INSTITUTE OF CHEMICAL TECHNOLOGY

(Deemed University under Section 3 of UGC Act 1956)

Matunga, Mumbai-400019

Review meeting for assessment of institutes wrt CoE

CENTRE OF EXCELLENCE IN PROCESS INTENSIFICATION

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Areas/branches related to Centre of Excellence

- Chemistry
- Chemical Engineering
- Chemical Technology
  - ✓ Fiber & Textile
  - ✓ Polymers and Surface Coating
  - ✓ Oils, oleo-chemical and surfactants
  - ✓ Dyestuff
  - ✓ Pharmaceutical chemistry and technology
  - ✓ Foods

Brief description about objectives of CoE

Process Intensification:

- Significant reduction in the energy consumption for the process
- Significant reduction in the batch or Processing time
- Significant reduction in the equipment size for the process

CoE Objectives:

- Design and Optimization of Chemical Reactors
- Reaction Separation Systems
- Batch Processing and Scheduling to batch-to-continuous conversions
- Intensification of processes by cavitation
- Microwave assisted extraction and reactions

How would you assess the progress of CoE (milestones)

The CoE is handling 13 research projects and training 23 research assistants.

Milestones	Jan-Mar 2014	Apr-Jun 2014	Jul-Sept 2014	Oct-Dec 2014	Jan –Dec 2015
Literature survey					
Preliminary lab work					
Equipment and consumable procurement					
First Review					
Detailed research					
Second Review with industry partners					
Manuscript Writing					
Patent drafting					
Project report writing					
Implementation of Technology					

Current status of staff as against requirement

Number of Staff appointed on CoE is 2 on various post i.e.

1. Accountant-Cum-Clerk
2. MIS Officer

And 24 Research Assistant were appointed on various post and its details are given below

PROJECT TITLE	PRINCIPAL INVESTIGATOR	No Of RA's working on project
1. Microwave assisted / enzymes mediated extraction/ synthesis bioactive colorants indigoid / azulene / C-C bond formation.	Prof. N. Sekar	I. Ashwinkumar R.Wasnik II. Supriya S. Patil III. Priyanka R.Patil
2. Sorption Enhanced Hydrogen Production	Dr. P. D. Vaidya	-
3. Microwave assisted Halogenation reactions using flow reactor	Prof. Mariam S Degani	I. Neha P.Agre II. Puneet P. Jain
4. Microwave, Ultrasound and Solar Energy Assisted preparation of metal oxide nanomaterials.	Prof. B. M. Bhanage	I. Jayndra P. Ahire
5. Dyeing of Polyester and its blend using nano emulsions	Dr Ravindra D Kale Dr. Amit P. Pratap	I. Vikrant G. Gorade II. Reran B. Kane
6. Design aspects of two-opposed-jet micro-extractor (TOJME): Experimental and Computational Fluid Dynamics	Dr. C. S. Mathpati	I. Anand P. Chavan II. Aniket S. Waval III. Anju A. Ingle IV. Harshawardhan A. Kulkarni

Current status of staff as against requirement cont.

PROJECT TITLE	PRINCIPAL INVESTIGATOR	No Of RA's working on project
7. Process Intensification for Extraction of Turmeric and Pepper Oleoresin by Enzyme-Assisted Supercritical Carbon Dioxide	Prof.R.S.Singhal	-
8. Bifunctional catalysts - Microwave assisted Tandom reactions	Prof. R.V. Jayaram	-
9. Extraction of Natural Ingredients using novel extraction techniques	Dr. V. K. Rathod	I. Archana S. Aher II. Kavita J. Lanjekar III. Kiran J. Lute IV. Manjeshwari P.Sonar
10. Continuous Synthesis of Metformin Hydrochloride in Microwave and Microreactor	Professor V.G.Gaikar	-
11. Process Intensification of crystallization using sonochemical reactors	Dr. Parag Gogate	I. Avinash S. Mhetre II. Mayuri R. Vaidya
12. Enzymatic process Intensification for the manufacture of structured lipids to enhance the yield	Dr J.S.Waghmare	I. Asma D. Fakir II. Sadanand S. Kadam III. Snehal B. More
13.Synthesis of nanostructured Titanium Dioxide and effect of reaction parameters	Dr. S. T. Mhaske	I. Parth H. Kapoor II. Hitesh K. Singh

1. Microwave assisted / enzymes mediated extraction/ synthesis of bioactive colorants indigoid / azulene / C-C bond formation – Prof. N. Sekar

- Extensive literature survey on **C-C bond formation**.
- New route to synthesis of C-C bond formation i.e. microwave assisted synthesis using ionic liquid replaces hazardous chemicals required for reaction.
- Synthesis of Indigo dye by microwave heater better yield, & time consumption, for green synthesis. Alkali and sodium alkoxide replaced with greener media Ionic liquids.
- Extensive literature survey on synthesis of **azulene.**
- Synthesis of azulene involving preparation of the intermediates 3,4-dibromotetrahydrothiophene and 6-dimethylaminofulvene.
- 3,4-dibromotetrahydrothiophene thiophene-1,1-dioxide.
- Thiophene -6-dimethylaminofulvene strong base microwave azulene.
- Optimization of reaction in different green solvents high yield of azulene

2. Sorption Enhanced Hydrogen Production –Dr. P. D. Vaidya

- **Objectives** - Production of high-purity hydrogen via sorption-enhanced steam reforming of methane, ethanol and glycerol, and the development of novel adsorbents for CO_2 capture
- Sorption-enhanced reaction processes (SERP) comprehensively reviewed
- A review paper under preparation.
- Performance of a commercial Ni/Al_2O_3 catalyst for steam methane reforming investigated 400-800 ^oC, fixed-bed catalytic reactor. Analysis gas chromatography.
- Co-precipitation and impregnation techniques, multifunctional Ni/hydrotalcite and $Ni/CaO/Al_2O_3$ catalyst synthesis. Catalysts characterized by XRD, SEM, EDX and BET. Activity trials underway.

3. Microwave assisted Halogenation reactions using flow reactor – Prof. M.S.Degani

- **Objectives:** Development of nucleophilic aromatic fluorination process using combination of modern technologies namely microwave heating and continuous flow reactor in order to improve energy efficiency, yield, reaction time and make the process greener.
- Over 33 percent of pharmaceuticals drugs would be fluorinated in the near future.
- Order placed flow reactor and IR spectrophotometer has been done and ordering IR sensor in progress.
- Conventional & microwave assisted fluorination of aromatic compounds.
- Reaction was optimiza on for different solvents, reaction temperature and time.

4. Microwave, Ultrasound and Solar Energy Assisted preparation of metal oxide nanomaterials – Prof. B. M. Bhanage.

General Experimental Procedure

Zinc Precursor + Amino Acids + Solvent

Microwave/Ultrasound/
Solar Energy

Zinc Oxide Nanomaterial

Expectation: Better size distribution of nanomaterials, higher activity.

5. Dyeing of Polyester and its blend using nano emulsions -Dr. R. D. Kale, Dr. A. P. Pratap

- Nanodisperse dyes in oil-in-water nanoemulsions on microdenier polyester fabric.
- Nanoemulsions by ultrasonication, phase inversion composition and spontaneous emulsification process.
- Nanodisperse dyes for polyester-wool blend fabric to dye Polyester part.
- Dyeing of Polyester fabric and Polyester Wool blend with Natural dye through nano emulsions.
- Work presented at " Indo-Czech International Conference (ICIC2014) on Advancements in Specialty Textiles and their Applications in Material Engineering and Medical Sciences" held on 29th & 30th April 2014 at Kumaraguru College of Technology, Coimbatore where CoE-PI was duly acknowledged.
- **Equipments purchased for the successful completion of the project:**
- 1. Contact Angle Measuring System
- 2. Ultrasonic Sonicator/ Processor
- 3. High Speed/Shear homogenizer/Emulsifier
- 4. Miscellaneous Equipments: Oven, Magnetic Stirrers, Vacuum pump Overhead stirrer, Muffle Furnace etc

6. Synthesis of nanostructured Titanium Dioxide and effect of reaction parameters - Dr. S.T.Mhaske

- Titanium dioxide (TiO_2) Surface Coating and the Polymer industry as a pigment and a filler. As an additive in sunscreen and food coloring.
- Synthesis of nanostructured TiO_2 using sol-gel technique to obtain a 100% rutile polymorph.
- Sol-gel synthesis technique suitably modified by incorporating ultrasound effect of cavitation on the phase transformation, particle size, crystallinity and morphological (scanning electron microscopy) properties of the obtained nano-TiO_2.
- Using sonic energy, yield of the process was increased by 10% (85% to 95%).

7. Design aspects of two-opposed-jet micro-extractor (TOJME): Experimental and Computational Fluid Dynamics - Dr. C. S. Mathpati

Development of novel extractor system principle of impinging jets and very high mass transfer due to dispersion and turbulence created in impingement zone.

Activities completed

- Literature review for intensification of extraction process.
- Experimental prototype for understanding the fluid mechanics using particle image velocimetry fabricated inhouse.
- Purchase order for major equipment, softwares to study different chemical systems released and is expected by the end of June 2014.
- Preliminary CFD simulations carried out to understanding of hydrodynamics
- Design data available for liquid liquid extraction compiled ; support vector regression analysis under way the role of various parameters involved in extraction which will facilitate in process intensification.

Plan for next two months

- PIV experiment for a wide range of nozzle velocities will be carried out.
- SVM software for liquid liquid extraction.

8. Bifunctional catalysts - Microwave assisted Tandom reactions - Prof. R.V. Jayaram

- Literature survey on tandem reactions, bifunctional catalysts and microwave assisted synthesis .

Objective:-

- Preparation of acid/ base redox catalysts with functional characteristics
- Oxidation/ condensation reactions under thermal and microwave assisted conditions.

Work carried out till date-

- MoO3/SiO3 catalyst prepared using ammonium heptamolybdate (AHM) and tetra ethyl ortho silicate (TEOS) as molybdate and silica sources. Pure high surface area silica catalyst prepared for comparison purposes

Future Plans –

- Optimization of reaction conditions with respect to temperature, solvent and catalyst loading.
- Oxidation/ condensation reaction with the MoO3/SiO2 catalysts in microwave system.
- Test of catalyst reusability

9. Extraction of Natural Ingredients using novel extraction techniques - Dr. V. K. Rathod

- Licorice is extensively used in herbal medicines (anti-inflammatory, anti-viral, anti-allergic, anti-oxidant and anti-cancerous properties) Major active component : Glycyrrhizic acid (GA)
- Intensification of extraction process :Increased extraction yield and reduction in extraction time, extraction of glycyrrhizic acid form licorice : stirred reactor and under indirect sonication in ultrasonic bath
- Ultrasound assisted extraction optimized conditions **95.69 % extraction is obtained in 20 minutes, whereas in extraction using stirred reactor only 68 % extraction is observed in 60 minutes**
- Further to intensification using microwave under way

10. Process Intensification of crystallization using sonochemical reactors - Dr. Parag Gogate

- Improvement expected in crystal size distribution.
- Equipment specifications finalized ,orders placed.
- Literature survey completed .
- Experimental methodology finalized.
- Parameters for optimization decided
- The standard crystallization parameters and the ultrasound related parameters.
- Separation of crystals using filtration followed by drying. The dried crystals will be photographed using 10X optical zoom microscope for crystal shape and size analysis.

11. Continuous Synthesis of Metformin Hydrochloride in Microwave and Microreactor - Prof. V. G. Gaikar

- Metformin hydrochloride is an oral antidiabetic drug of the biguanide class.

Reaction: Cyanoguanidine + Dimethylamine Hydrochloride ⟶ Metformin Hydrochloride

Progress :

- Synthesis of metformin hydrochloride assisted with microwave in batch and semi-batch mode. Microwave driven synthesis was compared with conventional
- Microwave irradiation, increases the kinetic rate of reaction by localized heating, thereby, giving higher conversions compared to conventional heating in shorter duration of time

12. Process Intensification for Extraction of Turmeric and Pepper Oleoresin by Enzyme-Assisted Supercritical Carbon Dioxide -Prof. R. S. Singhal

- Supercritical fluid extraction (SCFE) reduces solvent consumption.
- High cost of extraction (high pressure and temperature) restricts applications.
- Enzyme-assisted SCFE can decrease costs.

Work done till date:

- Extensive literature survey.
- Modeling of extraction parameters for turmeric oleoresin extraction.
- Amylase and Glucoamylase enzymes: for turmeric oleoresin extraction .
- Sample preparation for extraction of turmeric oleoresin.
- Preliminary analysis on HPTLC, trials on SCFE in progress.

13. Enzymatic process Intensification for the manufacture of structured lipids to enhance the yield
- Dr. J. S. Waghmare

- Chemical interesterification. With Oleic acid was used as a fatty acid and capric acid .
- reaction parameters optimized.

- Atmospheric pressure and vacuum at varying temperature -> product of high acid value.
- Atmospheric pressure with nitrogen purging : product of quite low acid value.

- **Future work:**
- **Preparation of Structured lipids by using enzymes. Parametric optimization for three different enzymes.**

THANK YOU