

# BPS 2018

17<sup>th</sup> International Workshop  
for Young Scientists  
„BioPhys Spring 2018”

## BOOK OF ABSTRACTS

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Nitra, Slovakia



Ministry  
of Science  
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Republic of Poland



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17th International Workshop for Young Scientists

„BioPhys Spring 2018”

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**Conference Organisers:**

Slovak University of Agriculture in Nitra

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## **INTRODUCTION**

Dear friends and colleagues,

It is my privilege and great pleasure to welcome you on behalf of organising institution – Department of Physics of Slovak University of Agriculture in Nitra – at the 17<sup>th</sup> International Workshop for Young Scientists "BioPhys Spring 2018" in Nitra.

Seventeenth year of the BioPhys Spring workshop – that definitely means successful tradition of scientific event for young people. The workshop combines two basic tasks of international meeting: exchange of professional experience and integration of young people from different countries. Beginning of the workshop is dated in the year 2002 when the first BioPhys Spring workshop was organised in Prague under the authority of professor Blahovec and professor Horabik. The name of the workshop indicates its main orientation to physics in life systems – it represents wide topic of physical properties and processes occurring in biological, agricultural and food systems and includes application of physical methods in agriculture, biology and/or life sciences.

Let me cordially welcome young scientists at the BPS 2018 Workshop who will present results of their research in the area of the main and related topics.

The workshop is organised as an opened English spoken event without any fee. One (or two pages) page abstracts of contributions is published in this Book of Abstracts of the BPS 2018 Workshop. Full Papers will be published after reviewing process in the Proceedings of the BPS 2018 Workshop with intention of registration in the Web of Science database. Full papers can be also submitted for publication to the scientific journals: International Agrophysics, Acta Agrophysica, Research in Agricultural Engineering, Scientia Agriculturae Bohemica or Acta Technologica Agriculturae.

It is my pleasure to welcome you to spend a few days of May 2018 in friendly atmosphere between young people in Nitra.

**Vlasta Vozárová**

Chairman of the Organising Committee



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## SOME PROCESS PARAMETERS AFFECTING THE DENSIFICATION OF OLEAGINOUS BIOMATERIALS

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### ABSTRACT

Studies were conducted to investigate certain parameters which influence the course of densification of oleaginous biomaterials with a view to understanding these processes. Responses were evaluated using the method of the analysis of variance. All the factors studied had significant effects on mechanical response during the densification of the compressed material. Time rate of deformation had highly significant effect ( $p < 0.001$ ) on mechanical response. Material deformation, induced strain and specific energy demand correlated negatively with the time rate of deformation. The effect of the aspect ratio on deformation, specific energy demand and modulus of deformation was also significant ( $p < 0.001$ ). As the aspect ratio increased, deformation increased significantly and this resulted in significant reductions in specific energy demand. Repeated induction of compressive stress significantly improved achievable deformation and specific energy demands ( $p < 0.001$ ). The higher the number of compression cycles, the higher was the deformation and energy demanded. The lower the pressure ratio at the oil point, the wider was the margin for expenditure of energy. For multiple cycle densification schemes, therefore, it is possible to enhance performance through careful consideration of the pressure ratio. These parameters provide basis for optimising the performance of single and multi-cycle biomaterial densification schemes.

### CONCLUSIONS

Some parameters involved during the densification of oleaginous materials, namely the time rate of deformation, aspect ratio, repetitive induction of strain and the pressure ratio were investigated with a view to determining their influences on the course of densification. Higher degrees of deformation are favoured at lower rates of induction of densification and higher equipment aspect ratios. This means that large capacity presses are more efficient than those with lower capacities. Repeated induction of strain enhances scheme performance by allowing for thorough working of the processed material. The pressure ratio is an important indicator of the available margin for the expenditure of energy during a compression cycle.

### ACKNOWLEDGEMENTS

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## DESIGN AND EVALUATION OF A DRYING CHAMBER

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### ABSTRACT

A drying chamber (the dryer) has been designed and evaluated with five trays for different products items. The drying cabin dimensions are 50 cm × 50 cm × 100 cm length, width, and height, respectively. Dryer walls have been made from polystyrene, except the front wall of the chamber, which was made from 4 mm plastic glass sheet for observing. The five trays made from plastic nets and fixed with 10 cm distance between them. The dimensions of every tray are 38 cm × 40 cm length and width respectively.

The chamber is integrated with the solar collector by a small duct (indirect drying), then the exit heated air from the collector enters the chamber with high temperature and low humidity. The moist and hot air rises and escapes from the upper vent of drying chamber. Inlet and outlet of drying chamber have a diameter of 10 cm with a small slop angle for the upper side of the chamber to keep the smooth movement of the air. All air leakages from drying space was closed totally, as much possible. The product sample, which used through this study is apple. Apple selected as a sample because of its high initial moisture content and its high maximum allowable temperature. The initial moisture content and maximum allowable temperature for apple during drying process are 80% (wet base) and 70 °C respectively (Sharma et al., 2009).

The constructed drying chamber integrated with solar air collectors and mounted to the South on an iron simple frame. The system designed, manufactured and installed in the open laboratory area of Department of Physics and Process Control, Szent István University.

### CONCLUSIONS

Based on the evaluation of the measurements it has been stated that the helical fins increased the standers solar collector efficiency by about 6%. It means that such kind of construction can be advised to use.

During the experiments performed, after 5 hours drying period of 2 kg apple slices, the final weights were 1.16 kg and 1.37 kg by using horizontal and vertical finned solar air collectors respectively.

### ACKNOWLEDGEMENTS

This work was supported by the Mechanical Engineering Doctoral School at the Szent István University, Gödöllő, Hungary.

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## ANALYSIS AND CHARACTERISATION OF SOLAR PV MODULES WITH DIFFERENT TECHNOLOGIES

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### ABSTRACT

Solar PV power production is increasing continuously as a result of the various regional, sub-regional and country renewable energy policy schemes. Other factors accounting for this rise are the impact of technology development, reduction in cost and environmental concerns.

The characteristics of PV modules are provided by manufacturers after they have been tested and calculations made on them indoors under standard test conditions. These parameters under outdoor conditions and depending on climate conditions as well as the location may vary. It is therefore important to establish the quantity of PV energy modules will produce under real operation condition and specific location.

The aim of the study is to conduct a performance assessment and characterisation on different kinds of photovoltaic (PV) module technologies in the city of Gödöllő in Hungary and ascertain the behaviour of the real operation of the modules in outdoor conditions. The modules include amorphous silicon, monocrystalline silicon, polycrystalline silicon, transparent monocrystalline silicon module.

In characterizing the modules, measurement of their characteristics were performed. Moreover, the various meteorological parameters such as irradiance, temperature and humidity were also obtained using the G.U.N.T equipment. The performance parameters such as performance ratio, energy yield and efficiency are given and analyzed. The temperature of the module is also estimated and evaluated against experimental values.

### CONCLUSIONS

According to the experimental results the different photovoltaic technologies were compared and evaluated. Finally a suggestion is going to be made for the most appropriate technology working under the given radiation and other environmental conditions.

### ACKNOWLEDGEMENT

This work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

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## ANALYSIS OF COLLECTIVE ELEMENTARY EXCITATIONS IN SOLAR ELEMENT MATERIALS

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### ABSTRACT

It is well-known, 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 such condensed matter systems (Milosevic and Damnjanovic, 2010). One of the most successful mathematical techniques from this point of view is related to detailed application of the abstract-, and representation theory of discrete quasi-one-dimensional (Q1D) systems, also known under the name of line groups, representing a genuine mathematical background for successful structural investigation of polymers by diffraction methods for decades. 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, 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 line groups have not been applied. Earlier, we had demonstrated, that this open, very rapidly developing area of the symmetry theory of condensed matter systems may be of importance at accurate descriptions of the exciton-type collective modes, too (Kirschner et al., 2010). In the present work we describe in detail some further possible and very promising applications of this mathematical technique relevant for chain-type molecular systems, which may contribute to understanding and increase of the energy transformation efficiency in solar energetics. After a detailed investigation of some fundamental general orthogonal symmetry properties of incommensurate condensed systems, the line groups are applied for describing the complete structure of such modulated crystal structures. It is also demonstrated, that use of projective representations of these groups may lead to more refined descriptions of such very complex structures and significantly extends applicability of the diffuse scattering formalism, too. Finally, some of the newest available modelling results of collective elementary excitations in carbon-nanotubes are compared to our ones, and the possible future applications are also indicated.

### CONCLUSIONS

The selection rules relevant for discrete infinite Q1D systems must be incorporated into the quantum-statistical formalism of excitons propagating through molecular crystals. Taking into account the well-known structural properties of carbon-nanotubes, and other non strictly - crystallographic type condensed matter systems, which are able to scatter incoming electromagnetic waves coherently, it is necessary to extend the whole above-discussed formalism to quasi-two-dimensional (Q2D) (i.e.: layer-type-) systems, too.

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## DEPENDENCIES OF TIME-TEMPERATURE AND SHADING FOR PHOTOVOLTAIC PANELS

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### ABSTRACT

Photovoltaic is one of the most usable technologies from renewable energy sources (Rusirawan – Farkas, 2012). Due to the fact that solar energy is available everywhere and the efficiency of photovoltaic panels is gradually increasing. It is now possible to buy panels with an efficiency of around 24%. Čorba et al. (2009), Milićević et al. (2012) described the possibilities of photovoltaic system application. Nowadays is photovoltaic the current topic in our country because Slovakia is committed to producing 20 % of energy from renewable energy sources in year 2020. The construction of photovoltaic systems is supported by the state as part of the project “Green households”. There are many factors influencing the performance of photovoltaic panels for example: external temperature, temperature of photovoltaic module, wind speed, reflected radiation, shading etc. This article describes two important factors that negatively affect the power of photovoltaic cells. In the first part, a partial shading of the photovoltaic panel was simulated. This measurement was done in Physical Laboratory in the Agrobiotech. The measuring instrument consisted of the monocrystalline photovoltaic panel Suntech STP 045S-12/Rb with an efficiency of 12.6 %, halogen lamp with the J500-118 lightbulb, two multimeters Metex ME-31 which was used one as voltmeter and one was used as amperemeter. Impact of shielding was measured by two different procedures. Used photovoltaic panel consists from 12 cells. In first part of measurement the electric voltage and electric current were measured in the unshaded panel, and then one photovoltaic cell was covered and the electric parameters were measured. During second part was gradually covered the cells of photovoltaic panel. Then the power of unshielded and shielded panel was compared. In both measurements, the influence of partial shading on PV performance was identified. The performance dropped by 86.15 %. The bypass diode can be used to avoid this rapid drop in performance.

In the next part of article is presented the thermal model of photovoltaic system and combined model of energy transfer processes, which could be described by differential equation (1).

$$C_{PV} \frac{dT_{mod}}{d\tau} = q_{LW} + q_{SW} + q_{conv} - P \quad (1)$$

The solution of Equation (1) represents temperature changes of photovoltaic module and also influence of selected external factors. The temperature of PV module could be described by next formula (2):

$$T_{mod}(\tau) = \int_{\tau_0}^{\tau} C_{mod} [\sigma \varepsilon T_{mod}^4 + \alpha \Phi S_{mod} - h_c S_{mod} (T_{mod} - T_{amb}) - P] d\tau \quad (2)$$

where  $\sigma$  - is Stefan-Boltzman constant and  $\varepsilon$  - is emissivity,  $\alpha$  - is the absorptivity of cell surface,  $\Phi$  - is the total incident irradiance on module surface and  $S_{mod}$  - is the area of surface,  $h_c$  - is heat transfer coefficient,  $T_{mod}$  - is temperature of PV module,  $T_{amb}$  - is ambient temperature (Jones and Underwood 2001). From model is evident that there are many physical quantities which have important influence on photovoltaic module temperature, in our case was examined and modelled the coefficient of convective heat transfer  $h_c$  because there is direct effect on temperature.



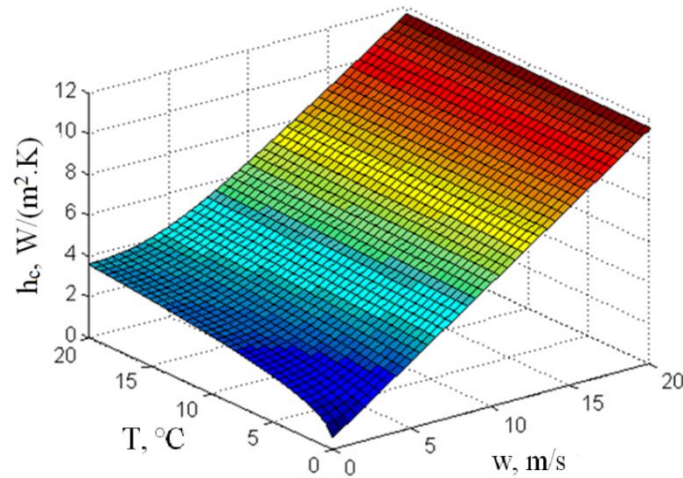


Fig. 1 Relation between coefficient of convective heat transfer, temperature and wind speed

In figure 1 is shown modelled relation between coefficients of convective heat transfer  $h_c$ , temperature of PV module in the temperature range from 0  $^{\circ}C$  to 20  $^{\circ}C$  and wind speed in the range from 0  $m \cdot s^{-1}$  to 20  $m \cdot s^{-1}$ . From graphical dependencies is evident that relation of convective heat transfer coefficient  $h_c$  to the temperature has nonlinear shape.

## CONCLUSIONS

From experimental results is clear that the photovoltaic system is not always installed in a place where it cannot be shaded. Shading is considered to be one of the factors that negatively affects the performance of photovoltaic panels. The measurement results confirmed this claim and the exact percentage drop of power was also determined. One of the possible solutions of this problem is usage of bypass diodes in the photovoltaic system. Presented mathematical model showed that temperature is one of the most influencing factors which has significant effect on operating parameters of PV module.

## ACKNOWLEDGEMENTS

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## APPLICATION POSSIBILITIES OF PHASE-CHANGE MATERIALS IN PV/T SYSTEMS

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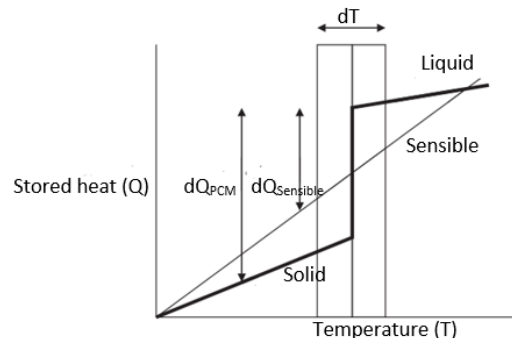
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### ABSTRACT

In photovoltaic/thermal (PV/T) systems a solar thermal collector unit is built behind the PV module that cools the PV module by subtracting its heat. Phase-change materials (PCM) initially absorb heat during the temperature increase, absorb latent heat and melt when their temperature reaches the melting temperature. The temperature of the installed phase change material does not change during the phase transformation, only stores the heat as shown in the figure (Preet et al., 2017).



In the recent work the main goal is to obtain information on the thermal conductivity of the material on the basis of the properties of the PCM material selected by using a suitable model experiment.

There are five main parameters of the PCM to determine, which are:

- specific heat,
- latent heat,
- liquid fraction (LF), which tells whether the PCM is in the liquid, solid, or in the mushy region,
- total enthalpy,
- volumetric sensible enthalpy.

### CONCLUSIONS

Based on the properties of the selected PCM material, we are making suggestions for PV/T systems to increase its electrical and thermal efficiencies.

### ACKNOWLEDGEMENTS

This work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

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## COMPARISON OF RHEOLOGICAL PROPERTIES OF NEW AND USED BIOLUBRICANTS

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### ABSTRACT

This work deals with study of physical properties of biolubricant. Physical properties – density and viscosity are measured as a function of temperature. Measurements were made under laboratory conditions with digital viscometer - Brookfield Viscometer. Viscometer is of the rotational variety. The experiments have been performed with use of ULA (0) spindle. We used densimeter Mettler Toledo DM40 to measure density. Temperature range in which both physical properties were measured is from 20 °C to 90 °C. The hydraulic fluid is of an Mol Farm Bio UTTO 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. It is used for lubrication of gearboxes, hydraulic circuits, for agricultural and construction machinery. Primary biodegradation per CEC L-33-A-93 is 90% within 21 days and test method CEC L-33-A-93 (28 days) 91 %. (Majdan, 2011). 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 10<sup>6</sup> cycles at the end of the test.

### CONCLUSIONS

Generally speaking, temperature dependency of dynamic viscosity which we presented is in accordance with theory and published data. All regression equations that we obtained are of Arrhenius type. Viscosity of biodegradable oils is determined by International Standard ISO 3448. Thermal treated sample has lower values than new sample of UTTO. This difference can be seen in determination coefficient and regression equation. The determination coefficients for all the samples are very high, which also confirms strong exponentially decreasing dependence. Density linearly decreases with temperature of oil. Experimental results have shown that temperature is one of the essential factors which have an influence on material properties and processes running in the researched material.

### ACKNOWLEDGEMENTS

This work was supported by the project KEGA 017SPU-4/2017 of Ministry of Education, Science, Research, and Sport of the Slovakia and by European Community under project no 26220220180: Building Research Centre „AgroBioTech“ and by GA SPU I-17- 010-00.

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## MICROPOROSITY OF PODZOLIC SOIL WITH BIOCHAR

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### ABSTRACT

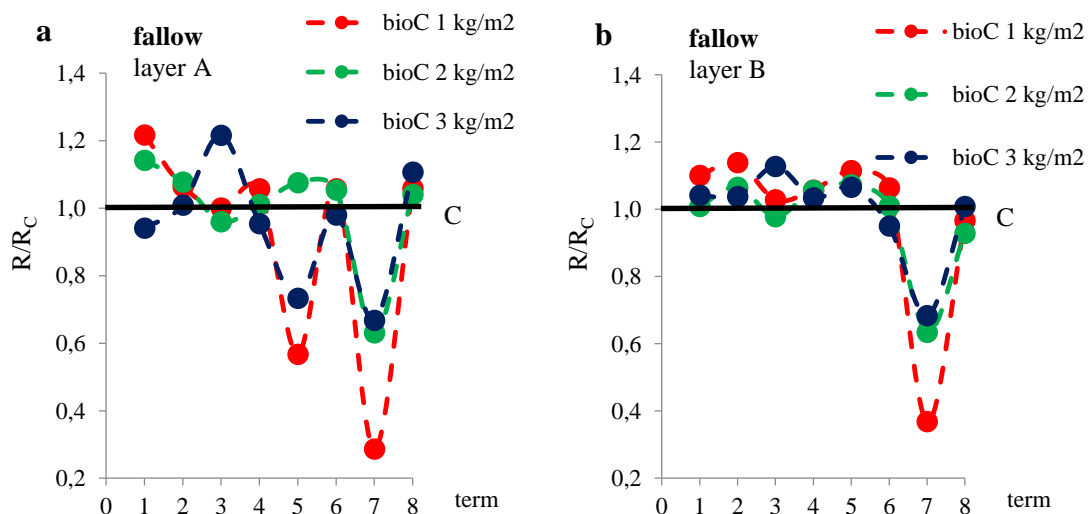
A soil porosity and pore – size distribution characterize its pore space, that portion of the soil’s volume that is not occupied by solid material. It is a single – number quantification of the amount space available to fluid within a specific body of soil (Nimmo 2005).

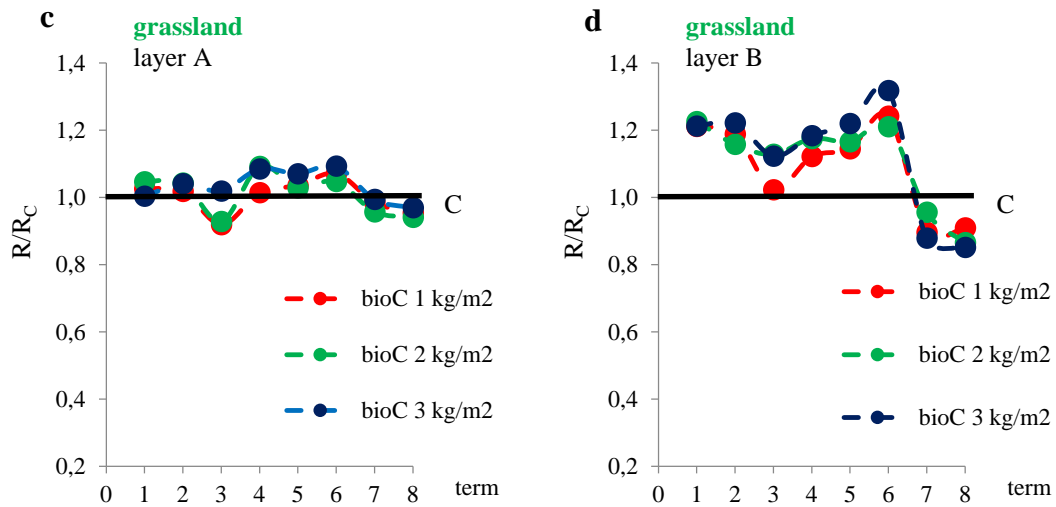
The microporosity of soil depends on several factors including: packing (bulk density), the breadth of the particle – size distribution (polydisperse versus monodisperse), the shape of particles, cementing materials and soil organic matter. Soil micropores and organic matter cannot be considered as separate, independent entities. Micropores of different size, shape and continuity are created by abiotic factors (e.g. tillage and traffic, freezing and thawing, drying and wetting) and by biotic factors (e.g. root growth, burrowing by earthworms) (Kay and van den Bygaart 2002).

The aim of the experiment was to analyze the biochar effect on microporosity of podzolic soil. Biochar is a carbon – rich product obtained from pyrolyzed biomass, during the heating under oxygen limited conditions (Jindo et al. 2014). The studies were conducted on a Haplic Luvisol derived from loess. Biochar used in the experiment is a commercial product – Biochar FLUID made by FLUID S.A. company (Poland). Biochar was applied to the soil sub – plots under fallow and under grassland in the amount of 0 (control), 1, 2 and 3 kg/m<sup>2</sup> of soil. Soil samples were taken three times per year during 2013 – 2015 from layer A (0 – 20 cm depth) and layer B (20 – 40 cm depth).

The micropores size distribution was determined from the desorption isotherms of water vapor at the relative pressure from  $\sim 0,35$  to  $\sim 0,97$  p-p<sub>0</sub><sup>-1</sup>. The relationship between the average radius of the micropore and the pressure was given by Kelvin equation (Schneider and Goss 2012).

Relative changes in the average radius of the micropore in Haplic Luvisol with biochar is presented on the Figure 1.





**Fig. 1.** Relative changes in the average radius ( $R$ ) of the micropore in Haplic Luvisol with biochar. **C** – control, **term**– term of sampling

## CONCLUSIONS

High microporosity of biochar makes it more effective in the formation of the texture and structure of soils, compared to other types of soil organic matter (van Zwieten et al. 2011). The values of the average radius of the micropore in soil changed significantly after biochar addition through the experiment. However, these changes were not proportional to the dose of applied biochar (Fig. 1a and 1b).

In the case of the surface layer of grassland, the biochar addition did not affect significantly on the relative values of the average radius of the micropore. In the deeper layer (in terms  $t_1$  –  $t_5$ ), an increase in the value of the examined parameter was observed, probably due to the displacement of organic matter, characterized by a higher degree of dispersion, into the soil profile.

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## PV PANEL WITH INTEGRATED LI-ION BATTERIES

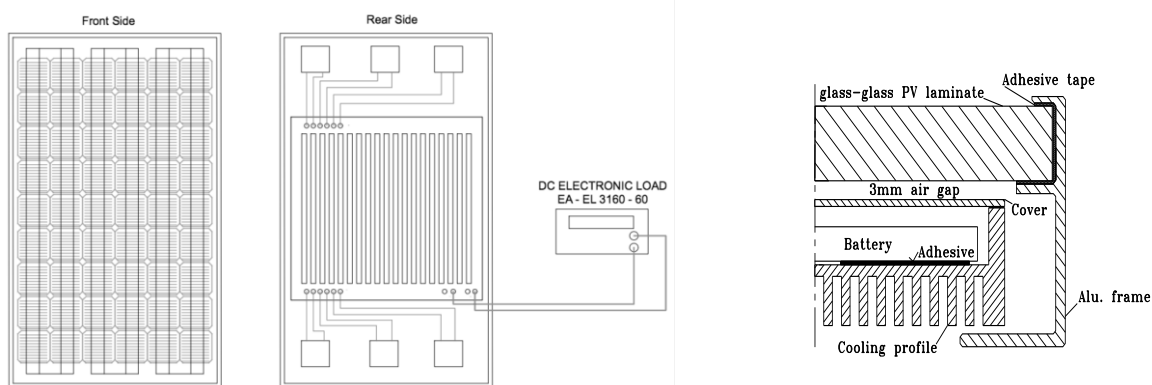
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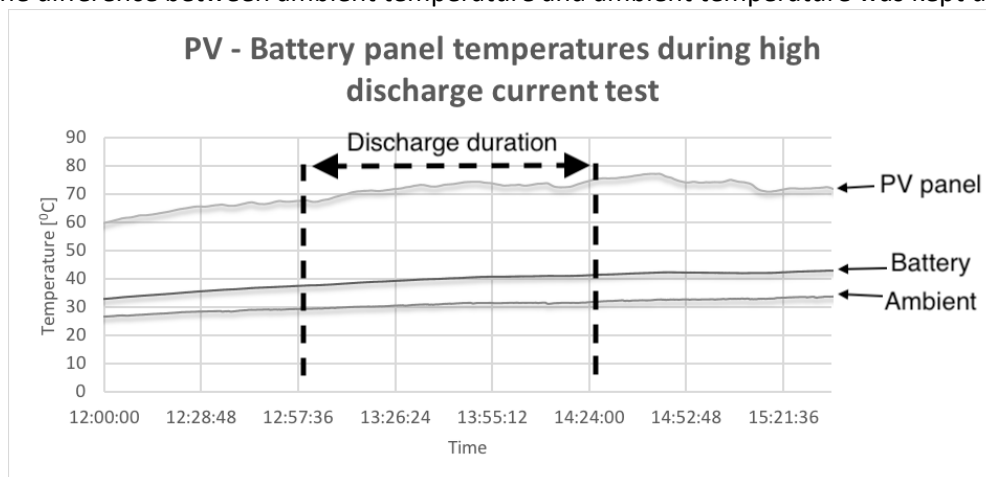
### ABSTRACT

Solar power system develops rapidly nowadays; however, due to the intermittent of solar radiation the storage system is essential to ensure constant energy supply. In the CULS we develop a compact concept (PV-battery panel) to integrate prismatic Li-ion battery (6x NCM 40Ah) to the back of PV panel (glass – glass with polysiloxane encapsulation). The passive cooling method is designed to dissipate the heat from the battery during operation to guarantee the safety of Li-ion battery. The combination of polysiloxane encapsulation and heat sink allow the PV-battery panel to operate in high temperature environment with minimal installation work and losses by wiring. The PV-Battery panel is then placed on a fixed mounting system with azimuth 0° and till angle 30°. Thermal sensors were deployed to record the temperature of PV panel, Li-ion battery, heat sink and ambient.

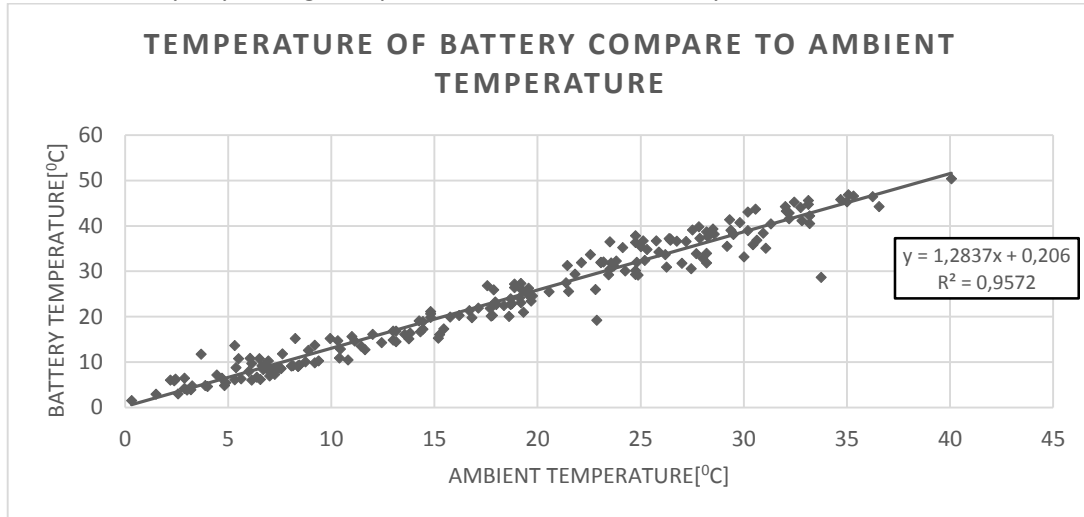


**Figure 1 Construction of PV – Battery Panel**

In order to examine the thermal behaviour of the PV-battery panel during high discharge current from the battery, on June 22<sup>th</sup> 2017 the DC electronic load EA-EL 3160-60 was used to discharge from the battery with discharge current 1.5C. The temperatures of PV-Battery panel were recorded as the chart below. The difference between ambient temperature and ambient temperature was kept under 10°C



Next experiment is long term monitoring for thermal behaviour of PV-battery panel from June 21<sup>st</sup>, 2017 to January 4<sup>th</sup>, 2018. During this period the battery is discharge with small current 1/40C for 8h during the night by a LED. The maximum temperature of battery and maximum temperature of ambient from every day during that period was taken out a study the correlation between them.



## CONCLUSIONS

The PV-battery panel is and compact design, which allows user to minimize their effort for installing and maintaining system. At the same time the PV-battery provide an independent power supply with storage capacity for off-grid and remote situation. The thermal behaviour of PV-battery from the high discharge current experiment and long-term monitoring show that the battery temperature would never higher than ambient temperature 28%. This means with maximum allowed temperature of battery is +65°C, the maximum allowed ambient temperature for safely using PV-Battery panel is 46.8°C. Further experiment with higher discharge current of battery during higher ambient temperature is preparing and will be conducting to gather more data about PV-battery panel thermal behaviour.

## ACKNOWLEDGEMENTS

This work was funded by Czech University of Life Sciences and company Solarmonitoring, Ltd.

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## ENERGY ANALYSIS OF BRIQUETTES FROM SOME BIOMASS MATERIALS UNDER COMPRESSION LOADING

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### ABSTRACT

This paper investigates the energy demand of briquettes produced from crushed sunflower stalks and crushed hazelnut husks under compression loading. In compression loading, the material is compressed in a vessel of known diameter with a piston (Fig.1a) under a universal compression-testing machine (Munson-Mcgee, 2014; Herak et al., 2010). In this preliminary experiment, three vessel diameters of 60, 80 and 100 mm, the maximum compressive force of 400 kN, constant speed of 5 mm/min and sample initial height of 60 mm were examined. The force-deformation curve of the biomass materials is shown in Fig.1b. The area under the curve is the energy, which was determined using Eq. 1. (Akangbe et al., 2017; Demirel et al., 2017; Divisova et al., 2014; Herak et al., 2012).

$$E = \sum_{n=0}^{n=i-1} \left[ \left( \frac{F_{n+1} + F_n}{2} \right) \cdot (x_{n+1} - x_n) \right] \quad (1)$$

where  $E$  is the deformation energy (J),  $F_{n+1} + F_n$  and  $x_{n+1} - x_n$  are the values of the compression force (N) and deformation (mm),  $n$  is the number of data points and  $i$  is the number of subsections of the deformation axis (-). The biomass materials briquettes from the compression test are shown in Figs. 2 and 3 respectively.

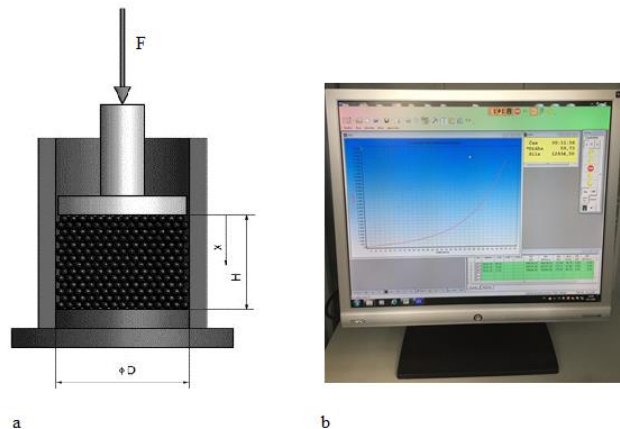


Fig.1 (a) Schematic of vessel diameter, (b) Force-deformation curve of biomass materials

Based on the compression test results, crushed hazelnut husks briquettes required more energy than crushed sunflower stalks briquettes. For all vessel diameters at the maximum force and minimum speed; sunflower briquettes indicated deformation values of 55.61, 62.06 and 56.78 mm while the energy values were 1234.55, 1522.83 and 1694.18 J. On the other hand, hazelnut briquettes recorded deformation values of 51.86, 48.54 and 42.08 mm and energy values of 1664.07, 1993.73 and 2296.89 J respectively. The thickness values of sunflower briquettes were 11.12, 12.45 and 12.75 mm while that of hazelnut briquettes were 19.85, 19.29 and 23.38 mm.





Fig.2 Crushed sunflower stalks briquettes of diameters 60, 80 and 100 mm



Fig.3 Crushed hazelnut husks briquettes of diameters 60, 80 and 100 mm

## CONCLUSION

In this paper, a summary of the preliminary results is highlighted. Determining the energy demand for producing biomass briquettes under compression loading is a step towards designing the optimum technology for large-scale production as an alternative approach to meeting the rapidly increasing energy requirement of the increasing population.

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## OVERVIEW OF SOLAR PV INDUSTRY WORLDWIDE

Farkas István

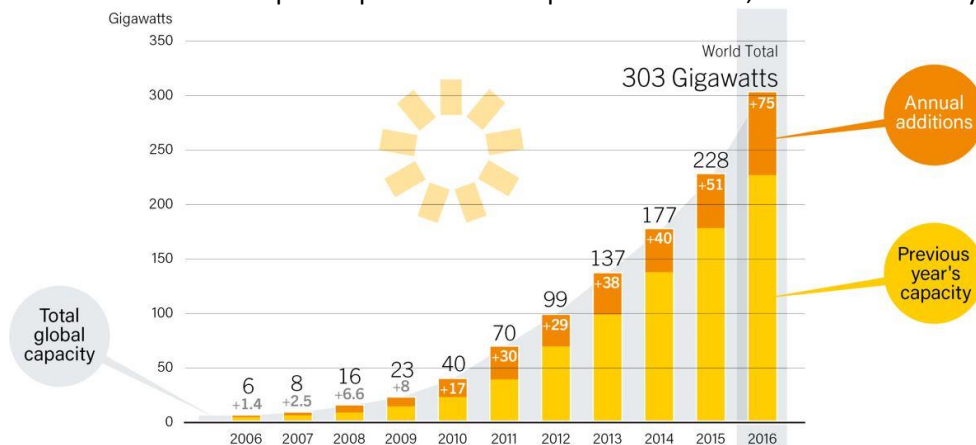
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### ABSTRACT

This paper gives an overview of the solar energy application fields worldwide, specifically related to the photovoltaic technologies. The new trends and technologies are also analysed and providing information on the solutions methods and approaches. Several examples are also given.

In spite of the recent economic situation all over the world a significant yearly increase of photovoltaic module production and their installation were performed in last couple of year period. However it can be observed sensitivity of the market change on the photovoltaic industry, the PV technologies still show increasingly high priority.

The solar photovoltaic global capacity (reaching 303 GWpv in 2016) and the annual additions worldwide are indicated in the following figure for the period 2006-2016 (Renewables 2017). In 2016, the increased amount of 75 GWpv is equivalent to the production of 31,000 modules every hour.



Just making a comparison of the different total renewable energy capacities in operation and their produced energy in 2016 along with their the growth rate of for the period of 2010-2016 it can be easily justified the increasing importance of the solar photovoltaic technology (Weiss et al., 2017).

### CONCLUSIONS

Due to the growing market demand of the solar photovoltaic applications several new specific issues came to the light. These factors include new type of modules along with wide range application of thin film technologies, colouring of the modules, transparency of the modules, extra size of modules and new type of fixation systems. The priority of the use of PV installations is obvious as electric power generation is basically required.

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## THE GELATION PROCESS OF SODIUM CARBONATE-SOLUBLE PECTIN FROM APPLES INFLUENCED BY PECTIN CONCENTRATION

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### ABSTRACT

Pectins belong to natural polysaccharides used in pharmaceutical and food industry mainly due to its gelling ability. Different factors have an influence on the gelation process. The low-methoxy pectins gel at pH=2-6 and in the presence of cross-linking agents (for example  $\text{Ca}^{2+}$ ) whereas the high-methoxy pectin gels are formed at pH<3.5 and high sugar content. However, the low-methoxy pectins may form a gel also in the absence of divalent ions (Gilsenan, Richardson, & Morris, 2000).

The aim of this study was to characterize the gelation process of sodium carbonate-soluble pectin (DASP) in the absence of cross-linking agents and at increasing pectin concentration. This pectin fraction was obtained as the result of sequential extraction according to the procedure by Cybulska, Zdunek, & Koziół (2015) with some modifications. The pH measurements and determination of parameters such as aggregation index, relative mean hydrodynamic diameter, electrophoretic mobility and electrolytic conductivity were executed. Structural changes of pectin fraction with an increase of pectin concentration were evaluated on the basis of atomic force microscopy images.

The pH measurements and theoretical calculations showed differences in hydrogen ion binding probably caused by hydrogen bonds formation. On the basis of analysis of aggregation index, relative mean hydrodynamic diameter, electrophoretic mobility and electrolytic conductivity, the values of gel point were determined. Even at the pectin concentration of 0.00005 % the macromolecules aggregation was observed. An increase of concentration above 0.01 % influenced a decrease in the aggregation index caused by pectin network extension. Atomic force microscopy images showed structural changes of pectin fraction during the gelation process. Typical amorphous gel structure occurred above the DASP concentration of 0.1 %.

### CONCLUSIONS

Pectin concentration had a significant influence on the gelation process of sodium carbonate-soluble pectin. Analysis of pH changes indicated that hydrogen bonds could be involved in this process.

### ACKNOWLEDGEMENTS

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## IMPACT OF APPLE POMACE ADDITIVES TO SOIL ON GROWTH OF BROAD BEAN

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### ABSTRACT

The development of global fruit industry generate enormous quantities of wastes. Exogenous organic matter (EOM) is organic material of biological origin. Post-harvest residue, fruit waste, manure as well as compost may be successively used as a EOM. EOMs can potentially contribute to the increase of soil fertility, with their effect being modified by soil conditions, agrotechnical treatments and climatic conditions. The use of EOM in agriculture is a method of recycling organic waste and promising way to increase organic matter content in soil and replace synthetic fertilizers (Malý and Siebielec 2015). One of the solid biomass waste obtained during the processing of apples is “apple pomace” (AP). Fruit wastes are well known as a good source of polysaccharides, vitamins, carbohydrates, minerals and even phenolic compounds with antioxidant properties. AP might be used by microorganisms as a substrate for the production of enzymes and organic acids (Bhushan et al. 2008). It also should be noted that AP could be a valuable source of exogenous organic matter. However overall impact of AP on plant growth conditions may be dependent on alterations in soil nitrogen transformations and resulting its availability for plants.

In this study we used AP as soil additives to evaluate its impact on the growth faba bean (*Vicia faba*). The conditions during the plants growth were as follows: day and night temperatures 24°C (14 h) and 18°C, photosynthetic active radiation 116  $\mu\text{mol photons m}^{-2} \text{s}^{-1}$ , and relative air humidity 60%. Plants were growing in PCV cylinders with a diameter of 10 cm and a height of 40 cm, filled with the soil to obtain the bulk density 1,5 g/ cm<sup>3</sup>.

- optimum soil water potential (SWP) throughout the whole grown period without apple pomace;
- optimum ( SWP) with addition of apple pomace;
- soil drought stress ( DS ) without apple pomace;
- soil ( DS) with addition of apple pomace.

Exogenous organic matter (apple pomace) was applied to the soil through mixing with soil form 0-10cm depth in a dose equivalent to 20 tons of fresh mass per hectare. The impact of AP on soil nitrogen and plant growth was evaluated at two soil moistures, optimum soil water availability and moderate soil water deficit. Water deficit conditions were induced by reduced watering starting from 18th day of plant growth.

As a result of applied AP substantial alterations in soil nitrogen were observed. Photosynthesis rate and plant biomass were not significantly differentiated by AP addition. Drought stress decreased biomass of root nodules, however the effect was less pronounced in soil with AP.

### CONCLUSIONS

Addition of apple pomace caused decrease of nitrogen bioavailability for plants. Addition of exogenous organic matter to the soil had no impact to plant growth in both objects independently of water availability.

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## FORECASTING MINIMUM AND MAXIMUM AIR TEMPERATURE USING COMBINED TBATS AND SVM METHODS

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### ABSTRACT

By modelling and forecasting of meteorological time series it is possible to improve understanding of the weather dynamics and fluctuations as a result of climate change. The most frequently used forecasting models are exponential smoothing, ARIMA models (Box and Jenkins, 1970), state-space models (Harvey, 1989) and innovations State Space Models (Hyndman et al., 2008).

The aim of this study was to check the effectiveness of the coupled TBATS and Support Vector Machines (SVM) model, supplied with some measured meteorological quantities to forecast air temperature in a several years' period for four climatic localizations in Europe.

The study was calculated in four locations from northern (Jokioinen in Finland), central (Dikopshof located in the west part of Germany and Nossen in the south part of Germany) and southern (Lleida in Spain) Europe to present different climatic conditions. Jokioinen city has a subarctic climate that has severe winters, with cool and short summers and strong seasonality. Lleida has a semi-arid climate with Mediterranean. Dikopshof represents maritime temperate climate. There are significant precipitation throughout the year in Dikopshof and Nossen. In the study we study on air temperature dataset collected on a daily basis from January 1st 1980 to December 31st 2010 (11322 days).

The performance of TBATS and SVM models for forecasting minimum and maximum air temperatures series was evaluated. It was noted that TBATS model could only successfully capture the seasonality of the mean temperature, whereas SVM could additionally model the diurnal variations observed in the data (but only if the seasonality captured by TBATS is considered as input). Extended SVM/TBATS model, except from measured air temperature data in the period preceding the prediction period, as inputs also uses other meteorological quantities available in the period of predicted air temperature. In this sense it cannot be treated as a pure forecast, but it may be used as a method to fill the gaps in the data.

### CONCLUSIONS

The precision of prediction of the maximum and minimum air temperatures strongly depends on the dynamics of the weather conditions, therefore varies for different localizations in Europe. For localizations with strong seasonality within the air temperature time series the prediction accuracy improves.

The lengths of the testing and especially learning sets have a considerable impact on the precision of prediction. In addition, the position of the learning data sets within the analysed time series in relation to the modelled testing sets influenced the models' performance.

### ACKNOWLEDGEMENTS

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## SELECTED PROPERTIES OF CHOSEN VEGETABLE OILS

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### ABSTRACT

Oils extracted from plants have been used since ancient times and in many cultures. The production process of vegetable oil involves the removal of oil from plant components, typically seeds. This can be done by mechanical extraction using an oil mill or chemical extraction using a solvent. Then the extracted oil can be purified and, if required, refined or chemically altered. Many vegetable oils are consumed directly, or indirectly as ingredients in food and oils can be heated and used to cook other foods. Vegetable oils consist of triglycerides (Rafiq et al., 2015).

Properties of different vegetable oils were examined by many authors: comparison between physical properties and chemical composition (Stedile et al., 2015); electrical properties of pumpkin seed oil (Prevc et al., 2015); etc. Vegetable oils are also used as an ingredient or component in many manufactured products: as additives in biodegradable films and coatings for active food packaging (Atarés and Chiralt, 2016); usage on rejuvenation of aged asphalt binders (Chen et al., 2014); bounding of masonry units (Heaton et al., 2014); etc. In many cases are vegetable oils used as alternate fuels or lubricants: chemical composition and physical properties, its ignition and combustion behaviour after injection (Emberger et al., 2015); fuel properties, engine performance and emission characteristics of biodiesel (Ashraful et al., 2014); as a fuel in burners (San José et al., 2015); etc.

In this article were compared densities and dynamic viscosities of sunflower and olive oils in approximate temperature range (5 – 35) °C. Results can be presented as temperature dependencies of mentioned quantities. From obtained results is clear that dynamic viscosity is decreasing exponentially with temperature, which is in accordance with Arrhenius equation (similar conclusions by Thomas et al. (2015)). From measured values can be seen that dynamic viscosity of olive oil is higher than for sunflower oil, which could be caused by different composition of oils. Values of density were decreasing linearly with temperature in this temperature range (same dependency by Thomas et al. (2015)). Density of sunflower oil was higher than for olive oil due to different composition of oils. Similar results for sunflower oil were obtained by Emberger et al. (2015), San José et al. (2015), and for olive oil by Tanilgan et al. (2007).

### CONCLUSIONS

Food materials are very complex in their composition and in their physical properties. These properties depend on the manipulation, external conditions and other factors, which determine their behaviour. Effect of temperature on measured samples of vegetable oils was searched and comparison of used vegetable oils was made. Temperature dependencies of vegetable oils dynamic viscosity can be characterized by decreasing exponential functions, which is in accordance with Arrhenius equation. Linear decreasing functions were applied at temperature dependencies of oils density in this temperature range. We found out that values of dynamic viscosity for olive oil were higher than for sunflower oil, which could be caused by different composition of oils. Due to the same reason were density values lower for olive oil.

### ACKNOWLEDGEMENTS

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## ELECTRICAL PROPERTIES OF VALUE-ADDED PASTA AND LINZ BISCUITS

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### ABSTRACT

Thanks to consumers' demand for healthier food, the food industry directs its development of new products to the area of functional foods and ingredients, thereby creating new value-added foods (Pasqualone et al., 2014). Samples of food materials, namely pasta and Linz biscuits were provided by the Department of Storing and Processing of Plant Products.

The control sample of pasta had the following composition - wheat flour, water, salt and egg. A control sample of Linz biscuits was prepared from the following ingredients: wheat flour, vanilla, butter, water, egg, sugar, bicarbonate soda. In both cases, added-value samples were made by adding nettle (*Urtica dioica* L.), carrot (*Daucus carota sativus*) and fruit elderberry (*Sambucus ebulus* L.) with a content of 3 %. The samples were ground, their chemical composition and dry matter content were determined. All measurements were carried out under an air temperature of 20 °C and of 60 % relative humidity. Bulk density was determined by the mass of constant sample volume. Low-frequency electrical properties of paste and biscuits were measured by an instrument GoodWill Instek LCR meter 821 at different frequencies from 0.1 kHz to 200 kHz using four-electrode (tetra polar) system.

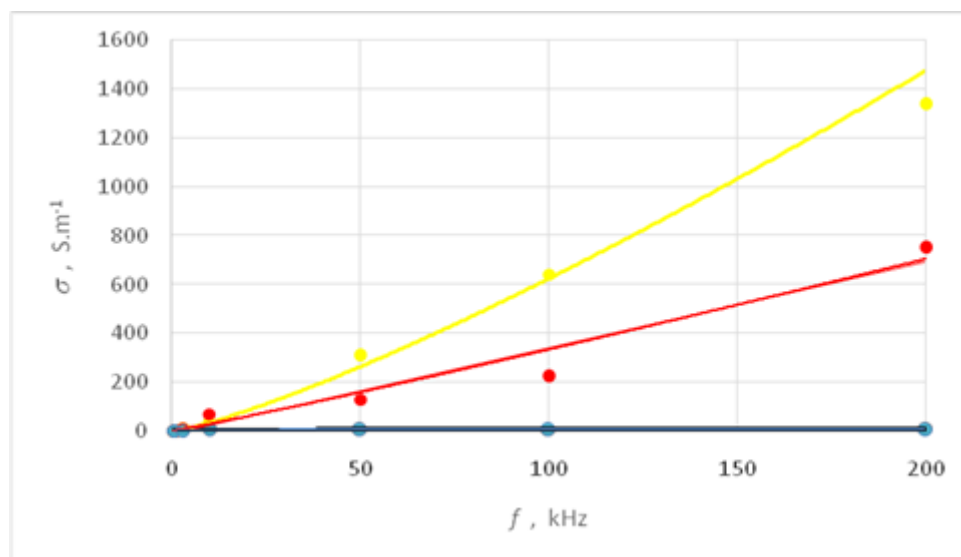


Fig. 1 The conductivity of pasta samples versus frequency

(● a control sample, ● a sample of pasta with carrot, ● a sample of pasta with an elderberry, ● a sample of pasta with nettle)

The sample was placed in the sensor with parameters: diameter of electrode 37.8 mm, electrodes spacing 49.2 mm, mass of empty sensor 208.89 g. The conductivity was calculated from values of resistance. For illustration, on Fig. 1 the conductivity versus frequency curves are shown for various



pasta samples. The frequency dependence of pasta conductivity was approximated by the power regression equation in the form:

$$\sigma = \sigma_0 \left( \frac{f}{f_0} \right)^k$$

where:  $\sigma$  – conductivity,  $\sigma_0$  – reference value of conductivity,  $f$  – frequency,  $f_0 = 1$  kHz. This frequency dependence also applies to other types of food (Sahin and Sumnu, 2006).

We found out that the resistance, impedance, and resistivity decrease with frequency according to power function. The change of these electric properties at low frequency is significant, compared to the higher frequencies. On contrary, the conductivity increases. The sample with elderberries has the highest values and the lowest ones are for control sample of pasta and sample with nettle. The measurements indicate that samples of pasta and biscuits must be included in the most complex objects. Its are organic heterogeneous multi-component semiconductors or dielectrics.

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## PRESSURE DISTRIBUTION IN BULK OF SEEDS IN A SHALLOW MODEL SILO

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### ABSTRACT

Undefined degree of mobilization of interparticle frictional forces precludes accurate determination of static pressure distribution in storage silos. Numerical simulations appear promising tool to fill this gap.

Experiments were conducted to determine the effect of the filling method, the seed size and its aspect ratio on the radial distribution of vertical pressure on the bottom of a model silo of 0.6 m in diameter and 0.6 m high. Construction of the bottom of the silo of five concentric rings allowed for determination of radial distribution of the tangent stress within the material. Three filling methods were applied: central, circumferential and distributed. Experiments were performed with rapeseed, wheat, horse beans and field pea seeds. Vertical pressure on the bottom of a shallow bin was found to be influenced by the filling method, the seed size and the aspect ratio. Wall friction was mobilized in the highest degree in the case of the central filling and in the lowest degree in the case of the circumferential filling.

The Discrete Element Method (DEM) simulations were performed with spherical particles or near ellipsoidal shape clusters of 2, 3, 5 and 7 spheres to reflect equivalent aspect ratio of horse bean ( $\alpha = 1.48$ ) and field pea ( $\alpha = 1.22$ ) seeds. Assembly consisted of 40–54 thousand particles in the case of horse bean seeds and 100 to 116 thousand particles in the case of pea seeds, depending on the number of spheres composing a particle.

Comparison of the results of DEM simulations with the experimental data indicated qualitative agreement of the vertical pressure on the silo bottom and the radial distribution of the shear stress in bulk of seeds.

### CONCLUSIONS

1. DEM predictions of radial distribution of vertical pressure on the silo bottom qualitatively agree with experimental data.
2. The radial profile of the normal pressure on the bottom of a shallow silo may be constant, increasing, or decreasing depending on the particle shape and filling method. Consequently, the radial profile of the shear stress  $\tau(r)$  in the bulk of particles follows linear, convex, or concave relationships, respectively. Central and distributed filling of non-spherical particles generated convex and concave  $\tau(r)$  relationships, respectively.

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## TECHNOLOGIES FOR OIL EXTRACTION FROM OIL-BEARING PLANT SEEDS – A REVIEW

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### ABSTRACT

This paper explores the available technologies for edible and non-edible oil extraction from oil-bearing sources. In the oilseed processing industry, mechanical screw pressing and solvent extraction are most commonly used methods for expressing oil from oilseeds (Karaj and Muller, 2009; Mrema and McNulty, 1985; Deli et al., 2011). Mechanical screw pressing results in lower oil yield compared to solvent extraction (Pradhan et al., 2011; Uitterhaegen and Evon, 2017). However, their combination enhances oil recovery with less residual oil in seedcake (Kartika et al., 2010). Cleaning, dulling, flaking, cooking among others are the unit operations performed prior to oilseed processing (Singh and Bargale, 2000; Williams, 2003). Historical and modern pressing systems, as well as innovative technology for recovering the oil, are reviewed.

### CONCLUSION

It is important to be abreast with the new approaches or technologies for oil expression from oilseeds and to know what further research is needed in this area.

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## PERFORMANCE ANALYSIS OF A SEMITRANSSPARENT MODULE PV SYSTEM

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### ABSTRACT

Among the renewable resources, the direct solar electricity production by photovoltaic (PV) energy is spreading with exponential growth even in Hungary. Now, PV systems are deployed in spite of the lack of governmental support. As the PV system prices are marketable, the development of these type systems can be afford by a reasonable arte of the households.

At this stage of the technology spreading, beside the price and the technical properties, the aesthetic point of view, the outlook of the system is an influencing factor. Partly this was the reason why our department decided to develop a PV system from semitransparent PV modules. Beside the aesthetic viewpoint, the transparent PV technology can be interesting for special applications, where the transparent part of the natural light is important. This can be interesting for the human areas (e.g. for covering atrium), but surely it will have importance for covering greenhouses.

In front of the Aula building of our campus a transparent PV system was installed last summer. The location of the system was willfully chosen to a central, easily visible place, as our other systems are almost in hidden places, for instance in the roof of the student hostel. For this case, that we try to bring the new photovoltaic technology close to the students.

The system has the nominal power of 3,3 kWp, and consist of 2 x 10 pieces of 165 Wp Solarwatt Vision transparent modules. The modules can be seen in Fig. 1.

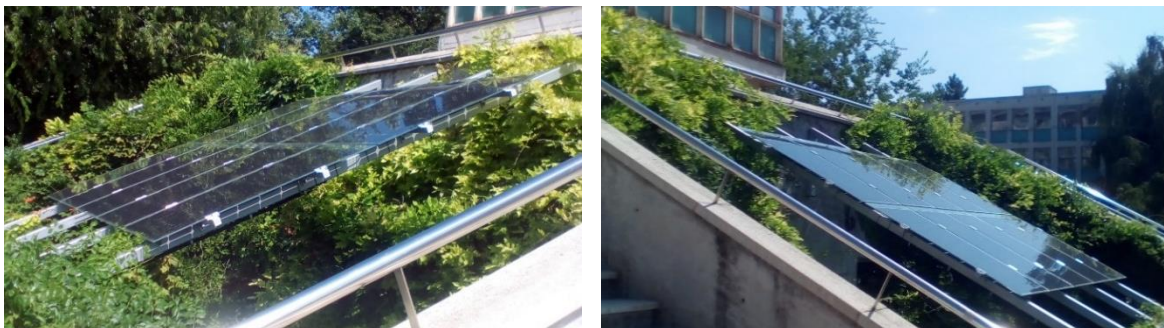


Fig 1. The installed system

### CONCLUSIONS

In the presentation the first year performance of a semitransparent PV system is introduced. First the yearly distribution of the energy production is analyzed, later the energy data are compared to the energy production data of other PV systems, operated by our department.

It can be concluded, that however the efficiency of the transparent modules are theoretically lower (because of the transparent light), the real specific energy production data is equal or in some cases higher than the same data for older non transparent systems.

### ACKNOWLEDGEMENTS

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## THERMAL AND STRUCTURAL PARAMETERS OF BIODEGRADABLE HYDRAULIC OILS

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### ABSTRACT

The biooil physical and chemical parameters were examined by many authors Conceicao et al. (2005), Guo et al. (2011) etc. They detected that biooils differ in its composition, consistency and its physical properties too. Our research was focused on identification of parameters which are necessary at defining of material's state. The article deals with thermal and rheological properties of biodegradable biooils. (BIH OIL 68 – sample No1 and BIH OIL 46 – sample No2).

For thermal parameters measurements was used Hot wire method, for detection of rheological parameters was used viscometer Brookfield DV2T LV and density was measured by densimeter Mettler Toledo DM 40. For both biooil samples were made two series of physical parameters measurements. In the first series were measured relations of thermal conductivity and thermal diffusivity to the temperature in the temperature range from 20 °C to 50 °C. The second series was focused on identification of dynamic viscosity and density in the same temperature range. Basic thermal and structural parameters were measured also for every biooil samples at constant laboratory temperature 20 °C and results were statistically processed. There were calculated statistical characteristics as: arithmetic average, standard deviation and probable error in %.

For relations of thermal and rheological parameters to temperature were obtained nonlinear dependencies. The relations of thermal conductivity and thermal diffusivity were polynomial functions of the second degree (Fig. 1 – 2). In all cases were obtained regression equations with relatively high the determination coefficients of the second degree, not less than the relevant value 0.95. For sample – BIH OIL 68 (sample No1) were detected higher values of thermal parameters than for BIH OIL 46 (sample No2). Differences between thermal parameters were caused by different chemical composition. Biooil No 1 is synthetic oil with bigger temperature range of usage – from -10°C to + 90°C and with longer time of biological degradability – 95% after 28 days. On the other hand biooil No2 has lower temperature range of usage – from -5°C to + 80°C and with shorter time of biological degradability – 95% after 21 days.

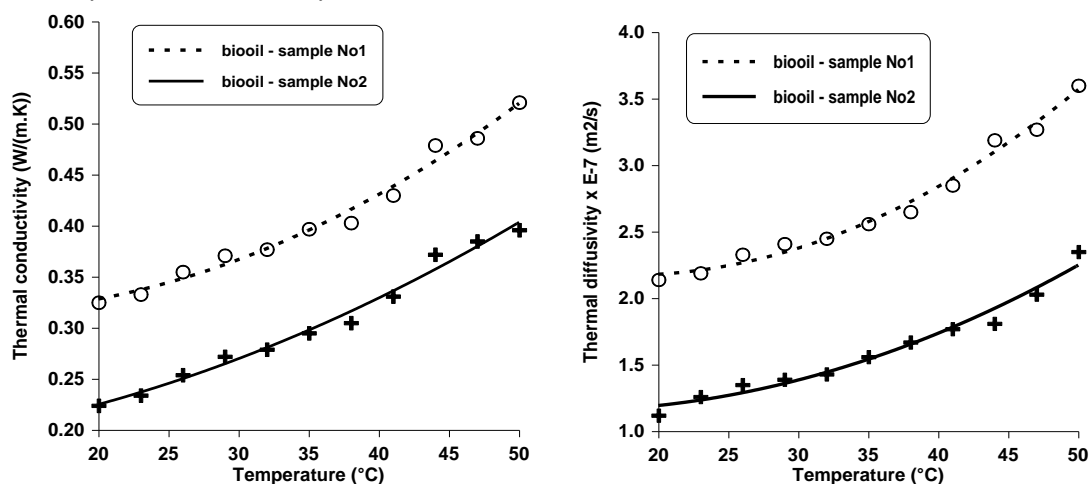


Fig. 1 – 2 Relations of thermal conductivity and thermal diffusivity to the temperature for sample – No1 BIH OIL 68 and sample No2 – BIH OIL 46

Rheological parameters and density were measured in the same temperature range (20 - 50)°C as thermal parameters. For dynamic and kinematic viscosity (Fig. 3) were obtained exponential decreasing relations, which is in accordance with Arrhenius equation presented in literature Božiková and Hlaváč (2010). Density of both biooil samples decreasing with increasing temperature linearly (Fig 4).

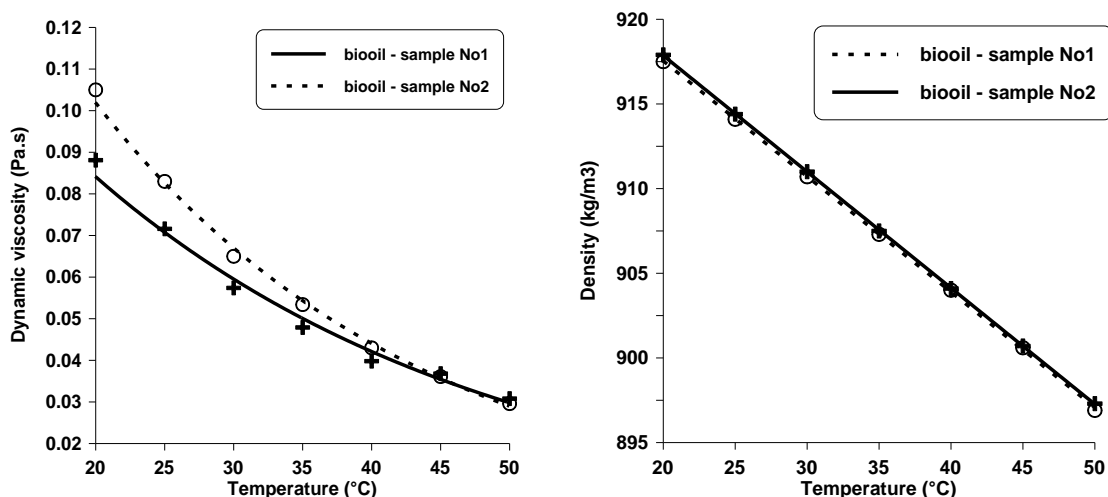


Fig. 3 – 4 Relations of dynamic viscosity and density to the temperature for sample – No1 BIH OIL 68 and sample No2 – BIH OIL 46

## CONCLUSIONS

In practice biooils are used in different temperature ranges according to way of usage. So the temperature is one of the most important factors which have significant influence on biooil behaviour. From presented results is evident that the biooil quality is not possible to describe by one type of physical parameter because important changes could be observed in other type of physical parameters. It is the main reason why is important to identify complexes of physical parameters in appropriate temperature ranges, in our case were examined thermal, rheologic and structural parameters during temperature changes. Obtained results could be relevant for biooil quality determination in context with other physical and chemical parameters.

## ACKNOWLEDGEMENTS

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## EFFECT OF THE POLYPHENOLS FROM DIETARY FIBRE PREPARATIONS ON THE STRUCTURE OF GLUTEN PROTEINS

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### ABSTRACT

Dietary fibre preparations contain polysaccharides that are not digested in the human intestine and polyphenols, which are important for health. Due to the beneficial effects on health, these preparations can be important elements of varied diet.

Polyphenols (phenolic acids, flavonoids, anthocyanins) are a large group of natural antioxidants. These compounds are regarded to have antioxidant, anti-inflammatory, antibacterial, antiviral and antithrombotic properties. They can also delay aging processes and prevent heart disease. Due to the fact that they have a large ability to pick up or inhibit the formation of free radicals, polyphenols can protect also against cancer.

A good way to introduce pro-health substances into the diet may be bread, which is a product commonly consumed. However, the addition of dietary fibre preparations to bread dough decrease the sensory quality of bread. It is related to the changes occurring in the structure of gluten proteins, which directly account for the quality of the bread.

Wheat bread supplemented with polyphenols is characterized by a higher antioxidant activity with respect to un-supplemented bread, which may indicate that the polyphenols react with gluten proteins during the mixing of the dough. This can be a result of formation of hydrogen bonds between polyphenols and groups C=O and NH<sub>2</sub> of gluten proteins (Sivam et al., 2010). This can also be confirmed by studies on the bioavailability of flavonoids after enriching the bread with onion skin. This study shows that a decrease in the antioxidant potential of phenol-enriched breads is not connected with thermal deactivation of bioactive supplements, but is mainly due to the formation of indigestible complexes with bread proteins (Świeca et al., 2013).

Supplementation of bread dough with polyphenolic compounds (ferulic, caffeic, syringic and gallic acids) causes decrease in mixing time, maximum resistance to extension of dough and bread volume (Han – Koch, 2011).

### CONCLUSIONS

Bread enriched with polyphenols is characterized by a higher antioxidant activity compared to un-supplemented bread. This property can indicate that polyphenols interact with gluten proteins and change their structure.

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## THE CAPABILITY OF COMMERCIAL SATELLITE AND UAV DATA TO PREDICT SUGAR CONTENT IN SUGAR BEET BULB

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### ABSTRACT

Despite a rapid decline in the second half of 20<sup>th</sup> century, sugar beet is still one of the main crops cultivated in the Czech Republic. Since it is a crop with high requirements for soil nutrition content, agricultural management must be planned utmost properly. Use of remotely sensed data became relatively common in agricultural practice. Technologies developed rapidly over recent decades and therefore there are plenty of options how to utilize them to analyze various soil or vegetation properties. Input data selection and their processing may be then adjusted to a particular research. Vegetation Indices are nowadays a common tool for vegetation cover evaluation based on remotely sensed data. However, there are mostly studies focused on grain yield prediction available in the scientific literature. In terms of sugar beet cultivation, there are separately beet leaves and beet bulb yield taken into account. Nevertheless, it is a percentage of sugar content in a sugar beet bulb that is crucial for farmers. Therefore, this study aimed to determine the relation between sugar content and commonly used vegetation indices. Moreover, two different kinds of remotely sensed data were utilized to derive Soil Adjusted Vegetation Index (SAVI) and Optimized Soil Adjusted Vegetation Index (OSAVI) that were both developed for evaluation of canopies with higher soil pixels contribution. Commercial satellite WorldView-3 and multispectral camera Parrot SEQUOIA carried by UAV were chosen to sense a 1.5 ha experimental plot of Crop Research Institute in Prague – Ruzyně. Input data variability was provided by 24 different fertilization managements repeated four times on 96 parcels. Indices were calculated for whole experimental plot and then averaged for each of 24 fertilization variants. For those, the percentage of sugar content was acquired as well. The correlation analysis was conducted to assess the relation between sugar content and selected indices derived from two different kinds of imagery. A negative correlation was detected at all levels of analysis. UAV data performed slightly stronger relation (SAVI -0.699; OSAVI -0.707) than satellite (SAVI -0.622; OSAVI -0.639).

### CONCLUSIONS

Based on the correlation analysis results it may be stated that there is a relation between spectral response of sugar beet leaves and a sugar content within a sugar beet bulb. The values of correlation coefficients were very close for both satellite and UAV data. However, despite the fact that multispectral camera SEQUOIA had a certainly higher spatial resolution (0.025 m/pix), indices derived from UAV data were only slightly more correlated to the sugar content than indices derived from the satellite data (1.2 m/pix). Remotely sensed data gives the information about characteristics of vegetation above the ground. This paper concluded that it is also possible to go deeper and predict one of the most desirable features of sugar beet bulb from under the ground. It is commonly known that evaluation of vegetation using spectral imaging is very effective especially because the whole process runs in a non-destructive mode. It is, therefore, possible to carry out more than one measurement; moreover, it enables the canopy to be monitored during one season. Since the



information about the percentage of sugar content is crucial for farmers in terms of potential economical income, the possibility of monitoring the vegetation and therefore also the possibility of sugar content prediction may be substantially beneficial. In addition, the analysis of two kinds of remotely sensed data also provides the information about price performance ratio. It was concluded that commercial satellite imagery provides almost same information as low-cost sensing method using UAV.

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## **GASES EXCHANGE (CO<sub>2</sub>, O<sub>2</sub>, CH<sub>4</sub>) IN CULTIVATED SOIL WITH BIOCHAR**

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### **ABSTRACT**

Soil respiration activity is determined by the consumption of O<sub>2</sub> and production of CO<sub>2</sub>. This is a particularly important indicator of soil microbial activity, because CO<sub>2</sub> emission from the soil can come from microorganisms even in 95%. Thus the consumption of O<sub>2</sub> (which is the basic substrate in aerobic respiration) in the soil is also regulated by microorganisms (Ryan and Law, 2005; Cook and Orchard, 2008). Methanotrophs are microorganisms responsible for the oxidation of methane (CH<sub>4</sub>). They commonly occur in the soil and reduce the emission of CH<sub>4</sub> to the atmosphere. On the other hand, methanogenesis takes place particularly intensively in swamps, rice fields or flood plains being one of the main source of CH<sub>4</sub>. Methane which if not used by methanotrophs, gets into to the atmosphere and contributes to the greenhouse effect (Stępniewska et al., 2012).

From this reason, the soil is considered as a one of the largest sources of greenhouse gases (GHG) on Earth. Currently, a lot of studies are aimed to reducing excessive GHG emission, especially CO<sub>2</sub> and CH<sub>4</sub> (Li et al., 2018). One of the method used more and more in agriculture which brings good results in reducing GHG level, and improving properties of soil, is use of biochar. Numerous research works confirmed the effectiveness of this way, thereto the addition of biochar in soil also brings a number of measurable benefits for soil properties and plant production (Kammann et al., 2017).

Fulfilling the global trend of research, an experiment was planned to assess the CO<sub>2</sub> emission and CH<sub>4</sub> and O<sub>2</sub> absorption (determining respiration and methanotrophic activity) in the cultivated soil with the addition of biochar at different humidity (laboratory conditions) in the context of the greenhouse effect.

In the experiment, the samples included cultivated soil and this soil with biochar addition. They were incubated for 14 days at 25°C, in two humidity variants (55% WHC and 100% WHC). During incubation the composition of the gas atmosphere of the samples was analyzed using a gas chromatograph. The physicochemical analyzes of the experimental material were also made (pH, WHC of soil and soil with biochar).

### **CONCLUSIONS**

Studies have shown a strong effect of biochar and humidity on the respiration and methanotrophic activity of the tested soil. Soil with lower humidity showed a higher respiratory activity, than the soil incubated at 100% WHC, and the addition of biochar does not significantly disturb this trend. On the other hand, the addition of biochar to the soil caused that methane oxidation was much more efficient than in soil without biochar.

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## DETERMINATION OF DIFFUSION COEFFICIENT OF THE CONIFEROUS WOOD PELLETS

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### ABSTRACT

Process of material drying is very complex field. The energy and mass transfer process take place within and on the surface of the material. The highly nonlinear processes inside drying products, non-homogenous distribution of temperature and humidity inside dryers effected great problems in the describing of the dryer process. The drying process is characterized by the pure diffusion, surface diffusion, evaporation and condensation, thermo-diffusion etc. Moisture diffusivity is the transport of matter due to the random motion of molecules. Moisture transfer within the solid porous body at the certain temperature is realized due to the different moisture content in the interior and on the surface of the solid body. The mass transfer rate by pure diffusion is proportional to the concentration gradient of the moisture content. The diffusion coefficient is the proportionality factor (Vasić – Grbavčić – Radojević, 2012).

Coniferous wood pellets produced by the company ISSA s.r.o. were used for the study. The samples had the cylindrical shape with the diameter 6 mm, moisture 10% and ash content up to 0.39%. The moistures of the pellets were measured by the moisture analyzer MAC 210/WH (RADWAG Balances & Scales, Poland). The moisture was measured as the change of the sample mass at the constant temperature 105°C during 34 minutes. The processed was simultaneously used for the measurement of the diffusion coefficient. The obtained absolute moisture of the samples was 10.18%. The heating capacity was measured by IKA calorimeter 5000 (IKA®-Werke GmbH & Co. KG, Staufen, Germany). The value reached 16.9 MJ.kg<sup>-1</sup>. The pellet bulk density was 639 kg.m<sup>-3</sup>.

According to Fick's laws (Moore, 1999) we can describe the simple diffusion by the equation:

$$\frac{c}{c_0} = \sqrt{\frac{D}{\pi h^2}} t^{1/2}, \quad (1)$$

where  $c$  is the mole concentration (mol.m<sup>-3</sup>),  $c_0$  is the initial mole concentration (mol.m<sup>-3</sup>),  $D$  is the coefficient of diffusion (m<sup>2</sup>. s<sup>-1</sup>),  $h$  is the diffusion trajectory (m) and  $t$  is the time of diffusion (s). Coefficient of diffusion was obtained as the slope of the regression equation.

### CONCLUSIONS

Determined coefficient of diffusion of the coniferous wood pellets was 2,21.10<sup>-7</sup>m<sup>2</sup>.s<sup>-1</sup>. Influence of porosity and tortuosity wasn't studied.

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## THE RELEVANCE OF PERFUME-SURFACTANT INTERACTIONS TO THE SELECTED PROPERTIES OF LIQUID DETERGENTS

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### ABSTRACT

Liquid detergents comprise a broad range of surfactant-based consumer products designed to clean various substrates or surfaces (Lai, 2006). The most common examples of these products include shower gels, hair shampoos, liquid soaps, dishwashing agents and liquid laundry detergents. The market success of a product from this category depends on many factors. Among these, the fragrance of a product is one of the most important quality features, contributing significantly to consumer preference. The fragrance compositions which are used in formulation of consumer products are complex mixtures of odorant compounds with diverse olfactory and physicochemical properties. Addition of the perfume to the liquid detergent formulation is therefore associated not only with imparting a desired scent to the product but may also result in alteration of other physicochemical and usable properties of the product, due to interactions of odorant compounds with other ingredients of the product (Jellinek, 1975).

Perfume raw materials (PRMs), when added to liquid detergents, distribute between bulk aqueous phase and surfactant micelles to the extent which depends on the properties of both surfactants and PRMs (Fan et al., 2016; Fieber et al. 2018). This in turn may result in alteration of bulk properties of the micellar solution as well as the volatilities of individual PRMs. Furthermore, PRMs may be adsorbed together with surfactants at various interfaces (Qi et al., 2018), which also leads to alteration of surface properties of perfumed liquid detergents. Therefore, the possible mechanisms of perfume-surfactant interactions in aqueous solutions and their effect on selected properties of liquid detergents, such as perfume release (Fieber et al., 2018), rheological properties (Lewandowski and Szymczyk, 2016; Tang et al. , 2017), and foaming characteristics (Kanei et al., 2005; Qi et al., 2018) are briefly reviewed. A special attention is paid to the effect of the molecular structure of PRMs on the qualitative and quantitative aspects of these interactions. Some of the physical methods of investigation of perfume-surfactant interactions are also described.

### CONCLUSIONS

Although used in minor quantities, perfumes contribute significantly to the overall cost of a liquid detergent formulations, due to their high unit prices. Nonetheless, they are used widely in these products thanks to their high impact on the overall product quality as perceived by the consumer. It is shown in this review that perfumes may also play an important role in determining various usable properties of liquid detergents due to perfume-surfactant interactions. The knowledge of the characteristics of these interactions may aid in the rational design of liquid detergent formulations and a proper selection of the fragrance for a specific application.

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## DETERMINATION OF QUANTITATIVE RELATIONS BETWEEN SAMPLE COMPONENTS BY MODIFIED HS-SPME PROCEDURE

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### ABSTRACT

The increased demand for food, pharmaceutical and cosmetic products containing natural substances such as essential oils (EOs) encourages scientists to develop of reliable and rapid methods for evaluation of plant material as main source of EOs. Most attention has recently been devoted to the environmentally friendly solvent-free sample preparation methods. Solid phase microextraction (SPME) is one of these methods. It is used routinely in the head-space (HS) analysis of volatiles in complex matrices of biological, food and environmental samples. The main limitation in standard HS-SPME application to estimate the quality of plants materials are different quantitative relations between EO components from those established by the other methods.

As is well known, the quantitative relations between volatile components obtained by the HS-SPME method depend on process conditions (i.e. extraction time and temperature, equilibrium time or sample mass). Therefore, it was decided to check if it is possible to find process conditions in which quantitative relations between components are the same as in essential oil from distillation. The experiments performed in system composed of thyme herb and Polydimethylsiloxane (PDMS) fiber demonstrate significant impact of process conditions on the quantitative relations, however, it is not possible to find the ones that allow to obtain the same relations as those established in the distillate. The results of ANOVA indicates significant differences in quantitative relations between EO components determined by both methods ( $F$  value in each case was  $>$  than  $F_{crit.}$ ). It should be noted, however, that the quantitative relations in HS-SPME procedure and direct analysis of distillate oil should be the same if the distribution constant between sample matrix/HS phase and between the HS phase/SPME fiber would be similar. Therefore, it was decided to examine the relations between the EO components in system containing the sample suspension in a liquid of the same character as SPME fiber coating. The obtained results for system composed of thyme suspension in silicone oil/PDMS fiber and their statistical analysis confirmed the lack of significant difference between the quantitative composition determined by both methods ( $F_{exp.} < F_{crit.}$ ). Commercially, many SPME fibers are available. The relatively easily accessible liquid of the same physicochemical character as the commercially available Carbowax fiber is polyethylene glycol (PEG). It was decided, therefore, to check whether in the system consisting of sample suspension in PEG and Carbowax fiber is also possible to find the same quantitative result as the one obtained for direct analysis of EO. This experimental part seems to be justified because of the differential character of interactions involved in distribution process of individual components between sample matrix/HS phase and HS phase/fiber coating in these two systems. As results from experiments for various plant materials and their statistical analysis, it was found that the same quantitative relations in HS-SPME procedure and direct injection of EO can be obtained only for low-molecular oxygen compounds.

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## INFLUENCE OF THE MAGNETIC FIELD ON THE BARE BAND STRUCTURE OF THE POLYMERS RELEVANT TO THE SOLAR CELL APPLICATIONS

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### ABSTRACT

Application of conjugated polymers is a one of the best promising way towards cheap and environment friendly solar cell technologies. Although the efficiencies of polymer-based solar cells are much lower than the silicon-based ones there are some cases when the usage of this type of solar cells mean the only practical solution.

Conjugated polymers are very interesting solar cell materials about physical processes reaching the process. Oviedo and co-workers (2017) raised up the possibility of the enhancement of efficiency applying external magnetic field. Magnetic field methods have key importance in the detection and in the analyses of photovoltaic processes in organic solar cell materials.

The basic characteristics of a given polymer is the  $E_g$  magnitude of the band gap (Cheng et al, 2009). Production of the small band gap conjugated polymers has great attention from both experimental and theoretical research works nowadays (The strategies are called by Band Gap Engineering)

Our goal is to study the bare band structure and the influence of the external magnetic field on the band gap of the most important solar cell polymers (PPP, PPV, polythiophene) in the frame of the Hubbard model continuing the Trencsenyi and co-workers method (2011) about the analysis of PPP hexagon chains. For the future plans of ours is hoped to study the platina containing polymer backbones to access the favourable triplet states (Wilson et al, 2001) in the frame of the Hubbard model using hopping terms in the Hamilton operator of the system describing the spin flip process jumping the electron between the hexagon rings.

### CONCLUSIONS

We study the magnetic field influence on the band gap and bare band structure of the most applied solar cell polymer backbones in the frame of the Hubbard model. Our studies are hoped to extend to the platina containing polymer backbones describing the spin flip process via new hopping terms in the Hamilton operator of the system.

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## CROP PERFORMANCE UNDER DROUGHT AND ACCOMPANIED ABIOTIC STRESSES

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### ABSTRACT

Drought is one of the major threats limiting crop yields in many regions worldwide. Water deficit affects plant growth and functioning at multiple levels including gene expression, biochemical metabolism and morphology (Zarzyńska et al., 2017). Increasing frequency of extreme weather events will increase the probability of exposure of crops to more than one abiotic stress. Heat and drought are the stresses that in field conditions often affects crops simultaneously (Lipiec et al., 2013). Co-occurrence of abiotic stresses is also highly probable for crops growing on acid soils that are the source of at least one persistent abiotic stress – aluminium toxicity. Strategies of plants response to combined stress may be different from that of two individual stresses. Moreover stress signalling networks of plants under action of combined stresses consist of several interacting pathways (Pandey et al., 2015). The aim of the study was to evaluate how drought perceived by wheat can be altered by one additional co-stressor: high temperature (HT), aluminium toxicity (AL) or earlier exposure to drought.

The analysis are based on results obtained in laboratory experiments with plants growing in soil columns. The stresses applied were controlled in term of duration and intensity. The system for precise measurements and maintaining soil moisture was used (Wilczek et. al., 2015).

The intensity of heat stress and drought induced similar reduction of photosynthesis, at the same time heat stress alone caused significant increase of transpiration. The reduction of photosynthesis rate due to combined action of heat and drought was stronger than a sum of the reduction of photosynthesis due to single stresses. This effect was caused by the increased evaporation that lowered soil water potential and increased temperature of leaves resulting from lower transpiration. The response of wheat to aluminium toxicity was strongly affected by specific resistance to Al. Aluminium reduced root length of sensitive cultivar (ES8) in comparison to tolerant (ET8) increasing sensitivity of the former to drought. At moderate drought significant differentiation of photosynthesis in response to growth conditions was observed only in sensitive cultivar ES8.

### CONCLUSIONS

The overall crop response to drought as affected by other abiotic stressor is difficult to predict as it depends on timing, duration, intensity, of the stressors and specie or cultivar resistance to the acting stresses. However analysis of environmental factors associated with impact of the single stresses may help in establishing general trends in the response of specified cultivar to the specified combination of the stresses.

### ACKNOWLEDGEMENTS

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## DIELECTRIC CONSTANT MEASUREMENT OF BIOETANOL

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### ABSTRACT

This work contains the results of dielectric constant measuring of bioetanol. Interest in electrical properties of biological materials resulted in engineering research in this field. The results of measurements are used for determining the moisture content, the surface level of liquid and grainy materials, in application of dielectric heating, and in many other technological processes (Hlaváčová). Electrical measurements on these materials are of fundamental importance in relation to dielectric heating characteristics. The aim of this work was to perform the measurements of dielectric constant on samples of bioetanol. Measurements were performed under variable frequency of electric field in the range from 1 MHz to 10 MHz, using Q meter with coaxial probe.

The capacitance of the testing capacitor was measured by the Q meter TESLA MB 560. By measuring the permittivity of testing capacitor, the real capacitor can be considered as a lossless capacitor connected with active resistance in a parallel or serial configuration. The substance of measurement is to determine the magnitude of capacitance and resistance of parallel or serial configuration of dielectric at a specific frequency. The Q meter was connected with the testing coaxial capacitor, which was used as a sample holder. The measurement was performed in a frequency range from 1 MHz to 10 MHz. Dielectric constant  $\varepsilon_r$  was calculated according following relations:

$$\varepsilon_r = \frac{C - C_x}{C_o} \quad (1)$$

$$C = C_1 - C_2 \quad (2)$$

where:

$C$  – capacitance of testing capacitor with a sample, F

$C_o$  – capacitance of empty testing capacitor free of interconnector capacitance, F

$C_x$  – capacitance of interconnector, F

$C_1$  – capacitance of tuning capacitor by resonance and by non-connection of testing capacitor, F

$C_2$  – capacitance of tuning capacitor by resonance and by connection of testing capacitor, F

It can be concluded that dielectric constant slightly correlate with frequency of electric field in this frequency range. The relationship of the dielectric constant and of bioetanol provides a basis for the design of many instruments and application of dielectric heating. In the future, more measurements on a wider frequency range would be desirable.

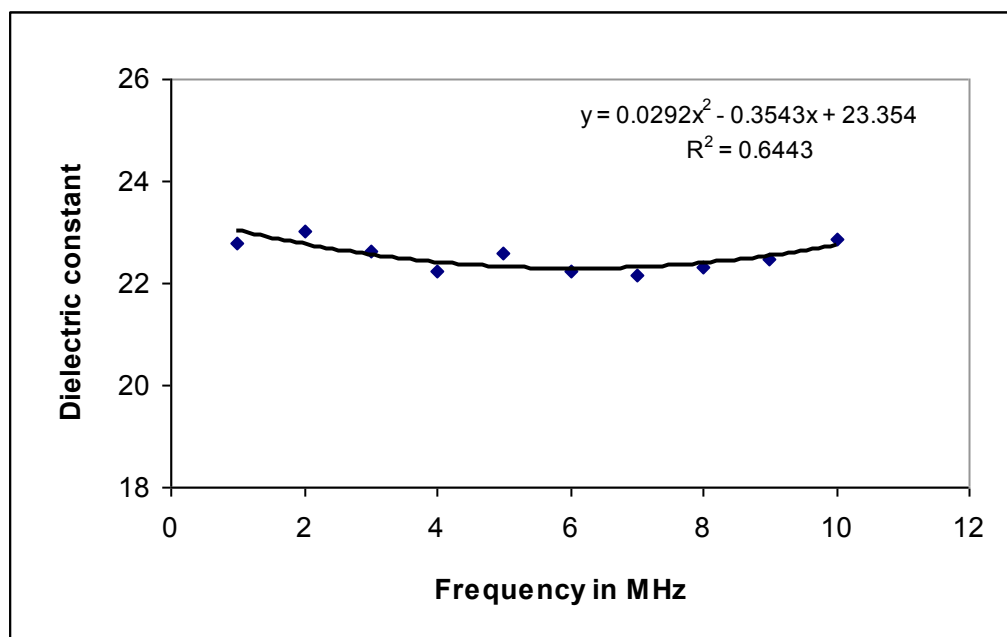


Figure 1 Dielectric constant of bioethanol in the function of frequency of electric field

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## DETERMINATION OF ACTIVATION ENERGY IN DEHYDROXYLATION REGION OF ILLITE-BASED CERAMICS BY THERMODILATOMETRY

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### ABSTRACT

During firing a ceramic body undergoes various chemical processes. These can be extensively studied by methods of reaction kinetics (Vyazovkin et al., 2011). Understanding the kinetics of reactions has practical and economical importance for industry processing.

Natural illite as a major component of clays used in production of traditional ceramics (Gaultieri et al., 2006) is studied in this paper. Extruded and machined samples of illite, from Füzéradvány of natural deposit in Hungary, are prepared by free drying at room temperature. For measurements a horizontal pushrod dilatometer with inert nitrogen atmosphere is used. Experiments are done applying a linear temperature program with heating rates 2, 5, 7, 10 and 15 K min<sup>-1</sup>. An apparent activation energy of dehydroxylation process in range of 300°C to 800°C is determined using Friedman differential method (Friedman, 1964). The temperature range is given by results of thermogravimetry and with respect to specific studies (Niето et al. 2010; Drits et al. 2007). Results indicate that reaction does not obey dominant single mechanism.

### ACKNOWLEDGEMENTS

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## PHOTOVOLTAIC PANELS DAMAGE EVALUATION

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### ABSTRACT

Photovoltaics (PV) is an important renewable energy source. It can be used for example in agriculture in the form of fixed or portable devices. However, PV panels can be affected by different kinds of damage, the most common of which are broken PV cells and interrupted connection contacts, degradation of the encapsulant, corrosion of bus bars, etc.

In broken photovoltaic (PV) cells the flow of electric current can be reduced in some places, which results in a lowered efficiency. In the present study, the damage of PV cells and panels was evaluated using electroluminescence of the PV cells. Infrared camera imaging and visual examination are possible as well, but the distinctive ability is lower. The damage is detectable by all of these methods. We present the electroluminescence in this paper. This method is very effective. The use of EL for the damaged PV panels examination was described by Kasemann et al. (2008) and Liu et al. (2016).

For the EL inspection in the near infrared spectrum, we let direct current flow into the PV panel. We used an OPX 1200SP apparatus as a power source. Pictures were taken by a cooled CCD chip CRYCAM-D camera (Crytur, Czech Republic) in a dark room. This camera is supposed to work in the visible spectrum, but it has some sensitivity in the near infrared spectrum as well. Electroluminescence could be seen thanks to long exposition (resolution 2052×1342 pixels (px)).

The PV panel EL image is given in Fig. 1. A severe damage is evident. White arrows indicate broken PV cell sections with uninterrupted contact. PV cell sections with interrupted contacts are also well visible. Parts of PV cell sections with no flow of current are black because there is no EL. Even in some undamaged sections, we can see that the density of current is not homogeneous. Lighter regions match the higher density of current.

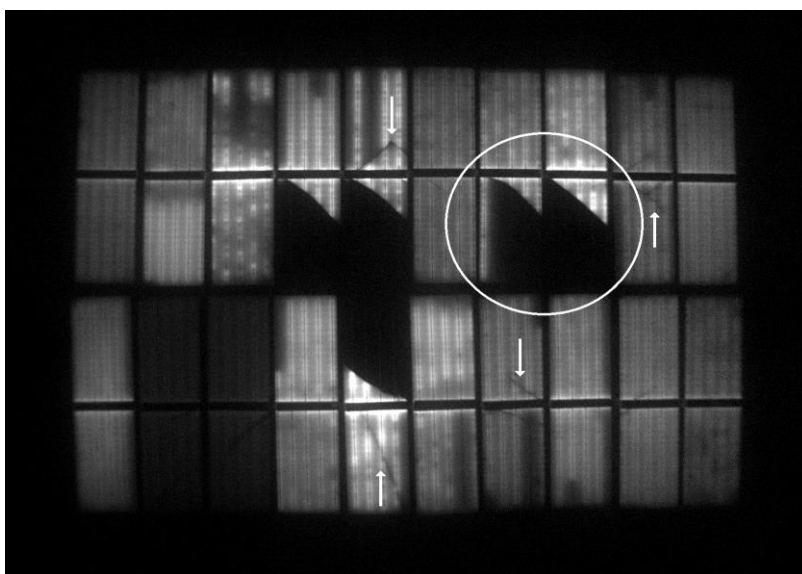


Fig. 1. Image of electroluminescence of a small damaged photovoltaic panel.

Fig. 2 shows  $V-I$  and  $V-P$  characteristic of PV panel during the autumn season with the solar radiation intensity of  $775 \text{ W m}^{-2}$ . According to this characteristic, the nominal output power  $P_{\text{max}}$  should be 1.4 W. As a result of the damage, this PV panel does not reach the above-mentioned parameters declared by its producer. The  $P_{\text{max}}$  and short-circuit current  $I_{\text{sc}}$  attain about 60% of the declared values (0.84 W and 1.08 A, respectively). In accord

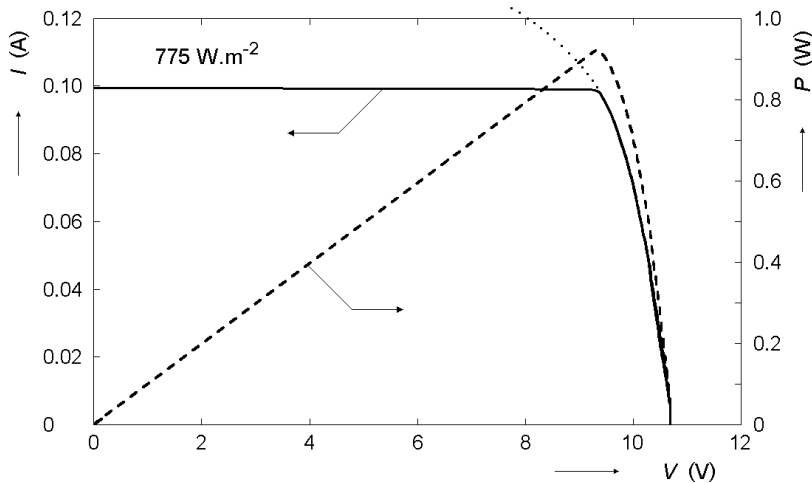


Fig. 2  $V$ - $I$  and  $V$ - $P$  characteristic of a photovoltaic panel during autumn season with solar radiation intensity of  $775 \text{ W m}^{-2}$ .

with the theory of fundamental physics, the open circuit voltage is not influenced by the damage of PV cells. The corrected ratio is  $0.84/1.4 = 0.6$ . It means that the power was reduced to 60% of the original value. Fig. 1 shows that there are totally five PV cells with the active area reduced by about 40% connected in series. It is well known that electric current in serial strings of PV cells is limited to the value showed by the cell

generating minimum current. So the power reduction of PV panel is in line with “dark” area of the solar cells disconnected from the initial string of solar cells.

Also, from the shape of the  $V$ - $I$  characteristic, we can see that current shows limitation probably because of the smallest active surface from all PV sections connected in the series. Characteristic of an undamaged PV panel would probably look like a plot growing to the higher value of the short-circuit current (approximately like the dotted line) (see Carrero et al., 2011; Munoz et al., 2011; Ding et al., 2014).

## CONCLUSIONS

To detect a damage of PV panels, the nondestructive method using electroluminescence is suitable. For the field PV panels inspection more expensive InGaAs NIR cameras sensitive in near IR and not sensitive in visible spectra are recommended. Standard EL cameras with silicone chips can be used in dark rooms only where the strong daily solar radiation “noise” is eliminated. The arrangement of the optical systems (lenses, etc.) has to be adjusted according to the real PV array layout.

## ACKNOWLEDGEMENTS

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## ISOTHERMAL KINETIC PREDICTIONS OF BIOMASS COMBUSTION

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### ABSTRACT

The growing interests of developing efficient biomass thermal conversion technologies provide the solution for current energy crisis. Nowadays, the biomass is one of the major energy sources contributing approximately 14% of the world annual energy consumption (Shen et al., 2009). Renewable energy derived from biomass reduces reliance on fossil fuels and it does not add new CO<sub>2</sub> to the atmosphere (White et al., 2011). On the other hand, due to the possibility of disruption of the bio-system balance, the combustion process must be optimized in order to ensure an effective combustion (Ondro et al., 2018). This can be achieved using isothermal kinetic predictions, from which the time depending variation of conversion degree can be predicted from non-isothermal kinetic parameters.

The results demonstrate use of isothermal kinetic predictions based on results of thermal decomposition of spruce wood published by Ondro et al. (2018). These computations are compared with thermogravimetric measurements performed using TGA/DTA analyser Derivatograph 1100° (MOM Budapest) in static air atmosphere on pellets made from residual processing spruce wood (*Picea abies*).

### ACKNOWLEDGEMENTS

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## INTRASPECIFIC METABOLIC AND GENETIC DIVERSITY OF HEAT-RESISTANT FUNGI *TALAROMYCES FLAVUS*

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### ABSTRACT

*Talaromyces flavus* is heat-resistant fungus able to survive heat-treatment during process of pasteurization and is responsible for spoilage of heat-processed food (Jesenská et al., 1993, Samson et al., 2011). *T. flavus* displays ability to produce numerous mycotoxins, and therefore presents serious threat to food safety (Proksa, 2010). These properties make *T. flavus* dangerous to food production and to consumer health. *T. flavus* was proven to be intraspecific diverse morphologically (Dethoup et al., 2007). Genetic diversity can be determined by analysis of fragments length obtained with restriction enzymes, like AFLP and RFLP, or by sequencing the DNA of studied strains. One of promising ways to determine the metabolic profile of this fungus is Biolog FF Microplate approach. The FF MicroPlate is 96-well plate coated with 95 discrete carbon sources and control well. Substrates are divided into specific groups such as: carbohydrates, amino acids, carboxylic acids, polymers, amines and amides.

The aim of the study was to analyse intraspecific genetic and metabolic diversity of environmental and reference isolates of *T. flavus*. To achieve this, we developed methods based on amplified fragments length polymorphism (AFLP) and DNA sequencing. We studied 6 reference and environmental strains isolated from soil and strawberries. To assess diversity of marker gene sequences, we sequenced D2 region of ribosomal large subunit. Moreover, we performed AFLP reactions with *Mse*I and *Pst*I restriction enzymes to determine genetic diversity. We studied metabolic diversity by performing analysis with Biolog FF Plates.

### CONCLUSIONS

Our studies distinguished two groups of organisms, one consisting of isolates from strawberries and reference strains and second of isolates derived from soil. Environmental isolates were able to metabolize sedoheptulose, while reference strains did not show this ability. The highest metabolic activity was observed with strains isolated from strawberries, while the lowest with these isolated from soil. Performed techniques for diversity studies showed similar results.

### ACKNOWLEDGEMENTS

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## EFFECTS OF FREEZING ON THE PHYSICAL PROPERTIES OF BIOFUELS

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### ABSTRACT

Biodiesel is considered to be a prominent choice for at least complementing conventional fuels (Aransiola et al., 2014). Its production from renewable sources such as vegetable oils and fats has been widely reviewed (Rahimi et al., 2014; Nautiyal et al., 2014; Banković -Ilić et al., 2014). The physical and chemical properties of any fuel are significant factors which help to decide whether the oils suitable for engine or unsuitable. In this work we conducted research on two rapeseed methyl ester samples, which is considered to be the leader in the field of biofuels in Europe. First one was frozen at -80 °C for three days and the other one was not treated in any way. Further, measurements of viscosity and density were carried out, to observe changes caused by freezing. For viscosity measurement the rotational viscometer DV2T fy Brookfield was used and densimeter Mettler Toledo DM40 for the determination of density. Temperature range in which both physical properties were measured is from 15 °C to 90 °C. Experimental results clearly confirm that both, viscosity and density decreased after freezing and defrosting of the samples. We also noticed that difference in density between samples at the beginning and at the end of this temperature range is much lower than in the middle of it. In the case of viscosity, the difference is increasing with increasing temperature.

### CONCLUSIONS

In recent time, the research on biodiesel is reaching to the peak because it is found as a good substitute to diesel than other sources. This study highlighted the physical properties under various thermal conditions. Results show that the freezing of biodiesel samples had an impact on viscosity and density. However, further research is needed to create complete picture of the effect of freezing on rapeseed methyl ester biofuel.

### ACKNOWLEDGEMENTS

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## BIOPRINTING – TECHNOLOGY OF FUTURE

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### ABSTRACT

Bioprinting has emerged in recent years as an attractive method for engineering of 3D tissues and organs in the laboratory, which can subsequently be implemented in a number of regenerative medicine applications. Currently, the primary goals of bioprinting are to (1) create complete replacements for damaged tissues in patients and (2) rapidly fabricate small-sized human-based tissue models or organoids for high-throughput diagnostics, pathology modeling, and drug development. However, there are several obstacles related to the modification of three-dimensional biomaterials. The mechanical, adhesive and physicochemical properties of polymers determine the distribution of cells, vascularization and work of the whole tissue and even the organ [1]. Therefore, the researchers undertook large-scale research on a wide spectrum of potential applications of various natural polymers, such as: cellulose, gelatin, alginate, or chitosan, and synthetic ones: polylactide (PLA), lactic and glycolic acid copolymer (PLGA), polyethylene oxide (PEG), or polycaprolactone (PCL), (Fig. 1). These polymers have been studied for changes in crosslinking properties after printing, mechanical and thermal properties, biocompatibility with living tissues as well as biodegradability [2].

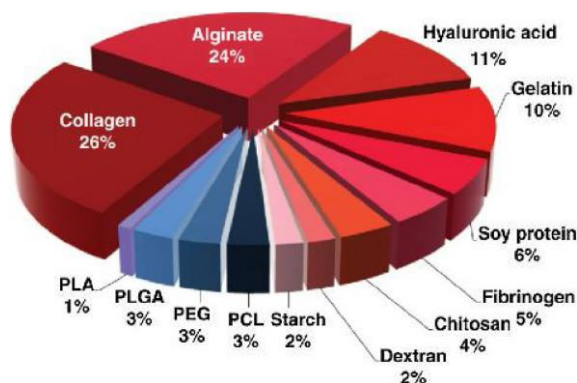


Fig. 1 Natural (red) and synthetic (blue) polymers used as matrixes in bioprinting technology [3].

This work presents general overview of the bioprinting technology and physicochemical characteristics of biopolymers and biomarkers, which are already used in this technology. Those properties that determine the potential applications include adhesion properties, support for the proliferation of cartilage cells, bones, skin, nerve tissues, and blood vessels. It will also discuss challenges related to the development of bioprinting technologies, possible innovative solutions, and the potential benefits that may be brought by the further development of this modern technique. Bioprinting is still a new field of science, although many scientific communities believe that in the future it will be possible to create fully biocompatible human organs such as: heart, liver, kidneys or artificial skin. It is estimated that in the next several years, bioprinting technology will grow to such a scale that new branches of medicine, biotechnology and tissue engineering will be created.

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## DO NOT BELIEVE TO YOUR EYE – OPTICAL EXPERIMENTS

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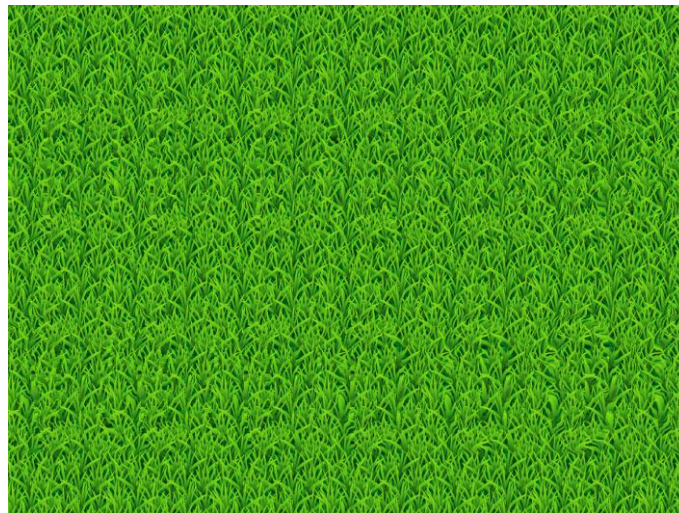
### ABSTRACT

In the conferences almost every participant present her/his research results, and for that the Prezi/Powerpoint presentation is the most common way. But we think, that among the important theoretical presentations the fun and the amusing side of the science has to be presented, as well. This is the reason why we started to present experiments from the different fields of the Biophysics, this year we plans to show optical experiments.

Our eye is our most important sense organ, most of the information is collected by the eye. In spite of the very sophisticated operation of the eye, there are a lot of tricks, how we can make it “fool”. Some experiments are connected to the natural operation of the eye. For example the colour sensing of the eye is highly relative. By changing the surrounding of an object can cause a feeling of colour change of the object. This fact makes possible for a wide range of pictures and experiments made our eye fool.

Although our eye is sensitive to the visible light (wavelength range of 380-780 nm), the neighbouring frequencies, the infra and UV ranges can be used to make very colourful experiments, we hope that we can show a few of them for you.

Numerous technical equipment uses optical methods for its operation. Some of them, which is using the polarization of the light will be demonstrated by experiments with polar filters. For example the working of the LCD screens, or the 3D vision technologies will be shown. But the 3D vision is possible without technical aid, as well. If you cannot see the 3D images of stereograms, we will try to teach it.



A stereogram, just for practicing 😊 (OK, it is easier in full page, the first solution worth a beer!)

Although the natural light (e.g. the solar radiation) has constant intensity, a lot of our artificial light-sources vibrating, their intensity change periodically in time. This can be disturbing in some cases, but it is perfect to produce real time optical illusions, where your brain is made fool, however you know, that what you see, that is impossible. We will use stroboscope with adjustable frequency for this purpose.

### ACKNOWLEDGEMENTS

This work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

## **WATER RELATIONS AND ROOT SYSTEM RESPONSE OF WHEAT TO SIMULTANEOUS DROUGHT AND ALUMINUM TOXICITY**

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### **ABSTRACT**

Plants in the natural environment are usually exposed to the simultaneous action of many abiotic stresses. Aluminium (Al) toxicity and drought stress are two major constraints for crop production in the world. On many acid soils, variability in rainfall distribution and longer dry spells during the main growing period of crops are becoming increasingly important yield-limiting factor with the change in global climate (Tang et al. 2001). It is well known that the primary site of aluminium toxicity is root system. The destroyed root system reduces the roots for exploring the acid soil to water and nutrient uptake which is particularly important under conditions of low soil moisture. Therefore the aim of our study was to determine the effect of simultaneous soil drought and aluminium toxicity on the growth and functioning of near isogenic wheat lines – characterized by contrasting resistance to aluminium toxicity. NILs are very useful for comparative physiological and biochemical studies of the function of a single gene – in this case in *alt1* gene

The experiment was carried out in controlled laboratory conditions using a system for monitoring and maintaining soil moisture, which allowed to control the intensity, time of introduction and duration of drought. Plant material were near isogenic wheat lines with different resistance to toxic aluminium ions - ET8 - tolerant and ES8 - sensitive wheat line (Delhaize et al. 1993). Measurements of root biometric measurements, root aluminium concentration and water consumption by plants allowed to assess the effect of soil drought in soil of low pH on the growth and functioning of wheat with a different tolerance to aluminium. Generally there was a very low impact of the adverse growth conditions on the total root biomass, as well as total root length of the aluminium tolerant line. However, a significant differentiation in the root biomass of aluminium sensitive line was observed in response to differences in aluminum concentration in soils. It was also found that reduced water uptake in treatments with drought resulted in increased aluminum concentration in NILs roots.

### **CONCLUSIONS**

The studies carried out showed different effects of drought in soil of low pH on the reaction of plants with different resistance to aluminium.

### **ACKNOWLEDGEMENTS**

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## PRIMING EFFECTS IN SOIL INDUCED BY POST-FERMENTATION SLUDGE AND GLUCOSE

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### ABSTRACT

Rapid development of biogas production results in increased amounts of biogas residues, i.e., a post-fermentation sludge. One possibility for utilizing such sludge is its addition into the soil, because sludge contains high levels of carbon (C) and the nutrients (N, P, K and Ca). Soils, especially managed agricultural soils with applied sludge, have the potential to store C, and in consequence mitigate greenhouse gas emissions. Iron oxide – one of the dominant metal oxides in soil – also plays an important role in C stabilization. However, there is no information about the additional effect of Fe<sub>2</sub>O<sub>3</sub> on C stabilization in sludge-amended soil. The main aim of this study was to determine how the mineralization of organic C sources occurs after the addition of post-fermentation sludge to soil, and whether it is possible to slow down or reduce the mineralization (and consequently increase C stabilization in the soil) by adding Fe<sub>2</sub>O<sub>3</sub>.

The experimental series included the incubation of soil samples with various addition/s: glucose, sludge or sludge with Fe<sub>2</sub>O<sub>3</sub>. The post-fermentation sludge, without and with Fe<sub>2</sub>O<sub>3</sub>, were added to soils at a rate of 240 mg C kg<sup>-1</sup>, and incubated for 110 days at 22 °C. Additionally, some of the soil samples received <sup>14</sup>C-labelled glucose on day 30 of the experiment. To determine changes in the soil organic carbon (SOC) turnover after the addition of post-fermentation sludge without and with Fe<sub>2</sub>O<sub>3</sub> and glucose (e.g. *priming effect*), dual <sup>13</sup>C/<sup>14</sup>C isotopic labels were successfully used.

The addition of post-fermentation sludge strongly increased the CO<sub>2</sub> emission from the soil. A δ<sup>13</sup>C analysis of the total CO<sub>2</sub> efflux revealed that post-fermentation sludge decreased the SOC mineralization. Added Fe<sub>2</sub>O<sub>3</sub> slightly increased the SOC mineralization but decreased the sludge mineralization, and therefore, increased C stabilization in soil. Glucose addition decreased sludge mineralization in the soil. Post-fermentation sludge addition induced a positive and negative *priming effect*, i.e., the acceleration or reduction of the SOC mineralization.

### CONCLUSIONS

Firstly, the application of post-fermentation sludge suppresses SOC decomposition, suggesting that its use as a fertilizer could positively influence long-term soil quality by maintaining the soil C levels. Secondly, Fe<sub>2</sub>O<sub>3</sub> addition decreases sludge mineralization, and therefore increases C sequestration in soil. Finally, the success of the <sup>13</sup>C natural abundance and <sup>14</sup>C labelling approach supports its use as an effective method of analysing various fertilization techniques with respect to soil nutrient retention.

### ACKNOWLEDGEMENTS

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## DESCRIPTION OF NATURAL ZEOLITE BY THERMAL ANALYSES

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### ABSTRACT

Zeolites are widely used material, for example in medicine, water treatment, shoe industry, agriculture and household (Lamprecht et al., 2015; Laurino and Palmieri, 2015; Polat et al., 2004). Nowadays, over 430 kinds of natural or synthetic zeolites are known. This material can be constituted by only an inorganic molecules or with addition of an organic molecules (Čejka and Žilková, 2000). In this investigation a natural zeolite from east Slovakia, Nižný Hrabovec, is used. The majority of this zeolite mineral is clinoptilolite. Moreover, the zeolite contains impurities as cristobalite, quartz, illite with mica, and albite (Vejmelková et al., 2015). Due to the zeolite properties this material has a potential for usage as an addition in building materials. For these reasons the thermophysical properties need to be examined.

Differential thermal analysis (DTA) and thermogravimetric analysis (TGA) were simultaneously performed on zeolite samples, using analyser Derivatograph 1100° (MOM Budapest). The temperature regime consists of linear heating rate 5 °C/min from 30 °C to 1030 °C.

### CONCLUSIONS

The results of TGA and DTA show that zeolite during heating has two important regions. The first region is in the temperature interval (30 – 150) °C, where mass loss of samples is ~3 wt.%, which is caused by drying and evaporation of the physically bound water from surface. This corresponds to the DTA results, where the peak with maximum temperature difference of 5.5 °C/g can be seen. The second region is in the temperature range of (150 – 630) °C where mass loss of samples is ~7 wt.%. The DTA curve shows the endothermic peak in the same temperature range. This peak presents a vaporization of the physically bound water from channels and structure transformation of matrix. Mass loss at temperature 1030 °C is 11.35 %.

### ACKNOWLEDGEMENTS

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## THE APPLICATION OF THE BET THEORY AND ARANOVICH THEORY TO DETERMINE THE SPECIFIC SURFACE AREA OF SOILS

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### ABSTRACT

Soil is a biologically active, surface layer of the earth's crust, which was created as a result of soil-forming processes such as: the action of microorganisms and climatic factors on the parent rock. It can be defined as a non-homogeneous three-phase system consisting of a solid phase, a soil solution and soil air, which remain in relation to each other in specific volume and weight ratios. The physical properties of the soil are granulometric composition, porosity, density, etc. and the physico-chemical properties are surface group content, pH, specific surface area, etc. (Petersen et al., 1996). The specific surface area is the parameter that expresses the surface area of the substance per its quantity. The specific surface area is a function of the fragmentation of mineral soil components, their composition and the content of humus compounds (Dobrzański et al., 2009).

The aim of research was to analyze the application of the BET theory and Aranovich theory to determine the specific surface area of soils. Experiment materials were Haplic Podzol (developed from loamy sand) and Haplic Luvisol (developed from loess material), which was taken from the A-horizon (0-20 cm) in the locations of Sobieszyn and Felin (Lublin voivodeship, Poland). The adsorption isotherms of water vapor were measured by gravimetric method and the specific surface area was obtained in agreement with the Polish standard method (PN-Z-19019-1, 1997).

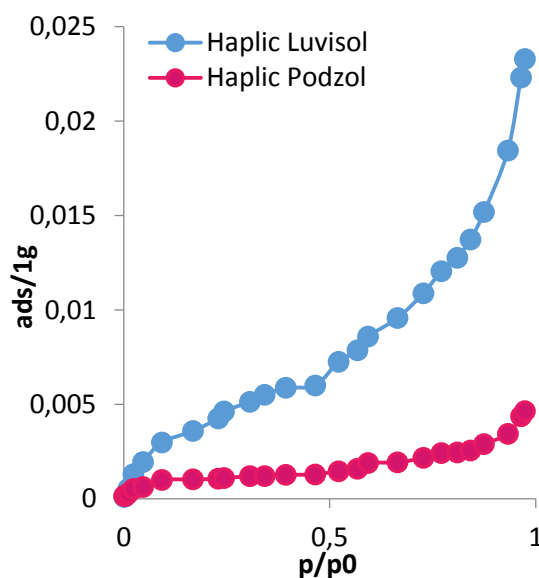


Fig. 1. Experimental isotherm of water vapor adsorption for Haplic Podzol and Haplic Luvisol.

Figure 1 presents examples of adsorption isotherms for the studied soils. They were prepared on the basis of experimentally obtained data of adsorption values of water vapor. These are type II isotherms of the BET classification.

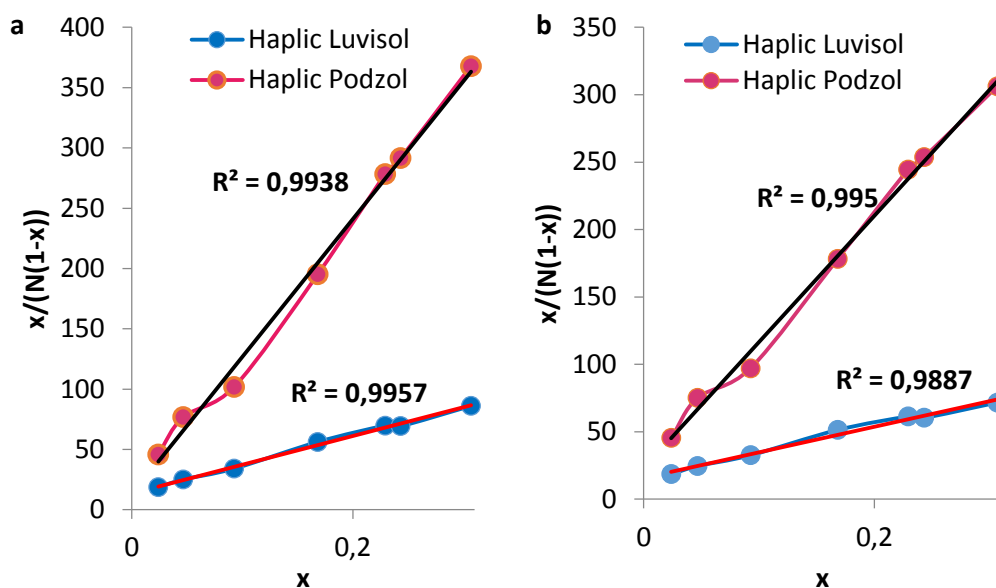


Fig. 2. A linear form of BET (fig.a) and Aranovich (fig. b) isotherms for soils. Explanation: x - vapor pressure,  $x / N (1-x)$  - monolayer capacity, red and black lines - approximation with a linear equation.

The BET and Aranovich equations were used to describe the experimental data. Correlation coefficients obtained from both equations are high (Figures 2 and 3), always higher than 0.9. The adsorption of water vapour data have been used to evaluate the values of the specific surface area (Leao and Tuller, 2014) applying the BET theory and Aranovich theory (Aranovich and Donohue, 1996). It was found that the specific surface area  $S$  of the silty soil is almost three times higher than the sandy soil. Larger specific surface area of Haplic Luvisol is caused by higher content of organic carbon as well as clay and silty concentration in comparison to Haplic Podzol. Samples of sandy soil exhibit lower sorption properties than the samples of silty soil.

## CONCLUSIONS

The adsorption isotherms have a similar shape and course for all samples of soil. The BET equation leads to higher values of correlation coefficients, which better approximate the experimental data and what should be more reliable. The size of water vapor sorption was higher for Haplic Luvisol, which has higher content of organic carbon, silt and clay. Larger specific surface area of soil increases its porosity, which affects water absorption, sorptive capacity and nutrient retention in the soil.

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## BLOCK-ORIENTED SIMULATION OF SOLAR THERMAL SYSTEMS

Tóth János – Farkas István

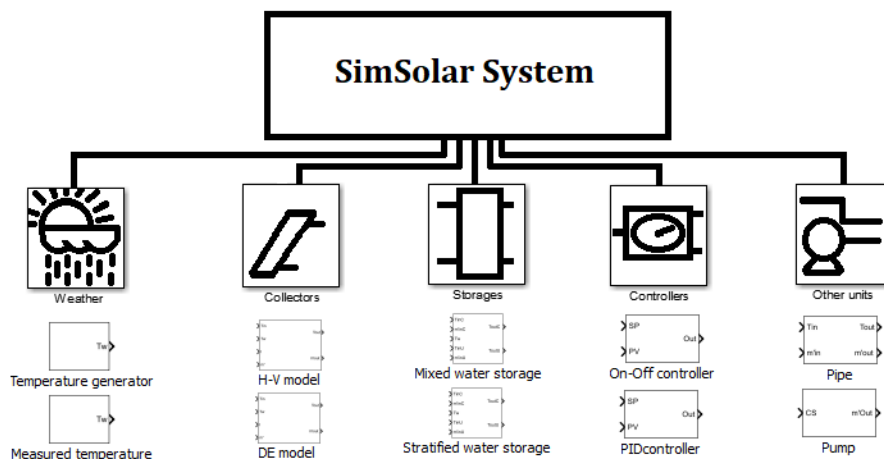
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### ABSTRACT

The development of the solar system is highly speeded up in the recent years. For that reason, quite a lot of experiments were carried out along with creating several prototype systems. With the aid of the computer assisted modelling methods the planning and installation costs can be reduced, but such algorithms were developed for a specific task, and they not provide sufficiently enough flexibility, so far.

In the recent work the main goal is to show the possibilities of a system study in a block-oriented way. The MATLAB + Simulink software package, made by MathWorks, is an ideal choice for the base for modelling and operational environment.

The flowing figure shows the structure of the designed system, called SimSolar.



There are five main categories of components, which are:

- Weather – for input data based on weather models / measurements
- Collector – for solar collector models
- Storages – for heat storage models
- Controllers – for control algorithms
- Other units – for pipes, pumps, etc.

### CONCLUSIONS

We created a Simulink library for solar thermal applications containing the necessary device models needed for operation. This library is capable of the simulation study of a solar thermal system. A test with the DHW system has been performed.

### ACKNOWLEDGEMENTS

This work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

## EFFECT OF COATINGS ON SOLAR MODULE PERFORMANCE

Víg Piroska – Bagi Bence

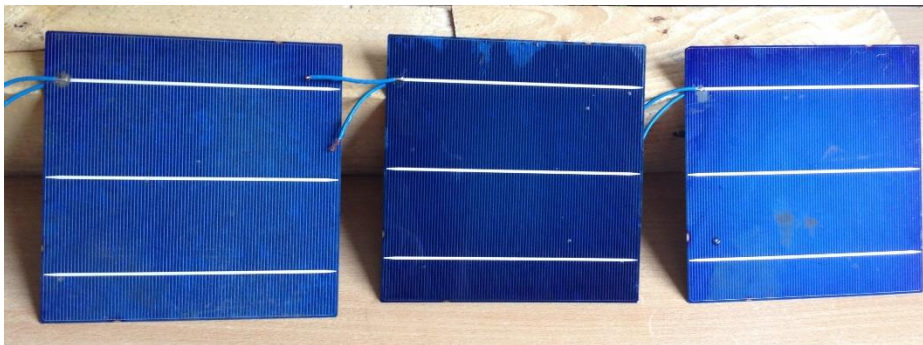
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### ABSTRACT

Among the renewable resources, to use the solar photovoltaic (PV) energy is gaining ground, thanks to the more environmentally conscious approach, price reduction due to the increase in distribution, subsidies, and the fact that solar electricity is easily accessible through existing networks. The types of PV module, the geographical and meteorological conditions of the location, the orientation, the angle of inclination, the shadings and the pollution of the solar modules are influenced the performance of PV systems. The PV technology is not yet fully matured technology, the latest results of modern physics, materials sciences and nanotechnology generated the continuous development of this area.

The application of nanotechnology coatings in various fields is more and more popular. For self-cleaning effect the photocatalytic thin layers and coatings with lotus-effect are the most important at solar modules. Applying these coatings at solar modules, the first question is how the coating itself affects the performance of the solar modules. In this study the effects of several layers on the solar module performance is studied and compared.

A 4 W power polycrystalline solar module with 156x156 mm<sup>2</sup> area without cover, as untreated and same modules, 2 with photocatalytic thin layer and 4 with lotus-effect coated, 1 with water and 1 with glass layer were compared. The I-V characteristics of the solar modules were determined under the same boundary conditions, using artificial lighting, so the difference in the powers were caused by several coatings. A lotus-effect, a water covered and an uncovered modules as can be seen in the figure.



### CONCLUSIONS

It can be stated that the coatings and the water or glass layer themselves increase the performance compared to the performance of the same non-coating solar module. Cooling due to evaporation of water and several optical effects such as by layer modified reflection, dispersion, transmittance and spectral sensitivity are the reasons of the increase the performance of transparent layer coated solar modules.

### ACKNOWLEDGEMENTS

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## TGA AND DCS METHODS AS A TOOL OF BIO-MATERIALS INVESTIGATION

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### ABSTRACT

The contribution deals with the possibilities of use the most common methods of thermal analysis – thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) in the study of bio-materials properties and thermal behaviour investigation (Haines, 1995). Differential scanning calorimetry provides information on endothermic or exothermic processes in the material; thermogravimetric analysis provides information on decomposition behaviour of thermal treated materials.

Experimental results, in graphical form - TGA and DSC curves, allow identification of processes running in the materials, changes of physical and chemical properties and the conditions under which they take place. Experimental results based on use of these methods of thermal analysis are presented in the work: study of phase transitions - melting, freezing and crystallization of bio-materials (edible oils, bio-lubricants and biodiesel), drying (solid bio-fuels), oxidation stability and thermal stability (edible oils, bio-lubricants and biodiesel), chemical reaction, activation energy (agricultural waste), denaturation, compositional analysis, purity, characterization of plastic packing materials, etc.

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

### CONCLUSIONS

Experimental results obtained by the most common methods of thermal analysis – thermogravimetric analysis and differential scanning calorimetry brings important information about bio-materials properties and they allow thermal behaviour investigation during technological processes.

### ACKNOWLEDGEMENTS

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## COMBINED EFFECT OF LEAD AND VARIED MOISTURE ON METHANE OXIDATION IN SOIL

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### ABSTRACT

Greenhouse effect is very common phenomenon on our planet caused by collecting of GHG in the atmosphere. The concentration of one of them, the methane, is still rising since the last 200 years. The main reason of this fact is its increasing CH<sub>4</sub> emission from sources such rice cultivation, burning of wastes, mining or fossil fuels combustion. One of the way reducing the atmospheric CH<sub>4</sub> concentration is its absorption by soil due to oxidation by methanotrophic bacteria, which naturally colonize aerated layers of soil. In favorable condition, methanotrophs use the methane as a source of carbon and energy necessary for survival. The methane oxidation can be regulated by many factors like soil moisture, temperature, contamination. In agricultural soils nitrogen fertilizers and heavy metals belong to the most common factors. Heavy metals main sources are transport, mining, sewage sludge application. The aim of the study was to determine the effect of lead contamination and three moisture levels on the process of methane oxidation in three European mineral soils. The study was carried out in laboratory conditions, based on the observation of consumption of added methane (1% v/v) by soil samples with and without Pb (two doses) under different moisture (three levels).

### CONCLUSIONS

Stronger effect of water content on methanotrophy was observed in compare to Pb contamination. The results of the research showed a tolerance of methane oxidising bacteria for used Pb doses. The doses of Pb used in the tests did not significantly affect the course of the methane oxidation process. The eventual inhibitory effect of heavy metal contamination was observed in the second week of incubation.

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## COMPOSITES BASED ON SILVER NANOPARTICLES AS FUNCTIONAL NANOSYSTEMS

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### ABSTRACT

The world of nano-dimensional structures remain the rich source of inspiration for basic research and everyday solutions. The interdisciplinary nature of nanotechnology provides a challenge for inventors and for new applications (Schmid (2008)). Intensive research in this field has resulted in a progressive source of new nanoproducts, including nanometals, polymer materials, silica based materials, ceramics, and clays. By contrast, application of nanocomposites and hybrid nanomaterials remains at an early stage and requires further work for full implementation. In the case of nanocomposites, which are also hybrid materials, the most essential goal is optimization of the combined properties of their components (polymers and nanostructured fillers) to change or improve the optical, electronic, mechanical, and antimicrobial properties of the final system over that achievable with the individual phases. The assumptions made in the formation of nanocomposites are as follows: even minor additives substantially improve many properties of the initial polymer, replace conventional materials, and maintain low production costs and manufacturing on an industrial scale. The development of new types of composites is the result of the demand for materials better adapted to developed technologies. The composites based on noble metal nanoparticles are currently developed and particular attention is paid to its biological properties and applications in various fields: medicine, industry food and agriculture. Incompleteness of knowledge about multiphase systems enforces undertaking research for enlargement and description new properties of nanocomposites and defining the relationships between particular elements.

In this work, the composites based on silver nanoparticles were investigated. These will include: chitosan phase (CS) in the form of polymer nanofibers decorated by silver nanoparticle (AgNP) and porous silica phase modified by silver nanoparticles. CS nanofibers materials were synthesized by electrospinning technique of polymer mixture for obtaining highly porous 3D nanofiber scaffold. Silver nanoparticles in this case, in the form of well-dispersed metallic phase were embedded in these nanofibers by deposition of silver nanoparticles synthesized in an external step as well as by deposition of silver precursor (diamminesilver(I) complex  $[\text{Ag}(\text{NH}_3)_2]^+$ ). The proposed way aims to use the natural reducing properties of biopolymer and obtain composites with very small sizes of metallic crystallites. The composition of noble metal nanoparticles with polymer nanofibers can be versatile route for building new biocide materials and allowing a further extension of the wide range of applications. Moreover, the reproducibility and comparability of composite formation techniques should be highlighted. The silver nanoparticles were also deposited on porous silica supports. In this study, the possibility of using different types of silica materials in the role of carrier for silver nanoparticles were investigated. In this instance, mesoporous silica materials with high surface area and ordered system of mesoporous (SBA-15) and nonporous fumed silica (Aerosil) were selected as a groundwork of nanosized silver particles. The physicochemical characterization of investigated materials using the appropriate analytical techniques as well as their applicability in the characterization of obtained nanocomposites were discussed. The nanocomposites were characterized using small angle X-ray scattering (SAXS), X-ray diffraction (XRD) and atomic force microscopy (AFM). The morphology of composites, size of nanoparticles and their crystallinity, as well as chitosan fibres characteristic were illustrated by electron microscopy techniques (SEM and TEM). The potential of new materials and their

antibacterial activity has been tested on two bacterial strains and compared to a nanocomposite without silver nanoparticles as well as to silver nanoparticles in the form of colloidal solution. Particular attention was paid to the characteristics of the resulting metallic phase, its distribution in the polymer network and the potential interaction with the chitosan matrix. As a result of the work, materials with a high distribution of metallic nanoparticles have been obtained. Small variation in the dimensions of the nanoparticles (20-50 nm in the case of one group of materials and ~5 nm in the case of materials obtained from in-situ reduction of metallic precursor) guarantee biostatic activity. This activity confirmed with reference to E. Coli and S. Aureus strains was significantly increased compared to pure CS/silica composites.

### **CONCLUSIONS**

Nanoparticles and nanostructured materials play a significant role in materials innovations and nanotechnology based resources. Silver nanoparticles based materials belongs to the group of matters which have important antibacterial, catalytic and photocatalytic properties. Hence the great interest in the systems of supported highly dispersed silver on solid supports and functional materials. It is important to comprehend how the size, shape, surface, and aggregation state of the metal nanoparticles change after integration with solid materials and predict properties of new composites.

### **ACKNOWLEDGEMENTS**

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