.95 lac	0.8 lac	0.65 lac	1 lac	0.05 lac	Rs 70
Indigenous	0.2 lac	0.1 lac	0.12 lac	0.1 lac	0.1 lac	0.01 lac	Rs 15
Avg. annua consumptio	6 Nos.	6 Nos	20	5	2	4	30000
Avg. annua savings	5.4 lac	5.1 lac	13.6 lac	2.75 lac	1.8 lac	0.16 lac	16.5 lac

OP-43

DEVELOPMENT OF HYDROGEN CHARGING INSTRUMENT FOR REACTOR CORE STRUCTURAL COMPONENTS

Prasun Ghosh, Y. Balaji Rao, K. Madhav Krishna, A.K. Nayak, R.K.Chaube, Komal Kapoor*
Control Laboratory, Nuclear Fuel Complex, Hydearabad-500062, India
Email: ybrclabnfc@gmail.com / ybr@nfc.gov.in,

temperature of 400°C. Apart from this, the development has resulted in avoiding the uThe critical structural components for Indian pressurized heavy water reactors (PHWRs) are being fabricated at Nuclear Fuel Complex (NFC) using Zirconium (Zr) and Zirconium-Niobium (Zr-Nb) based alloys. However, their susceptibility to hydrogen pick up under reactor operating conditions can lead to hydrogen embrittlement, which has detrimental effect on their structural integrity, there by potentially impacting the safety and efficiency of nuclear power plant (NPP). The F_N number is a critical parameter in evaluating the hydride embrittlement of structural component. In view of this, susceptibility of fabricated structural components to hydride embrittlement is carried-out by externally charging gaseous hydrogen into samples drawn from the components at 400°C and evaluating the F_N number by microscopic examination of hydride platelets formed. The amount of hydrogen picked up by the sample is measured by drop in the in pressure in sample chamber. The hydrogen charging is controlled by pressure, volume and temperature. Presently glass based apparatus having mercury based pressure measurement system is being employed for hydrogenation of these components. The frequent breaking of this apparatus due to fragile nature of glass and frequent spillage of mercury during breaking of glass has severe environment hazards. Further to this, control of pressure in small increment is extremely difficult in mercury based apparatus and it is particularly challenging in achieving desired level of hydride formation for evaluating the F_N number. Keeping these difficulties in view, a successful attempt has been made at our Lab in developing a robust hydrogenation apparatus using SS316 using local resources. The critical components of this in-house developed instrument includes a reactor, heating furnace, gas/vacuum manifold, vacuum pumping system and pressure monitoring device. During making of this instrument, special attention has been given to one end open quartz tube reactor to accommodate more amounts of sample and lowest out-gassing during heating. Leak rate of the reactor assembly is improved by introducing metal connector in other end of the reactor tube. Tubular furnace with three heating zone equipped with PID temperature controller in master/slave configuration used to attain better temperature control. Gas/vacuum manifold is made up of SS316 tubing and designed with a combination of needle valve and ball valve to fine control of gas charging. It is essential to accurately monitor the hydrogen pressure inside reactor during the gas absorption reaction. So, high accuracy capacitance type gauges along with pirani gauge is used for pressure monitoring of the system. With this development, manifold increase in throughput of the hydrogenation of samples along with desired level of hydride formation has been achieved. Besides this, instrument is made with complete safety features to carry out hydrogenation reaction at high sage of hazardous mercury. Using this in-house developed instrument, several reactor components have been hydride to a desired level successfully.

References:

1. R. N. Singh etal., Bhabha Atomic Research Centre Mumbai, Report No. BARC/2003/E/034.

OP- 44

DETERMINATION OF BORON AND CADMIUM IN ZIRCONIUM BASED ALLOYS BY FLAME-AAS USING ATOM TRAP CELL

Y BalajiRao[a]*, Zahida Begum[a], P V NagendraKumar[b], Dinesh Srivastava[a]
[a] *Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India*
[b] *Assistant Professor, Dept. of Chemistry, GITAM University, Hyderabad-502329, India*
**Email:* ybrclabnfc@gmail.com / ybr@nfc.gov.in

Nuclear Fuel Complex is involved in the manufacturing of several reactor structural components for PHWRs, BWRs and VVER reactors operating in India using zirconium based alloys such as Zirconium alloy-2 (zircaloys-2 /Zr-2), Zirconium alloy-4(zircaloys-4/Zr-4) and Zirconium-Niobium alloys (Zr-1%Nb alloy& Zr-2.5%Nb alloy). With their superior corrosion resistance and mechanical strength coupled with low neutron absorption cross section, they are preferred materials for fabrication of reactor core components. These desirable properties are impaired by the presence of various impurities mainly boron(B) and cadmium(Cd), even at trace levels and therefore, 0.5ppm and 0.3ppm are specified for boron and cadmium respectively. In view of this, monitoring them has become a very important part of Chemical Quality Control (CQC) of these alloys and thereby an integral part of QA/QC programme. Several methods like FAAS, ICP-AES, ICP-MS, DC-Arc Emission Spectrograph and SSOES are cited in literature for this purpose. But for application of routine kind, these techniques may prove to be of limited use for a variety of reasons except for ICP-AES and FAAS techniques. FAAS, ICP-AES with their multi-elemental analysis capabilities are best suited for chemical analysis of any industrial laboratory because of high analytical load generally encountered on regular basis. A prior separation of matrix from other impurity elements to avoid spectral interference is essential for ICP-AES for achieving the desired detection limits. However, it is very difficult and time consuming to separate both matrix elements Zirconium (Zr) and Niobium (Nb) from sample solution which may likely to introduce non-reproducible recovery errors also. In view of this, it has become a necessity to develop a simple, precise and accurate method for determination of B, Cd specified level in Zirconium based alloys. The present paper discusses a new methodology developed for estimation of B, Cd in zirconium based alloys by Flame-AAS (F-AAS) using Atom Trap Cell (ATC). Application of Flame-AAS (FAAS) technique is not as such suitable for analysis of B, Cd the specified levels. The advantages of using trap cell to make F-AAS suitable for the purpose is described in the paper. Dissolution of sample in sulfuric acid, hydrofluoric acid and nitric acid followed by standard addition with appropriate standards has been carried-out for calibration of instrument. Boron and Cd are measured at selected wavelength of 249.89nm and 228.80 nm respectively using Atomic Absorption Spectrometer (Make: GBC SavantAA∑ Australia) with atom trap cell (ATC). The ATC has been fabricated indigenously and details are given in the paper. A 10cm Air-Acetylene burner has been used in this analysis. While developing the method, instrument parameters like fuel flow, oxidant flow, burner head height, atom trap cell position etc., have been optimized to get maximum sensitivity. The results obtained by FAAS-ATC are compared with ICP-AES and found to be in good agreement. A RSD of < 5% at specified levels in Zirconium based alloys has been achieved by this method.

OP-45

DEVELOPMENT OF INERT GAS FUSION TECHNIQUE FOR QUANTIFICATION OF HYDROGEN IN ZIRCONIUM BASED ALLOY USING DIFFERENT FLUX MATERIAL WITH TCD AND NDIR DETECTION

Y BalajiRao[a]*, Prasun Ghosh[a], P V NagendraKumar[b], Dinesh Srivastava[a]

[a] *Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India*

[b] *Assistant Professor, Dept. of Chemistry, GITAM University, Hyderabad-502329, India*

**Email:* ybrclabnfc@gmail.com / ybr@nfc.gov.in

Concentration of hydrogen in nuclear grade zirconium based alloys plays a critical role in its performance under reactor condition [1]. Therefore, a specification of 5ppm max has been laid down for Zr-Nb alloy products and 25ppm is specified for zircaloy products. Various analytical techniques are available for quantification of hydrogen in zirconium based alloys, each analytical technique has their own advantages and disadvantages [2].Among different analytical techniques inert gas fusion (IGF) is a widely accepted technique for quantification of hydrogen in zirconium based alloy due to its accurate, precise and rapid determination ability. In IGF technique for determination of hydrogen, metal samples are heated in a graphite crucible with a suitable flux material at high temperature. Hydrogen either quantified in the form molecular Hydrogen using thermal conductivity detection (TCD) or in the form of H_2O using non dispersive infrared (NDIR) detection. Present work is focused on the comparison of analytical method using both the detection techniques using tin and nickel flux.Tin is widely used as a flux material for the exclusive determination hydrogen in zirconium and its alloys. However, nickel is used as flux materials when hydrogen is determined along with oxygen and nitrogen. Graphite crucible and flux material are also contain some amount of gaseous impurities like oxygen, nitrogen and hydrogen. Hence crucibles are out gassed before introduction and heating of the samples to achieve lower blank value and detection limit. In the time of exclusive determination of hydrogen, tin fluxes are degassed along with crucible and samples are introduced separately. Evolution of oxygen and nitrogen in zirconium and its alloy required relatively higher temperature (~2700^{o}C) compared to evolution of hydrogen. Tin flux cannot be used for determination of oxygen and nitrogen in zirconium and its alloy as a flux material due to its limitation of low boiling point. Therfore, for simultaneous determination of oxygen, nitrogen and hydrogen, nickel is used as flux material and is introduced along with sample.The aim of this present work is to compare and evaluate three analytical methods for hydrogen determination and assessing their limit of detection and precision. Method-1 involves release of hydrogen through IGF method and detected through NDIR using nickel as flux material and in Method-2, hydrogen is liberated through IGF and detected by NDIR using tin as flux material. Similar to Method 2, Method-3 utilizes tin as flux material for IGF and hydrogen is detected through TCD. The limit of detection (LoD) for Method-1 is 2.9ppm and for Method-2 is 1.4ppm. Where-as for Method-3, it is 0.2ppm. It is observed that precision of all the three methods also follows the same order. Few Zircaloy-4 and Zr-2.5% Nb samples are analysed by the above mentioned three methods. Better precision and LoD in Method-3 is achieved due to initial outgassing of both graphite crucible and flux material. Whereas in Method-1, samples are introduce along with flux material and thus hydrogen impurity contain in the nickel contribute to blank value and there-by affects both limit of detection and precision of the method. In spite of poor LoD and precision, Method-1 has added advantage of simultaneous determination of oxygen, nitrogen and hydrogen in zirconium based alloy samples. From these observations, it is clear that Method-3 is preferred choice for applying to Zr-Nb alloy products and Method-2 is good enough. However, Method-1 is not preferred for Zr-Nb alloy products.

References

1. A. T. Motta, L. Capolungo, L. Chen, M. N. Cinbiz, M. A. Daymond, D. A. Koss, E. Lacroix, G. Pastore, P. C. A.
Simon, M. R. Tonks, B. D. wirth and M. A. Zirky, *Jornal of Nuclear Materials*, 2019, 518, 440–460.
2. Z. Weiss, *Hydrogen*, 2021, 2, 225-245.

OP-46

Application of Thermal Analysis Techniques in Aluminium Research/Industries

SU Bagde, M T Nimje and Anupam Agnihotri

Jawaharlal Nehru Aluminium Research Development and Design Centre, Amravati Road, Nagpur – 440 023, India

Thermal analysis is a group of techniques in which a physical or chemical property of a sample is monitored against time or temperature. This method has different type of techniques. Thermal Analysis techniques are used in a wide range of disciplines, from pharmacy and foods to polymer science, materials and glasses, minerals, soil, alloy, metal…etc. Thermograms represent characteristic properties which can be used to characterize material quality. Where changes in sample behavior are observed under controlled conditions. The wide range of measurements possible provide fundamental information on the material properties. Due to the increasing demands for rapid and quantitative assessments of samples from Aluminium research and Aluminium industry thermal analysis techniques are a unique, means to characterize the complete analysis.

JNARDDC have two technique of thermal analysis using TGA & DSC. The instrument is **NETZSCH STA 409 PC Luxx. (Simultaneous Thermal Analyzer).** In TGA measuring the variation in mass of a sample when it undergoes temperature. In DSC, determining the variation in the heat flow given out or taken in a sample when it undergoes temperature. Thermal analysis has found increasing use in basic characterization of materials and in a wide range of applications in research, development and quality control in industry.

Keywords: Thermal Analysis, TGA, DSC, Thermogram, Aluminium Industry.

OP-47

Chemical and Mineralogical Assessment of Ceramic Material Developed from Unused Industry Reject: Case Study of Manganese Mine Overburden Dump of Dongri, Buzurg, Maharashtra, India

* Paparao Mondi, Kiran Janbandhu, Mohamed Najar, Upendra Singh and Anupam Agnihotri

Jawaharlal Nehru Aluminium Research Development and Design Centre, Amravati Road, Nagpur – 440 023, India

Corresponding Author's Email: paparao.mondi@gmail.com, Contact No.: +91 9164898889

Abstract

Open-cast mining of manganese generates sandy crystalline reject material including rock and soil contain different minerals which spreads below the top soil. The rejects are generally called overburden and traditionally discarded over the useful lands beside. A preliminary observation and chemical characterization of the of the unused reject materials highlighted the presence of alumina-silica-potassium based mineral constituents as major components. To assess the potential and practical use of the reject as useful secondary resource for value added products, effort was made for checking the active nature of mineral phases. Consequently, overburden samples were collected from Dongri, Buzurg opencast mines from Bhandara district, Maharashtra; these were crushed and ground to a particle size of <75 µm. The ground overburden samples were characterized in terms of chemical and mineral composition using X-ray fluorescence (XRF) and X-ray diffraction analysis (XRD) techniques. XRD revealed the presence of highly crystalline chamosite $(Fe,Mg,Fe)_5Al(Si_3Al)O_{10}(OH,O)_8$.) and muscovite ($KAl_2$ (F, OH)$_2$) as main mineral phases, in addition to microcline ($KAlSi_3O_8$) as trace mineral phase. The chemical analysis revealed that the overburden contains 64.12% SiO_2, 16.85% Al_2O_3, 9.09% Fe_2O_3, 3.47% K_2O and 1.39% MgO as major oxides and TiO_2, Na_2O, and CaO as minor oxides. Considering the predominant crystalline nature of the reject material, chemcial activation was performed with aqueous mineral acids in 1:1 v/v and 9:1 v/w liquid to solid ratio. The overburden material was chemically treated separately under sulphuric and hydrochloric acids at 100ºC ± 2 ^{0}C for about 2 hours followed by thorough washing with water to remove the acid residue. Iron content was reduced to less than 1% in the acid washed samples. The chemcial treatment selectively lowered most of the alkali (K & Mg) and iron bearing mineral phases (chamosite and microcline) from the matrix and exposed activated silica and alumina bearing mineral phases for binding with heat treatment. The acid treated powder was comprising of mainly quartz and muscovite phases. The acid treated dry powder was mechanically homogenised and a flowable wet slurry was prepared with water for drying in moulds at room temperature (20-30°C) followed by heating at100ºC ± 2 ^{0}C for about 2 hours. After cooling, the demoulded dry bricks were subjected for firing at 1200°C for 1-2 h to produce ceramic bricks. The phase changes during the sintering were studied in ceramic bricks by using XRD and product was chemically characterised by XRF. Leaching trials was performed for the fired product and the leachate was studied by ICP for traces of heavy metals.

Keywords: Overburden rejects; Mineral characterization; Chemcial leaching; Heat treatment; Product evaluation

OP-48

Extrudability of AA3103 in comparison with AA6063 alloys by numerical simulations and press trials

*V.N.S.U.Viswanath Ammu, K. Immanuel Raju, R.N.Chouhan, Anupam Agnihotri,

Jawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur-440023, India
*Corresponding Author: viswanatha@jnarddc.gov.in

Abstract

Extrudability of Aluminium alloys is a function of alloying elements and process parameters during extrusion. In the shop floor, extrudability is stated as the maximum speed of extrusion without any defects on the product. In this technical communication, extrudability of two alloys i.e. AA3103 and AA6063 were compared using numerical simulations. Numerical simulations were carried out for estimating uniform velocity distribution and extrusion load requirements of an architectural profile. Simulations indicated higher flow stress and higher extrusion load requirement for AA3103 alloy in comparison with AA6063. Also, a die was fabricated and extrusion trials conducted using 14MN extrusion press on the profile indicated higher load requirements for the Aa3103.

Keywords: Extrudability, AA3103, Numerical simulations, AA6063, Architectural profile

OP-49

Utilizing XRF for Chemical Analysis of Minerals and Ores

Priyanka Nayar, Anirudha Gijare, Upendra Singh, Anupam Agnihotri
Jawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur

Abstract:
This paper explores the efficacy of X-ray Fluorescence (XRF) spectroscopy as a powerful analytical technique for determining the elemental composition of minerals and ores. The study aims to elucidate the robustness, accuracy, and practicality of XRF in identifying and quantifying elemental constituents present in geological samples. The paper begins by introducing the fundamental principles of XRF spectroscopy, highlighting its non-destructive nature and capability to detect a wide range of elements across diverse sample matrices. The focus then shifts to the methodology utilized, highlighting the significance of sample preparation techniques and instrument calibration crucial for achieving accurate and precise measurements. A comprehensive analysis of case studies and experimental results showcases the application of XRF in the analysis of various mineralogical samples. Additionally, the paper addresses the limitations and challenges associated with XRF analysis, such as matrix effects and detection limits, and discusses strategies to mitigate these constraints. Furthermore, the discussion encompasses the significance of XRF in geology, mining, and metallurgy, underscoring its role in resource exploration, process optimization, and quality control. In conclusion, this paper serves as a comprehensive overview of the capabilities, challenges, and potential advancements in utilizing XRF spectroscopy for chemical analysis of minerals and ores, positioning it as a valuable tool in the field of geological sciences and resource exploration.

OP-50

Prospective of "Sustainable Process Development for the Recovery of Rare Earth Elements from aluminium dross"

Shweta Dhamande, K.L.Wasewar, Upendra Singh and Anupam Agnihotri
Jawaharlal Nehru Aluminium Research Development and Design Centre,
Amravati Road, Nagpur – 440 023, India

Abstract

This comprehensive review paper meticulously examines recent strides in sustainable processes designed for the recovery of rare earth elements (REEs) from aluminum dross, an often-overlooked by-product of aluminum production. The critical analysis within this review not only addresses pressing environmental concerns but also delves into the overarching issue of REE scarcity, amalgamating insights derived from cutting-edge experiments and research initiatives.

With a primary focus on aluminum dross, this paper introduces innovative techniques that are specifically tailored to maximize resource efficiency, ensure economic viability, and foster technological innovation. By presenting novel experimental approaches, the review explores alternative extraction methods and materials, providing a dynamic perspective on the constantly evolving landscape of sustainable REE recovery processes.

A notable segment of the review details a related study wherein black dross, recognized for its richness in REEs, undergoes a meticulous separation into metal and non-metallic fractions through a combination of crushing and screening. The non-metallic fraction then undergoes a two-step treatment involving water and acid leaching. During water leaching, a selective separation of NaCl, KCl, and CaCl is achieved for subsequent crystallization, while acid leaching with hydrochloric acid effectively dissolves REEs such as Ce, La, Nd, and Pr. The review highlights the potential of selective precipitation with oxalic acid and solvent extraction using D2EHPA or PC88A, demonstrating the capability to recover up to 92.6% of REEs from the oxide-salt fraction.

Furthermore, an additional review explores a two-stage leaching process utilizing citric acid and sulfuric acid to selectively recover scandium and REEs from aluminum dross. In a separate investigation, the paper delves into the intriguing realm of REE recovery from aluminum dross through molten salt electrolysis, presenting yet another promising avenue for sustainable and efficient extraction methods.

In summation, this review paper not only consolidates recent advancements but also paints a vivid picture of the diverse and promising approaches that are reshaping the landscape of sustainable REE recovery from aluminum dross.

Keywords: Rare Earth Elements, Aluminum dross, Sustainable processes, Resource recovery, Technological innovation

OP-51

Lithium Determination in Indian Brines by High Resolution-Continuum Source (Flame) Atomic Absorption Spectrometer (HR-CS-(F)AAS)

M. Krishnakumar[a], Beena Sunilkumar[b] andG.V.S. UmamaheswaraRao[c]

[a]Chemistry Laboratory, AMD/DAE, SR, Nagarbhavi, Bengaluru-560072, India

[b]Chemistry Group & [c]RMRE Group, AMD/DAE, HQ, Begumpet, Hyderabad- 500016, India

[a]Corresponding Author's Email: krishnakumar.amd@gov.in,

Contact No.: +91 8099003118

Lithium, the lightest metal, has several critical applications in battery (EV), non-linear optics,lubricants, metallurgy, fine chemicals, medicine and nuclear energy industries [1]. Naturally, lithium resources exist in minerals, clays, brines and seawater, among which brines and several ores are considered valuable for exploitation due to the economic concentration of lithium. [2]. Lithium is considered as the new oil of the 21st century [3].

The trace level determination of lithium in complex brine samples (TDS of the order of 400 g/L) using spectrometric techniques is a challenging task owing to the spectral and chemical interferences during the analysis. Separation of Li is quite complex and laborious and requires specially engineered ionophores and crown ethers. The conventional Line Source (LS)-AAS analysis after dilution gave a much reduced recovery of Li. HR-CS-AAS the latest variant of AAS has high intensity lamp, high resolution optics and truly simultaneous background correction routines. This technique was employed for trace level analysis of Li in brines received from Pachpadra, Rajasthan. To counter the effect of complex matrix, both standard addition calibration and matrix matching, using a synthetic brine were attempted. Studies carried out to estimate the effect of matrix elements (Na, K and Mg) on determination Li at 670.791 nm by HR-CS-AAS (ContrAA 300) and a comparison of results obtained by LS-AAS (NovAA 330) at 670.8 nm is presented. Signal suppression by Na was found to be maximum whereas, Mg and K showed signal enhancement to up to 1 mg/mL concentration level beyond which signal gets suppressed. Table below depicts the comparison of results for Li using HR-CS-AAS for brine samples and their beneficiation products. Details of method development and validation studies will be discussed during the presentation.

***Keywords**: Lithium; brine; HR-CS-AAS; matrix matching calibration*

[illegible]: Comparison of Li values obtained after Matrix matching and Standard addi calibration routines of HR-CS-AAS				[illegible]-AAS
Brine Samples (Pachpadra Salt pans, Rajasthan, India and their beneficiation products)		[illegible]		
		[illegible] calibration	**[illegible] calibration**	[illegible]
[illegible]-1		[illegible]	[illegible]	[illegible]
[illegible]-2		[illegible]	[illegible]	[illegible]
[illegible] preconcentration from	[illegible]-1	[illegible]	[illegible]	[illegible]
	[illegible]-2	[illegible]	[illegible]	[illegible]
[illegible] are average of 3 replicate analysis (n=3)				

References

[1] Stringfellow, WT, Dobson, PF. *Energies* 2021; 14, 6805.

[2] Gui, L., Zhongwei Z, Ahmad G. *Hydrometallurgy*, 2019; 187, 81-100.

[3] Tarascon, J. Is lithium the new gold?. *Nature Chem* 2010; 2, 510.

OP-52

New Methods of Analysing Autoradiographs for Mixed Nuclear Fuel Characterisation

Vrinda Devi K.V[a]. and Jayshree Ramkumar[b]
[a]Radiometallurgy Division, [b]Analytical Chemistry Division,
Bhabha Atomic Research Centre, Mumbai, India.

Abstract

Mixed nuclear fuels have been envisaged to be vital in all the stages of the three stage nuclear programme of the nation. Mixed Oxide (MOX) and Mixed Carbide (MC) fuels have been used in thermal and fast reactors for efficient plutonium utilisation. Characterisation of these fuels have been conventionally carried out using chemical analytical methods which is time consuming and also generate high level radioactive liquid waste. Non destructive techniques (NDT) based on radiation assay and radiation imaging have been extensively attempted for the same purposes. Plutonium is primarily an alpha emitting nuclide having very high specific activity which makes its mapping quite easy in presence of other nuclides having lower specific activity which is the case with the usually associated fertile nuclides present in mixed fuels.

Alpha radiations emitted from plutonium can generate autoradiography images which can be used for different aspects of fuel characterisation. Manual microscopic evaluation of these radiography images is challenging when the concentration of plutonium is high as in the case of fast reactor fuels. Image analytical methods also were found to have limitations arising from crowding of nuclear tracks. Alternate techniques were explored to overcome these limitations and were found effective for the objective.

Solid State Nuclear Track Detectors (SSNTD) used for alpha imaging have characteristic optical properties which can be evaluated using spectroscopic methods. Effect of alpha irradiation on these properties were extensively studied using various analytical methods such as UV-Vis spectrophotometry, Photo luminescence spectroscopy and Raman spectroscopy. The changes were found to be in linear correlation with the incident fluence of alpha radiation. A large number of samples were irradiated using plutonium standard sources for establishing the correlation and this calibration was found to be effective in fuel characterisation.

It was possible to apply this analytical study for characterisation of fuel samples ranging from 1% to 75 % plutonium in mixed matrices. The analysis of characteristic spectra in each method was found extremely effective in not only estimating plutonium concentration in the sample but also identifying and quantitatively estimating plutonium heterogeneity in the fuel samples. It also has an application for estimating the alpha fluence of actual fuel samples which is practically unfeasible. The studies were backed by informations provided by SRIM simulation also.

Spectro-analytical methods of evaluating auto radiography images have advantages over the conventional methods as listed below.

1) The analysis does not require to be enclosed in glove box as needed for any spectroscopy instrument when dedicated for radioactive sample analysis because the sample is not radioactive at all but is just a radiography image generated by the active sample.
2) This method does not generate any high level radioactive liquid waste which by itself is a challenge to be managed.
3) The imaging part only needs glove box handling and does not need any trained personnel.
4) The method is very accurate and effective for all the required objectives.

OP-53

Residence Time Distribution Measurements in Cross Flow Reactor

S Goswami[a], J Biswal[a], V K Sharma[a], V Kumar[b], A Quiyoom[b], P K Rakshit[b], Ravi Kumar V.[b], H J Pant[a]

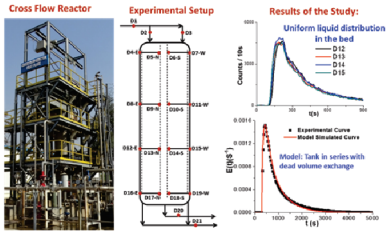
[a]*Isotope and Radiation Application Division, Bhabha Atomic Research Centre, Trombay, Mumbai, 400085, India*

[b]*Corporate R&D Centre, Bharat Petroleum Corporation Limited, Greater Noida, 201306, India*

[a]Corresponding Author's Email: hjpant@barc.gov.in, Contact No.: +91 022-2559 3735

Abstract

Hydroprocessing is a secondary refining process wherein heavier feedstocks are treated to produce superior quality fuels. Conventionally, hydroprocessing is carried out in three-phase reactors, known as Trickle Bed Reactors (TBRs). These TBRs have several disadvantages such as high pressure drop, catalyst inhibition, feed vaporization, hot spot formations leading to shutdown of the reactor. Corporate R&D Centre of Bharat Petroleum Corporation Limited (CRDC, BPCL) has developed a novel reactor technology, named as Cross Flow Reactor (CFR) to overcome the above-mentioned disadvantages of the TBRs [1]. The CRDC has installed a demo-scale CFR unit having a catalyst capacity of 3 tons. To understand the liquid phase flow behaviour, optimize CFR design and process scale up, a series residence time distribution (RTD) measurements were carried out using ^{99m}Tc as radiotracer.



Graphical Abstract of the RTD study using Radiotracer

The results of the first phase investigation indicated, non-uniform liquid distribution at inlet of the liquid distributor and as well as at four catalyst cages of the CFR; and a weeping fraction of 25-30 % was observed. Based on the results, the design of the liquid distributor of the CFR was modified and a second and third phase radiotracer experiments were repeated in the modified CFR. The results indicated that no major flow abnormalities were present in the modified CFR. The weeping fraction of liquid was reduced significantly after design modification. A flow model (plug flow component in series with tank in series dead volume exchange model) was developed to quantify the degree of mixing of the liquid phase in the CFR. The results will also be useful for validation of numerical models and process scale up of the CFR

Keywords: Cross Flow reactor, Hydroprocessing, Radiotracer, ^{99m}Tc, Residence time distribution scale-up,

References

[1] Tan J, Ji Y. N., Deng W. S., Su Y. F., Process intensification in gas/liquid/solid reaction in trickle bed reactors: A review, Petroleum Science, 18(4), 1203-1218 (2021).

OP-54

Application of Thin Layer Activation Technique for Corrosion Inhibition of Carbon Steel

Jayashree Biswal[a,b], V. K. Sharma[a], H. J. Pant[a,]
[a]*Isotope and Radiation Application Division, Bhabha Atomic Research Centre Trombay, Mumbai 400085, India*
[b]*Homi Bhabha National Institute, Anushakti Nagar, Mumbai 400094, India*

Corresponding Author's Email: hjpant@barc.gov.in, Contact No.: +91 222593735

Abstract

Due to easy weldability, cost effective and shock resistant properties, carbon steel (CS) is a material of preference in pipelines in a number of industries [1]. However, the corrosion of carbon steel is a major problem in these industries. Thin layer activation analysis (TLA) is a well-established nuclear technique used for wear, corrosion and erosion monitoring of industrial components [2]. The use of different types of inhibitors is a prudent approach for corrosion control of various metals and alloys. In the present study the corrosion inhibition of carbon steel (CS) has been studied by using hexamethylene tetramine (HMTA) as an organic inhibitor. Carbon steel coupons of size 0.02 m × 0.02 m × 0.002 m each and a set of stacked foils of iron were irradiated with proton beam at BARC-TIFR Pelletron accelerator facility at Mumbai. CS coupons and pure iron stacked foils were irradiated with 13 MeV proton beam having beam current 200 nA for 4 hours. Iron (Fe) being the major element in the composition of CS, the radioisotope ^{56}Co is formed in irradiated CS coupon surface through nuclear reaction ^{56}Fe(p,n)^{56}Co. The cross section and threshold energy of this nuclear reaction are 392 mb at 13 MeV and 5.44 MeV, respectively. The product isotope has half-life 77.3 days and gamma energies 847 KeV (100 %) and 1238 KeV(67 %). The gamma spectra of the irradiated CS samples measured with a NaI(Tl) based spectrometer are shown in Fig 1. The radioactivity produced in these samples were estimated to be 190 – 300 kBq. The corrosion of CS was measured in 1 mol dm^3 aqueous HCl solution under ambient condition and HMTA in the concentration range 0-1000 ppm was used as inhibitor (Fig 2). The corrosion rate was minimum for 500 ppm HMTA with an inhibition efficiency 89.8 %. HMTA has electron donating nitrogen atoms, which can contribute to formation of covalent bond on CS, threby protecting Cs from corrosion.

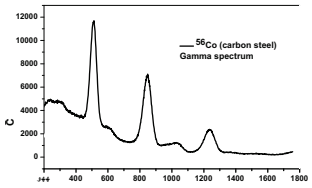


Fig 1. Gamma spectra of irradiated carbon steel sample

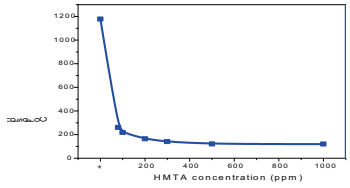


Fig 2. Variation of corrosion rate of with carbon steel HMTA concentration

Keywords: Thin layer activation, corrosion, inhibitor, carbon steel, cobalt-6

References

[1] J. Enani, *Int. J. Sci. Eng. Res.* 2016; 7, 1161–1164.
[2] IAEA-TECDOC-924, 1997; Vienna, Austria.

OP-55

Radiotracer Studies in a vacuum distillation column

S Goswami[a], H J Pant[a], V K Sharma[a], J.S. Samantray[a], Rajesh Kumar[b]

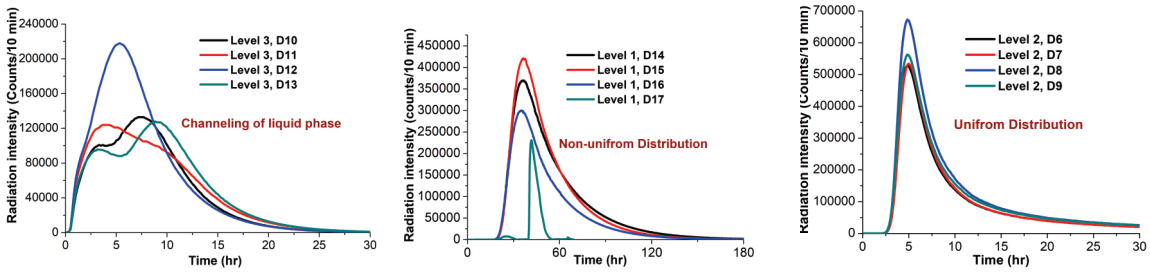
[a]*Isotope and Radiation Application Division, Bhabha Atomic Research Centre, Trombay, Mumbai, 400085, India*

[b]*Heavy Water Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400085 India*

[a]Corresponding Author's Email: hjpant@barc.gov.in, Contact No.: +91 022-2559 3735

Abstract

Heavy water (D_2O) is used as a moderator and primary heat transfer medium (coolant) in pressurised heavy water reactors (PHWR). Two most commonly used and commercially viable processes for production of D_2O are the water-hydrogen sulphide exchange and the ammonia-hydrogen exchange processes. The heavy water produced by these two processes is usually enriched up to 10-30% and further enrichment to the reactor grade (99.85%) is carried in vacuum distillation columns [1]. A fourteen stages vacuum distillation column was not performing as per design specifications and thus being operated at lower efficiency. In order to identify the flow malfunction(s) and investigate flow behaviour of liquid phase in the distillation column, it was decided to carryout radiotracer investigation in the distillation column using ^{82}Br as radiotracer [2].



Graphical Abstract of the radiotracer study

The results of the study indicated significant flow misdistribution in some of the sections of the column. To quantify the degree of mixing of the liquid phase in the column axial dispersion model was used. The values of model simulated Peclet Number (Pe) observed in the distillation columns are in the range of 3 to 20, which indicates that in some of the column section significant amount of back mixing/ mal-distribution of liquid phase is taking place. The back-mixing of liquid phase has adverse effect on distillation. Based on the results of the studies, packing of the few sections was changed to increase the production efficiency of the distillation column.

Keywords: Heavy Water, Radiotracer, ^{82}Br, Axial Dispersion, Flow malfunction, Distillation

References

[1] Benedict M, Pigford T H, Levi W F, Nuclear Chemical Engineering, Second Edition, McGraw-Hill, New York, 1981.

[2] Abdulmohsin R S, Al-Dahhan M H, Axial dispersion and mixing phenomena of the gas phase in a packed pebble-bed reactor", Annals of Nuclear Energy 88, 100–111 (2016).

OP-56

ANALYSIS OF INHIBITED MINERAL INSULATING OILS AFTER OXIDATION USING FT-IR SPECTROSCOPY

Neha Pradeep N, Ann Pamla Cruze
Dielectric Materials Division
Central Power Research Institute
Bengaluru

ABSTRACT:

Power Transformers (PT) are used in electric power generation, transmission and distribution systems to step up and step down voltage. Mineral insulating oils are used as insulation, cooling and diagnostic liquid in power transformers. They play a crucial role in the long term operation of transformers [1]. These mineral insulating oils deteriorate due to the oxidation process and also due to constant thermal and electrical stress [2]. The performance of mineral insulating oils depends on their stability towards the oxidation process. The formation of oxidised products is one of the major effects of deterioration of the oil. During the oxidation, there is a change in the properties of insulating oils which affects the overall performance of the insulation system leading to the failure of transformers. The oxidation stability of mineral insulating oil is extended by the use of Ditertiary Butyl Para Cresol (DBPC) as antioxidants at appropriate quantities. As per the product specification of IS: 335/IEC 60296, up to 0.4% of antioxidants are allowed to be inhibited [3-5]. Every newly manufactured batch of transformer oil needs to be tested in the laboratory. Therefore, inhibited oils are oxidised for a duration 500 hours according to IEC 61125-2018 (IS 12422: 2023). Thereafter the conditioned oil is analysed for changes in Dissipation Factor, Acidity and sludge content to assess the quality of the oil. In this work, an attempt has been made to analyse the remnant antioxidant content in the oil after oxidation conditioning by using Fourier Transform Infrared Spectroscopy (FT-IR) to analyse the deterioration of the oil [7]. FT-IR identifies that antioxidants are not fully consumed after oxidation duration of 500 hours. Further, by FT-IR increase of acid content of oxidised oil is compared.

REFERENCE:

[1] H Kalathripi, Karmakar S. Analysis of transformer oil degradation due to thermal stress using optical spectroscopic techniques. *Int Trans Electr Energ Syst*. 2017; e2346. https://doi.org/ 10.1002/etep.2346

[2] Sandra Weber, KarolaSchrag, GerdMildau, Thomas Kuballa, Stephan G Walch and Dirk W Lachenmeier,, Analytical Methods for the Determination of Mineral Oil Saturated Hydrocarbons (MOSH) and Mineral Oil Aromatic Hydrocarbons (MOAH)—A Short Review, *Analytical Chemistry Insights* Volume *13*: 1–16.

[3] IEC 61125:2018/ (IS 12422:2023), Unused hydrocarbon based Insulating Liquids- Test

Methods for – Evaluating the oxidation Stability.

[4] IS 335 :2018: New insulating oils – Specification (Fifth version)

[5] IEC 60296:2020, Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment.

[6] Anton Georgiev, Ilyana Karamancheva, Liliana, Determination of oxidation products in transformer oils using FT-IR spectroscopy, Topalova University of Chemical Technology and Metallurgy, *Journal of Molecular Structure* (2008), *872*, 18–23.

[7] IS: 13631:2017 / IEC 60666:2010: Detection and determination of specified additives in mineral insulating oils.

OP-57

UV-VISISBLE SPECTROMETRIC TECHNIQUE FOR QUANTIFICATION OF URANIUM AND SUBSEQUENT DEDUCTION OF NITRATE CONTENT IN AMMONIUM DIURANATE SAMPLES

Y. Balaji Rao[a*], Vinod.K. Ray[a], P.V. Nagendra Kumar[b], Dinesh Srivastava[a]
[a&*] *Nuclear Fuel Complex, Dept. of Atomic Energy, ECIL post, Hyderabad- 500062, India*
[b] *Associate Professor, Dept of Chemistry, GITAM University, Hyderabad-502329, India*
Email: corresponding author: ybr4793@gmail.com / ybr@nfc.gov.in

Heat Treated Uranium Peroxide (HTUP), Sodium Di-Uranate (SDU) and Uranium Ore Concentrate (UOC) are the different raw materials used for production of natural uranium oxide (UO_2) pellets as fuel for all PHWRs operating in India at Nuclear Fuel Complex (NFC). The production process involves several steps like dissolution of raw materials in acid, solvent extraction, calcinations, reduction, sintering followed by fabrication processes. Uranyl Nitrate Pure Solution (UNPS) is produced after the dissolution of raw material in HNO_3 followed by solvent extraction and Ammonium Di-Uranate (ADU) is generated by precipitation of uranium from UNPS using vapour ammonia. Measurement of uranium content in ADU samples is necessary in order to do material accounting. Davies & Gray method [1] is used for this purpose, which requires usage of variety of chemicals and also generates significant volume of analytical waste. Moreover, sample throughput is also low. Further, analysis of moisture and nitrate content in ADU samples is essential in order to monitor powder properties. Analysis of moisture content is carried out gravimetrically by measuring weight loss at 110^0C. For analysis of nitrate sample is dissolved in sulphuric acid media and analysis is carried out using redox titrimetry in which excess ferrous is back titrated using standard potassium dichromate. Being an industrial lab, quick analytical feedback is an essential requirement for continuous operation of production plants. In order to have un-interrupted operation of plants, it becomes necessary to develop a method which is simple and has high sample through put. Further, generation of analytical waste should be minimum. Therefore, efforts were made to exploit self-absorption of uranyl ion in the visible region for determination of uranium in ADU samples. Hence, effect of sulphuric acid concentration was studied on uranium determination so that the same solution can be used for uranium estimation in addition to nitrate in order to have high sample through put. Further, efforts were also made to quantify nitrate from uranium and moisture content using a derived mathematical equation relating uranium, moisture and nitrate content. The derived equation is given below.

$$\%\ NO_3 = \left\{100 - \%H_2O - \frac{\%U_{sample}}{\%U_{pure}ADU/100}\right\} \times \frac{62}{80}$$

Where, $\%\ H_2O$ is moisture percentage in sample; $\%\ U_{sample}$ is uranium percentage in sample;

$\%U_{pureADU}$ is Uranium percentage in pure ADU (i.e moisture & nitrate free ADU)
This has resulted in removal of usage of chemicals required for Davies & Gray method for uranium and redox titrimetry for nitrate. The results obtained for uranium and nitrate were compared with that of conventional method which are found to be in good agreement. The advantages of the developed method are: the uv-visible spectrometric method developed in the present work doesn't require any chromophoric agent for quantification of uranium. Further modification has resulted in usage of a single aliquot for analysis of nitrate and uranium there-by making recycling of analytical waste easier as it contains only uranium.

References:

1. W. Davis, W. Grey, *Talanta*, **11** (1964) 1203.

OP-58

Source attribution of pollutants using WRF-Chem model for Indore, India

Suvarna Tikle[1], Idir Bouarar[1], Rajesh Kumar[2], Lya Lugon Cornejo von Marttens[1] and Guy Brasseur[1,2,]

[1]Environmental Modeling - Max Planck Institute for Meteorology, Hamburg, Germany
[2]Atmospheric Chemistry Observations and Modeling Laboratory - National Center for Atmospheric Research, Boulder, USA

Abstract

Indore is facing severe air quality crises due to the rapid development in various sectors. Poor air quality can adversely affect the health of the public and needs to be mitigated. The goal of the study is to use the WRF-Chem model in the tracer mode to identify source contributions of $PM_{2.5}$ and CO emissions from different regions over Indore, India, to quantify local and transboundary sources scale. The model is configured in a two-domain with the vertical grid composed of 42 levels extending from the surface around 20 km with an enhanced resolution for 2019. The results show that local CO anthropogenic sources and sources located outside the considered model domain, i.e., transported across the domain boundaries, are the most contributing sources to CO concentrations in Indore. However, on some specific days, CO anthropogenic sources located outside Indore could be as significant as local sources. Biomass burning is the highest contributing source to $PM_{2.5}$ during November, December, and April. Indore itself contributed as a high source for $PM_{2.5}$ during the entire year within the Indore district boundary. The general spatial distribution of simulated CO is fairly similar to MOPITT, with similar higher values and lower values over the domain, but simulated CO values are relatively low because the secondary sources and biogenic emissions are not considered during modeling. The model simulations also captured the spatial distributions of key meteorological parameters over the domain compared to different datasets like IMERG, MOPITT, and ERA5.