18th International Workshop
for Young Scientists

BioPhys Spring 2019

BPS 2019

May 22-24, 2019

Gödöllő, Hungary

BOOK OF ABSTRACTS

Conference organisers:

Szent István University, Gödöllő, Hungary

Czech University of Life Sciences, Prague, Czech Republic

Institute of Agrophysics Polish Academy of Sciences, Lublin, Poland

Polish Academy of Sciences, Branch in Lublin Poland

Slovak University of Agriculture in Nitra, Slovak Republic

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INTRODUCTION

Dear Friends and Colleagues,

It is really my great pleasure to welcome you in attending the 18th International Workshop for Young Scientists "BioPhys Spring 2019" (BPS 2019) which, this time, going to be held in Gödöllő, Hungary during May 22-24, 2019.

The meeting continues the tradition of previous workshops oriented on training of young researchers and exchange of professional experience in the field of physics applied to biological, agricultural and food systems as well.

It is cordially invited the young scientists to participate in the activity of BPS 2019 Workshop, and to present their results of research in application of physics to life sciences.

The abstracts of contributions are published in an ISBN numbered printed BPS Book of Abstracts. Additionally, selected papers can be submitted for publication in the Journals issued by the participating institutions.

The Workshop is to be organised as an English spoken event along with a registration of fee 80 EUR.

It is my pleasure to invite you to spend a few days of May 2019 in friendly atmosphere between young people in Gödöllő.

During your stay, you may visit the facilities of the Szent István University Campus, the laboratories and installations of the Department of Physics and Process Control and of course, the city of Gödöllő and its area.

Special thanks are devoted to the Mechanical Engineering PhD School, Szent István University, Gödöllő, Hungary for the support of organizing the event of BPS 2019.

Prof. I. Farkas

Chairman, BPS 2019

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LECTURES

RELIABILITY AND DEGRADATION RATE OF GROUND MOUNTED SOLAR MODULES IN TROPICAL CLIMATE OF THE SUB-SAHARAN

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The market share of solar photovoltaic (PV) in the power sector has grown so fast in the last decade as a result of the numerous advantages like its inexhaustibility, cleanness, the depletion of fossil fuel resources and the several governmental and non-governmental policies for its adaptation. The limited power output guarantee given by most manufacturers for PV modules is 25 years of 80% level of efficiency.

However, there are reliability issues as a result of degradation and failure on site which arise from climate specific conditions such as solar irradiation and ambient temperature, humidity, wind, water ingress and ultraviolet (UV) intensity.

The aim of the study is to assess the degradation rate of solar PV modules exposed to the tropical climate of the sub Saharan. A twelve year ground mount single crystal solar modules in the tropical climate of Ghana has been studied for its degradation rate. Visual inspection, *I-V* curve characterization and thermal imaging were used for the assessment of the modules. The process of partial shading of modules was also applied to assess the state of the bypass diodes.

Over the twelve years exposure of the modules, results show a decrease in short circuit current (I_{sc}) ranging from 7% to 16.4% with an average percentage decrease in I_{sc} being 11.7% compared with nameplate values. Decrease in open circuit voltage (V_{oc}) ranges from 11.4% to 17.1% with an average decrease of 14.8%; Fill Factor (FF) decrease ranges from 11.5% to 20.45% and the power loss was between 34.5% to 41.4%.

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THE INFLUENCE OF LIGHT INTENSITY AND NITROGEN AVAILABILITY ON THE SYNTHESIS OF EXOPOLYSACCHARIDES BY *EUSTIGMATOS MAGNUS*

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Eustigmatos magnus is a unicellular microalga able to synthesize exopolysaccharides (EPS) which consists mostly of sugar (often modified by non-sugar residues) but also proteins, aminoacids, fatty acids, nucleic acids and other molecules. However, algae synthesize low amounts of EPS. To intensify this process, it is necessary to apply stress condition for example light or nutrient stress.

EPS show a wide diversity in structure and composition, which contributes to numerous physiochemical and biological properties. These substances play important functions mostly associated with cell protection against adverse environmental conditions, for example changes of temperature, salinity or heavy metals presence. EPS also have antimicrobial, anti-mutagenic and anti-inflamatory functions. EPS show flocculating, thickening, emulsifying, metal binding and adhesion abilities. This enable application in medicine, agriculture, many branches of industry like food, pharmaceutic, cosmetic and also wastewater treatment.

In this study the influence of light intensity, light/dark cycle and nitrogen concentration on the EPS synthesis by *E. magnus* were examined. Purified and lyophilized EPS was used for measuring sugar and protein concentration and flocculating activity using spectrophotometric methods. The results show that EPS yield was higher at high light intensity, continuous light and nitrogen limitation (50% compared to control conditions).

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ULTRASOUND-ASSISTED EXTRACTION OF ADDED-VALUE COMPOUNDS FROM ENERGY WILLOW BARK

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Fast growing willow trees are currently being used as an energy crop, mainly targeting the production of solid biofuels (e.g. wood chips). Although this is a sustainable value chain (in all of its three pillars), there is still opportunities to improve economic yield, specially taking into account the recommendation by Olah et al. (2018) to intensively explore the biomass resources before burning it.

In fact, is it known that plants are a significant source of active added-value compounds, and especially willow bark is described as a source of salicin, a compound well known for its pharmaceutical applications to treat rheumatic fever and subacute bacterial endocarditis among other applications.

The present work explores the usage of energy willow bark as a source of active compounds in a complement to the use of energy willow as a biofuel.

Classical Soxhlet extraction (Sluiter, Ruiz et al. 2008) and solid – liquid extraction using water and solvents mixtures were tested using shake-flasks and ultrasound assisted extraction (UAE) using an Elma Transonic T 700 ultrasound bath (Germany) with 35 kHz frequency.

The extracts were analysed qualitatively and quantitatively using a Capillary Zone Electrophoresis Systems (Agilent). Diverse phenolic compounds were identified, namely, salicylic acid derivatives, cinnamic, coumaric and 4-hydroxybenzoic acids in distinct relative amounts depending on extraction conditions.

Ultrasound-assisted extraction using water as sole solvent is a promising solution as compared to the state-of-the-art technologies (Bombardelli, Giori et al. 2009) indicating that it should now be further studied both at lab- and at a pilot-scale.

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ANALYSIS OF THE PHOTOVOLTAIC MODULE TEMPERATURE

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The conversion of solar energy to the electricity is one of the most usable technologies from renewable energy sources. Temperature of photovoltaic system depends on many technical and physical factors such as: solar irradiation, azimuth angle of sunlit surfaces orientation, the angle of surface inclination, which is dazzled, local climate and temperature conditions (Malínek et. al, 2018). This research deals with creation of thermal model for photovoltaic module which is usable in real climatic conditions with localization in Central Europe region. In Department of Physics Slovak University of Agriculture in Nitra, was designed and created measuring system. This system contains components from Austrian brand B&R, 24 temperature sensors and works fully automatically. The measurements were done during the summer on polycrystalline photovoltaic module, which were installed in building of Czech University of Life Sciences in Prague. Climate data was collected from the weather station. The results are presented in the graphical relations. From obtained results is clear that the response of the module temperature is dynamic with changes in irradiance and the accurately model module temperature, particularly during periods of fluctuating irradiance. For every graphical relation was obtained polynomial function of the second degree with relatively high coefficients of determination. After application of fitting procedure to real dependencies and correlation analysis was obtained the temperature model of photovoltaic module.
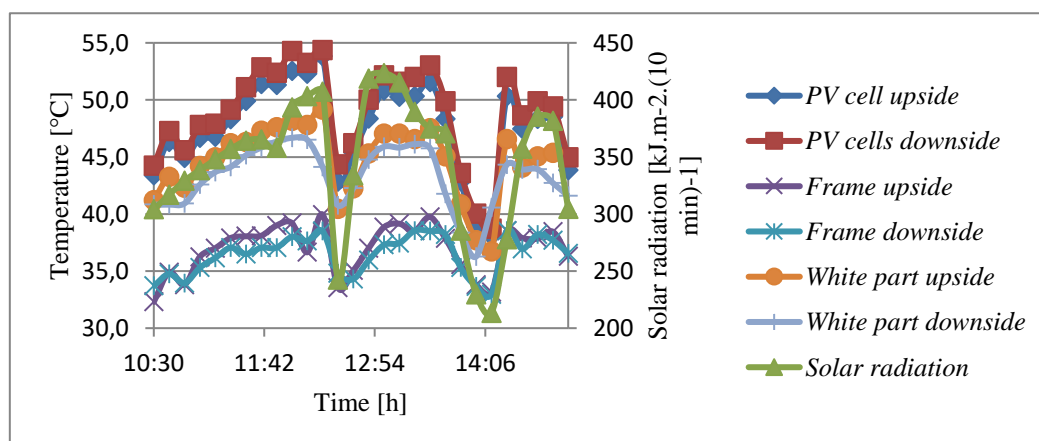
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MODELING OF HYBRID PHOTOVOLTAIC-THERMAL SYSTEMS USING TRNSYS SOFTWARE

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Solar power is a key driver for increasing the integration of renewable energies and reducing the current dependence of fossil fuels, which is a major challenge for engineers in the built environment, especially solar systems based on hybrid photovoltaic-thermal (PV/T) collectors (Ramos et al., 2017). The purpose of the PV/T collector is duel: it generates electricity from the PV module and produces heat by supplying the liquid passing through the copper pipe. Cooling the PV module to recover heat from the module, which allows high power output, and provides hot water for industrial or swimming pool preheating and domestic heating (Huang et al., 2014).

The TRaNsient System Simulation program addresses the equations that are connected to a user-configured system. The TRNSYS components can be configured representing different models of the system, e.g. fuel cells, solar collectors, etc. The user can create a solar thermal systems that evaluate their performance and high complexity. This can be achieved using TRNSYS "TYPES". Each TYPE contains a set of equations for a standard device and provides inputs/outputs that are defined by the user, affected by the simulation (Berger, 2016).

In the recent work the main goal is to set up the TRNSYS model of the system to test the thermal and electrical efficiency, the efficiency dependence of the PV/T module for the seasonal and the whole year. The established TRNSYS model enables the evaluation of measurement results, the analysis of energetic properties, the identification of the factors influencing the efficiency of the system, the performance of sensitivity analysis and the development of new methods for increasing efficiency.

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COMPARISON OF NEW AND USED BIOLUBRICANTS BASED ON RHEOLOGICAL PROPERTIES

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This work deals with study of physical properties viscosity and density of biolubricant. Viscosity and density of materials change with the temperature. The hydraulic fluid is of a Mol Farm Bio ERTTO and it is a biodegradable tractor oil. The oil is made from vegetable natural oil and special additives. The oil is designated for use in the gearbox and hydraulic circuit of agricultural and construction machines. Sample was worn in special laboratory equipment, which was at the Department of Transport and Handling at Faculty of Engineering, Slovak Agriculture University in Nitra. The laboratory equipment was constructed from the elements of the hydraulic systems of the tractors. Hydraulic pump was loaded with cyclically changing pressure from 0.1 MPa to the nominal pressure of the hydraulic pump 20 MPa during the test (Tkáč, 2014). We measured new sample and sample after 750 000 cycles which demonstrate running-in procedure of device.

Measurement results of density of oils are presented on the Figure 1. Density linearly decreases with temperature of oil. Dynamic viscosity of ERTTO is decreasing exponentially with increasing temperature. The exponential dependency for each sample was obtained in accordance with Arrhenius equation. Experimental results have shown that temperature is one of the essential factors which has an influence on material properties.
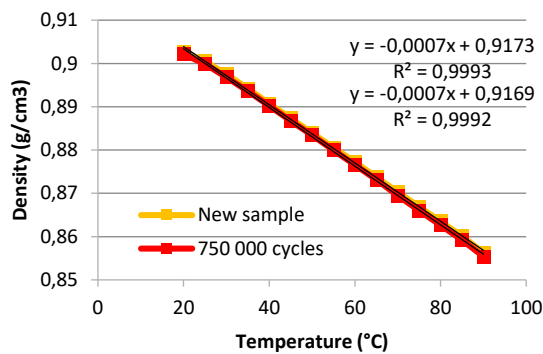

Fig. 1. Temperature dependencies of oil density
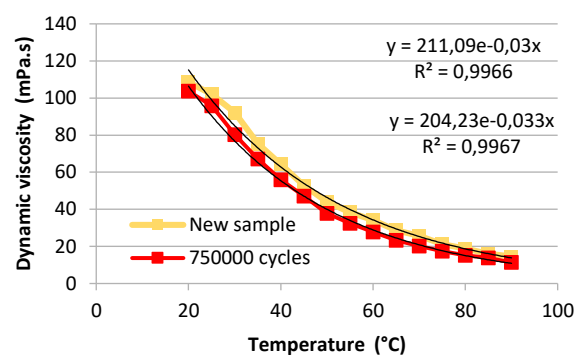
Fig. 2. Temperature dependencies of oil dynamic viscosity

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THE INFLUENCE OF ENZYMES ON THE STRUCTURE OF POLYSACCHARIDES OF FRUIT CELL WALLS ON THE EXAMPLE OF "DIPRET'' STRAWBERRIES

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It is recognized that shortening the shelf life of fruit is associated with a changes in the cellular structure of parenchyma tissue and with transformations of cell walls resulting from the action of enzymes produced by fungi attacking fruits both during growth and during storage. Softening of fruits during maturation and storage is associated with the loss of pectin network cohesion in the large degree (Cybulska et al., 2015; Fischer and Bennett, 1991). The loss of cohesion results from the modification and relaxation of pectin chains (Goulao and Oliveira, 2008). The pectin network occurring between microfibril structures of xyloglucan-cellulose is a scaffold that is responsible for maintaining the integrity of the cell wall (Gwanpua, Sunny et al., 2014). The integrity of the cell wall can be lost, e.g. due to the action of pectinlytic enzymes.

The work presents the activity of enzymes that hydrolyze cell wall polysaccharides produced by fungi of the genera *Aspergillus aculeatus* and *Aspergillus niger*. The alcohol insoluble residues of strawberries of the Dipret cultivar were subjected to a 24-hour incubation in the presence of the following enzymes: α-L-arabinofuranosidase (*A. niger*), β-galactosidase (*A. niger*), α-rhamnosidase (prokaryote), endo-polygalacturonanase M2 (*A. aculeatus*). The cell wall structure was determined using the FT-IR spectra and the AFM microscope.

Based on the results of the analyzes carried out, the influence of the tested enzymes on the structure of the cell walls of the examined strawberry variety was confirmed. From the results it can be concluded that β-galactosidase and α-L-arabinofuranosidase responsible for the cleavage of the side chains of pectin and increasing the porosity of the cell wall. The cell wall is then more susceptible to endo-polygalacturonanase and rhamnosidase cutting the pectin chain to smaller subunits. This is confirmed by the fact that fungi of the genus *A. aculeatus* and *A. niger* significantly change the structure of strawberry cell walls.

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DEVELOPMENT OF SOLAR CELL EFFICIENCIES

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The recent paper gives an overview of the solar photovoltaic (PV) energy application fields worldwide. Specific consideration will be given to the new trends and technical development related to the cell efficiencies.

In 2017, the solar photovoltaic global capacity reached 402 GWpv along with the annual additions of 98 GWpv, which is equivalent to the production of about 40 thousand modules every hour (Renewables 2018). In 2018 it is estimated additional 18% capacity addition (IEA PVPS, 2018).

Due to the extensive growing market demand of the solar photovoltaic applications several new issues came to the light. Among the others, such factors include the wide range of cell manufacturing technologies, colouring, transparency and extra size and concentrated type of modules along with the new type of fixation systems, as well.

Concerning to the third generation of PV cells several schemes have been suggested to increase the efficiency of PV cells above the limit of a single bandgap device, which maximum efficiency is 40.7% (SQ limit). The new technologies are aiming at to reduce the losses due to the non-absorption of sub-bandgap photons and the thermalisation of above bandgap photons.

Recently, it is worth to mention the organic and perovskite type of solar cells for which several significant scientific research and industrial investments were performed in the last couple of years (Fraunhofer ISE, 2019). In June 2018, perovskites solar cells have reached efficiencies of 27,3% in laboratory environment.
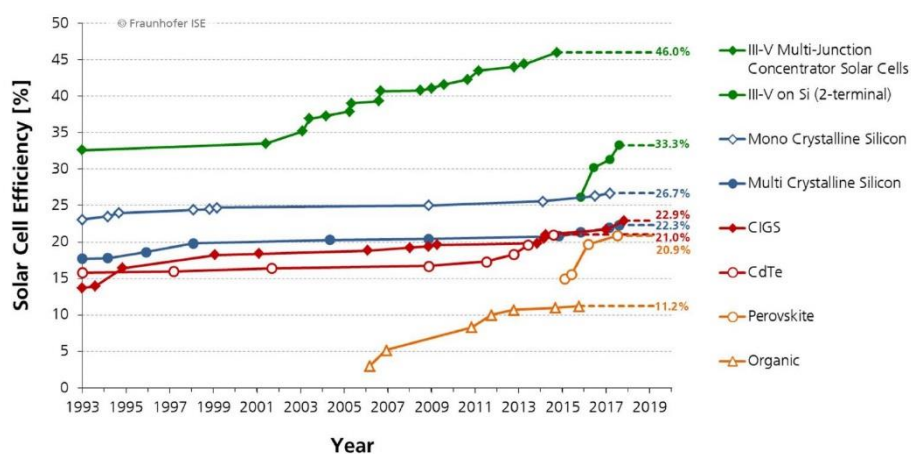
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MECHANICAL PROPERTIES OF FOOD POWDERS

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The mechanical properties of food powders are currently of interest to researchers, technologists and designers. The food-related purpose of materials requires maintaining their high quality during the technological process. During processing, the bulk material undergoes a series of treatments and processes that allow it to be used in subsequent stages of the process. Therefore, to improve the process and reduce the risk of undesirable phenomena, it is important to know the mechanical parameters at the stage of designing the production technology.

In the processing of food powders, physical parameters are being used more and more often, which significantly improve the technological processes. In addition to granulometric analysis of the material, the most frequently described parameters include flow, coefficient of friction, modulus of elasticity etc. whose measurements are possible due to the continuous development of methods and apparatus. Although these parameters are well characterized in powders, there are still problems in the industry that hinder the proper processing of powdery raw materials. One of the undesirable phenomena in powders is caking, which causes a number of adverse changes in the material, and also contributes to the increase in production costs, which is a loss for the company.

The aim of this presentation is to introduce the subject of powder mechanics and to present the basic methods of measuring the physical parameters of powders and also pay attention to problems and undesirable phenomena in processing powders. The work also presents the results of changes in the material during the caking process.

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FREE CONVECTION HEAT TRANSFER IN SOLAR CHIMNEY FOR SOLAR DRYER

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A solar chimney is a way for improving the natural ventilations of a given application by using convection of air heated by solar energy. Passive solar design refers to the use of the sun's energy for heating the air inside the chimney. In passive indirect solar dryer system, convective heat transfer occurs by natural means such as buoyancy. When the heated air from the solar collector flows through the drying chamber, it losses its energy to evaporate the water from the product. Thus the temperature of the air decreases as it leaves the drying chamber which in turn lowering the movement of the airflow in the system. Hence to maintain the airflow rate the so-called "chimney effect" may be used. The heat transfer performance on the chimney is depends the operating parameters of heat transfer coefficient.

To study the performance of the chimney on the distribution of the wall temperature, local and average heat transfer coefficients and local and average Nusselt numbers for a wide range of Grashof numbers. Also, correlations for the coefficient of heat transfer by free convection from vertical solar chimney were obtained in a dimensionless form as a function of Rayleigh numbers. The mathematical calculation used in this study employed (Chungloo, 2009) procedure. The *Nu* number is evaluated by:

$$Nu = \frac{hD}{K} = C \left(\frac{\rho^2 g \beta C_p \Delta T L^3}{\mu^2} \frac{\mu}{C_p K} \right)^{0.25},$$

where:

$$h = \frac{Q}{A(T_h - T_a)} \qquad and \qquad Q = \dot{m} C_p (T_o - T_a).$$

The *Nu* number results will be correlated by the dimensionless group Rayleigh number *Ra*, theoretically evaluated by:

$$Ra = \frac{g \beta \Delta T L^3}{v^2} \text{Pr}.$$

The present work introduces correlations of Nusselt number for free convection from vertical solar chimney at a given chimney height. The trend of the results of the present work was compared from literature and the trends were consistent.

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Acknowledgements

DETERMINATION OF WHEAT GRAIN PHYSICAL PROPERTIES USING SINGLE KERNEL CHARACTERIZATION SYSTEM

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The aim of this study was to evaluate selected physical properties of wheat grain: hardness, weight, moisture and diameter. These parameters have high significance in grain storage, separation, transport and processing.

As research material common wheat (*Triticum aestivum*) and durum wheat (*Triticum durum*) were used. Physical properties of kernels were determined for twenty five wheat varieties using Single Kernel Characterization System (SKCS 4100). The analyser determines the characteristics for each and every kernel in the sample – one by one – in a fully automatic mode.

Moisture, hardness, diameter and weight were analysed for each individual 300 kernels. Hardness was expressed in unmaintained units (from -20 to 120) which are based on the characteristics of the grain destructive force (grain is placed between the stationary surface and the moving cylinder).

The moisture of tested wheat ranged from 7.2% for Karmadur variety to 9.17% for Banderola variety. The kernels of the investigated wheat types (common and durum) differed in most physical properties. The lowest value of hardness index was found for Kandela variety ($HI = 37,9$) and higher index was observed for Lupidur variety ($HI = 88.9$). All durum wheat where classified as hard wheat or very hard, whereas common wheat was classified as middle soft or medium hard.

The weight of tested kernels ranged from 33.83 mg for Izera variety to 47.04 mg for Komnata variety. The diameter of tested grains changed from 2.75 mm (Lupidur variety) to 3.13 mm (Zawisza variety). We found significant and negative correlation between kernel diameter and hardness.

APPLYING THE INTELLIGEN MEASURING SYSTEM (IMRe) TO A COOLING SYSTEM USED IN THE FOOD INDUSTRY

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Chilled food risk factors involved in the cooling system equipment is extremely important for food chain safety. Transportation and distribution does not have much of this kind a high-tech systems. With these basic systems, supervision and monitoring the temperature it is usually not possible for the driver. As a result, food safety risk in the transport of refrigerated isothermal operating safety, measurement, data collection will be in focus.

In the case of an examined system, the task of the diagnostic is to quantify the parameters by comparing the parameters with the expected values in order to determine whether the system is functioning properly. The experimental equipment is a rack cooler model consisting of a Webasto CC5 split-type refrigeration unit and a room modelling the cold room of a vehicle.

The Intelligent Measuring System (IMRe) applied to the equipment is designed to be a low cost and be easily producible, cheap system with the main functionality goals like upload sensor data directly to the internet via Wifi connection, counts two pulse and two temperature inputs. To ensure the device can always restart itself when an issue detected (self monitoring and error correcting software), an additional monitoring micro-controller has to be added which restarts the main micro-controller if needed. A graphic environment of server software running in the background as cloud service. In this way, the transmitted data records can be visualized in a diagram shown below.
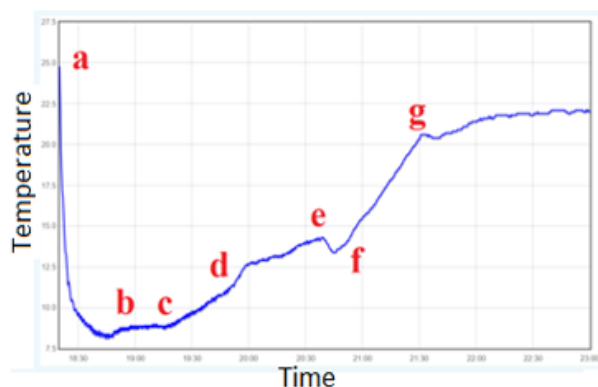
a-b: cooling to reach the operating temperature of cold room
b-c: normal operation
c-d: beginning of ice buildup of evaporator
d-e: intensive ice buildup
e-f: unknown process
(need more investigation)
f-g: cold room temperature is increasing
(lack of cooling performance)
point g: cooling switched off

The cause of the problem was unknown when the graph had been created. The faulty behaviour was caused by a misplaced sensor. To eliminate the problem temperature sensor was placed between heat exchanger fins. Henceforward under several days of testing good results were taken.

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APPARENT VISCOSITY AND DENSITY OF CHOSEN TOMATO KETCHUPS

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This study is focused on determination of apparent viscosity and density of chosen tomato ketchups. The aim of the work was to analyse the rheological properties and determine qualitative changes in ketchup behaviour dependent on temperature changes and storage time. The measurements of all samples were carried out under the same conditions in approximate temperature range (5 – 30) °C. First measurements were performed at the beginning of storing, second measurements were done after two weeks of storing and last measurements were realised after four weeks of storing. There were constructed dependencies of rheological properties on temperature and storage time and evaluated by the regression equations and the coefficients of determination. Ketchup is a non-Newtonian material, so apparent viscosity was measured. The measurements of apparent viscosity were performed on a digital rotational viscometer Anton Paar DV - 3P. Densities of measured samples were determined according to definition. We found out that apparent viscosity of samples decreased exponentially with increasing temperature, so the Arrhenius equation is valid.

Comparable rheological results for ketchup were reported by Sharoba et al. (2005). Ketchup's fluidity was increasing exponentially with the temperature. We also found out that apparent viscosity had decreased with storage time and on the other hand fluidity was increasing with storage time, which can be caused by structural changes in samples during storing. Temperature dependencies of ketchup densities were sufficiently characterized by decreasing linear function in measured temperature range.

Same type of dependency was used also by Thomas et al. (2015) and Kelkar et al. (2015). The calculated rheological characteristics can be used for designing of technological equipment or containers for distribution of the product to the final users. The knowledge of flow behaviour is also important for the development of new recipes and direct qualitative assessment of the products.

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ELECTRICAL PROPERTIES OF TWO TYPES OF PERGA

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Nowadays with the increase in demand for products of beekeeping, scientists and practitioners are interested in the development of the technologies of beebread production. The result of research conducted by universities the National University of Life and Environmental Sciences of Ukraine and the Slovak University of Agriculture in Nitra is patented technology (Brovarskyi et al., 2017).

Perga samples were collected by beekeepers from selected regions of Ukraine. One type was polyfloral perga and second was from buckwheat (*Fagopyrum esculentum* Moench). Low-frequency electrical properties of perga were measured by an instrument GoodWill Instek LCR meter 821 at different frequencies using four-electrode (tetra polar) system. We measured capacitance, resistance, impedance and loss tangent. Each property was measured in the frequency range from 0.1 kHz to 200 kHz, at all frequencies three times. For frequency dependencies of electrical properties, we used power model. This model describes the curves very well and has high value of coefficients of determination in interval from 0.7 to 0.94.
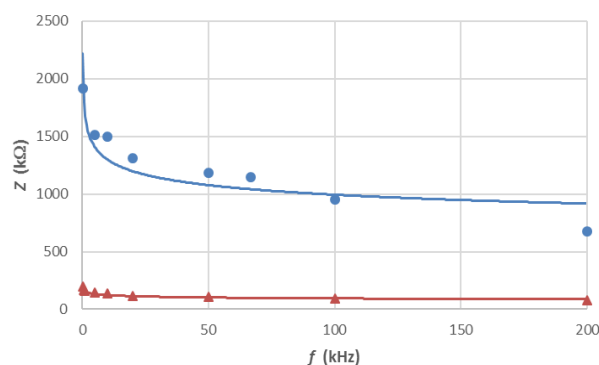
Fig. 1 The impedance versus frequency curves for buckwheat (•) and polyfloral perga (Δ)

We can conclude that samples are created for all types as a mixture of perga and air. The resistivity values show that perga belongs to semiconductors. The measurements indicate that perga must be included in the most complex objects. It is organic heterogeneous multi-component semiconductor or dielectrics. We found differences in electrical properties of two types of perga (see in Fig. 1), which can be used to distinguish these samples.

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Acknowledgements

DEM MODELLING OF TENSILE STRENGTH OF STARCH TABLETS

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Agglomeration of powders is one of the unit operations improving the final product characteristics and functionality. It is widely applied in pharmaceutical, agricultural, food, mineral, metallurgy, fuel biomass industries. Quality of compacts are influenced by a powder and binder properties, and the compaction pressure. The strength of agglomerates is one of the most important properties of the final product. Numerical simulations and experimental study of compaction and the diametral compression test (Procopio et al, 2003) of potato starch were conducted to analyze the microscopic mechanisms of formation of tablets and the origins of their breakage strength. Simulations were performed with use of the EDEM software. Samples of 120 thousand of spherical particles with diameters normally distributed in a range from 10 to 72 μm (S.D. 15 μm) were compressed in a cylindrical die 2.5 mm in diameter. The linear elastic-plastic constitutive contact model including linear adhesion (Luding, 2005) was used to model compaction, unloading and relaxation of tablets. In modeling the diametral compression test the adhesion model was substituted by the parallel bonded particle model (Potyondy, Cundall, 2004). DEM simulations were compared with experimental results. The potato starch of the moisture content of 17% w.b. without any additives or with addition of 5% of gluten or ground sugar was compacted in cylindrical die with a diameter of 10 mm up to the compaction pressure of 38, 76, 115 and 153 MPa. Unloaded and relaxed tablets were compressed diametrally to determine the tensile strength.

Finally, it can be concluded that:

Starch agglomerates may exhibit brittle, semi-brittle or ductile breakage mode depending on applied binder. Starch agglomerates at the moisture content of 17% behaved as the semi-brittle material. Addition of sugar increased the tensile strength of agglomerate and changed the breakage mode into the brittle. Addition of gluten resulted in considerable reduction of the tensile strength and changed the breakage mode into the ductile.

The bonded-particle model applied together with the linear elastic-plastic contact model can describe brittle, semi-brittle or ductile mode of breakage depending on the ratio of the strength to stiffness of the bond and relation between stiffness of the bond and the particle stiffness. Low stiffness and high strength of the bond resulted in the ductile breakage. High stiffness of the bond and high compaction resulted in the brittle mode. Intermediate conditions resulted in the semi-brittle breakage mode.

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CHANGES IN THE STRUCTURE OF GLUTEN PROTEINS IN THE MODEL BREAD DOUGH, AS A RESULT OF THE USE OF SELECTED PHENOLIC ACIDS

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Currently, the awareness of people related to proper nutrition is growing significantly, as is their taste for food consumption. Consumer awareness is growing with regard to the impact of consumed products on health and well-being, which is greatly influenced by the diet. Therefore, there is a need to improve and enrich the food with healthy and nutritional ingredients. Bread, which is still a product commonly consumed, can be a convenient way to deliver the valuable substances to the body.

Phenolic acids are compounds characterized by antioxidant, antibacterial and anti-inflammatory properties. These compounds can eliminate reactive oxygen species, block free radicals, as well as chelate metal ions, e.g. copper or iron. Therefore, they can protect the human body against oxidative stress and related diseases, i.e. cancer or diseases of the cardiovascular system. Numerous studies have shown that the properties of phenolic acids are related to their chemical structure, and more specifically to the number of hydroxyl and methoxy groups they possess.

Phenolic acids, as these "pro-health" ingredients, can be an appropriate supplement of wheat bread. However, the addition of different substances to the wheat dough disturbs the structure of the gluten network, as well as affects rheological and sensory properties of the obtained bread.

The aim of the conducted research was to study the influence of selected phenolic acids (cinnamic, ferulic, coumaric, coffeic, chlorogenic) on the structure and properties of a model wheat dough. These compounds were added at concentrations of 0.05%, 0.1% and 0.2% to the model flour consisting of wheat starch and wheat gluten in a ratio of 80:15(w/w). The samples in the form of powder were tested using two complementary methods: FTIR spectroscopy and FT-Raman spectroscopy. FTIR spectroscopy allows insight into the secondary structure of proteins by analyzing the amide I and amide III bands and observing changes in water populations ($2800-4000 cm^{-1}$). Raman spectroscopy, on the other hand, allows us to study the tertiary structure of proteins by analyzing band connected with the disulfide bridges. In addition, Raman spectroscopy allows the study of the environment of two aromatic amino acids - tyrosine and tryptophan, which provide information on hydrogen bonds. These bonds as well as disulphide bridges are important during the process of dough mixing.

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COMPRESSIVE PROPERTIES OF BUCK WHEAT PERGA

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Chemical and biochemical composition of bee pollen depends mainly on its botanical origin, but also on the time of harvesting, soil and climatic conditions. (Bleha et al., 2015). The term "bee bread" is reserved for the original bee pollen stored in the combs. The bee bread (or the perga) has already been processed by the bees for storage with the addition of various enzymes and honey, which subsequently ferments. This type of lactic acid fermentation is similar to that in yoghurts (and other fermented milk products) and renders the end product more digestible and enriched with new nutrients (Brindza et al., 2015). Bee bread is a product of the hive obtained from pollen collected by bees, to which they added honey and digestive enzymes and subsequently stored in the combs, starting a lactic fermentation which gives it greater power conservation (Zuluaga et al., 2015). The process of bee bread formative on starts with gathering of pollen, then a bee mixes it with flower nectar or honey and saliva, and carries to the beehive, where non flying bees fill the mixture into honey comb cells for the three quarters of the cell volume. We interested with the uniaxial compressive test of the perga samples. Compressive properties such as the failure stress and strain as well as the modulus of elasticity can be used to evaluate the behaviour of the buckwheat perga pellets (*Fagopyrum esculentum, L.*) under the static loading. A testing machine Andilog Stentor 1000 (Andilog Technologies, Vitrolles, France) was employed for uniaxial compression tests. The samples of the perga have been tested at the different strain rates. The experiments were performed at four velocities 10, 30 60 and 90 mm.min^{-1} in order to achieve the different strain rates. The influence of strain rate on the stress was studied.

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SAGO PALM VEGETATION USING SENTINEL-2 IMAGERY

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Papua has been considered as one of the centers of sago diversity, due to the high genetic variations of sago palm. Based on some previous studies, it was found that the primary product of this palm were used as a food product in traditional cakes, noodles, syrups, raw material for agro-industry as well as bio-ethanol industry (Karim et al., 2008). Moreover, around 85% of all sago palm plantation area is in Indonesia; 4.7 million ha are located in Papua, and 510.000 ha in West Papua (Bintoro et al., 2018). However, natural forest sago palms in Papua are stand mixed with other similar plants such as oil palm, nipa palm, also today, palm sago are cultivated with other crops. Therefore, it is necessary to recognize the palm with other similar features.

On other side, some laboratory experimental methods have been done but due to the costs of the methods and time-consumed (Manavalan et al., 2018); justify an alternative approaches such as machine learning or deep learning (Koda et al., 2018). Those models are will be used to deal with classification or detection problem. Hence, several studies have classified object using machine learning and deep learning, but detection of different plant or individual sago palm tree in Papua is not examine yet.

This paper is going to present the theoretical approach using Sentinel-2 imagery to distinguish sago palm vegetation among other typical plant. The recent study will take the advantage of using remotely sensed data specifically at the airborne platform with Sentinel-2 and multispectral sensor to identify vegetation of field work in Papua. The imagery obtained on 1 to 4 April 2019 at 13 spectral bands in the Visible (VIS), Near Infrared (0.842 of central wavelength and 10m of resolution) and Short Wave Infrared (SWIR). The image and all associated data will be observed and analysed using SNAP software.

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FUNGAL PATHOGENS IN ECOLOGICAL STRAWBERRY FIELDS

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The area of organic fruits cultivation in the world have had significantly grown since 1999, and this land have increased in every continent. Central European countries share almost one-quarter of the organic lands on the planet and half of the world's production of soft fruits such as strawberry, blueberry and raspberry (FAOSTAT).

Fruits grown in ecological manner are especially susceptible to fungal diseases due to eradication of chemical spraying from the cultivations. The diseases are able to lower the yields down up to 50% and to remain dormant in the soil for many years. Pathogens most frequently attacking ecological strawberry cultivations are those of the *Verticillium* spp. and *Phytophthora* spp., as well as *Botrytis cinerea* and *Colletotrichum acutatum.* Until now, the most effective way to control fungal expansion is to immediately identify and remove infected plants from the cultivation (Mertely, 2007; Spitzer, 2017). Traditional methods of the pathogen identification are time consuming and error-prone, which is the reason to develop improved methods for detecting and identifying of fungi dangerous for berry plants. The polymerase-chain reaction (PCR) amplifies the genetic material of selected organism and is useful for its identification and further analysis. The quantitative PCR (qPCR) allows to observe results of reaction in real-time and to estimate the amount of amplified genetic material (Saiki 1988, Higuchi 1993).

The aim of the study was to develop effective molecular methods for rapid identification of crucial strawberry pathogens. We proposed and developed qPCR as an efficient tool for this purpose.

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A NEW APPLICATION OF THE LINE GROUP THEORY IN THE SOLAR ELEMENT MATERIALS

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It is well-known nowadays, that the detailed experimental and theoretical investigation of basic structural and physical properties of different types of carbon nano-tubes plays a role of continuously increasing importance in both fundamental research activities in the condensed matter physics, as well as in the various types of energetic engineering applications (Barros et al., 2006). Among them, the possible new solar-energetic applications seem to be particularly promising, because of the need of replacing of the recent very low-efficiency characteristics machines ranging from mobile engines till large-scale energetic systems.

In the material sciences, description of symmetries of the incommensurately modulated crystals represents still one of the most interesting problems, not in the domain of the classical crystallography only, but in the whole condensed matter physics, including stereoregular polymers, too. One of the basic problems in this area is that the classical crystallographic symmetry theories cannot completely cover the experimentally confidently proven structure symmetries of such systems, which are nevertheless able to scatter X-rays, neutrons or electrons coherently (Vainshtein, 1966). Among the newest methods of investigations of such types of condensed matter systems, research activities connected to possible applications in solar cells became also very significant, e.g. (Li et al., 2008), despite of the fact, that even in the most detailed quantum-statistical models of collective elementary excitations relevant for light absorbing organic materials, the selection rules based on the representation theory of the relevant symmetry groups describing quasi-one-dimensional systems have not been applied in detail.

In the present study a further refinement of such-type symmetry methods being applicable in the relevant materials science domains will be described in a completely novel manner.

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NEW AND INNOVATIVE METHODS FOR REMOTE DETECTION OF ALPHA RADIATING PARTICLES IN THE ENVIRONMENT

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Szent István University takes part in an international partnership on the research field of the possibility of the remote detection of alpha emitting radionuclids. The leader of this partnership is the Physikalisch-Technische Bundesanstalt, (PTB) (Braunschweig, Germany). Main principles and ideas about this possibility are outlined here.

Due to the few centimeters of mean free path (range) of alpha particles (He-atomcores) measuring methods of alpha radiating materials by traditional detectors requires the direct contact between the measuring device and the alpha emitting source. But thanks to existing secondary processes namely interaction of alpha particles with the molecules (mainly with the nitrogen) of the air a cascade process (de-exciting of N_2 molecules) leads to an UV (ultraviolet) radiation of the air. This so-called alpha-radioluminescent phenomenon can be detected from distance of kilometers range. Because of the photon measurings this method will be optical.

The first basic step toward remote detection of alpha particles was done by Baschenko (2004) by measuring the atmospherical alpha-radioluminescent spectrum under standard conditions. The outdoor-type applications of these results have a great difficulty: the intensity of the solar UV spectrum exceeds the alpha-radioluminescent one. Methodes to overcome these challenges developed by researchers of PTB will be outlined.

Another (active) measuring method based on the laser-induced fluorescent phenomenon will be also presented.

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THEORETICAL STUDY OF POLY(P-PHENYLENE VINYLENE) AND ITS DERIVATES BY POSITIVE SEMIDEFINITE OPERATORS

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Conjugated polymers have important role in the field of semiconductor device physics (for example LEDs Field Effect Transistors), radiation detection and solar cell applications as well. From the viewpoint of our research work this latest field is the relevant.

Thanks to their delocalized π-electron system in conjugated polymers photovoltaic effects can occur. After absorption of the energy of sunlight Coulomb bonded electron-hole pair (exciton) can be generated. For better charge separation and transportation to the electrodes fullerene molecules as electron acceptor materials can be blended to them.

The one of the best important solar cell polymers are the poly(p-phenylene vinylene) (PPV) and its derivates (MEH-PPV, MDMO-PPV etc.). We wish to study these ones theoretically in the frame of the Hubbard model. This model contains three parameters: $t_{i,j}$, ε_i and U_n which are the so-called electron hopping term describing the energy change after the hopping of the electron from one lattice site to the other one, the on-site potentials describing the power of the side groups connecting to the backbone of the polymer and the positive electron-electron on-site Coulomb interacting term respectively.

It will be presented a method for calculating the bare band structure and for deducing the ground state wave function. This latest procedure is based on the Method of the Positive Semidefinite Operators. The advantage of this method that there are no needs to any preconceptions about the ground state. Calculations will be carried out for the case of the presence of the external uniform magnetic field too. We will analyse the ground state of PPVs from the viewpoint of the ferromagnetism and we will give expressions for calculating the energy of the ground state in the low and high electron concentrating cases (half-filled lowest and highest band). After these some future plans will be presented.

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IMPACT OF STRESS MEMORY ON GRASS GROWT AT WATER DEFICIT CONDITIONS

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Drought is associated with complex response of plants including morphological, physiological, biochemical and molecular alterations that are also interrelated. In natural conditions with sporadic precipitations plants are often exposed to changing levels of soil moisture, that can be different in amplitudes and frequencies. Due to changing climatic conditions, a further increase in the frequency of drought events is being predicted. Plants have evolved mechanisms of adaptation to fluctuations in their environmental conditions that have recently been given the term "stress memory" (Walter et al., 2011).

In this work the change in the response to drought of two grass species due to earlier exposure to water deficit was analysed. *Tall fescue* (Fa) and *Perennial ryegrass* (Lp) grass species with a different resistivity to water deficit were grown in soil with a precisely controlled soil moisture (Nosalewicz et al., 2018). Soil moisture control was based on TDR probes (ETest, Poland) placed in each of the soil columns at depths of 5, 15, 25 and 35 cm. The average value of volumetric soil moisture from all of the depths was used to control soil available water in each single column during periods of time when optimum soil moisture was maintained. Automatic watering was applied every 6 hours in a volume needed to reach the specified soil moisture level.

The specific water use pattern during two successive drought events, that was different for both species, affected the intensity of the perceived stresses. The increased allocation of root biomass in deeper soil was noted in grasses exposed earlier to water deficit. Both species were characterised by higher leaf stomatal conductance and photosynthesis during the second drought. Reduction in water use of the Lp due to pre-exposure to drought allowed it to maintain higher leaf RWC thus minimizing the negative non-stomatal effects on the rate of photosynthesis as compared to plants without stress in their history.

Our results indicate that:
- grass species demonstrate improved functioning during drought when exposed to a drought during an earlier growth period;
- the improved functioning during secondary drought comes with the cost of growth inhibition.
- the mechanism of plant response to drought is a combination of alterations in plant structure, water use patterns and photosynthesis.

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ISOLATION OF MICROBIAL DNA FROM SOIL – METAGENOMIC APPROACH

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Soil is probably the most diverse, complex and heterogeneous biological ecosystem. The microbial population of soil is known to be a vast reservoir of biomolecules, enzymes or antibiotics.

Studying the biodiversity and properties of microorganisms in soil presents great difficulties. Traditional approach to study soil ecosystems involves culturing the microbial isolates, communities on various selective media or profiling with BIOLOG EcoPlate system. However, great majority of microorganisms inhabiting soil are reported to be unculturable. This trait renders the traditional methods for microbial research very limited.

To overcome these difficulties, the metagenomics approach in research must be employed.

Metagenomics of soil involves employment of molecular methods that are independent of microbial cultivation to research the biodiversity and properties of soil microbial communities. The isolation of DNA from soil is the most important and crucial step in metagenomics studies with high-throughput sequencing (Next Generation Sequencing – NGS). As different types of soil present varying properties that impact on the success of DNA isolation, some of the DNA extraction protocols may introduce different errors and biases in downstream applications. The most common troubles concern overestimating or underestimating the abundance of one type of microorganism. The other problems are connected with incorporating inhibitors to next steps of analysis that may have impact on performance and specificity of enzymes used in studies. Therefore, the need to determine and optimise the extraction protocol that is best suited for soil and downstream applications used in research.

Metagenomic approach to screening of soil microbial communities, has already led to the identification of various novel biomolecules, including enzymes and antibiotics of industrial importance.

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INFLUENCE OF BIODIESEL BLENDING WITH GASOLINE ON DENSITY

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The physical properties of any fuel are significant factors which help to decide whether the oils are suitable for engine or not. The prediction of various properties of biodiesel or blends of biodiesel with gasoline is vital for the design of different systems of diesel engine. Therefore, this paper is dealing with characterization of density of biodiesels according to present standard testing methods. Temperature is a factor that pretty much impacting the properties of the materials. Density change with temperature is significant and it can be mathematically described by the exponential equation of the Arrhenius type. It is an important fuel property which affects the engine performance as change in density affects the mass of fuel injected. The basis of this work is experimental material research in the field of biofuels. The main aim is to evaluate effect of gasoline addition to biofuel. The concentrations of gasoline in the blends were set at 5, 10, 15 and 20 % by volume.
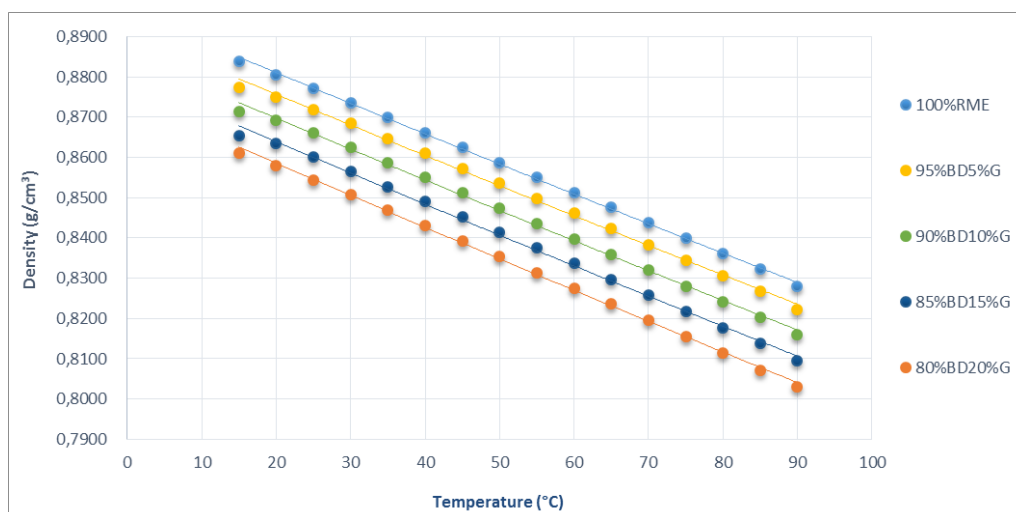
It is observed that the density decreases linearly with an increase in the blending ratio. Based on these data, $\rho=0.8838$ g.cm^{-3} for biodiesel is not fully acceptable in all referenced standards, and therefore without blending cannot be used in United States. However, still is in limit range for use in Europe.

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Acknowledgements

METHANE ANAEROBIC DIGESTION OF INSECTS BREEDING RESIDUES RESULTS IN HIGH BIOGAS YIELDS

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Insects are increasingly being used both in industry and food technology. Their larvae have a high protein and fat content, which can be added into the human diet after appropriate processing and can also be used as animal feed. Insect farming generates a large amount of residues, which are often used as fertilizer. An innovative solution for the management of breeding waste is the production of biogas in the methane fermentation process. Biogas mainly consists of high-calorific methane, so it can be used as a renewable energy source for heating, cooking and to generate electricity.

The aim of this study was to determine the usefulness of insect waste as a substrate for methane fermentation. The figure views the insect and waste used in the experiment.

Hermetia illucens waste   Mealworms waste   Crickets waste
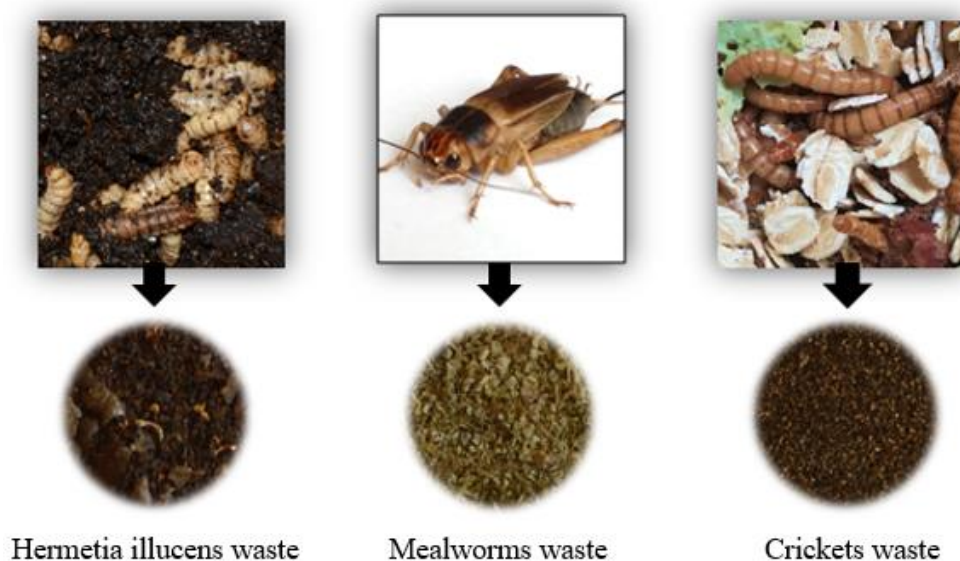
The highest value of the total biogas amount related to weight of the waste added to the bioreactor was observed for cricket waste (389.5 ml·g^{-1} TS), followed by mealworm (378.1 ml·g^{-1} TS) and *Hermetia illucens* (351.4 ml·g^{-1} TS) waste. Summarizing the results of the research, it should be concluded that the value of maximum methane concentration in biogas for *H. illucens* (52.7% in 5th day) *Tenebrio molitor* (62.3% in 8th day) and *Gryllus* sp. (62.1% in 6th day) provides a solid basis for continuing the work towards increasing the proportion of this component in biogas.

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INFLUENCE OF SELECTED FIVE DIETARY FIBRES IN THE FORM OF POMACE AFTER OIL PRODUCTION ON THE GLUTEN PROTEINS STRUCTURE STUDIED BY FT-IR AND FT-RAMAN SPECTROSCOPY

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The interest in healthy, natural and fresh food has increased significantly in the last years. Appropriate lifestyle and diet have a huge impact on the people health. Wheat bread still occupies a leading position in the European diet, and thus, it can be regarded as an adequate carrier to deliver nutritionally valuable compounds. The source of such compounds may be pomace after the oil production from various types of oil plants. The pomace is a source of not only dietary fibre, but also valuable unsaturated fatty acids, antioxidants and macro- and microelements. The above mentioned compounds have positive effects on human health. Interactions between dietary fibre preparations and gluten proteins are very important in the baking industry. The addition of dietary fibre to bread causes reduction in its quality, which is connected with changes in the structure of gluten proteins.

The purpose of the research was to determine the effect of the pomaces addition on the structure of gluten proteins. The selected pomaces after oil production from: black seed, hemp, pumpkin, milk thistle and primrose were added to model flour in the amount of 3%, 6%, and 9%. Model flour was reconstituted from wheat gluten and wheat starch. The gluten samples were washed out from unmodified and modified by fibre dough samples and analysed. Structural changes in gluten proteins were studied using spectroscopic techniques such as Fourier transforms Raman spectroscopy (FT-Raman) and Fourier transform infrared spectroscopy (FT-IR). These two spectroscopic methods are regarded as complementary.

Changes in the gluten structure were determined by analysis of the amide I band (1570-1720 cm^{-1}) using FT-IR spectroscopy, conformation of disulphide bridges and environment of the aromatic amino acids - tyrosine (TYR) and tryptophan (TRP) using FT-Raman spectroscopy. Based on the analysis of the spectra, it can be concluded that the pomaces interact with the gluten proteins. The difference spectra were calculated by substraction of the control infrared spectrum from the spectra of gluten-fibre mixtures. The analysis of difference spectra indicated aggregation of gluten proteins into hydrogen bonded β-sheets. These β-sheets can be formed by other β-sheets, β-turns, antiparallel- β-sheets and/ or α- helices. Other changes observed in the gluten structure like changes in conformation of disulphide bridges and aromatic amino acid microenvironment, can depend on the pomaces chemical composition.

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MODELLING OF THE PHOTOVOLTAIC MODULE CHARACTERISTICS USING VISUAL BASIC FOR APPLICATION MICROSOFT EXCEL

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In this research, modelling of the photovoltaic (PV) module characteristics has been performed using Visual Basic Application (VBA) Microsoft Excel, which is the later named as characteristics of photovoltaic (Cpv) software. The feature of the Cpv software is presented in the figure below:

A model was developed based on single diode model (five parameters: light generated current, I_l; reverse saturation current, I_o; diode quality factor, n; series resistance, R_s; and shunt resistance, R_{sh}) and double diode model (seven parameters: R_s, R_{sh}, I_l, I_{01}, I_{02}, n_1, n_2). One of the outcome of this research is finding the appropriate type of PV model (single or double). The PV module characteristics resulted by PVSyst commercial software is used as a reference. The margin error parameter is used as an indicator to find the suitable model Cpv and PVSyst.

Based on the Cpv simulation, it is found that the PV module characteristics executed by single diode model in Cpv is similar with PV module characteristics resulted by PVSyst, with margin error less than 7%. It means that the model used in PVSyst can be said as single diode model. As a case study, the type of PV module used for simulation is JA Solar, JAM-6-60-250.

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# AUTONOMOUS PHOTOVOLTAIC SYSTEM FOR NIGHT-TIME LIGHTING

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Autonomous photovoltaic (PV) systems are suitable for powering various appliances or scientific instruments in the field, for automatic data collection, for signaling, etc. (Ghafoor, Munir, 2015). At the Czech University of Life Sciences Prague, we have designed an experimental autonomous PV system for night-time lighting and for orientation in the stable for horses. Few years ago, we designed similar larger PV system for night illumination (Kouřím et al., 2015). The article describes the construction of a PV system with a PV panel rated at 170 Wp, with a lead-acid battery and a 1.5 W LED light source. The data collection was automated. Next figure shows the scheme.
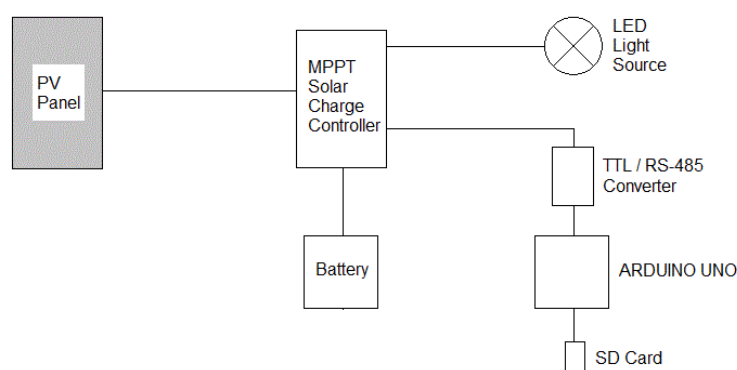
The data evaluation shows that during the whole year, the PV system has been recharged and there was no lighting failure. Next figure shows the time dependences of the battery voltage, LED current and global radiation intensity during the selected summer days.
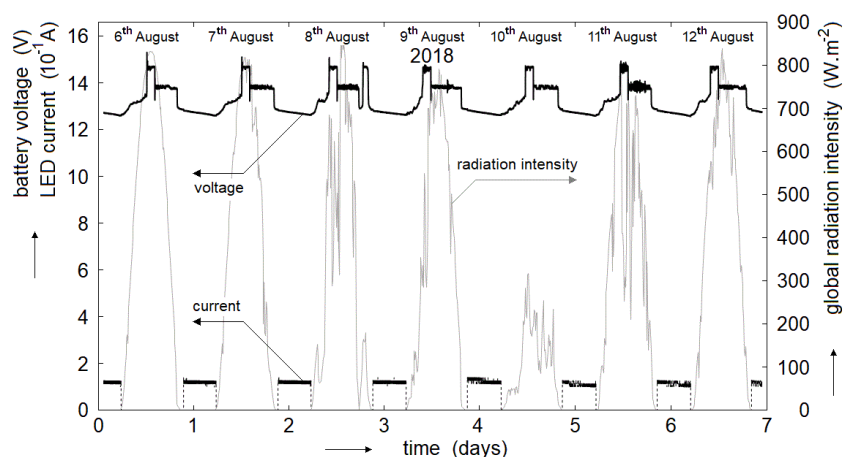
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UTILIZATION OF ENVIRONMENTAL ENGINEERING TECHNOLOGY IN PALM OIL AGRICULTURE IN INDONESIA

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Many efforts have been made to overcome environmental destruction caused by palm oil agricultural practice. At the same time, due to global market demand for various use of palm oil, to produce highest yield possible is a necessity. To serve this purpose, technology became an important aspect not just to assist large scales production but also smaller scales farming in rural areas.

One of the technologies most introduced in palm oil agriculture nowadays is remote sensing. Along with the advancement of satellite images, sensors, and mobile phones, the technology has continuously refined to meet the needs of farmers to understand various responses and characteristics of plants and make precise judgement for precise treatment. However, as many researches have found, innovation and adaptation of agricultural technology among smallholder farmers in rural areas remain debateable considering some impacts that may occur. One of the concerns is the replacement of human labour by the technologies that will lead to the decreasing number of employment opportunity for the people in the local areas (Cardoso et al., 2018; Kansanga et al., 2019). Another distress arises concerning the absence of necessary skills and experience of local farmers that will later be less benefited by the utilization and in contrary more beneficial for immigrant smallholders with prior exposure to palm oil agriculture (Obidzinski et al., 2012).

This paper is a small part of a bigger attempt to understand the sustainability impact of remote sensing technology utilization in Palm Oil Agriculture in conditions of Indonesia. With a qualitative method of review of literature, the paper aims to present different types of remote sensing utilized in small scale palm oil agricultural practice in rural areas in Indonesia and identify some challenges and opportunities faced.

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EXPERIMENTS AT LOW TEMPERATURE

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The demand for the usage of the low temperature is spreading in more and more areas. An often used method for the food quality conservation is the cooling, freezing and the freeze-drying. But the superconductivity and the superfluidity, the hibernation needs extreme low temperatures as well. Even in the kitchen for the molecular gastronomy the fast freezing is used (baked ice-cream), but the freezing is also an important factor in the bio climatology (the pest perishes at low temperature). Low temperature has to be used during different imaging technologies (e.g. in case of electron microscopy or during scanning tunnel microscopy). All these facts gave the actuality to make experiments about how the living and lifeless material reacts for the extreme low temperature.

There are several methods how to reach low temperatures, one option is a thermal contact with a colder substance. In our experiments dry ice and liquid nitrogen will be used for this purpose.

It will be demonstrated, that the mechanical properties of the material change drastically in low temperature (elastic bodies became rigid). The electric resistance change will be demonstrated, together with the behaviour of a glowing wire in liquid nitrogen. The Leidenfrost effect will also be shown together with the volume and pressure increase of the phase change of the low temperature materials (CO_2 bubbles, nitrogen fountain, PET rocket, etc.)

The temperature drop can be realized by adiabatic expansion as well, which will be demonstrated by an alcohol cloud model. During the experiments a heat pump and the magnetocaloric effect will also be demonstrated.

Acknowledgements

EFFECT OF WHEY PROTEINS ON PHYSICOCHEMICAL PROPERTIES OF CHEESE SAUCES OBTAINED ON THE BASIS OF ACID CASEIN

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Whey is a by-product of cheese production. Until recently, it was treated as a post-production raw material that was problematic to manage. In order to effective use of whey, producers started to produce fermented drink with a sour taste that was not suitable for drinking to all consumers. The second option was to use whey in a liquid or dried form as animal feed. However, the most often, way was considered as waste and was poured into the rivers, polluting the environment. Nutritional benefits of whey were discovered thanks to research that was forced on producers due to the high penalties for polluting the natural environment. After they were carried out it turned out to be a source of very valuable proteins, whey proteins (Brodziak et al., 2012).

The purpose of this study was to obtain cheese sauces in laboratory scale based on acid casein and test the effect of whey protein concentrate (WPC80, 2-8%) on texture (hardness, adhesiveness, cohesiveness and springiness), viscosity and water activity of the obtained product.

The use of various concentrations of whey protein concentrate (WPC80) had an impact on the physicochemical properties of obtained cheese sauces. As the WPC80 whey protein content increased, there was also observed an increase in hardness, adhesiveness, cohesiveness (2-6% WPC80), springiness (2-4% WPC80) and viscosity. The water activity of the tested product remained at a similar level.

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Acknowledgements

HARDWARE-IN-THE-LOOP CONTROL OF A SMALL-SCALE THERMAL SYSTEM

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The development of the solar systems is highly speeded up in the recent years. For that reason, a lot of experiments were carried out and several prototype systems were built. Generally saying, it is expensive to build a full-scale physical system to do experiments. With the help of the computer-aided modelling methods these costs can be reasonably reduced.

The model-based design is a possible way to resolve this issue. This designing method uses mathematical models and the simulation of them to reduce the cost and the time of the development. This approach is useful to analyse and develop an existing solution, as well. The extension of the model-based design is the hardware-in-the-loop (HIL) simulation, where real-time data is used as an input of the model, is achieved by using embedded systems and sensors. The "hardware" part can be either FPGA devices or more commonly embedded systems, such as Arduino or Raspberry Pi. There are two main approaches to make a HIL simulation, where the simulation runs on a host machine and the embedded system acts like an input. In this way, a complex simulation can be built without the hardware limitations of the embedded system. The other method is where the whole simulation runs on the embedded system, and this way the system becomes portable, but it requires more advanced hardware.

The examined system contains two Fused Deposition Modelling (FDM) printed peristaltic pumps to control the flow rate of the working fluid, which is water. The control ability of the system means to change the speed of the pumps by the stepper motors through A4988 stepper driver-boards. The controlled parameter is the temperature of the user-output of the heat storage measured by PT1000 sensors. The heat storage unit is a polypropylene plastic bucket insulated by roof insulation material with a built-in brass coil, which is used to exchange heat between the storage and collector loop. The collector is modelled by an electric heater unit that can precisely dose the energy representing the solar thermal energy input. The consumption of the user is represented by a heat exchanger equipped with a fan. The connection between the system and the control computer is granted by an Arduino Mega board.

Currently the On-Off and the PID controlling algorithms were tested with the setup explained in this study.

The presented simulations were performed using a custom-made Simulink library called SimSolar software, which provides a block-oriented modelling environment.

OPTICAL EFFECTS OF WATER DROPS AT PHOTOVOLTAIC MODULES

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Due to the challenges of environmental protection and the depletion of conventional energy sources, electricity generated from solar modules getting more and more prominent. The efficiency of solar modules is influenced by many factors. For example, the purity of the solar module is also significant. Self-cleaning coatings are a novel solution for cleanliness of solar modules. These nanotechnology thin layers often use the lotus effect. The water droplet which gets on the hydrophobic coating, in addition to helping to remove dirt, also affects the optical properties of light coming to the surface. The present study is related to the latter effect.
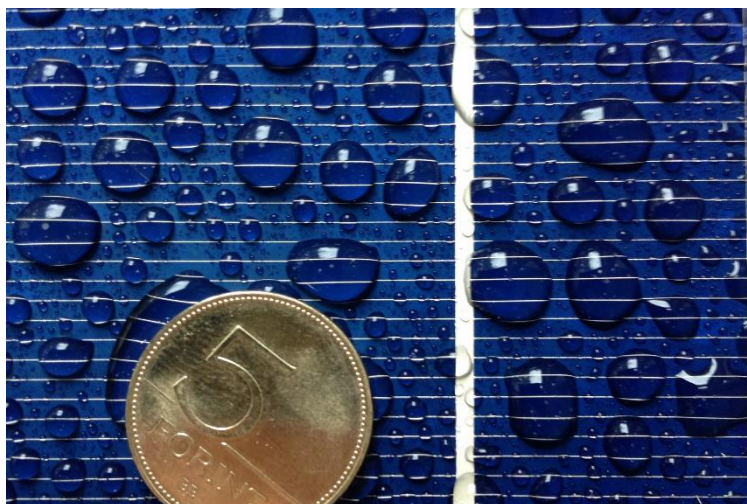
The sunlight coming through the water drop makes the uneven illumination of the solar panel, as it acts as a collecting lens, in some regions it increases intensity and in other places it decreases. At the same time, the water drop leads some of the reflected light back to the surface of the solar module, thus it having an anti-reflexive effect. This work examines these two effects.

A heavily modified version of a raytracer-engine, written in C++, was used for the determination of quantitative results. The model describes the refraction and reflection using Snell's law and the intensity of the light beams, based on the Fresnel equations. The simulations examine the light intensity on the horizontal solar module surface, in case of several contact angle, depending on the angle of incidence of the sunlight. For example, if the water drop spherical on a horizontal module surface and the light arrive with high incidence angle, from the reflected light can be traced back to the surface up to 40%. The detailed results are shown in the presentation.

The results near used for examining the intensity conditions of wet solar modules, can be used for determination of the optical effect of the water droplets in plant leaf or human skin as well.

Acknowledgements

FAST ORIGINALITY CONTROL OF PRODUCTS BY DSC METHODS

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The contribution deals with the possibilities of use one of the most common methods of thermal analysis – differential scanning calorimetry (DSC) in the fast originality control of products. Differential scanning calorimetry provides information on endothermic or exothermic processes in the material and information on thermal stability of material at the same. Experimental results, in graphical form – DSC curves, allow identification of processes running in the materials, changes of physical and chemical properties and the conditions under which they take place.

The present work deals with DSC study of food (pure olive oil and mixture of olive and sunflower oil) and of technical liquids (pure coolant and mixtures with distilled water). Monitoring of crystallisation and melting behaviour and enthalpy of transitions is provided by differential scanning calorimetry (DSC) (Wagner, 2013). Based on the results of DSC analysis temperature interval of samples thermal stability is defined, as well as comparison of crystallisation and melting behaviour including enthalpy of transitions of individual samples (pure olive oil and mixed with sunflower oil and pure coolant and mixtures with distilled water).

It is concluded that the pour point of the mixtures is shifted in proportion to the percentage of added sunflower oil. In case of technical liquids (coolant) it was observed that the pour point slowly increases with percentage of distilled water. Obtained results prove that application of DSC method is promising tool for detection of olive oil adulteration with sunflower oil (Chiavaro et al, 2009). DSC method allows fast originality control of technical materials, for example coolant, as well.

Investigation methods and used experimental equipment are presented in the paper more in details. Research of thermal behaviour of bio-materials and technical liquids by DSC methods was provided in the Laboratory of Physical Properties of Raw Materials and Foodstuffs (Research Centre "AgroBioTech" of Slovak University of Agriculture in Nitra).

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FACTORS REGULATING METHANE CYCLE IN AGRICULTURAL SOIL

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The greenhouse effect is a very important occurrence affected by an elevated concentration of gases with strong infrared absorption (CO_2, CH_4, N_2O). The increase in the temperature on our planet causes a number of negative phenomena like ocean warming, permafrost melting and changes in all ecosystem activities.

Soil is an environment which plays a significant role on methane management as this ecosystem may be source (due to methanogenesis) and sink (due to methanotrophy) of this gas. Both processes have a strong effect on the atmospheric CH_4 concentration and thus, on the global warming on our planet.

The rate of both processes depends on soil physical and chemical properties (texture, temperature, air-water conditions) and factors which may be changed by agriculture practices (pH, salinity, C/N ratio). Also the activity of both processes depends on the intensity of this human interference. The applied agricultural treatments i.e. plant protection products, fertilization (mineral, organic), type of cultivation (plough, zero-tillage) or meliorations may change the methanotrophy and methanogenesis in soils. In addition, their microbiological activity is also influenced by heavy metals, which can be introduced into soils (and accumulate) together with applied fertilizers. Their effect depends on the applied dose.

In consequence, agricultural soils exhibit lower methanotrophic / methanogenic activity than natural ecosystems.

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FLEXION-ROTATION ANGLE OF THE NEW MODEL OF THE KNEE PROSTHESIS IN ADAMS PROGRAM

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In the case of normal flexion or extension of the human knee joint, the local kinematics of the patellofemoral joint can be characterized as partial rolling and sliding. This particular movement is under the control of the connecting femoral tibial surfaces and the connecting ligaments. The precise ratio of the sliding-rolling phenomenon throughout the active functional arc of the knee is currently unknown, although it is commonly accepted by the early works of (Zuppinger, 1891) and (Braune et al., 1904) that up to 20-30˚ of flexion angle rolling is dominant, while beyond these angles the roles invert, and sliding becomes prevailing.

The sliding-rolling ratio between the femoral and tibial condyles throughout the active functional arc of the knee (20-120º of flexion angle). Since wear is the most determining lifetime factor of the current total knee replacements, the presence of sliding-rolling cannot be neglected. The reason lies in the fact that this phenomenon causes different material abrasion compared to pure sliding or rolling alone. Only a limited amount of studies have dealt with this question related to the condyles of the knee prostheses, most of them by means of experimental tests and only in the segment where the motion begins (0 to 20-30º).

The primary aim of this paper is to compare the Flexion-rotation angle changes, between the five different knee prostheses in the functional arc of the knee (20-120º) and new model of prosthesis geometry. For the analysis, numerical simulations were carried out using the MSC.ADAMS program system.

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