

## Framework Topics of Master Thesis

*for Masters in Mechanical Engineering - Process Engineering*

**Academic Year: 2020/2021**

Supervisor	Topic
Assoc. Prof. Ing. Lukáš Krátký, Ph.D.	<b>Experimental determination and modelling of energy demand for mechanical size reduction of wastes.</b> Experimental work deals to evaluate energy demand of biomass size reduction in dependence of process parameters, demanded size reduction ratio and biomass moisture.
Assoc. Prof. Ing. Lukáš Krátký, Ph.D.	<b>CO<sub>2</sub> to X conversion technology in biorefinery concept: a techno-economic study.</b> Techno-economic study evaluating a feasibility, attractiveness and TRL level of CO <sub>2</sub> to X conversion technology in biorefinery concept – design and balancing of technology using AspenPlus, PINCH optimization, economic and sensitivity analysis of the proposal.
Assoc. Prof. Ing. Karel Petera, Ph.D.	<b>CFD simulation of sedimentation of small particles</b> The aim of this work is modelling of sedimentation of small particles (below 1 mm) in liquid which can appear in numerous industrial processes (sedimentation tanks, mixing vessels, ...). ANSYS Fluent software will be used in this work. It provides several approaches (Euler-Euler, DPM, DEM) which will have to be compared and select the most suitable one. Then, simulations for a chosen apparatus will be carried out and the results will be compared with available experimental data.
Assoc. Prof. Ing. Karel Petera, Ph.D.	<b>Modeling light distribution in a photobioreactor</b> This work aims at modeling of light propagation in systems like photobioreactors using ANSYS Fluent software. The light is the key factor of algae growth and its permeability decreases with increasing density of algae culture. The light intensity decreases with increasing distance from the illuminated wall in general. It can be affected by the hydrodynamics of the given system which is determined by the geometry and operational parameters. Light is electromagnetic radiation in principle therefore radiation models (focused on visible part of electromagnetic spectrum) can be used in its description. One aim of this work will focus on implementation of absorption coefficient dependency on coordinate and algae culture density.

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Assoc. Prof. Ing. Karel Petera, Ph.D.	<p><b>Optimization of heat transfer between fluid stream and heat transfer surface</b></p> <p>Heat transfer from a fluid stream towards the heat transfer surface (apparatus wall, for example) can be affected by many parameters. This work aims at description and assessment of available modeling tools in optimizing the shape of the heat transfer surface. Various shapes respecting low technological demands could substantially increase the heat transfer effectiveness. It can be used in many equipment like in classic heat exchangers, or chemical and biochemical reactors where the heat transfer can be the key factor affecting the efficiency of whole process.</p>
Assoc. Prof. Ing. Jan Skočilas, Ph.D.	<p><b>Production of ceramic aggregates in rotary furnace</b></p> <p>A ceramic gravel aggregates are made from clay and slate. The granules are formed from mined clay, and they are expanding in rotary furnace during heating up to temperature 1150°C. The expanded granules are cooled down and they are used for civil engineering purposes. Perform analysis of mass and energy balance of rotary furnace with aim to describe whole process of heating, expansion and burn-out of the granules. Focus on the calculation of the heat transfer in the batch and effect of the build-in construction in the furnace on the heat transfer efficiency and better distribution. Find out critical points of material treatment and propose the arrangements which will led to improvement of the actual state.</p>
Assoc. Prof. Ing. Jan Skočilas, Ph.D.	<p><b>Spray Dryer for gluten free powder production</b></p> <p>Special equipment in the spray dryer, by so called nebulization process, it is possible to produce powder with particle size of micro and nanometers. In case of the water solution made from water algae, powder cad be produced, which is applicable in food industry for product fortification or gluten free flour. Design the spray dryer for given application with nebulization process. The design will content the mass and enthalpy balance, flow diagram, auxiliary devices and construct design of the dryer.</p>
Assoc. Prof. Ing. Jan Skočilas, Ph.D.	<p><b>Design of extruder for L profile production</b></p> <p>Extrusion process is the most frequently utilized process for infinite polymer profiled product in plastic industry. Design of the device for production of these profiles represents knowledge of heat transfer, rheology and strength and stress calculations. Main parts of the screw extruders are screw and extrusion dye. Design the screw, cylinder and extrusion dye for L profile production made from basic material HDPE.</p>

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Ing. Jiří Moravec, Ph.D.	<p><b>Experimental stand for observation of flow of suspension in a pipe</b></p> <p>The aim of the work is to propose an experimental equipment, which would enable to measure velocity, concentration and temperature profiles in a suspension flowing in a pipe at laminar regime of flow. The work should contain a conceptual design of the whole equipment. All the parts of the equipment (vessels for suspension preparation and storage, piping, pumps, sensors, and all the necessary other parts) should be proposed/designed. The work is complex. Student should carry out a literature search on ways, possibilities and precision of methods for measuring velocity, concentration and temperature profiles in a liquid containing a solid phase and flowing in a pipe at laminar regime of flow. Based on the obtained knowledge, student should propose a design of the experimental equipment for the measurement. The work can be also limited to chosen parts or in contrary expanded to turbulent flow (according to the demands and possibilities of a student).</p>
Ing. Jiří Moravec, Ph.D.	<p><b>Measuring sensor for rheological properties of fluids</b></p> <p>The up to date knowledge in the field of measuring rheological properties of fluids using impellers (literature search) should be used to design a measuring sensor which would enable to measure flow properties of different liquids/suspensions at desired temperature range easily and systematically. The sensor design should be compliant with a rheometer Rheotec RC20 which is used in the rheological laboratory of the department. Except the above mentioned literature search, the work should contain complete design of the sensor in form of production drawings. The sensor should be produced (ensured by the supervisor) and its usability should be tested in several checking measurements using liquids of known viscosity.</p>
Ing. Jiří Moravec, Ph.D.	<p><b>Power consumption of impellers during vessel filling/draining</b></p> <p>The aim of this topic is to describe changes in impeller power consumption which occur at processes of filling or draining a vessel, i.e. in states when the liquid level is close to the impeller position. It will be necessary to prepare a stand for experimental measurement, carry out the necessary experiments, determine the required power consumption from measured data and discuss the results. This topic represents typical experimental work. Its results can be applied to industrial mixing devices in form of recommendations for their practical usage.</p>

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Ing. Jiří Moravec, Ph.D.	<p><b>Carbonation of water (production of sparkling water)</b></p> <p>The topic is aimed on description of used methods for carbonation of water in beverage industry. The aim is not only to describe the existing technological methods used for production of sparkling water but also suggest procedure for correct design of parts of equipment used for carbonation and also limits of each technology. Student should also define, what is the relation between the main parameters of the carbonation parts and the amount of CO<sub>2</sub> saturated in water and also the quality of saturation (quality of bond between CO<sub>2</sub> and H<sub>2</sub>O, its stability, size of bubbles after decompression etc.). The work should be based on a literature search (existing methods of carbonation, basic theory and calculations) and a proposal of correct design procedures for different technological methods should be performed. The topic can be also modified so only one of the methods is studied and described in the work but more in detail. Experiments can be also provided to study dependency of saturation of CO<sub>2</sub> in water on setting of the main parameters of carbonating equipment for any of the methods. The final topic and content of the work will be discussed with student.</p>
Ing. Jiří Moravec, Ph.D.	<p><b>Balance of CO<sub>2</sub> produced by vehicles with different types of engine</b></p> <p>The aim of the work is to discuss the amount of carbon dioxide produced by production, usage and liquidation of vehicles with main types of drives, i.e. with spark-ignition engine, compression-ignition engine, electric drive or a combination thereof. Within the work, raw material demands on production of the main parts of engine and also on production of fuel (petrol, diesel, gas, electricity) needed for the vehicle should be described and discussed. In the result, a complex overview of usability of different drives should be presented. The aim is to clearly describe, which type of drive is the most efficient from the viewpoint of low CO<sub>2</sub> emissions and low demands on raw materials.</p>
Ing. Jiří Moravec, Ph.D.	<p><b>Free topic</b></p> <p>I offer the possibility of supervision of a diploma thesis with an own topic suggested by student. The work can be aimed on any topic from the field of process engineering (engineering or computational proposal of equipment, balancing of processes, experimental works, CFD and others). The final topic and scope of solution will be prepared after consultation with the student.</p>
Ing. Jaromír Štancl, Ph.D.	<p><b>Electric properties of foods</b></p> <p>The aim of this work will be the literary review focused on methods of experimental determination of specific electrical conductivity and dielectric properties of food-</p>

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	<p>stuff substances (solid, liquid, pasty substances) - especially apparatus arrangement, design of the electrode system, identification of advantages, disadvantages and problems of individual solutions. Next, for example, a proposal of the design of an electrode system for measuring the specific electrical conductivity and dielectric properties of a selected food sample will be made and the measurement of electrical properties will be carried out in dependence on predetermined parameters. A simple model describing the electrical properties of the selected sample will be identified from the measured data.</p>
Ing. Jaromír Štancl, Ph.D.	<p><b>Dependence of deformation on the electrical properties of the biopolymer</b></p> <p>The aim of this work is a design of the modification of existing extrusional rheometer, for measuring the electrical properties during flow of the biopolymer material (collagen) through a narrow gap, and measurement of electrical properties depending on the deformation of the extruded material. A simple mathematical model describing the influence of the electrical properties on deformation will be identified from measured data.</p>
Ing. Jaromír Štancl, Ph.D.	<p><b>Proposal of selected processing line</b></p> <p>The aim of this topic is to prepare process flow diagram in several variants of the processing line and perform the mass and energy balances and economical evaluation of proposed variants.</p> <p>The selected processing line should be for food processing industry, or chemical industry (not automotive industry or assembly and manufacturing).</p>
Ing. Michal Netušil, Ph.D.	<p><b>Water separation from the air</b></p> <p>Measurement on a unique state for the separation of water from the air stream. Measurement optimization / modification. Determination of suitable boundary conditions. Measurement evaluation and analysis of results</p>
Ing. Michal Netušil, Ph.D.	<p><b>Pollutants in the filter element</b></p> <p>Analysis of impurities trapped during air filtration. Literature research focused on types of air pollutants and methods of their identification. Based on the acquired knowledge, analyze real filter elements. Analyzes evaluation and determination of trapped impurities.</p>
Ing. Stanislav Solnař	<p><b>Measurement of thermal conductivity of materials based on oscillation method</b></p> <p>The thermophysical properties of materials can also be measured by the thermal oscillation method (ie heat and sine waves). Design and manufacture (manufacture) a measuring device that allows the application of an oscillating method to measure thermal conductivity, and perform verification experiments with known ma-</p>

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	terials. The result of the work should be a small measuring device, a method for evaluating the measured data and recommendations for further measurements.
Ing. Stanislav Solnař	<b>Heat exchangers for computers</b> A modern way to cool components in a PC, where heat dissipation by the radiator into the air is no longer sufficient, is a water circuit with heat exchangers. Today, you can buy a large number of differently shaped exchangers, but are they really the best? Try to design your own design that would guarantee high performance and at the same time have the least possible pressure loss (or challenge a classmate to a competition). The result of the work will be several designs of heat exchanger and recommendations for further designs with regard to the transferred heat output and pressure loss.
Ing. Mgr. Vojtěch Bělohav	<b>CFD simulation of hydrodynamic conditions in flat panel photobioreactor</b> Design the element for homogenization of culture medium in flat panel photobioreactor. Prepare a literature and patent review of existing design variants for mixing and homogenization of the culture medium. Based on the critical review, design the most suitable constructions for a pilot-plant flat panel photobioreactor. Prepare drawing documentation and a 3D model of the element for homogenization. For the selected variant, elaborate a CFD model to simulate hydrodynamic conditions. Based on the created model, evaluate the influence of the designed element on the operating conditions of the pilot-plant flat panel photobioreactor.
Ing. Mgr. Vojtěch Bělohav	<b>Design of aeration element for flat panel photobioreactor</b> Design an aeration element for the flat panel photobioreactor. Based on a critical literature and patent review, design a system for homogeneous aeration of the culture medium in a pilot plant flat panel photobioreactor. Elaborate a drawing documentation for the designed aeration element. For the developed variant, perform a test of the operating conditions on a pilot plant flat panel photobioreactor.
Ing. Mgr. Vojtěch Bělohav	<b>Effective harvesting technology for separation of microalgae from culture medium</b> Harvesting is one of the key units of the 3rd generation biomass production system, which significantly affects the economic aspect of the whole technology. The aim of this work is elaborate a literature and industrial review of existing technologies and design variants of harvesting systems. Based on a critical research, select the most suitable technologies that could be implemented on an industrial scale. Define design and oper-

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	ating parameters for the selected technology. Elaborate a techno-economic analysis of the selected technology.
Ing. Viktor Vajc	<b>Surface tension in technical applications</b> Write a literature survey on the topic of surface or interphase tension, capillarity and wettability. Focus on one or more innovative technical applications related with these phenomena (e.g., biphilic surfaces, wicks of heat pipes, atomization, wet granulation, measurement methods and apparatuses, surfactants, etc.). Develop a basic mathematical model or a simulation for a chosen application, which will treat surface tension as an input parameter. Create drawings, manufacturing instructions, or technological guidelines for the chosen application.
Ing. Viktor Vajc	<b>Spray cooling</b> Prepare a literature survey on the topic of spray cooling of parts in industry. Focus mainly on advantages, suitable application of this method, basic principles, mechanisms, correlations and equations and on design of nozzles. Compare cooling with one nozzle and system of multiple nozzles. Design a spray cooling system for a chosen practical application. Create drawings and diagrams for the designed system.