CCUV4 - GREEN DEAL STRATEGIES FOR V4 COUNTRIES: THE NEEDS AND CHALLENGES TO REACH LOW-CARBON INDUSTRY

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INTRODUCTION TO THE UNIVERSITY OF MISKOLC, FACULTY OF MECHANICAL ENGINEERING AND INFORMATICS

The CCUV4 Working Meeting No.1
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Slovak University of Technology
Bratislava

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FACULTY OF MECHANICAL ENGINEERING AND INFORMATICS

UNIVERSITY OF MISKOLC

- the world's first institution of technology, the Berg-Schola have founded in 1735 in Selmecbánya (Banská Štiavnica), what is the legal predecessor of the University
- the leading higher education institution and academic centre in the North Hungary research and development centre
- appr. 100 hectare area
- appr. 8000 students
- 8 faculties
- large numbers of high educated foreign speaking students
- close partnership with the industrial area

Faculties at the University of Miskolc

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- Faculty of Earth Science and Engineering
- Faculty of Materials Science Engineering
- ***Faculty of Mechanical Engineering and Informatics***
- Faculty of Law
- Faculty of Economics
- Faculty of Arts
- Faculty of Health Care
- Faculty of Music Bartók Béla

Faculty of Mechanical Engineering and Informatics

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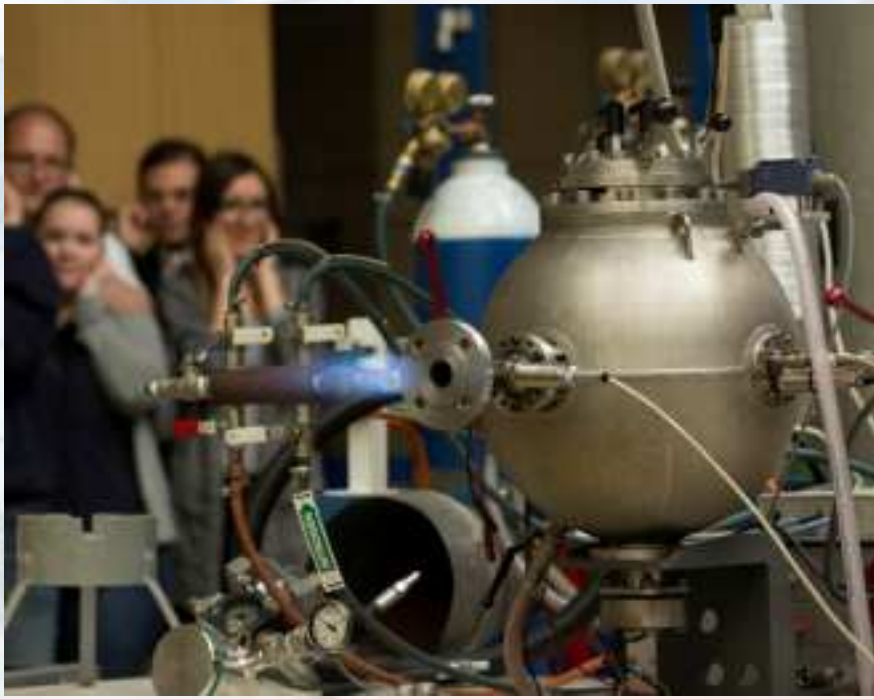

- Largest faculty at the university
- 11 institute
- 12 BSc, 6 MSc courses, 2 PhD doctoral school
- More than 50 laboratories
- Number of academic staff: 170 persons
- Number of students: appr. 3000 persons
- Number of graduated students / year:
  450 persons (60 % BSc, 30 % MSc, 10 % PhD)
- Dual Training: more than 100 partners
- Large number of national and
  international R&D projects
- Success in student competitions – Go-Kart Go-Bosch, Formula Student, Asia Supercomputer Challenge, SolarDecathlon etc.

History

- On 17 August 1949 the Parliament of Hungary approved the law on establishing a Technical University for Heavy Industry and decided to start studies on Mechanical Engineering.

- From the mid-1960s new areas of specialisation were offered to students. These included a programme in mechanical engineering for the chemical industry, silicate industry, specialisation for machine tool design, applied mechanics and the technical translation program.

- In the early 1990s, further new training programs emerged: Engineering Informatics, Engineering Management, Electrical Engineering.

- Faculty of Mechanical Engineering and Informatics from 2006.

Institutes at the Faculty of Mechanical Engineering and Informatics

- Institute of Mathematics
- Institute of Mechanics
- Institute of Physics and Electronic Engineering
- Institute of Logistics
- Institute of Machine and Product Design
- Institute of Manfacturing Science
- Institute of Materials Science and Technology
- Institute of Energy Engineering and Chemical Machinery
- Institute of Machine Tool Engineering and Mechatronics
- Institute of Automation and Communication Technology
- Institute of Informatics Sciences

Programmes of Bachelor and Master, PhD Studies

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Bachelor's Programmes (11 pcs)

- Energy Management Engineering
- Business Information Technology
- ***Mechanical Engineering***
- Industrial Design Engineering
- Mechatronics Engineering
- Engineering Information Technology
- Engineering Manager
- Software Information Technology
- Electrical Engineering
- Logistics Engineering
- Vehicle Engineering

Master's Programmes (6 pcs)

- Energetics Engineering
- ***Mechanical Engineering (In English)***
- Logistics Engineering
- Mechatronics Engineering
- Engineering Information Technology (in English)
- Electrical Engineering

Doctoral (PhD) Studies

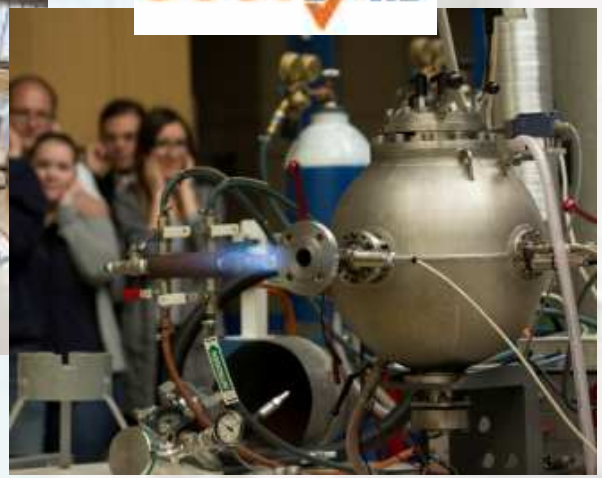
- ***Sályi István Doctoral School of Mechanical Engineering Sciences***
- Hatvany József Doctoral School of Information Science and Technology

FACULTY'S LABORATORIES

More than 50 laboratories within the Faculty

Intelligent Vehicle Control Laboratory

High-tech Logistics Laboratory



Explosion Safety Laboratory

Appointment of Focus Areas

- Adaptive data mining systems
- Power plant structures and their integrity
- Development of production and logistics networks
- Integrated engineering systems for digital production
- Intelligent production support systems
- ***Simulation-based technology and product development***

INTERNATIONAL PROJECTS

Visegrad Fund

- HORIZON2020 NMBP LoCoMaTech - Low Cost Materials Processing Technologies for Mass Production of Lightweight Vehicles (2017-2019)
- H2020 TWINNING Umi-TWINN - Reinforcing the scientific excellence and innovation capacity in logistics technologies of the University of Miskolc (2016-2018)
- ERASMUS KA HEIBus - Smart HEI-Business Collaboration for Skills and Competitiveness (2017-2019)
- ERASMUS KA ProdLog - Development of a Bologna-based master curriculum in resource efficient production logistics (2017-2020)
- ERASMUS KA RMWF - Implementation of International Guidelines for Risk Management in Welding Fabrication (2016-2018)
- ERASMUS LLP RePCi - Reshaped Partnerships for Competitiveness and Innovation Potential in Mechanical Engineering (2013-2017)

NATIONAL PROJECTS

Visegrad Fund

- GINOP-2.3.4-15-2016-00004 - Establishment of Advanced Materials and Intelligent Technologies HEICC at University of Miskolc
- EFOP-3.4.3-16-2016-00015 - „Főnix ME” - Renewable University
- EFOP-3.6.1-16-2016-00011 - Younger and Renewable University, Innovative Knowledge City
- Higher Education Institutional Excellence Program (2018-)

Student Competitions

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Formula Racing Miskolc

Go-Kart Go-Bosch!

Formula Students

Student Competitions

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Asia Supercomputer Community
Student Supercomputer Challenge

SolarDecathlon 2019

SCIENTIFIC CONFERENCES

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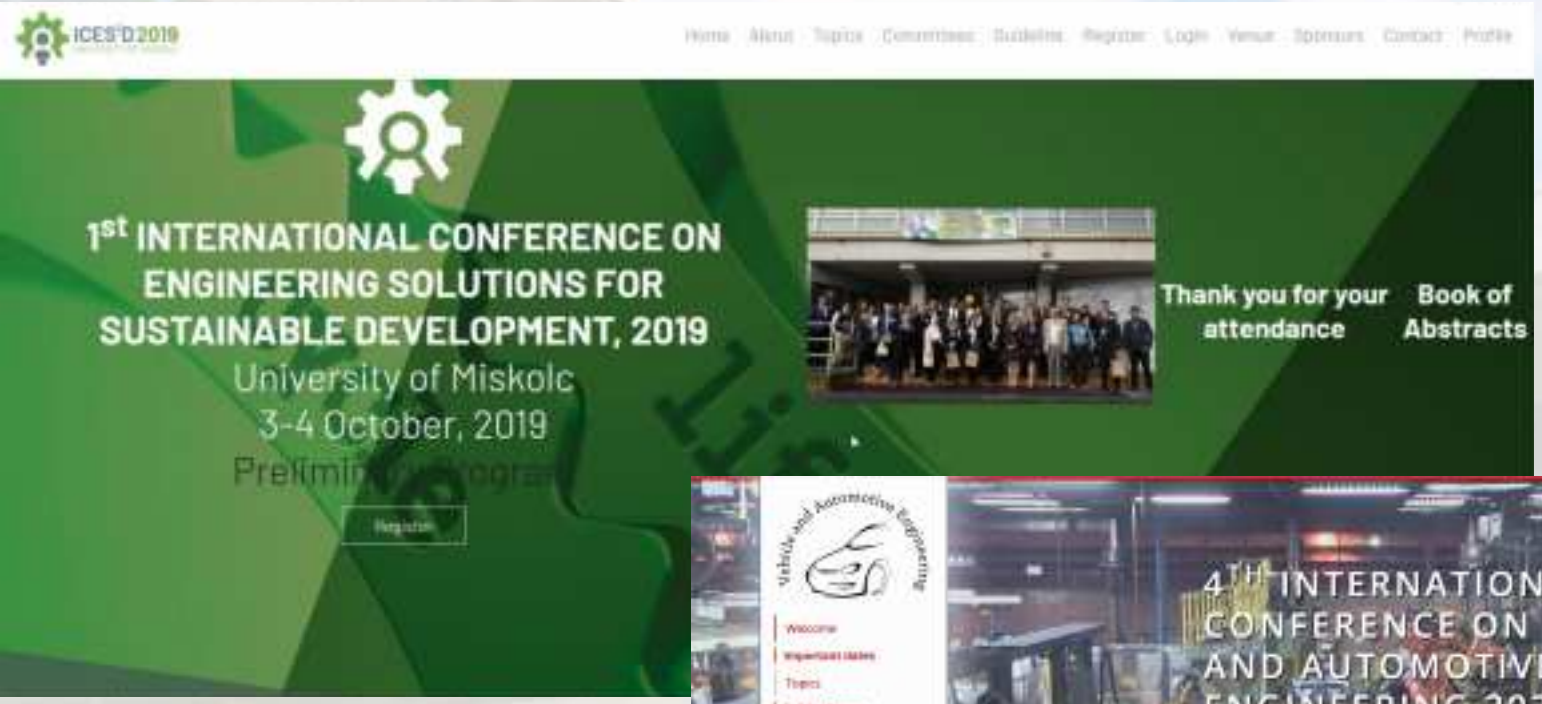

Department of Chemical Machinery - R&D Activities

- Innovative eco-friendly technologies and green chemistry in the chemical industry;
- Increasing energy efficiency in the chemical industry;
- Examination of unit operations using theoretical, experimental and simulation methods;
- Examination of dust and gas explosion, design of explosion protection, system safety technology, hazard analysis, overpressure protection;
- Design and testing of pressure vessels, pipelines, storage tanks by theoretical, experimental, standard and simulation tools;
- Examination of acoustic oscillation in a compressor pipes;
- Environmental protection. Examination of the treatment procedures for organic industrial waste on the basis of environmental impact, energy efficiency and economy aspects. Life Cycle Assessment (LCA). Complex design and optimization of waste management systems. Environmental economic assessment of environmental technologies.

Department of Chemical Machinery – Laboratories

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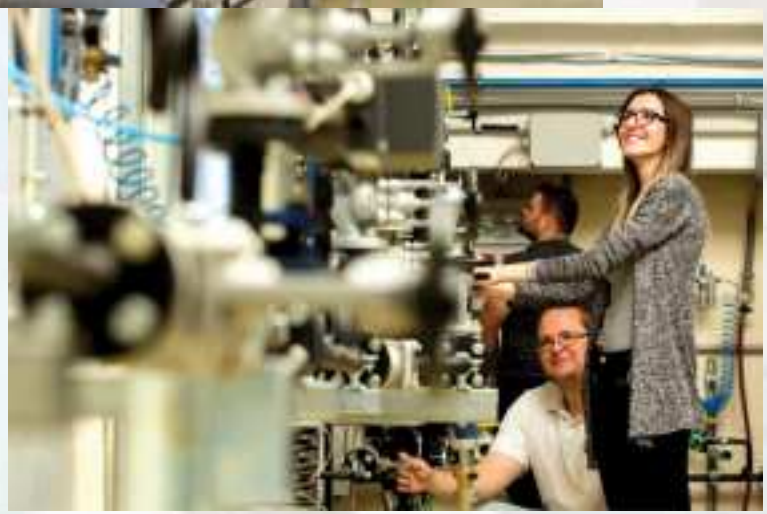
- DUSTLAB explosion test Lab
- GUNT Heat Transfer Demonstration Lab
- Steam demonstration Lab
- Wind tunnel
- Unit Operation Lab
- Strength Analysis Lab
- Software: Equist Weld, Visual Vessel Design, ADINA, CFDesign, AUTOCAD, SolidEdge, Caepipe, CADMATIC Plant Design, FLACS/DESC, SC/TETRA, GABI, CHEMCAD, UniSim Design, HYSYS, ANSYS, AmeTank

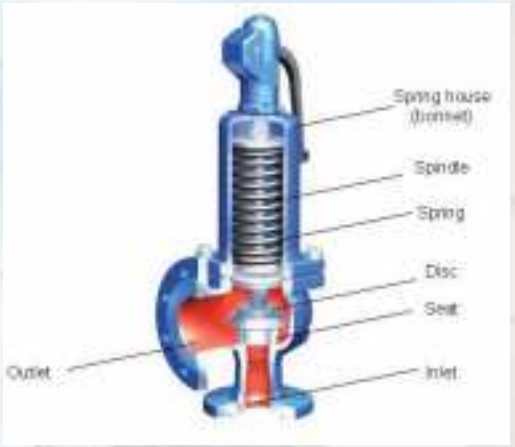


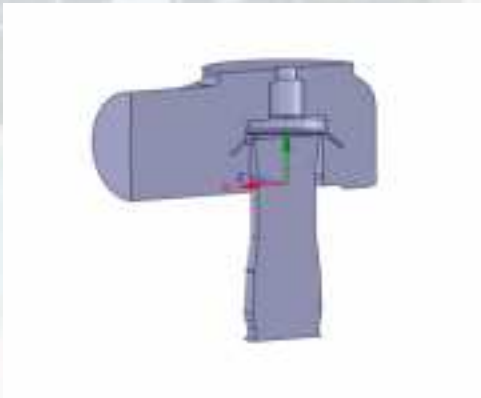
Department of Chemical Machinery – Safety Engineering

- Chemical Machinery specialization in the BSc and MSc Mechanical Engineering courses safety engineering disciplines
  - Industrial overpressure protection
  - Hazardous substances, risks analysis
  - Explosion properties of substances
  - Design of protection against explosion
- Ex/Hazloc Engineering Postgraduate Course
  - Founder of training UM, first start 2021, 70 student (more than 90 applicants)
  - Two semester, 160 lessons, Industrial partner in education
  - Aim: to acquire theoretical and practical knowledge in hazardous substances and technologies, primary/secondary/tertiary explosion safety methods

CFD ANALYSIS ON A DIRECT SPRING-LOADED SAFETY VALVE TO DETERMINE FLOW FORCES

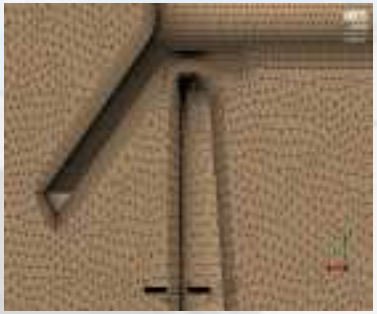
- Opening if the inlet pressure in the protected equipment is higher then the set pressure of the safety valve
- Safety valve is a pressure relief device
- Can be equipped on a pressure vessel, heat exchanger or pipe segment
- Safety valve can blowdown to the atmosphere or to a blowdown pipe system

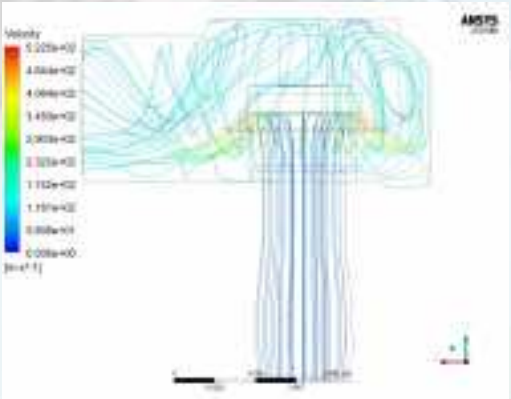


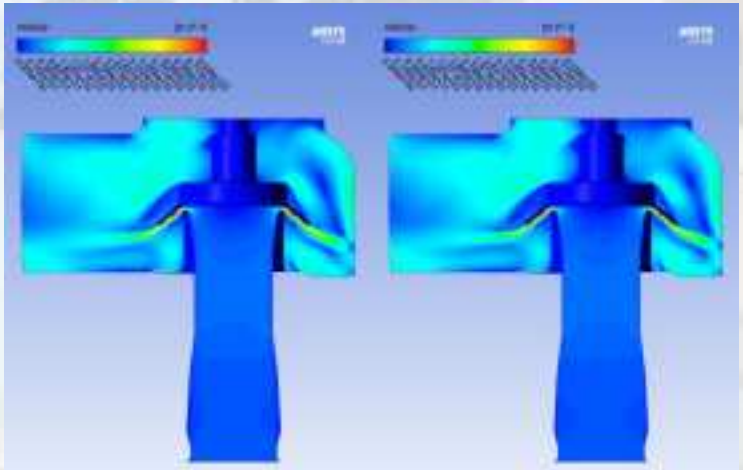


CFD ANALYSIS ON A DIRECT SPRING-LOADED SAFETY VALVE TO DETERMINE FLOW FORCES

- Meshing
  - Body sizing on the whole body
  - Body sizing in the middle region
  - Inflation on the walls
  - Number of elements between 5 million and 6.5 million
- Validation of the numerical model with experiments

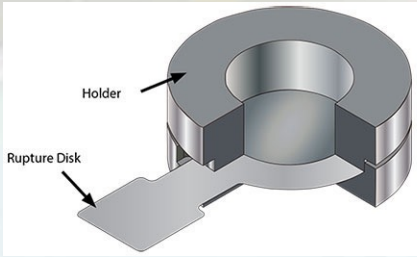




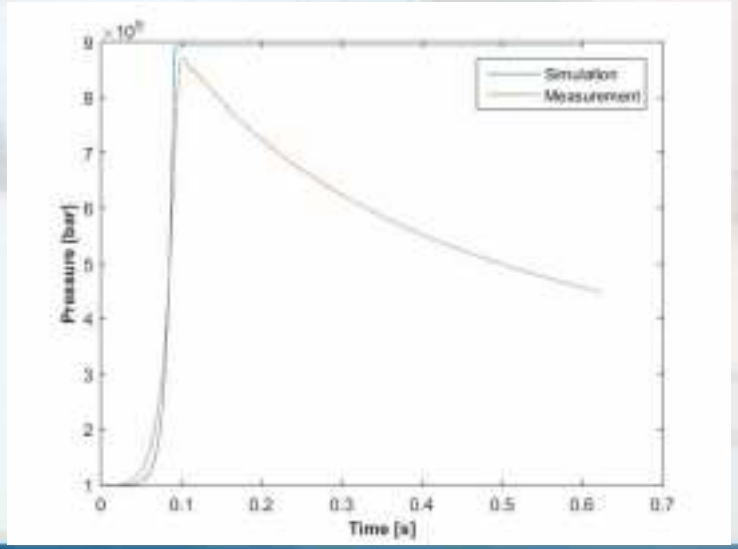


GAS EXPLOSION IN CLOSED VESSEL

- Prevention of explosion damage:
  - Explosion-proof construction
  - Avoidance of spread
  - Suppression
  - Venting
- Venting of explosion:
  - Specified activation pressure and opening area
  - Rupture disks and panels, vent ducts



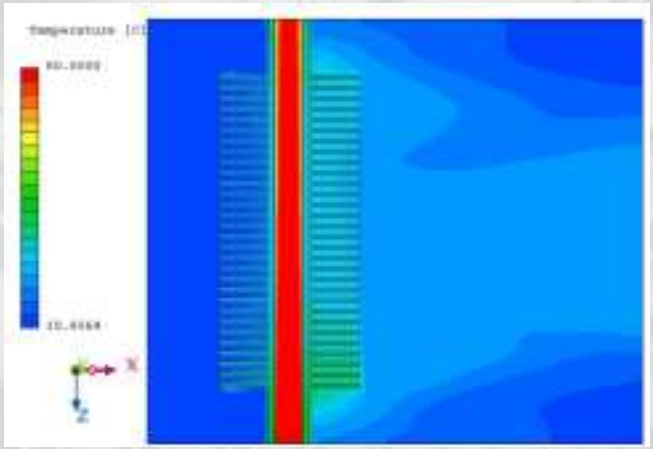
- Features and simplifications:
  - Premixed model: the gas mixture is uniform in composition before the ignition
  - Central ignition
  - The flame thickness is negligible.
  - Unburnt and burnt gases have constant specific heat ratio: 1.22 and 1.36 respectively.



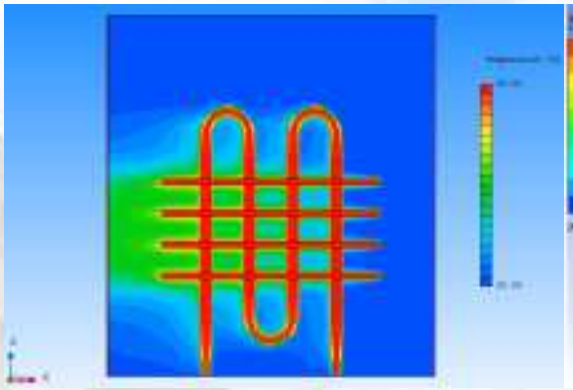
RELAVANT RESEARCH TOPICS

Visegrad Fund

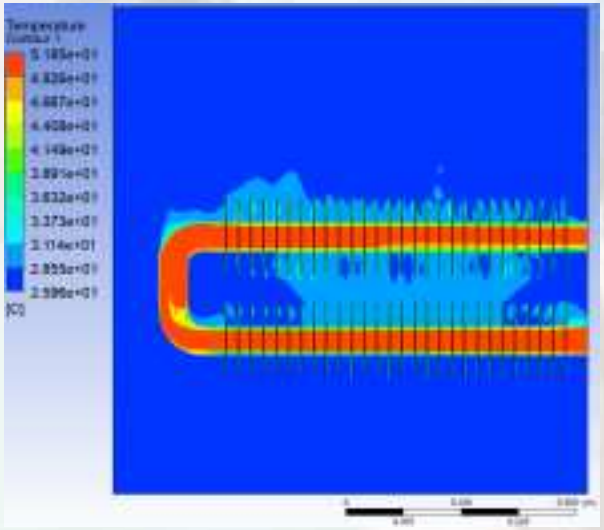
HEAT TRANSFER PROCESSES



investigation of the effect of the fin geometry



simulation techniques of finned tube heat exchangers

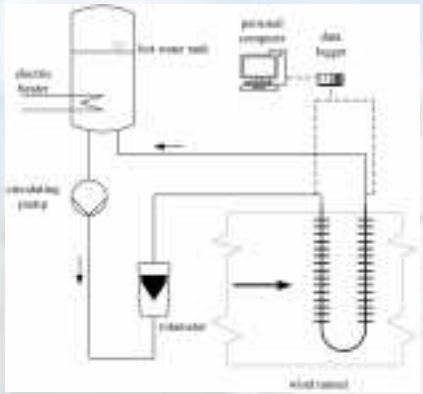


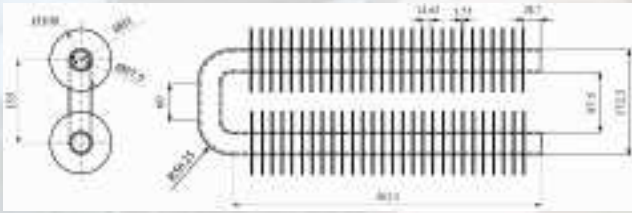
compare the results of measurement, CFD and theoretical method

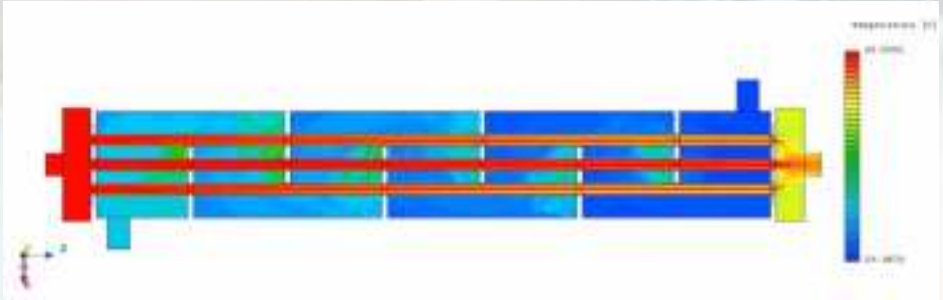
RELAVANT RESEARCH TOPICS

HEAT EXCHANGERS

- measurements and modeling of heat exchangers
  - shell-and-tube heat exchangers
  - finned tube heat exchangers
- optimiztions possibilities
  - total mass (amount of used structural material)
  - total cost (cutting, welding, operating, maintenance)



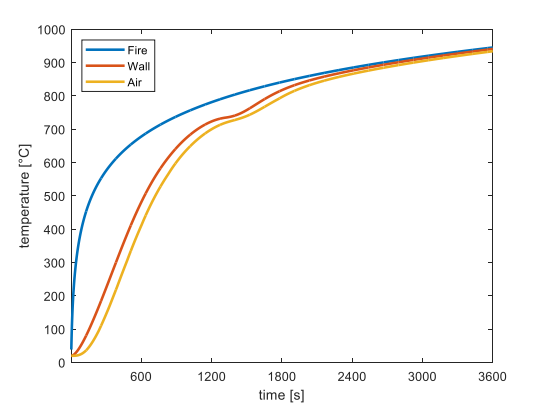


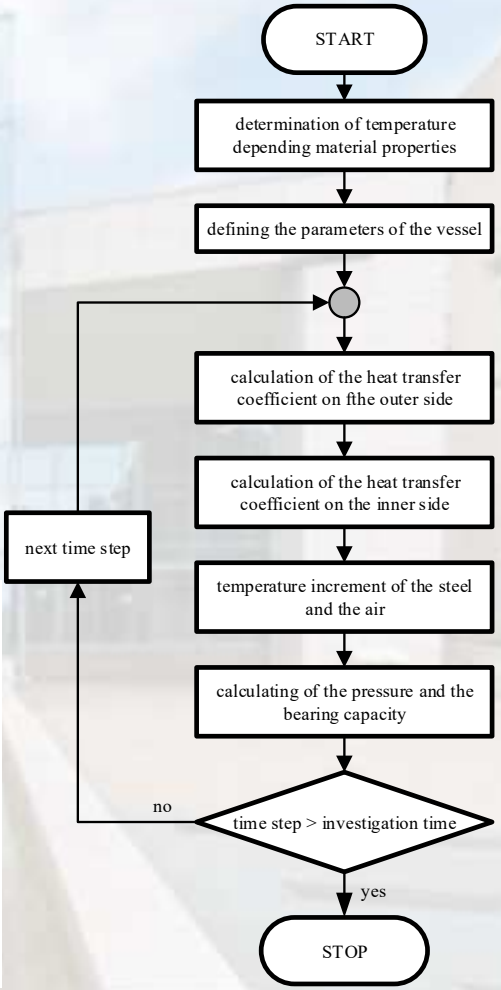


RELAVANT RESEARCH TOPICS

FIRE PROTECTION AND FIRE MODELING

- fire phenomenom after gas/dust explosion
- numerical modeling methods
  - lumped system (only time)
  - distributed system (time and spatial variables)
- calculating temperature and pressure
  - design conditions
  - dangerous overpressure
  - fire exposure time
- problems during cooling process





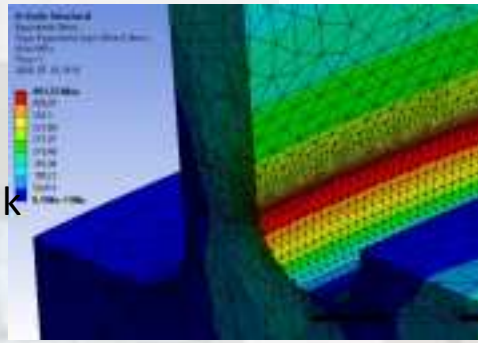
THERMAL RUNAWAY MECHANISM OF LITHIUM BASED BATTERIES

- thermal runaway of the lithium-ion battery initiates an unstoppable chain reaction
- the temperature rises rapidly within milliseconds
- the energy stored in the battery is suddenly released
- temperature rises above 400 °C, the material of the protective layer becomes flammable gaseous
- after that the cathote decomposes also, oxygen generated
- further gases: methane, ethane, ethylene, propylene, CO, CO2, H2, HF4, C4+
- two major types of electrical failure:
  - external short circuit
  - overcharging

RELAVANT RESEARCH TOPICS

INVESTIGATION OF HEAT EXCHANGER FAILURE

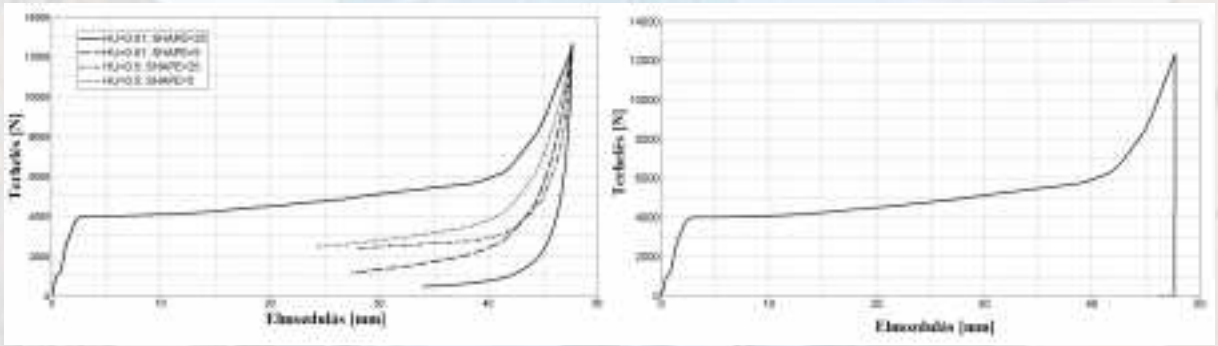
- Several quench coolers near the connection point of the upper tubesheet and the shell.
- The failure was visible as a crack in the cross-section of the welding seam.
- Seven different operating parameters.
- Conclusions:
  - a flawless weld free of cracks and undercuts has been formed, otherwise peak stresses appear near the welding, which in critical load cases
  - the most stressed zone just coincides with the cross section of the welded joint
  - normal operating load or properly performed heat-up process could not have caused the failure of the equipment
  - The cracks around the failure cannot happen by fatigue in normal operating conditions



RELAVANT RESEARCH TOPICS

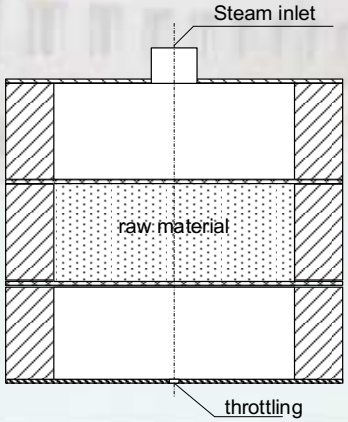
GREEN EPS MATERIAL

- own produced EPS material with straw stiffeners



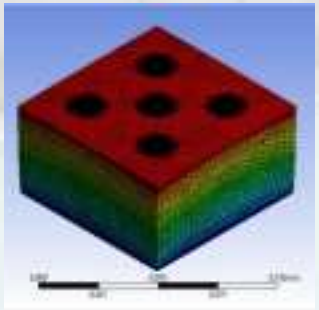
force-displacement diagram of EPS material

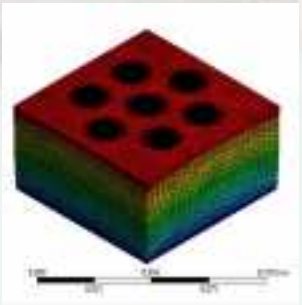
- production of EPS

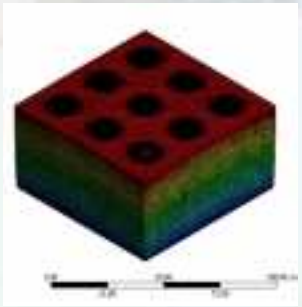


GREEN EPS MATERIAL

- significant factors influencing the production of the product were:
  - initial particle size,
  - primarly vapour temperature, pressure,
  - throttling size (pressure drop)
  - initial particle mass,
  - size, number and location of plastic cylindrical stiffener tubes
- FEM analysis to structural and thermal properties

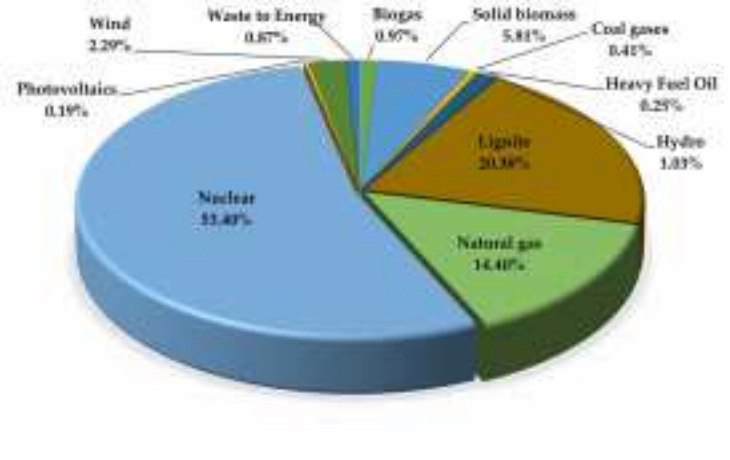




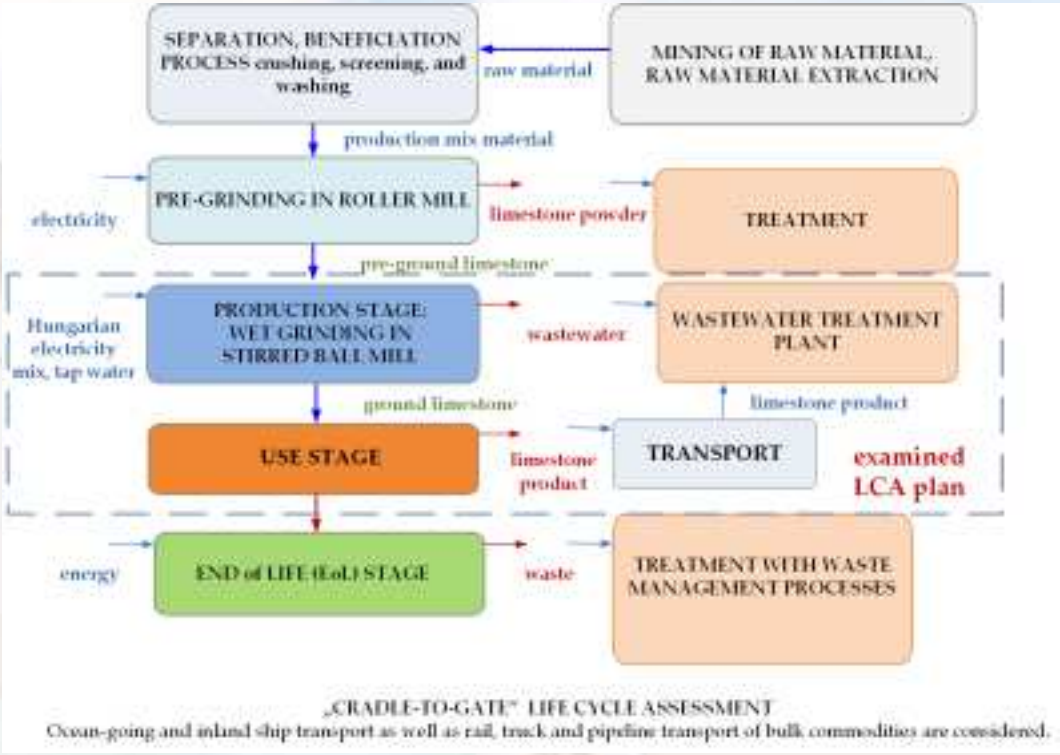


RELAVANT RESEARCH TOPICS

LIFE CYCLE ASSESMENT



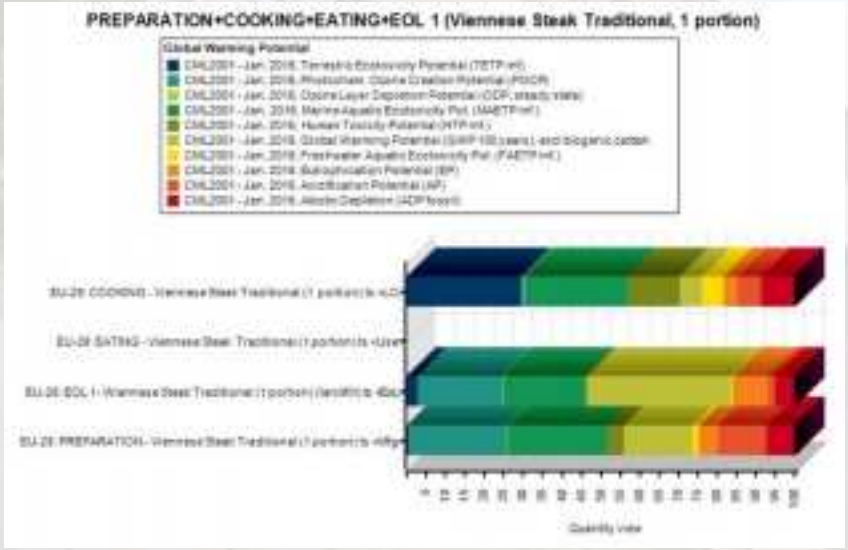
Hungarian electricity mix (year: 2021)



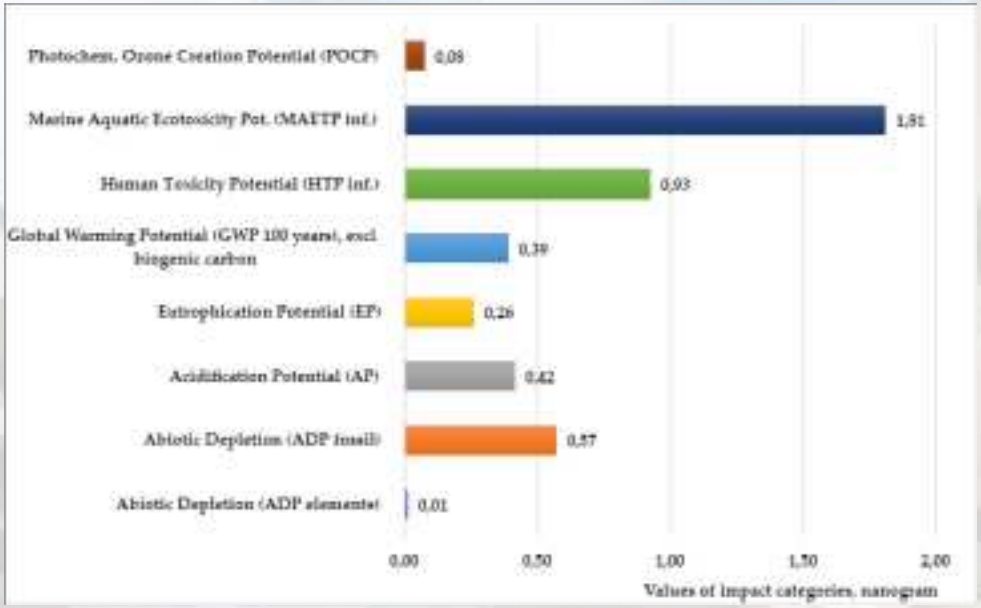
Combination of Energy-Model and Life Cycle-Model for Mechanical Grinding Processes)

RELAVANT RESEARCH TOPICS

LIFE CYCLE ASSESMENT



Percentage distribution of environmental impacts for entire life cycle of a traditional Hungarian main course (Viennese steak with boiled potatoes) with GaBi 8.0 software. Functional unit: 1 portion (0.427 kg) of product.

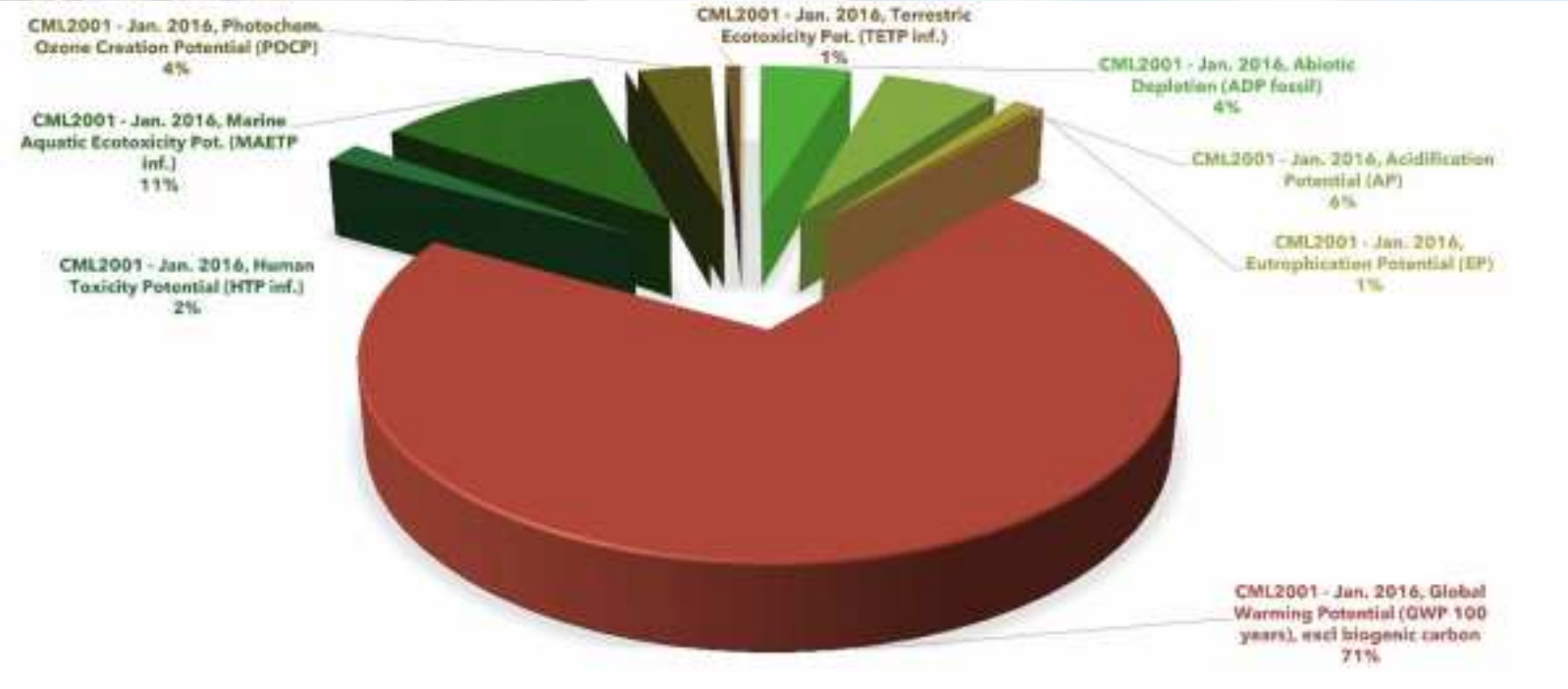


Normalized and weighted environmental impact categories for the cooking life cycle stage of a traditional Hungarian main course (Viennese steak with boiled potatoes) with GaBi 8.0 software in nanograms. Functional unit: 1 portion (0.427 kg) of product.

RELAVANT RESEARCH TOPICS

Visegrad Fund

LIFE CYCLE ASSESMENT

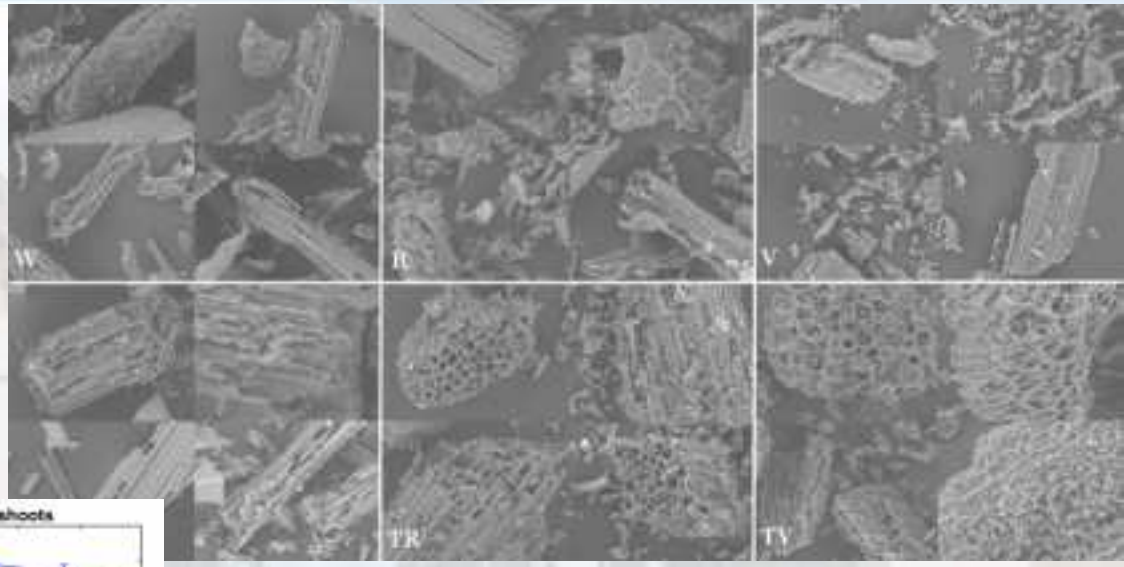


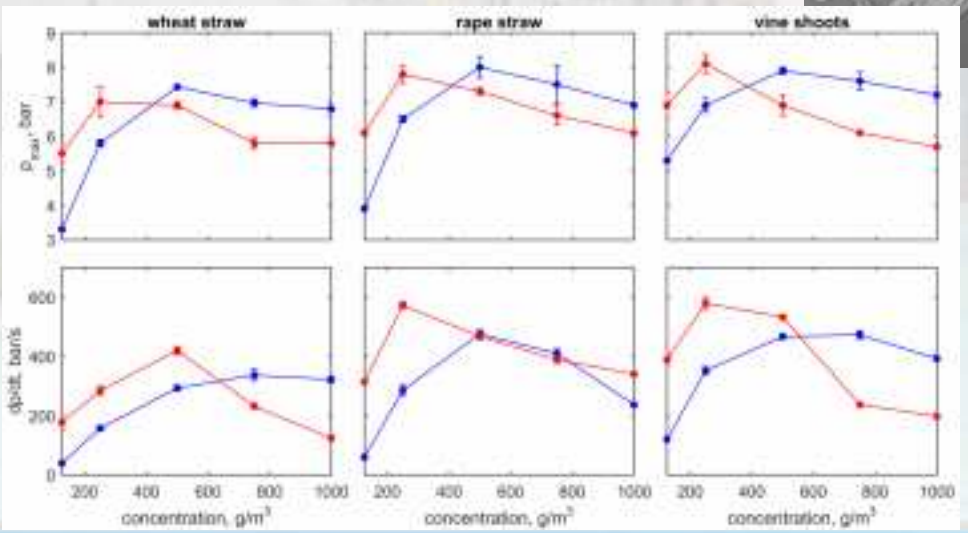
Percentage distribution of the main environmental impacts for the conventional incineration of food waste with energy recovery.

RELAVANT RESEARCH TOPICS

RESEARCH OF BIOMASS USAGE

- Torrefaction

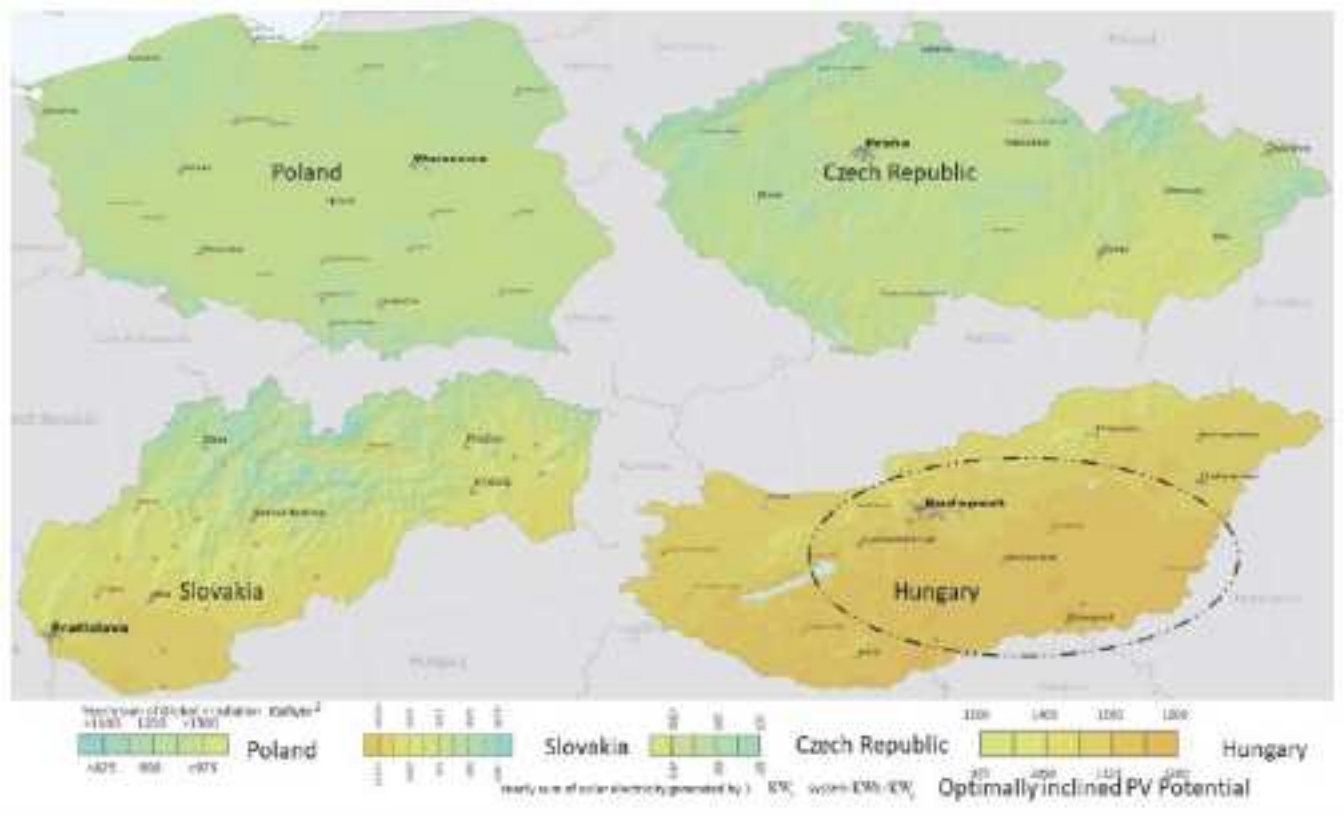




RELAVANT RESEARCH TOPICS

RESEARCH OF BIOMASS USAGE

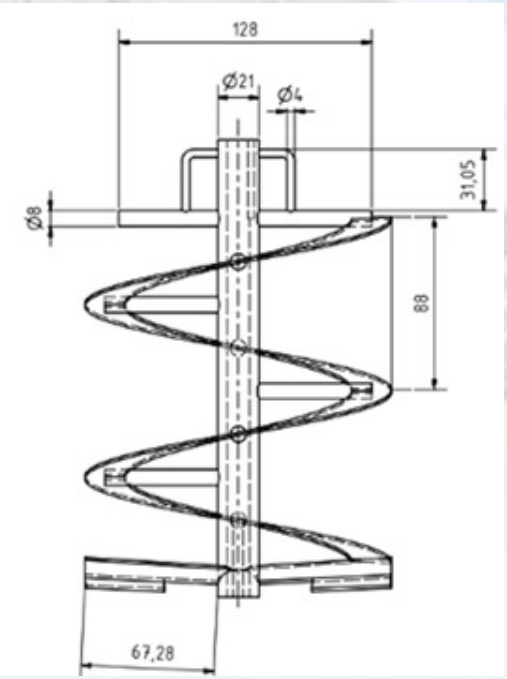
- Solar drying

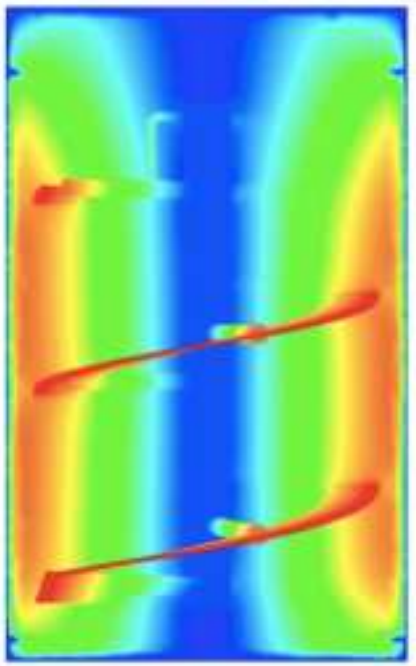


RELAVANT RESEARCH TOPICS

RESEARCH OF BIOMASS USAGE

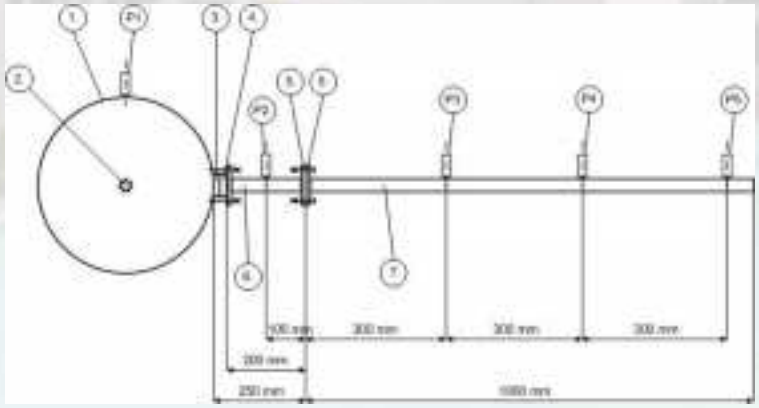
- Biogas production

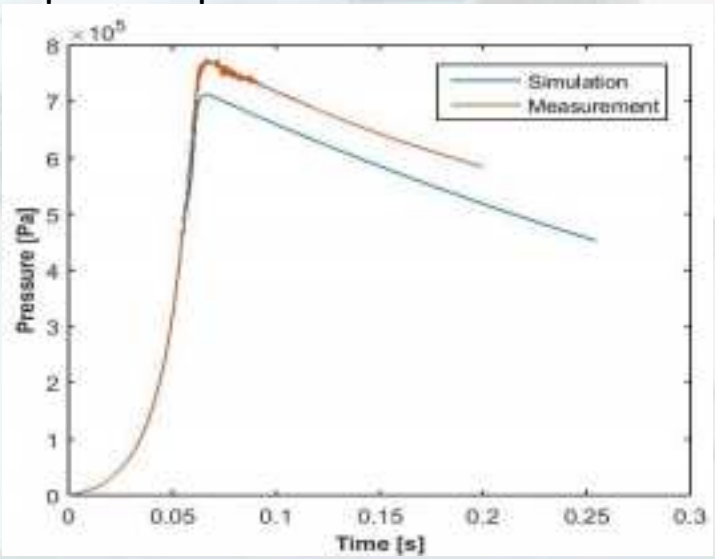




RELAVANT RESEARCH TOPICS

- Theoretical, simulation and experimental investigation of systems with explosion protection (PhD thesis)
- Simulation and experimental investigation of emissions in potentially explosive atmospheres (PhD thesis)
- Simulation and experimental investigation of explosion processes in closed and vented volume
-





THANK YOU FOR KIND ATTENTION!

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