60 years

Department of Chemical Engineering

UCTM

70 years UCTM

University of Chemical Technology and Metallurgy

Съдържание

Content

Мисия

Мисията на катедра „Инженерна химия“ е да запознае студентите със същността, механизма и кинетиката на съответните промишлени процеси, както и с тяхната взаимовръзка с конструкцията на апаратите, в които те протичат.

В този смисъл катедра „Инженерна Химия“ се явява основно образователно звено, обединяващо познанията по физика и химия (свързани с природата на процесите, протичащи при производството на даден химически или фармацевтичен продукт) с тези от инженерно-техническите дисциплини като приложна механика (обединяващи необходимите познания за избор на оптимални апарати и конструиране на цялостни производствени инсталации).

Основна задача на катедрата при обучението на студентите от специалност „Инженерна химия“ и от други инженерни специалности в ХТМУ, е изграждането на специалисти, притежаващи уникална комбинация от познания в областта на природните и инженерно-техническите науки, индустриалните производствени системи и съвременните тенденции в това направление. Разработват се нови курсове, след-

Mission

The mission of the Department of “Chemical Engineering” is to acquaint students with the essence, mechanisms, and kinetics of relevant industrial processes, as well as their relation to the design of the apparatus and equipment used for conducting them.

Therefore, the Department of Chemical Engineering serves as a fundamental educational unit that combines knowledge of physics and chemistry (related to the nature of the processes in the production of a chemical or pharmaceutical product) and of engineering and technical disciplines, such as engineering graphics and applied mechanics, integrating the necessary knowledge for selecting optimal apparatus and designing integral production facilities.

The main task of the “Chemical Engineering” Department in educating students in the “Chemical Engineering” specialty, as well as in other engineering specialties at HTMU, is to produce specialists with a unique combination of knowledge in the natural and engineering sciences. This means teaching students both the fundamental knowledge of industrial production systems and contemporary trends in this field. New lecture courses are being

ващи тенденциите за проектиране на инсталации за опазване на околната среда, разработване на системи за провеждане на биомиметични процеси и използване на математически модели чрез специализиран софтуер за създаването на ефективни и екологосъобразни производствени инсталации.

Научно-изследователските дейности, провеждани в катедрата, са свързани с проектиране, оптимизация и внедряване на авангардни процеси, целящи производството на високотехнологични продукти, наноматериали при рязко намаляване на материалните и енергийните разходи и ефекта върху околната среда.

Друго основно направление на изследователските дейности е проектирането и разработването на производствени апарати с оптимален дизайн чрез прилагането на съвременни математически методи и съответните специализирани софтуерни продукти. Тези дейности се провеждат в тесни контакти с партниращи университети и научни институти от Германия, Франция, Испания и Великобритания.

Най-актуалните научноизследователски полета са свързани с разработването и проектирането на биотехнологични инсталации, съоръжения за инактивация на химически замърсители и интензивни мембранни технологии в подкрепа на кръговата икономика и ефективното оползотворяване на природни ресурси.

developed in line with the trends in the development of environmentally friendly facilities, the development of systems for conducting biomimetic processes, and the use of mathematical modeling through specialized software to create efficient and environmentally friendly production facilities.

The research activities conducted at the Department are related to the design, optimization, and implementation of cutting-edge processes aimed at the production of high-tech products and nano-materials while significantly reducing material and energy consumption and their impact on the environment. Another major direction of research activities is the design and development of production apparatuses with optimal design through the application of modern mathematical methods and specialized software products. These activities are conducted in close and intensive collaboration with partner universities and research institutes in Germany, France, Spain, and the United Kingdom.

The latest trends of scientific research are aimed at the development and design of biotechnological facilities, facilities for the inactivation of chemical pollutants, and intensive membrane technologies in support of the circular economy and the efficient utilization of natural resources.

Катедра Инженерна Химия

Department of Chemical Engineering

През годините ръководители на катедрата са били, както следва: член кор. проф. днт Димитър Еленков (1963-1974); проф. днт Александър Асенов (1974-1993) и (1995-2000); доц. д-р Петър Петров (1993-1995); проф. д-р Иван Пенчев (2000-2012); доц. д-р Стилиян Чаушев (2012-2020); доц. д-р Димитър Пешев (2020-2023) и доц. д-р Чавдар Чилев (от 2023 г. и понастоящем).

През **1949 г.** на студентите от специалност „Индустриална химия" в Държавна политехника започва да се чете дисциплината „Процеси и апарати в химическата промишленост". Лектор е хоноруваният преподавател инж. Д. Пасков. Коренна промяна в съдържанието на дисциплината се осъществява през **1953 г.**, когато организирането на курса се възлага на **инж. Димитър Еленков**, който поставя основите на науката „Химично инженерство" у нас. Той реорганизира коренно курса с помощта и съдействието

Over the years, the heads of the Department are listed as follows: Corresponding Member of the Academy Prof. Dr. Dimitar Elenkov (1963-1974); Prof. Dr. Alexander Asenov (1974-1993, 1995-2000); Assoc. Prof. Dr. Petar Petrov (1993-1995); Prof. Dr. Ivan Penchev (2000-2012); Assoc. Prof. Dr. Stiliyan Chaushev (2012-2020); Assoc. Prof. Dr. Dimitar Peshev (2020-2023) and Assoc. Prof. Dr. Chavdar Chilev (2023 to the present).

In **1949**, the students specializing in Industrial Chemistry at the State Polytechnic Institute began studying the lecture course "Unit Operations in the Chemical Industry". A part-time lecturer was engineer D. Paskov. A significant change in the contents of the lecture course occurred in **1953** when the organization of the program was entrusted to Engineer **Dimitar Elenkov**, who laid the foundations for the field of Chemical Engineering in our country. With the assistance and support of Profes-

на проф. П.Г. Романков от Ленинградския технологичен институт „Ленсъвет“ и проф. А.Г. Касаткин от Московския химикотехнологичен институт Менделеев.

През октомври **1963 г.** се обособява самостоятелна катедра **„Процеси и апарати в химическата промишленост“**. За ръководител на катедрата е избран доц. Димитър Еленков.

През **1973 г.** за ръководител на катедрата е избран проф. Александър Асенов. Той остава такъв до 2000 г. с тригодишно прекъсване (1993-1995), по време на което ръководител е доц. Петър Петров.

От **1982 г.** катедрата е преименувана на **„Инженерна химия“**. По същото време в генералния план на висшето образование в България е приета специалност „Химично инженерство“.

Специалността „Химично инженерство“ предоставя фундаментални познания в сферата на преносните процеси (на маса, топлина и момент), моделирането и мащабния преход при технологичните процеси, създаването и оптимизацията на технологични схеми, както и контрола и симулацията на химични и биотехнологични процеси.

Вече повече от 30 години студентите в Химикотехнологичния и металургичен университет учат на немски език съобразно германските учебни планове в специалност „Инженерна химия“, получавайки финансова подкрепа от Германската служба за академичен обмен (DAAD). Записаните студенти провеждат стажове

sor P.G. Romankov from the Leningrad Technological Institute “Lensoviet” and Professor A.G. Kasatkin from the Mendeleev Moscow Chemical-Technological Institute, he did a profound reorganization of the course.

In October **1963**, an independent department named **“Unit Operations in the Chemical Industry”** was established. Associate Professor Dimitar Elenkov was appointed as the Head of the Department.

In **1973**, Professor Alexander Asenov was appointed as the Head of the Department. He held this position until the year 2000, with a three-year interruption from 1993 to 1995 when Associate Professor Dr. Peter Petrov served as the head.

From **1982**, the department was renamed to “Chemical Engineering.” Simultaneously, **“Chemical Engineering”** was included in the general higher education curriculum in Bulgaria as a specialty.

The specialty of “Chemical Engineering” provides fundamental knowledge about transport processes (mass, heat, and momentum transfer), modeling and scaling of basic technological processes, the creation and optimization of technological schemes, as well as control and simulation of chemical and biotechnological processes.

For more than 30 years now, students at UCTM have been studying in German according to German curricula in the course of “Chemical Engineering”, financially supported by the German Academic Exchange Service (DAAD). The enrolled students carry out internships and work on their theses in partnering German

и работят по дипломни проекти в университети и научни институти в Германия, партниращи на ХТМУ. Поради признатата идентичност на учебните планове и високото качество на образованието в ХТМУ дипломантите от специалността получават съвместна диплома (Doppelzeugnis) с ТУ Хамбург-Харбург и Университета „Ото фон Герике“ в Магдебург. През същия период от време в специалност „Химично и биохимично инженерство“ ХТМУ обучава отговарящи на европейските изисквания висококвалифицирани двуезични инженери с френски език (първите в България). Съществена предпоставка за успешното изпълнение на тази задача е използването на учебни планове, програми и подкрепа от утвърдени университети от Франция, Канада, Белгия и интензивните контакти на преподавателите от ХТМУ с тези университети.

През **учебната 2001/2002 г.** се дипломира първият випуск бакалаври по „Инженерна химия“, след като през 1998 г. пет-годишния цикъл на обучение за придобиване на образователна и квалификационна степен (ОКС) „магистър“ е реформиран и се стартира обучение в цикъл за ОКС „бакалавър“ с продължителност от четири години, и се дава възможност за последващо придобиване на ОКС „магистър“.

universities and research institutes. Due to the recognized identity of the curricula and the high quality of the education at UCTM, the graduates from the specialty receive “Double diplomas” with TU Hamburg-Harburg and Otto-von-Guericke-Universität Magdeburg. For nearly the same period of time, UCTM can boast with its highly qualified bilingual engineers who meet the European requirements in the specialty “Industrial Chemistry” with French language teaching (the first in Bulgarial). The substantial prerequisite for successful implementation of this programme is the use of curricula, programs, and support of established universities from France, Canada, Belgium and the intensive contacts between the lecturers from UCTM and these universities.

In the **academic year 2001/2002**, the first batch of bachelor graduates in “Chemical Engineering” completed their studies, following the reform of the five-year educational cycle for obtaining an educational and qualification degree (EQD) of “Master” in 1998. A four-year bachelor degree program was introduced with the option for subsequent attainment of a “Master”.

Over 50 doctoral dissertations have been successfully defended the department as well as 5 Doctor of Sciences.

От основаването на катедрата до момента в нея са защитени над 50 докторски работи и 5 – за доктори на науките. Катедрата е била координатор по проблем 4 „Пречистване на отпадъчни газове от серен диоксид“, както и основател на школата за следдипломна квалификация по опазване на околната среда.

Катедрата винаги е поддържала тесни връзки с промишлеността, като са разработвани и са в процес на разработване приложни научни тематики за редица предприятия в България.

След 1990 г. членове на катедрата са участвали и продължават да участват в европейски проекти като ТЕМПУС, Еразмус, Еразмус-Мундус, Еразмус+, Седма рамкова програма (Implementation membrane technology to industry - 218068), Оперативна програма „Развитие на човешките ресурси“, CHEMEPASS – проект за създаване на тестове за уеднаквяване нивото на обучение по инженерна химия.

В периода от 2020 г. до 2023 г. е направено основно обновяване на всички изследователски и учебни лаборатории към катедра „Инженерна химия“, като са оборудвани с нова научно-изследователска и демонстрационна апаратура. През 2023 г., във връзка със 70-годишния юбилей на ХТМУ, президентът на Република България г-н Румен Радев и кметът на София г-жа Йорданка Фан-

The department served as the coordinator for Issue 4” Purification of waste gases from sulfur dioxide” and was the founder of the postgraduate school in environmental protection.

The department has consistently nurtured strong links with industry, developing applied scientific topics with partners in Dimitrovgrad, Plovdiv, Razgrad, Devnya, Vratsa, Pleven, and more.

Since 1990, members of the department have been actively involved in various European projects, including TEMPUS, Erasmus, Erasmus Mundus, Erasmus+, Seventh Framework Programme (Implementation of membrane technology in the industry - 218068), the Operational Programme “Human Resources Development”, and CHEMEPASS – a project aimed at creating tests to standardize the level of education in Chemical Engineering.

Between 2020 and 2023, a significant renovation of all research and teaching laboratories at the Department of “Chemical Engineering” was carried out, equipping them with new research and demonstration equipment. In 2023, in celebration of the 70th anniversary of UCTM, the President of the Republic of Bulgaria, Mr. Rumen Radev, and the Mayor of Sofia, Mrs. Yordanka Fandakova, visited the renovated laboratories of the department and

дъкова посетиха обновените лаборатории на катедрата и се срещнаха с преподаватели и студенти.

По инициатива на доц. Димитър Пешев, който освен ръководител на катедрата в този период е и „Експерт по международни образователни програми“ към ХТМУ, висококвалифициран екип от академичния състав на катедрата взема активно участие в проект BG05M2OP001-2.016-0013 „Модернизация, дигитализация и интернационализация на обучението в Химико-технологичен и Металургичен Университет“. В рамките на този проект, съвместно с асоциирания партньор, University of Alabama in Huntsville, са разработени учебен план и учебно съдържание по магистърска програма в специалност „Chemical and environmental engineering“ с преподаване на английски език. Първият випуск студенти е приет през академичната 2022/2023 година.

had meetings with faculty and students (photos from the event can be included here).

At the initiative of Assoc. Prof. Dimitar Peshev, who serves as both the department head and the “Expert in International Educational Programs” at UCTM, a highly qualified team of the academic staff of the department actively participated in the project BG-05M2OP001-2.016-0013, “Modernization, Digitalization, and Internationalization of Education at the University of Chemical Technology and Metallurgy.” Within this project, in collaboration with their associated partner, the University of Alabama in Huntsville, they developed a curriculum and educational content for a Master Program in “Chemical and Environmental Engineering,” taught in English. The first group of students was admitted in the academic year 2022/2023.

Академичен състав

Academic staff

доц. д-р инж. **Чавдар Чилев**
(ръководител катедра)

ОБЛАСТИ НА ИНТЕРЕСИ
- Преносни процеси
- Математическо моделиране
- Нанотехнологии
- Адсорбция
- Технологии за разделяне
- Дестилация и процеси на екстракция

Assoc. Prof. Eng. **Chavdar Chilev,** PhD
(Head of the Department)

MAIN FOCUS
- Transport phenomena
- Mathematical modelling
- Nanotechnology
- Adsorption
- Separation technology
- Distillation and extraction processes

доц. д-р инж. **Димитър Пешев**
(Зам.-Ректор по Науни дейности)

ОБЛАСТИ НА ИНТЕРЕСИ
- Технологии за мембранно разделяне
- Компютърно моделиране и симулация на процеси
- Преносни процеси в ненютонови течности
- Интензификация на процесите
- Хомогенни и хетерогенни химични реактори

Assoc. Prof. Eng. **Dimitar Peshev,** PhD
(Vice-Rector for Research)

MAIN FOCUS
- Membrane separation technologies
- Computer modelling and simulation of processes
- Transport processes in non-Newtonian fluids
- Process intensification
- Homogeneous and heterogeneous chemical reactors

доц. д-р инж. **Ивайло Хинков**

ОБЛАСТИ НА ИНТЕРЕСИ
- Синтез и охарактеризиране на графен и въглеродни нанотръби
- Фундаментален подход от теория, моделиране и симулация за разработване на съвременни материали и процеси

Assoc. Prof. Eng. **Ivaylo Hinkov,** PhD

MAIN FOCUS
- Synthesis and characterization of graphene and carbon nanotubes
- Fundamental approach from theory, modelling and simulation to develop advanced materials and processes

гл.ас. д-р инж. **Десислава Мутафчиева**

ОБЛАСТИ НА ИНТЕРЕСИ
- Преносни процеси
- CFD симулации на двуфазни системи
- Математическо моделиране и мащабиране на биореактори

Senior Assist. Prof. Eng. **Dessislava Moutafchieva,** PhD

MAIN FOCUS
- Transport phenomena
- CFD simulation of two-phase systems
- Mathematical modelling and scale up of bioreactors

гл.ас. д-р инж. **Светломир Дянков**

ОБЛАСТИ НА ИНТЕРЕСИ
- Преносни процеси: екстракция на растения, импрегниране
- Синтез на наночастици

Senior Assist. Prof. Eng. **Svetlomir Diankov,** PhD

MAIN FOCUS
- Transport phenomena: plant extraction, impregnation
- Nanoparticle synthesis

гл.ас. д-р инж. **Катя Пашова**

ОБЛАСТИ НА ИНТЕРЕСИ
- Нанотехнологии
- Синтез и охарактеризиране на графен
- Компютърно моделиране

Senior Assist. Prof. Eng. **Katya Pashova,** PhD

MAIN FOCUS
- Nanotechnologies
- Synthesis and characterization of graphene
- Computer modeling

гл. ас. д-р инж. **Младен Попов**

ОБЛАСТИ НА ИНТЕРЕСИ
- Биохимично инженерство
- Генно-инженерни технологии

Senior Assist. Prof. Eng. **Mladen Popov,** PhD

MAIN FOCUS
- Bioprocess Engineering
- Recombinant DNA Technology

ас. инж. **Благой Стоилов**

ОБЛАСТИ НА ИНТЕРЕСИ
- Оценка на риска при химически процеси
- Масо- и топлообменни процеси

Assist. Prof. Eng. **Blagoy Stoilov**

MAIN FOCUS
- Risk Assessment in Chemical Processes
- Heat and Mass Transfer

ас. д-р инж. **Ирина Неделчева**

ОБЛАСТИ НА ИНТЕРЕСИ
- „Downstream“ процеси
- Мембранно разделяне (нанофилтруване)
- Електрохимично рафиниране в медната металургия

Assist. Prof. Eng. **Irina Nedelcheva,** PhD

MAIN FOCUS
- Downstream processing
- Membrane separation (nanofiltration)
- Electrochemical refining in copper metallurgy

ас. инж. **Стефан Атанасов**

ОБЛАСТИ НА ИНТЕРЕСИ
- Приложение на йонни течности във фармацефтичната индустрия
- Оптимизация на биохимични и каталитични процеси

Assist. Prof. Eng. **Stefan Atanassov**

MAIN FOCUS
- Application of ionic liquids in pharmaceutical industry
- Optimization of biochemical and catalytic processes

ас. д-р инж. **Веселин Идакиев**

ОБЛАСТИ НА ИНТЕРЕСИ
- Процеси и апарати в химическа и фармацевтична индустрия
- Разработване на продукти с определени свойства

Assist. Prof. Eng. **Vesselin Idakiev,** PhD

MAIN FOCUS
- Apparatus and processes in chemistry and pharmacy
- Particle engineering with targeted properties

проф. дтн **Йордан Христов**

ОБЛАСТИ НА ИНТЕРЕСИ
- Преносни процеси
- Математическо моделиране
- Риск и безопасност
- Флуидизация и дисперсни системи

Prof. **Jordan Hristov,** PhD, DSc (Emeritus)

MAIN FOCUS
- Transport phenomena
- Mathematical modelling
- Risk and safety
- Fluidization and disperse systems

проф. д-р инж. **Евгени Симеонов**

ОБЛАСТИ НА ИНТЕРЕСИ
- Хидродинамика, топло – и масообменни процеси
- Проектиране на топло- и масообменно оборудване
- Масопренос твърдо-течно
- Извличане на биоактивни съединения от суровини – кинетика и моделиране

Prof. Eng. **Evgeni Simeonov,** PhD

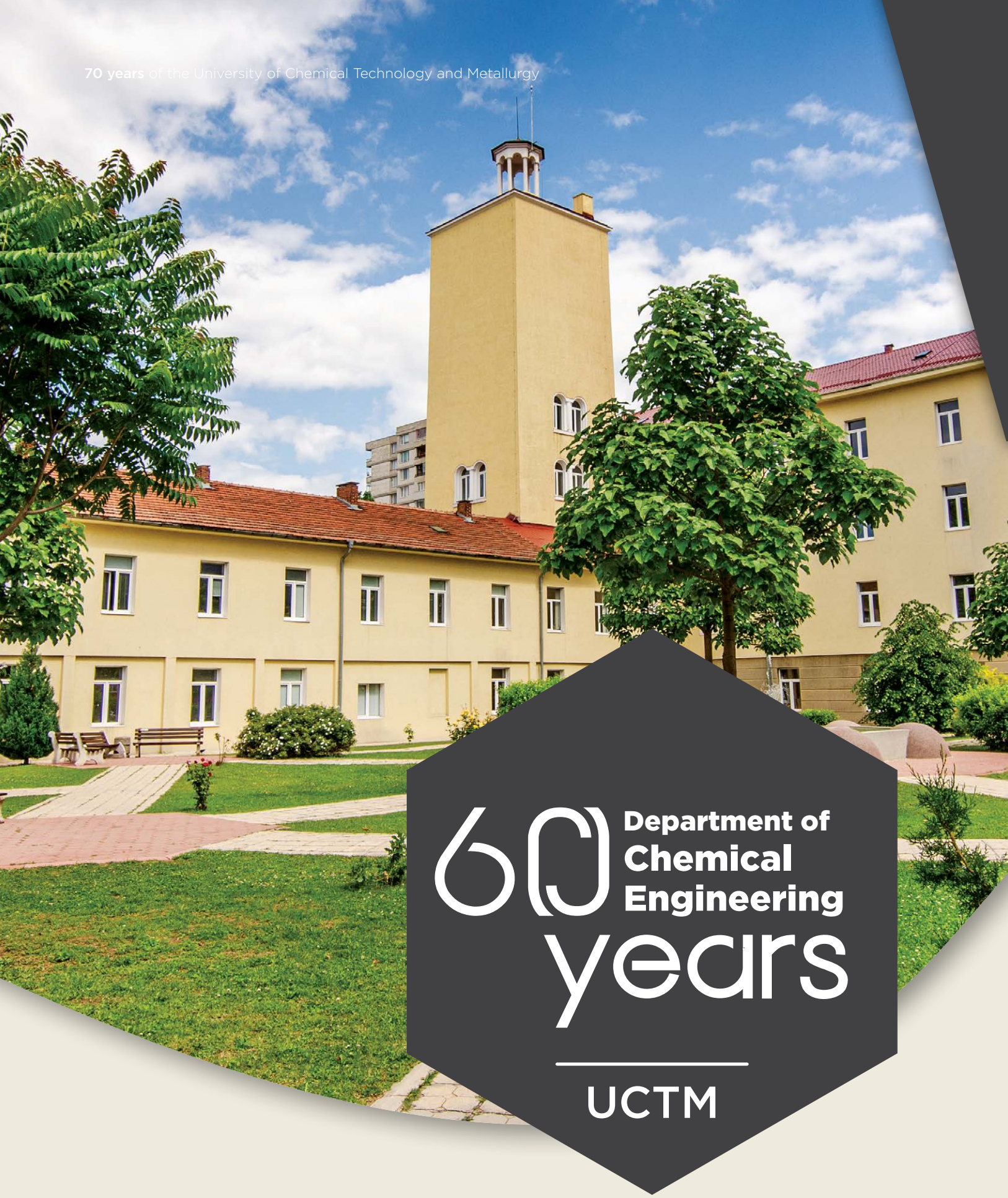
MAIN FOCUS
- Hydrodynamic, Heat and Mass transfer processes
- Design of heat and mass transfer equipment
- Solid-liquid mass transfer
- Extraction of bioactive compounds from raw materials – kinetics and modelling

доц. д-р инж. **Илонка Съйкова**

ОБЛАСТИ НА ИНТЕРЕСИ
- Нови методи за извличане на биологично активни вещества от растителни суровини в различни екстракционни системи
- Моделиране на въздействието на електрически импулсни полета при преработка на природни суровини
- Приготвяне на биоматериали на базата на естествени полимери с включени биологично активни вещества

Assoc. Prof. **Ilonka Saykova,** PhD

MAIN FOCUS
- New methods for extracting biologically active substances from plant raw materials in various extraction systems
- Modeling the impact of electric impulse fields during the processing of natural raw materials
- Preparation of biomaterials based on natural polymers with biologically active substances included


60
Department of
Chemical
Engineering
years
UCTM

Jubilee International Conference

20.11.2023

Scientific committee

Prof. Eng. **Senya Terzieva-Zhelyazkova**, PhD
Assoc. Prof. **Dimitar Peshev**, PhD
Assoc. Prof. **Ivaylo Hinkov**, PhD
Assoc. Prof. **Chavdar Chilev**, PhD

Industrial participants in the conference

Petko Sabev	Director of **Bencovski Co**
Ivan Ivanov	President of **Bulgarian Water Association**
Ralitsa Radoeva	Technological engineer at **Bul Bio NCPID Ltd.**
Yavor Pisanov	Manager of Process Instrumentation **Hub Ltd.**
Ivan Aleksandrov	Head of the department "Investigation of new technologies for metal extraction" at **Elatsite Med Ltd.**
Veneta Dimitrova	Chief Operating Officer of **TechnoPhos JSCo**
Hristo Dyulgerov	Process Engineer at **Technophos JSCo**
Vladimir Tasev	Manager/owner of **ECO INDUSTRIES LTD.**
Rumen Petrov	Owner at **Relina Ltd.**

ORAL PRESENTATIONS

MEMBRANES, MOLECULES, AND MONEY

Andrew Livingston
Professor of Chemical Engineering, Vice Principal Research and Innovation,
Queen Mary University of London

There are many trials and tribulations in taking university research from the laboratory to the commercial scale while trying to make some profits along the way. This talk will describe two such adventures.

Livingston Lab is based at Queen Mary University of London. The research in the lab is about developing solvent-stable membranes for molecular separation in organic solvents – Organic Solvent Nanofiltration. This work has made original contributions to membrane fabrication, transport phenomena, materials formation and chemistry, and has discovered new approaches to the use of molecular separations in chemical synthesis, most recently the creation of the Nanostar Sieving platform. It has also led to the formation of two start-up companies.

Membrane Extraction Technology (MET) was founded in 1996 with Andrew Livingston as Managing Director to exploit the Extractive Membrane Bioreactor (EMB), at the time a new style of reactor for separating and degrading toxic organic molecules from chemical industry wastewater. By 2002, the company had succeeded in demonstrating that a successful business would not grow from this technology and turned their attention to Organic Solvent Nanofiltration, OSN, entirely different membrane technology with applications in production processes. Typically OSN will use a small fraction of the energy of thermal methods such as evaporation and distillation and can work at temperatures around ambient. MET licensed technology and set about commercialising it with main application areas to concentrations, purification, recycling of organometallic catalysts, solvent exchanges, and metal (Pd) removal from post-reaction mixtures. They successfully scaled up the manufacture of the DuraMem TM series of OSN membranes, and MET was acquired by German chemical major Evonik Industries AG on 1 March 2010 on favourable terms and became part of the Evonik Fibres and Membranes business line.

Further innovation in the University setting then led to a new company, Exactmer, set up to commericialise Nanostar Sieving. This new platform is based on liquid phase reactions with a soluble macromolecular homostar molecule, coupled to membrane purification. This provides a fully liquid phase platform capable of producing synthetic polymers of exquisite molecular accuracy. It has also been applied to peptides. Perhaps most exciting are the applications to oligonucleotide therapeutics. Nanostar Sieving, licensed to scale up Exactmer Limited, creates an alternative with the potential for substantial efficiencies and is undergoing an accelerated £15M commercialisation programme between Exactmer and the Medicines Manufacturing Innovation Centre, sponsored by pharma companies Novartis, AstraZeneca, Alnylam and Innovate UK.

CARBON DIOXIDE RECYCLING IN FUEL CELL APPLICATION

Venko Beschkov, L. Liutzkanov, S. Stefanov
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The considerable charges on the atmosphere by greenhouse gases overwhelming the capacity of nature to cope with them is considered a fundamental challenge for climate change.

One of the most important reasons for the use of biomass as a renewable energy source is the fact that the present biomass is almost completely recyclable, as the released carbon dioxide by combustion is converted by the vegetation by photosynthesis. A good example of this approach is the treatment of organic waste to produce biogas. The latter is mostly used as a fuel but its application as a feedstock for chemicals is also considerable.

On the other hand, the inevitable release of carbon dioxide could be remediated after its conversion into chemicals (e.g. synthesis gas. methanol, formic acid) and to fuel, like methane by chemical, electrochemical or biotechnological processes.

The present work summarizes the up-to-date methods and approaches for carbon dioxide recycling recent author results conversion and carbon dioxide conversion to chemicals and fuels. The fuel cell approach enables the drastic reduction of carbon dioxide released during its conversion into value-added chemicals, i.e. formic acid, methanol, etc. Our results show the formic acid production with reasonable yields in a fuel cell where bicarbonate and carbonate are used as oxidizers.

GAS TURBINE WITH ISOTHERMAL EXPANSION

Dimitar Kolev
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The greatest shortcoming of a gas turbine is that to decrease its inlet temperature up to 1200- 1300°C the burning chamber works with a large excess of air, which significantly reduces its efficiency. To overcome this disadvantage, the over stoichiometric air excess, partially [1], or practically fully [2-5] is changed with steam.

Results: The technological scheme of the new installation, which ensures its high efficiency and elimination of the NOx building, is presented. Data for the composition of the inlet gases of the turbine as a function of the temperature, pressure, coefficient of air excess and steam-to-methane ratio are given. A special soot factor based on thermodynamic consideration is defined to calculate the area of parameters when no soot formation is possible.

Conclusions: A new gas turbine installation with a combustor operating at a lack of oxygen and burning of the H_2 and CO obtained under these conditions in the first part of the turbine at a constant temperature at expansion is described. The results of thermodynamic investigations of the combustor and a new factor for the determination of the conditions for no soot formation are presented.

APPLICATION OF NANOMEMBRANE SEPARATION FOR ISOLATION OF NATURAL BIOLOGICALLY ACTIVE COMPONENTS.

Dimitar Peshev
Department of Chemical Engineering, Faculty of Chemical and System Engineering, UCTM, Sofia, Bulgaria

The development of new solvent-stable materials in the past two decades has permitted the application of membrane filtration techniques to different processes in organic solvents and solvent mixtures. The biologically active constituents of plants are traditionally isolated trough solid-liquid extraction and further evaporation of the obtained dilute liquid extracts. Due to their susceptibility to thermal degradation and oxidation, traditional thermal separation technologies result in poor product quality. Significant reduction of the specific energy consumption while preserving product activity during the concentration or fractionation of liquid extracts from rosemary or spent coffee grounds, using nanofiltration, is demonstrated via experimental data and process simulations. Even though the concept has been proved at a laboratory scale with short term experiments, the application of nanofiltration for processing of natural extracts at production scale is rather scarce. The two main obstacles are the fact that until couple of years ago a reliable multiscale modeling framework and tools for simulation of these processes were not available and also that commercial membranes are prone to fouling from the target components of the plant materials. To address the first obstacle we a complete modeling framework to support the nanofiltration process design has been developed. The developed modelling tool, called „OSN Designer", was supposed to: cover all phenomena from the membrane nanoscale to the process macroscale; to require only limited number of experimental data at lab scale and thus reduce the costs and materials; to be incorporated in existing process modeling environments, such as AspenONE, ChemCAD, ProSim etc. Using OSN Designer we are also capable to investigate the effects at process level from drastically enhancing the membrane permeances by using different technics to answer the question: will ultrafast membranes lead to ultrafast processes?

Particular attention is drawn on the current results of a project for fundamental research dealing with application of nanofiltration for valorisation of the waste streams from the essential oil industry. The distribution of biologically active compounds in the aqueous effluents and waste plant mass were theoretically predicted using the COSMO-RS method, which has the quantum-chemical basis of the Conductor-like Screening Model (COSMO). The possibility to fractionate hydrosols, residual waters, and hydroalcoholic biologically active extracts from spent plant material from the steam and hydrodistillation of essential oil plants, using nanofiltration was demonstrated.

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POSTER PRESENTATIONS

IMPACT OF HIGH ENERGY BALL MILLING ON CHEMICAL AND MICROSTRUCTURAL PROPERTIES OF CALCITE-QUARTZ-APATITE SYSTEM

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The objects of this study are the phosphotites differing in their P_2O_5 total content and mineral composition. The HEM activation was carried out in a planetary mill with Cr-Ni milling bodies with a diameter of 20 mm. The aim of this investigation is to determine the possibilities of micro-structural changes and transformations and chemical reactivity as a result of HEM-activation of the samples. This is achieved by studying the activation effect and the impact of calcite and quartz on the phase transformations occurring in the apatite structure.

The results from the study of apatite samples of various origins have evidenced the formation of a nano-sized phase with a lowered degree of crystallinity. The microstructural changes of the activated samples are related to the increasing assimilable form of P_2O_5, the incorporation of CO_2 and OH- in the apatite structure. The results were confirmed through the complex of methods – chemical analysis to define the solubility of P_2O_5, Specific surface area, Powder X-ray diffraction and Fourier Transformed Infrared spectroscopy.

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HYDROMETALLURGICAL TREATMENT OF COPPER CONVERTER ESP DUST

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During the conversion of copper matte, part of the charge leaves the converter space together with the off-gases in the form of dust entrainment. Volatile components also pass into the dust-gas flow, due to which it is enriched with impurities harmful to the following technological process of electrowinning. The formed dust-gas flow passes through dust collection equipment, where the main part of it is captured. Most often, the captured dust is recirculated, which leads to a decrease in the productivity of the smelting furnace. In order to overcome these problems, it is necessary to take out of the melting cycle part or all of the recirculating converter dust and process it for extraction of the valuable metals and disposal of the harmful substances. In metallurgical practice, the processing of copper converter dust has mainly been accomplished by the hydrometallurgical route.

In the present research work, the laboratory results on hydrometallurgical treatment of copper converter electrostatic precipitator (CC-ESP) dust are presented. The effect of the main technological parameters affecting the degrees of main metals recovery in solution is studied. Based on the experimental results, the optimal conditions for hydrometallurgical treatment of the CC-ESP dust are determined.

SYNTHESIS OF MnO_2/AgNPs COMPOSITE MATERIAL FOR APPLICATION IN HYBRID SUPERCAPACITORS

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One of the challenges of the modern world is the storage and conversion of energy. In this regard, there is an increased interest in the search and development of high-performance devices for energy storage from renewable sources, which are as environmentally friendly as possible. Among them, special attention is paid to supercapacitors.

This work presents the results of synthesis and physicochemical characterization of a new MnO_2/AgNPs composite material to improve the performance of the positive electrode in hybrid supercapacitors and increase their energy density. MnO_2 was also obtained in order to compare the physicochemical and electrochemical characteristics of the two materials. A commercial Aquivion®E87-05S membrane activated with Na_2SO_4, K_2SO_4, and $LiSO_4.H_2O$ was used as an electrolyte. The synthesized materials were characterized using X-ray diffraction (XRD), scanning electron microscopy and energy dispersive analysis (SEM-EDX) and determination of the specific surface area by the Brunauer-Emmett-Teller (BET) method. The hybrid supercapacitor cells were investigated electrochemically by galvanostatic charge/discharge tests and cyclic voltammetry. AgNPs were found to significantly improve the performance of the supercapacitor.

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SILVER NANOPARTICLES AS BIFUNCTIONAL CATALYSTS FOR APPLICATION IN AEM WATER ELECTROLYSIS

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In this work, preliminary results of bi-functional catalysts based on (AgNPs/XC-72-R) applicable in aqueous anion conducting membrane electrolysers are presented. The integration of the silver nanoparticles into the catalytic carrier was carried out by the sol-gel method. The silver particles were previously obtained by a green synthesis method using direct sunlight. During the synthesis, the main factors affecting the synthesis process of silver nanoparticles, such as the concentration of the starting substances and the synthesis time, were investigated. The obtained materials were characterized physicochemically. The catalytic activity with respect to the partial reactions for oxidation and reduction of oxygen and hydrogen, respectively, were investigated by means of linear voltammetry in a three-electrode cell with a liquid electrolyte of 25% KOH at room temperature. Spherical silver nanoparticles as catalysts have been successfully synthesized and integrated. Catalysts based on AgNPs/XC-72-R were found to be suitable for the hydrogen and oxygen evolution reaction.

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USE OF FEEDSTOCK WASTE TO GENERATE HEAT AND POWER THROUGH GASIFICATION

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As society develops, fossil fuels are increasingly used to generate heat and electricity, resulting in the generation of large amounts of greenhouse gases. By presenting this technology for the gasification of feedstock waste materials, we aim to obtain energy from this renewable plant-based source. The technology proposes the gasification of the tars obtained by pyrolysis of the feedstock waste material in the gasifier itself without the use of a catalyst. The heat carried by the generated gas is utilized by condensing the carried water vapor.

USING ANSYS ROCKY DEM-CFD COUPLING TO DETERMINE THE OPTIMAL OPERATING CONDITIONS FOR A SMALL-SCALE FLUID BED COFFEE ROASTER

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Both the ANSYS software packages - Rocky and Fluent provide the opportunity to computationally investigate particulate and fluid flow, respectively.

Using the two-way coupling capability a direct connection between particulate and fluid flow is established. Combining both of the physics and taking into account the particle's shape gives a very close approximation to real physical phenomena.

The above-described tools were implemented for the determination of the optimal key operating conditions of a small-scale fluid bed coffee roaster. The results were used to select a proper air velocity and the packed bed height.

CREATION OF AGGLOMERATION CUP FOR LABORATORY AGGLOMERATION INSTALLATION

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Globally, not all ores and concentrates in the field of ferrous metallurgy meet the requirements for direct processing. The concentrates obtained as a result of various beneficiation operations, fines from ore mining, throat dust and others must be aggregated before their further use.

Agglomeration (or sintering) is called the process of agglomeration, and the necessary heat is obtained by burning fuel in the starting materials. It is a thermal method for coagulating iron and other ores and concentrates with fluxes, additives and fuel. The agglomerated products have sufficiently high strength, the uniform granulometric and chemical composition. Agglomeration by air infiltration is carried out on belt agglomeration machines, and in laboratory conditions – by agglomeration cups. This method has received the widest application - about 80% of the world's agglomerating product production.

The aim of the development is the design and creation of a compact agglomeration cup, as the first stage of the construction of a laboratory agglomeration installation for the needs of the MTEEE Department.

ENHANCING CHEMICAL ENGINEERING STUDENTS' SKILLS IN GERMAN AND ENGLISH (SCHOLAR CIRCLE AT THE DEPARTMENT OF CHEMICAL ENGINEERING AT UCTM-SOFIA)

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Catalytic science plays a key role in solving many environmental problems by developing new, highly active, and stable catalysts for processes that lead to zero-waste technologies in industry and transport. The efficient utilization of catalysts requires a thorough understanding of the surface structure and surface chemistry of the catalytic material. The focus of this study is to present some aspects of the application of the temperature-programmed analysis technique for the investigation of heterogeneous catalysts at the Institute of Catalysis in the Bulgarian Academy of Sciences. Three reactions were studied as a function of temperature: reduction, oxidation, and desorption. Temperature-programmed desorption (TPD) is used to analyze adsorbed species (which might be deliberately introduced by a pre-adsorption step) in inert atmospheres. Temperature-programmed reduction (TPR) and temperature-programmed oxidation (TPO) probe the susceptibility to reduction and oxidation, respectively, and are carried out in the presence of hydrogen in the case of TPR and oxidants such as oxygen or carbon dioxide in the case of TPO. The results of the described techniques can be useful for researchers to effectively optimize the performance of catalysts and develop novel materials with enhanced properties.

VALORISATION OF WASTE PRODUCTS FROM THE HYDRODISTILLATION OF CLOVES ESSENTIAL OIL

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Cloves (Syzygium aromaticum) is a valuable spice that has been used for centuries as a food preservative and for many medicinal purposes. This plant is one of the richest sources of phenolic compounds such as eugenol and gallic acid and possesses great potential for pharmaceutical, cosmetic, food, and agricultural applications.

The aim of the present work was to evaluate the feasibility of nanofiltration for the valorisation of the waste materials resulting from the production of cloves essential oils. Therefore, nanofiltration of residual water and cloves hydrosol, obtained via hydrodistillation at a laboratory scale, was performed. The feed, retentate, and permeate fractions from the filtration with commercial membranes of both waste materials were tested for their antioxidant activity and content of key biologically active constituents. The results confirmed the high potential of nanofiltration for efficient recovery of valuable biologically active compounds from the effluent streams.

Acknowledgements: This study is funded by the European Union - NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project № BG-RRP-2.004-0002, "BiOrgaMCT" and the Bulgarian National Science Fund (contract KP-06-H37/14).

EFFECT OF NOVEL LIGNIN AND LIGNIN-MORIN NANOPARTICLES ON THE BIOCHEMICAL LIVER FUNCTION PARAMETERS OF MICE WITH ACETAMINOPHEN-INDUCED HEPATOTOXICITY

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Oxidative stress has been recognized as a critical pathogenetic mechanism for the initiation and progression of hepatic injury in a variety of liver disorders. The purpose of the current study was to assess the hepatoprotective effect of newly synthesized lignin (LNP) and morin-encapsulated lignin (LMNP) nanoparticles against acetaminophen-induced hepatotoxicity in mice. The effects of pre-administration of LNP and LMNP on mice were assessed on the basis of biochemical liver function parameters: alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP) activity, as well as creatinine, albumin, cholesterol and triglycerides levels. Male ICR mice were divided into 8 groups – one control group and 7 groups injected intraperitoneally with morin, LNP, LMNP, acetaminophen, morin + acetaminophen, LNP + acetaminophen, LMNP + acetaminophen. LNPs, LMNPs and morin pretreatment attenuated the induced liver injury by diminishing the serum AST, ALP, and ALT levels. The observed hepatoprotective effect was most tangible for the flavonoid-loaded lignin nanoparticles. The serum triglyceride levels of both types of nanoparticles and morin-treated mice were decreased as compared to that of the acetaminophen-treated group. The latter results have shed light on a novel approach for the treatment of acetaminophen-induced hepatotoxicity.

NUMERICAL SIMULATION OF A HYBRID PROCESS FOR BIO-OIL SEPARATION

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Biomass as a whole offers a more diverse potential for valorisation than any other renewable energy source. As one of the stages in the separation of bio-oil involves the liquid mixture of acetol and acetic acid, and as both components are particularly well suited for valorisation, a hybrid method has been developed for their separation with a high purity level through an approach combining liquid-liquid extraction and rectification. In order to design and simulate the flowsheet, the ChemCAD 7.0 simulation software has been used. Sensitive analyses have been carried out to investigate the influence of the different parameters in the rectification columns such as the reflux ratio, the feed stage location, and the vapour/bottom molar flow ratio. The effect of different extractants and their excess on the separation process as well as the possibility of regenerating the extractant has also been studied. Tri-n-octylamine has accordingly been selected as a separating agent which has been fully recycled. The end result for separating an initial 48/52 wt% acetol/acetic-acid liquid mixture has been acetol with a purity of 99.4 wt% and acetic acid with a purity of 100 wt%.

EXTRACTION OF CROTON LECHLERI BARK BY TWO TECHNIQUES: PRELIMINARY RESULTS

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Plant biomass is a sustainable source of secondary metabolites with pronounced beneficial effects on human health. An example is Croton lechleri Müll. Arg., known as Sangre de Drago tree since its bark releases a blood-red latex demonstrating antibacterial, antiviral, antioxidant, anti-inflammatory, anticancer, etc. activities. Our goal was to evaluate the efficiency of two techniques for extracting latex from C. lechleri bark - Soxhlet method using organic solvents, e.g. n-hexane, ethanol, and an advanced approach utilizing supercritical CO_2. The preliminary results for both methods, with a focus on their effectiveness regarding yield, show that Sohxlet n-hexane renders 5 times lower yield than that obtained by ethanol (2.38 vs 11.61). Extraction with neat $scCO_2$ was performed at T = 60°C and p = 500 bar, while that with $scCO_{2+}$ with 10% ethanol – at T = 60°C and p = 300 bar. The yield with $scCO_2$ was 1.35 %, while that with $scCO_2$ + 10% ethanol -3.0 %. Still, it is almost 4 times lower than Soxhlet ethanol. To the best of our knowledge, our preliminary results are the first to reveal the influence of the extraction method on the recovery of Sangre de Drago latex from C. lechleri bark.

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ANALYSIS OF HETEROGENEOUS ENVIRONMENTAL CATALYSTS BY TEMPERATURE-PROGRAMMED DESORPTION, REDUCTION AND OXIDATION - ASPECTS AND APPLICATIONS

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Catalytic science plays a key role in solving many environmental problems by developing new, highly active, and stable catalysts for processes that lead to zero-waste technologies in industry and transport. The efficient utilization of catalysts requires a thorough understanding of the surface structure and surface chemistry of the catalytic material. The focus of this study is to present some aspects of the application of the temperature-programmed analysis technique for the investigation of heterogeneous catalysts at the Institute of Catalysis in the Bulgarian Academy of Sciences. Three reactions were studied as a function of temperature: reduction, oxidation, and desorption. Temperature-programmed desorption (TPD) is used to analyze adsorbed species (which might be deliberately introduced by a pre-adsorption step) in inert atmospheres. Temperature-programmed reduction (TPR) and temperature-programmed oxidation (TPO) probe the susceptibility to reduction and oxidation, respectively, and are carried out in the presence of hydrogen in the case of TPR and oxidants such as oxygen or carbon dioxide in the case of TPO. The results of the described techniques can be useful for researchers to effectively optimize the performance of catalysts and develop novel materials with enhanced properties.

STUDY OF FLUIDIZED BEDS WITH AN INNOVATIVE HEATING METHOD

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In a fluidized bed, a fluid, whether it is a liquid or gas, is circulated through the bulk material, causing it to become more fluid and loose. This leads to the solid-liquid or solid-gas mixture behaving like a fluid itself. Recently, this technology has been gaining popularity in various industrial processes such as shaping, coating, and drying due to its ability to enhance heat and mass transfer between the fluid and the solid materials.

Energy is conventionally introduced into fluidized beds by heating the fluidizing gas through convection. An alternative method for energy input involves inductive heating, which employs electrically conductive but chemically inert particles and an electromagnetic field. Thus, heat is not generated by heating the fluid flow entering the fluidized bed but is directly transferred through the non-contact heating of conductive particles within the bed. This allows for efficient heat exchange and a high energy density since heat is dissipated across a large surface area in the bed material. Additionally, inductive technology enables rapid heating and cooling of the bed material, leading to increased efficiency and improved product quality.

This work provides a general description of fluidized beds with inductive heating and provides information about potential application areas.

ACTIVITY MEASUREMENTS OF K-, CO-PROMOTED RE(MO) SYSTEMS - PATH FOR SEARCH OF WATER-GAS SHIFT REACTION CATALYST GETTING CLEAN HYDROGEN

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[1]University of Chemical Technology and Metallurgy, Sofia, Bulgaria
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Hydrogen is embraced as a global energy solution. The water gas shift (WGS) reaction ($CO+H_2O \leftrightarrow CO_2+H_2$) is a process for hydrogen cleaning and generation for decarbonizing energy systems. Our efforts are concentrated on the design of K-, Co-promoted Re (Mo) catalyst for low-temperature WGS reaction, suitable for FC applications by reducing CO content below 1% and overcoming cooling step in the middle of commercial process realization by high-temperature Fe2O3-Cr2O3-CuO (300–450 °C) and low-temperature Cu-ZnO (180–250 °C) catalysts. For this purpose, initial studies are targeted to find successful catalyst composition and corresponding suitable conditions of reduction/activation and WGS reaction.

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GREEN HYDROGEN PRODUCTION PART 1

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Hydrogen has been always attractive as an alternative to fossil fuels such as oil and natural gas. On the other hand, there is no waste as a result of its combustion; i.e., water is produced, being a feedstock for further hydrogen production. The benefits of bio-hydrogen production and utilization are multiple. First, it is an energetically beneficent process, compared to traditional electrolysis. Next, bio-hydrogen production relies on waste organic products, thus combining energy production with waste treatment. The practical production of bio-hydrogen on a large scale presumes the use of low-cost substrates such as residues from the food industry, beverage and ethanol production, residues from agriculture, etc. Various substrates for fermentative hydrogen production have been tested. Studies with glucose, cellulose and other sugars are available. There are two main groups of microbial processes leading to hydrogen production depending on the light involvement. First, there is photo fermentation using light to produce sugars by photosynthesis and then to convert organic molecules into hydrogen and carbon dioxide. Next, there is dark fermentation when anaerobic bacteria and algae convert complex substrate molecules into hydrogen and carbon dioxide.

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GREEN HYDROGEN PRODUCTION PART 2

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A newly isolated strain, Clostridium beijerinckii 6A1, was tested under batch conditions for hydrogen production capacity with glucose, glycerol and alcohol stillage as substrates. Relatively high molar yields of hydrogen (up to 2.23 mole H 2 /mole glucose) and modest hydrogen production rates (0.052 L hydrogen/L medium/h) were achieved when glucose was used as a substrate. Similar results for the specific molar yield of hydrogen were achieved when stillage and glycerol (at low initial concentration) were used as substrates. At higher initial concentrations of glycerol, the hydrogen yields were considerably lower because of the accumulated acetate and propionate, being inhibitors to hydrogen production and because of the excessive consumption of NADH. The products of glycerol digestion show that the pathway with no formic acid is observed and small amounts of butanol are detected. When glucose or hexose-based substrates, such as alcohol stillage, were used the formic acid formation was observed, i.e., the pathway involving fatty acids and ethanol formation was appropriate for the observed process of hydrogen release. In all cases, substrate digestion stopped the accumulation of acetic acid, propionic acid and ethanol.

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COMPUTATIONAL FLUID DYNAMICS AS A TOOL FOR DESIGNING MIXING TANKS

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Computational Fluid Dynamics (CFD) has become an indivisible part of the works of academic researchers and industrial Research and Development (R&D) departments. Chemical engineering is one of the fields that is highly and positively impacted by the advances in both CFD and the computational power of modern computers. The current work presents its capabilities to aid the design process of mixing tanks.

A modern approach for designing mixing tanks had to be developed in order to reduce the number of prototypes and reduce the previously extensive testing for performance characterization. A 3D CAD tool was used to model a mixing tank. The simulations performed via ANSYS Fluent were focused on determining its performance with and without baffles in the tank. Parallel to that the different mixing patterns caused by 3 types of impellers were observed. The results from the CFD analysis were validated experimentally – the vessel was made from PMMA (Polymethyl methacrylate, Plexiglas), the shaft – stainless steel and the impeller was 3D-printed with PLA (Polylactic acid). A good agreement between experiments and simulations was observed.

It can be concluded that simulations greatly reduce the number of prototypes that have to be constructed before the optimal design is reached.

SELECTIVE EXTRACTION OF RICE STRAW HYDROLYZATE COMPONENTS B Y PHOSPHONIUM IONIC LIQUIDS

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In recent years, much effort has been devoted to the utilization of wood and agricultural waste, as well as non-food algae and aquatic weeds. In the production of energy compounds, biomass is first pretreated and then saccharified to fermentable sugars. Acid hydrolysis aims to break down the bonds among lignin, cellulose, and hemicellulose with minimum loss of hemicellulose. Diluted sulphuric acid hydrolysis results in a high recovery of the hemicellulosic sugars in the liquid and in a solid cellulose fraction that can easily be digested by enzymes. Moreover, in some cases, an enzymatic hydrolysis step could be omitted as the acid itself hydrolyzes the biomass into fermentable sugars. Under the pretreatment conditions, the biomass constituents may undergo various transformations. Pentoses and hexoses can be dehydrated to aldehydes, furfural, and HMF, and further on, to formic and levulinic acids. Acetic acid, which is not a sugar degradation product but a result of the hydrolysis of hemicellulose acetyl groups, is another acid found in the liquor.

The possibility of reactive extraction of components from rice straw hydrolyzate using hydrophobic phosphonium ionic liquids (ILs) – tetradecyl(trihexyl)phosphonium bis(2,4,4-trimethylpentyl)phosphinate [C14C6C6C6P][BTMPP] and tetradecyl (trihexyl)phosphonium neodecanoate ([C14C6C6C6P][NDec]) was investigated in the present work.

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TWO POTENTIAL APPROACHES TO PROCESS LIGNOCELLULOSIC MATERIALS WITH IONIC LIQUIDS

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In relation to biofuel production from renewable raw materials, the availability of lignocellulosic biomass (LCB) in the form of various wastes has attracted considerable scientific attention. Lignocellulose possesses a complex structure consisting mainly of the polymers cellulose, hemicellulose, and lignin. Pre-treatment becomes a required step for the preparation of LCB for its further processing into biofuels and value-added chemicals. Ionic liquids (ILs), considered as relatively green solvents, have found application in LCB processing as well.

Two potential approaches for the deconstruction of LCB using ILs are presented. In the first one, the IL mainly dissolves the lignin portion of the biomass, while cellulose remains undissolved. In the second one, the IL is selected to dissolve primarily cellulose. In both ways, the filtrate will contain dissolved lignin, hemicelluloses, and extractable organics to be further processed into chemical products and organic fuel. The final cellulose fraction has to be as free of IL as possible to avoid inactivation of the enzymes or inhibition of the microorganisms in the following steps of saccharification and fermentation for bioethanol production.

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VALORISATION OF THE WASTE STREAMS FROM THE STEAM DISTILLATION OF ESSENTIAL OILS, USING NANOMEMBRANES

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The present work aims to evaluate the possibility of using nanomembrane technologies in the essential oil industry. More specifically, the valorisation of different waste products. The first part of our work focused on the laboratory simulation of the waste fractions of several essential plants and their nanofiltration. The content of the main components was evaluated chromatographically. Information on their antioxidant and antibacterial properties was also of interest. Our aim was to analyze whether the waste fractions pose a potential hazard to the environment where they are disposed of. Another goal was to find out if any of the main biologically active compounds could be successfully filtrated and concentrated by the nanomembranes. The main components of the essential oils of roses, lavender, cloves, and others have numerous applications in the food and beverage industry, medicine, and cosmetics. The integration of new technologies is necessary and can be beneficial to essential oil distilleries, the environment, and companies where concentrated solutions of biologically active substances with high added value can be used.

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PRODUCTION OF BIOETHANOL FROM CEREALS

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High-quality dehydrated ethyl alcohol is produced at the Almagest EOOD plant. The installation for the production of the active substance ethanol 96% is built according to the design and know-how of the leading engineering company Vogelbusch GmbH. State-of-the-art waste-free technology is applied for the production of ethyl alcohol and feed raw material.

Vogelbusch GmbH's technology for ethanol production from grains such as wheat, corn, and sorghum involves saccharification, fermentation, distillation, and rectification.

Almagest EOOD is the only Bulgarian producer of bioethanol-dehydrated ethyl alcohol, which can be used as a substitute for gasoline fuel in internal combustion engines.

- In the process of burning bioethanol in gasoline engines, greenhouse gases released into the atmosphere are at least 60% less compared to the use of gasoline fuels.
- Bulgarian legislation stipulates that a minimum of 7% of the gasoline fuel sold must be bioethanol.

Despite the requirements of international standards for bioethanol to have an alcohol content of 98.7%, the bioethanol produced by Almagest EOOD is of higher quality and has an alcohol content of 99.99%.

ALPHA-AMINO ACIDS-BASED DERIVATIVES AS NANOCARRIERS OF BIOLOGICALLY ACTIVE COMPOUNDS

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The development of nanocarriers, suitable to deliver biologically active compounds, is a modern interdisciplinary area that attracts the interest of researchers with different scientific backgrounds. Their potential application is mainly for medicinal purposes but they can also be designed as carriers of bioactive compounds for delivery in plants.

Our research is aimed at the design and synthesis of alpha-amino acids-based amphiphiles because despite being biocompatible, alpha-amino acids derivatives possess a tendency to form supramolecular complexes. Here, we present newly synthesized amphiphilic derivatives of L-Asp, structurally belonging to either monomeric or gemini surfactants, that have a negative charge. Biological in vitro tests have shown that they are non-toxic, and studies of their solutions have demonstrated their propensity to form supramolecular nanostructures, investigated and confirmed by DLS analysis. These supramolecular complexes can be loaded with indole-3-acetic acid (IAA) and thidiazuron, which are biologically active compounds (plant growth hormones). The next step is to test in vitro these supramolecular complexes on plants in order to evaluate the effectiveness of the release of the two hormones and to monitor the changes in the plant's growth.

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GREEN SYNTHESIS OF SILVER NANOPARTICLES USING PURSLANE EXTRACTS AND INVESTIGATION OF THEIR ANTIOXIDANT ACTIVITY

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Portulaca oleracea (Purslane) is an annual plant with fleshy leaves that is sometimes considered a weed but it is a medicinal herb with anti-inflammatory, antioxidant, immunomodulatory, and anti-tumor properties. Various extracts of the plant are used for the treatment of several diseases. In this study, an in vitro assessment of the antioxidant activity of aqueous-ethanol extracts (0%, 50%, 70%) of P. oleracea was performed, as well as an extract in combination with silver nanoparticles (AgNPs). The synthesis of AgNPs was confirmed by UV-visible absorption at 460 nm and TEM. The obtained extracts were analyzed for total polyphenols (TPC) and antioxidant capacity (AOC), expressed as IC50 (μg mL -1). The radical scavenging ability of the extracts was compared to the stable radical DPPH through direct EPR spectroscopy. It can be assumed that the antioxidant properties of the plant increase significantly after the synthesis of nanoparticles (NPs), due to the saturation with adsorbed bioactive substances such as polyphenols, and others.

SYNTHESIS OF SILVER NANOPARTICLES WITH PLANT EXTRACTS

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In this work, we present an efficient and rapid "green" method for silver nanoparticle synthesis by using an extract from St John's wort (Hypericum perforatum), Purslane (Portulaca oleracea), red pepper and direct sunlight irradiation. For this purpose, the primary factors influencing the process of silver nanoparticle synthesis were examined including the use of direct sunlight as an energy source, subjecting the samples to a microwave field, and continuous stirring with a magnetic stirrer.

Following UV-Vis and TEM analyses of the prepared samples, it was observed that the solutions of silver nitrate with plant extract, which were prepared with continuous stirring, exhibited the highest absorption intensity. The color of the samples changed from colorless to yellow. Based on the color change, it can be inferred that spherical nanoparticles were formed. This assertion was confirmed after TEM analysis, which demonstrated the presence of spherical silver nanoparticles. It has been proven that the formation and growth of these particles are significantly influenced by sunlight. The benefits of using plant extract for synthesis are that it is energy-efficient, and environmentally friendly, leading to less waste and safer products.

BIOLOGICAL AGENTS AS OCCUPATIONAL HAZARDS – METHODS FOR DETERMINATION AND PREVENTION

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Harmful biological agents are living microorganisms or toxins produced by living plants or animals that have the ability to cause disease or illness in humans. In the present work, some risky industries are considered, where workers are exposed to biological agents. Sampling methods and equipment are discussed, as well as methods for their determination.

QUALITY CONTROL OF POTASSIUM DETERMINATION IN SOIL TESTING LABORATORY

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Potassium (K) is an essential macronutrient for plant growth and different extraction methods are used in soil testing laboratories. Regardless of the chosen method, quality control of the obtained results is required. In that respect, control samples are used daily in maintaining a quality control for soil analysis, which ensures that the quality of the analysis will remain constant from day to day and throughout the year.

In a summer practical program for students, in a soil-testing laboratory, a quality control sample for potassium content was chosen. The sample was analyzed following the same extraction and detection methods for plant-available potassium as the routine soil samples. For each of the 15 soil samples, one control sample was analyzed in duplicate. The calculated mean values were used for control chart preparation. The warning limits were set at 1*standard deviation and the action limits at 2*standard deviation of the results. In addition, the precision was estimated under lab reproducibility conditions by the standard deviation of concentration values obtained during the one-year period by different analysts with different reagents but the same instruments.

1,8 NAPHTHALIMIDE AND BASED LOGIC GATE AS A DIAGNOSTIC PLATFORM IN MEDICINE FOR CANCER CONDITIONS

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A new water-soluble 1,8-naphthalimide with a 4-amino-1,2,4-triazole substituent at the C-4 position of the naphthalimide core has been synthesized. The newly synthesized compound possesses fluorescence sensing properties to pH and environmental viscosity in the physiological range. Simultaneous detection of low pH and high viscosity is characteristic of cancer cells. Based on the new compound, an AND molecular logic gate was constructed in which pH and viscosity were used as input chemical signals.

Due to the good results, the new AND molecular logic gate could be used as a promising platform for rapid cancer diagnosis. Furthermore, to verify the practical applicability in biological objects, the cytotoxicity of the newly synthesized sensor compound was investigated. The results showed low toxicity.

RISK ASSESSMENT METHODS IN THE CHEMICAL INDUSTRY

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The purpose of the proposed study is to present some of the traditional and new methods for risk analysis and assessment in chemical technological processes.

Quantitative risk assessment methods enable the assessment of individual risk (IR) and societal risk (SR). Both criteria are based solely on the adverse effect on humans. The risk for the individual (Individual Risk) refers to the risk for the individual who is located near the source of danger. This measure includes the nature of the harm to the individual and the likelihood and time period of its occurrence. It is accepted that no individual should be exposed to a degree of risk greater than 10-6 per year. Societal or Group Risk is a risk faced by a group of persons affected by the accident. It is expressed as a ratio between the “frequency" and the "number" of people injured by the accident in a given place.

The presented methods for analysis and assessment of risk in technological processes in the chemical industry are an effective means of analyzing existing production processes and in the design of new ones with a view to minimizing the probability of occurrence of undesirable events (production accidents) with a negative impact on people and environmental components.

EXPERIMENTAL RESEARCH FOR OPTIMIZATION OF CLOVE OIL PRODUCTION

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This research was conducted for the optimization of the clove oil production process via hydrodistillation. The clove (Syzygium aromaticum) oil is used as an anti-inflammatory agent, due to its high content of flavonoids. It is also used to treat the symptoms of rheumatism and arthritis.

A major component of clove oil is eugenol ($C_{10}H_{12}O_2$; phenylpropanoid). It constitutes 90 % of the total amount of oil. Eugenol has antioxidant, analgesic, antimutagenic, antiplatelet, antiallergic, anti-edema and anti-inflammatory properties. It has antibacterial potential due to the free OH group in its structure.

The main parameters that affect the oil yield are the amount of distillate obtained per unit of the initial raw material and the heating intensity. The effect of both two parameters is investigated in the context of the amount of oil obtained, the required energy production, as well as the oil cost production. Two settings of heating of the work cell were tested. The results show that the optimal conditions are: the lower setting of heating (supply voltage 120 V) and using the 500 ml of distillate. Thus, 2.022 g of oil is obtained from 25 g of initial raw material.

A COMBINED APPROACH FOR BILINGUAL (GERMAN AND ENGLISH) TRAINING IN CHEMICAL ENGINEERING TERMINOLOGY

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The acquisition of specialized chemical engineering terminology (German and English) is of great importance for the students belonging to the Chemical Engineering Course in German language at UCTM. In the scholar circle at the Department of Chemical Engineering, we are going to test a combined approach for introducing and training specialized terminology in both German and English language. The method is tailored both to the students' general language preparation and to their professional interests. The proposed approach includes the following activities:

- Presentations with properly designed slides (including images with terms in both foreign languages and animation) for intensive comparative introduction of specialized terminology in German and English.
- Presentations with properly designed slides for training and testing the specialized terminology.
- Selected videos with specialized terminology with follow-up discussion in the field of Chemical Engineering;
- Presentations with student participation.

Introduction and training of specialized terminology are combined with a German and English grammar course for the improvement of students' communication and comprehensive skills. This is a parallel part of the current project.

СПЕЦИАЛНОСТИ 2023
SPECIALTIES 2023

ХИМИЧНО ИНЖЕНЕРСТВО
ОКС „бакалавър “ (4 години) и ОКС „магистър“ (1 година)

ХИМИЧНО ИНЖЕНЕРСТВО
с преподаване на НЕМСКИ ЕЗИК
ОКС „бакалавър “ (4 години) и ОКС „магистър“ (1 година)

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с преподаване на ФРЕНСКИ ЕЗИК
ОКС „магистър“ (5 години)

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