

# BPS 2021

20th International Workshop  
for Young Scientists  
„BioPhys Spring 2021“



INSTITUTE OF  
AGROPHYSICS  
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HUNGARIAN UNIVERSITY OF  
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# BPS 2021

20th International Workshop for Young Scientists

„BioPhys Spring 2021”

## BOOK OF ABSTRACTS

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Slovak University of Agriculture in Nitra

Polish Academy of Sciences Branch in Lublin

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## INTRODUCTION

Dear friends and colleagues,

It is our privilege and great pleasure to invite you on behalf of organising institutions – **the Institute of Agrophysics of the Polish Academy of Sciences, Lublin, Poland, together with Slovak University of Agriculture in Nitra, Slovakia, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, and Czech University of Life Sciences, Prague, Czech Republic** – to participate in the 20<sup>th</sup> International Workshop for Young Scientists "BioPhys Spring 2021" to be held in Lublin on **18<sup>th</sup> May 2021 in the form of video conference**.

The workshop is oriented on the deeper insight into the physical processes occurring in biological, agricultural and food systems. The workshop combines two basic tasks of international meeting: exchange of professional experience and integration of young people from different countries. We cordially invite young scientists to participate in the BPS 2021 Workshop and to present results of your research in application of physical methods to agriculture, biology and/or life sciences. The workshop is organised as an open English spoken event without any fee. One page abstracts of contributions will be published in the Book of Abstracts of the BPS 2021 Workshop.

**Józef Horabik**

Chairman of the Organising Committee



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## **Energy from renewable sources – part 1**



## New innovations in solar cell and module technologies

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**Keywords:** global market, photovoltaic capacity, solar energy

The paper deals with the recent status of the use of solar photovoltaic energy use. The worldwide situation is analysed based on the topic touched upon at the Solar World Congress (SWC 2019) organized by the International Solar Energy Society in Santiago, Chile in 2019, and also at the EuroSun 2020 Solar Conference organized online in Athens, Greece in 2020. Additionally, the most recently published books in this topic serve information overviewing the recent statements.

In 2019, the solar PV market increased by 12% reaching the global capacity of 627 GW<sub>p</sub> along with the record of annual additions of 115 GW<sub>p</sub>, which is equivalent to the energy production of about 47 thousand modules every hour (Renewables 2020; IEA PVPS, 2020).

Due to mainly photovoltaics technology, the distributed renewables for energy access becoming effective, and benefited about 150 million people around the world in 2019. The market for off-grid solar systems grew 13% in that year.

Concerning to the PV application development it is also a significant fact that the number of electric vehicles is getting increase. In 2019 around 7.2 million electric cars were on the world's roads. There are some countries having a national plan to reach the 100% electric vehicle target.

Putting into operation more solar plants is approaching to drive down the price of solar electricity. In case of large-scale ground-mounted plants there are concerns about the environmental impacts and agricultural lands. The floating PV projects continues their rapid expansion. Further new market segment is emerging such as agri-PV which is the combination of PV with agriculture.

In 2019 the modules' price dropped by around 12% to the world average of 0.36 USD per Watt. The new developments and innovations in PV technologies helped to get down the prices especially for polysilicon, wafers, cells and modules.

At the same time, strong research activities are conducted to reach more efficient cell technologies, for instance Perovskites, in tandem with crystalline silicon or thin-film base. There are projects focusing on the long-term stability of Perovskites. In the laboratory, the high concentration multi-junction solar cells achieved an efficiency of 47.1%, and modules with concentrator achieved 38.9% efficiency (Fraunhofer ISE, 2020).

At module level it is intended to develop higher power ranging at 400 W-plus mainly for building applications. Additionally, the bifacial modules offer potential gain. In such case the role of tracking will also to be increased.

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## Possible use of exergy analysis for PV/T collectors

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**Keywords:** solar energy, hybrid collector, exergy efficiency

Among the solar energy application possibilities, the solar thermal systems can reduce the consumption of traditional energy resources. By using less energy obviously leads us to less pollution. Flat plate collectors and PV modules are the most commonly used equipment of solar energy. The solar market has shown an effective 33% growth per year since 1997 until today. As a result of developing the photovoltaic solar energy system the hybrid photovoltaic/thermal system was developed. The term PV/T refers to solar thermal collectors that use PV cells as an integral part of the absorber plate.

At the Institute of Mathematics and Basic Science, Hungarian University of Agriculture and Life Sciences, Gödöllő various solar applications were installed for educational, demonstrational and research purposes, such as PV and solar thermal units, transparent wall insulation and solar dryer unit.

Thermal and photovoltaic technology combined into one system is known. The PV/T system can be segregated into two parts, the thermal solar technology what converted the solar energy into heat, and the photovoltaic technology which derived from solar cell technology and convert the solar radiation into electricity. The hybrid collector can reduce the main problem of photovoltaic systems, the high temperature of the solar cell effects reduction in the efficiency. In order to reduce that problem and get more efficiently system it is necessary to cool the PV cell and decrease its temperature. To solve the problem which is not an easy task especially in hot and humid climate areas, a flat plate hybrid collector was developed producing both thermal energy (by cooling back the module) and electricity at the same time. Thus, the PV/T solar collector gives opportunity to growing the overall solar efficiency and provides a better way utilizing solar energy [1]. The PV/T, combining PVs into the solar thermal module, indicates a new direction for renewable energy utilizing.

The PV/T module can collect solar energy at different brands of the spectrum and lead to energy and exergy efficiency [2]. Sum of the collector's thermal efficiency and the PVs' electrical efficiency gives the overall efficiency. Hybrid collector efficiency is defined as the ratios of useful system heat gain and electricity gain to the incident solar irradiation on the collector's absorbing surface [3].

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## Fundamentals and application of nanofluids in flat plate solar collectors

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**Keywords:** flat plate solar collector, solar energy, nanofluids

The role of solar energy in today's energy production is significantly growing. Solar energy is one of the leading renewable energy types since it is abundant, clean energy, freely available, utilized without polluting the environment. The sun is an available and infinite energy source that can be converted into electricity using photovoltaic solar cells (PV), thermal energy using solar collectors, and both using PV/T collectors. The possibility of increasing the performance of a solar thermal system is an important research area. Solar energy collectors are thermal circulation devices that convert solar radiation energy into direct energy inside the transport medium for heat fluids. The solar collector is the central part of every solar system. The lower efficiency of the flat plate solar collector (FPSC) energy conversion is a significant drawback. As this type of collector is the most used, its performance must be increased [1].

Nanotechnology has been active in various areas, including energy, medicine, textiles, cosmetics, food, cars, electronics, building, and construction. It is a powerful tool for the solar system, which provides a wide range of resources to resolve energy-related issues.

Traditionally, heat transfer fluids have been water, ethylene glycol, and oil. They have been used in industrial processes, from electrical generation to heating and cooling processes to chemical processes to industrial processes to transportation and more. They may have a low thermal conductivity in contrast to nanomaterials. Since the past few decades, a great deal of research has been invested in enhancing heat transfer flow and investing nanofluid use [2]. This study aims for innovations, possibilities, and attempts to evaluate and improve the flat plate solar collector system (FPSC) efficiency using nanofluids.

### Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and by the Doctoral School of Mechanical Engineering, Hungarian University of Agricultural and Life Sciences, Gödöllő, Hungary.

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## Materials of a solar cell operated hybrid tree

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**Keywords:** solar tree, PV technology, generating electricity, solar energy

There is a global trend towards alternative and sustainable energy sources, especially solar energy, because it is considered the most crucial source of clean energy, controlling emissions and noise harmful to the environment. Photovoltaic cells are one of the most important ways to get solar power. In a modern city building, the architectural form is carefully chosen for all the details of the facilities in these cities and the awareness of energy sources and the number of pollutants that will negatively affect the environment.

Solar trees are techniques that mix aesthetics and capture sunlight to produce electricity (Hyder, Sudhakar and Mamat, 2018). Solar trees are one of the new architectural parts that harness solar radiation without a large footprint, only 1% for the same producing power system (Prasad *et al.*, 2018). In this study is the essential components and materials of solar trees are to be presented.

Solar trees are inspired by natural trees that consist of the stem, branches, leaves, and there are accessories necessary to complete the generator's requirements. The solar tree does not have a specific structure, it can be built in a variety of ways to appeal to the public and use less space while avoiding shade effects on the leaves and modules (see in Fig. 1).

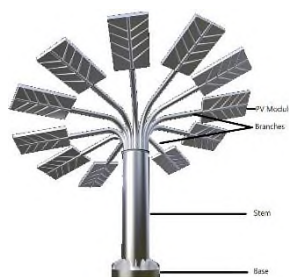


Fig. 1. Solar tree layout

### Acknowledgments

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## Modelling and control of hybrid solar collector systems

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**Keywords:** modelling, hybrid solar collector, PV/T system, performance comparison

The combination of photovoltaic (PV) and thermal solar (T) systems into a hybrid solar thermal collector (PV/T) shows a strong potential for incorporation, primarily because of the limited usable space and the advantages of electrical and thermal parallel production. The initial attempt flat plate-based PV/T collector was introduced by Wolf (1976) and it was reported by Zondag (2008). TRNSYS software was selected to use by presenting the specifications of the proposed PV/T collector's system model Fig. 1 as a TRNSYS component.

PV/T unit in TRNSYS program Type 50, which has four variants based on the transmissivity-absorptivity product and how the thermal losses are assessed (Klein et al., 2006). A method for the PV/T collector performance evaluation was developed as the first action of this study via the building of a mathematical model in TRNSYS. This study examines the effect of adding temperature controllers on the PV/T system, and also studies the effect of using the daily profile of hot water consumption. In order to make performance analysis and comparison, besides the PV/T system model two more models were developed in the TRNSYS system, e.g. the individual units of the PV module and flat plate collectors.

Based on the results of a comparison between the proposed system and the single units, it is observed that the PV/T system has higher electric energy than the PV module. Also, it is noted that the useful energy gain of flat plate collector as an individual unit has more amount of energy gain compared to the PV/T.

### Acknowledgment

This work was supported by the Stipendium Hungaricum Programme and the Doctoral School of Mechanical Engineering, Hungarian University of Agriculture and Life Sciences, Gödöllő Hungary.

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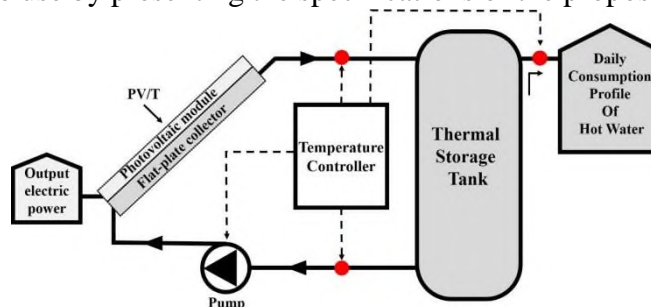


Fig. 1. The entire scheme of the PV/T system

## Influence of tilt angle to PV system energy production

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**Keywords:** solar energy, external factor, mathematic description

The article deals with the influence of photovoltaic (PV) module tilt angle to the PV system energy production. The optimal tilt angle of PV module in central European region is 35° [1], but it depends on the PV system location and azimuth angle orientation [2]. In our study was tilt angle changed in the range 0°–90° with the step 15°. The tilt angle 0° represent horizontal positioning of the PV modules and the tilt angle 90° is the perpendicular positioning. Data from PV system were processed by editor Microsoft Excel and software Matlab version R2015b. The statistical characteristics were calculated for every series of measurements. The regression analysis and polynomial approximation were applied on experimentally obtained graphical dependencies. The results of research are presented as two-dimensional (Fig. 1a) and three-dimensional graphical relations (Fig.1b). For all dependencies were obtained regression equations with relatively high coefficients of determinations. On the three-dimensional relations was applied polynomial approximation of the second degree. Model mathematical dependency is described by (Eq.1). It allows simple calculation of electric energy production by the PV system after entering the time value and the position which corresponds to the tilt angle  $\beta$  of the PV module. Based on the model equation, it is possible to determine the energy balance of a PV plant with an installed output of 100 kWp for any tilt angle and calendar month of the year in the central European region.

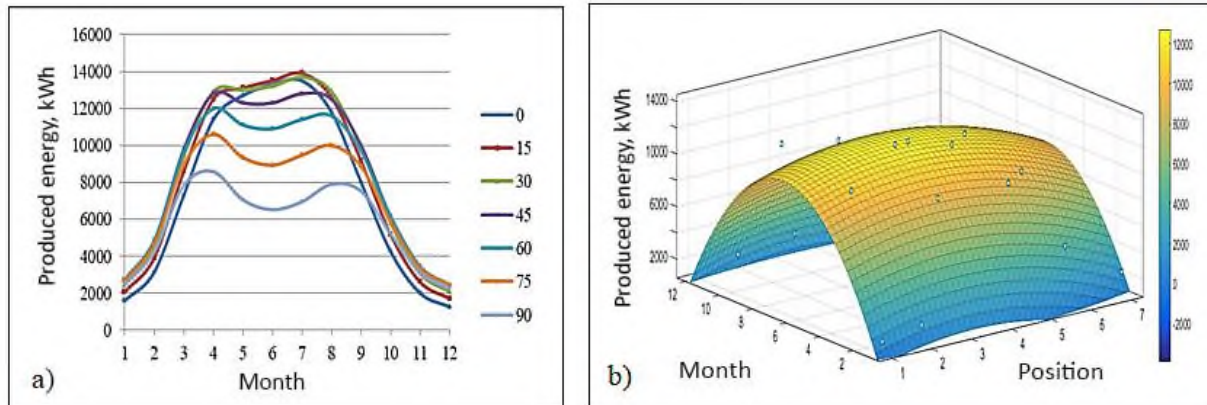


Fig.1. a) Dependencies of energy produced by the PV system for tilt angle range from 0° to 90° in different calendar months, b) Influence of PV module tilt angle on the amount of energy produced by the PV system after polynomial approximation

$$E_m(t, \beta) = -2486 + 1250 t + 4206 \beta - 202.3 t^2 + 12.76 t \beta - 340.9 \beta^2 \quad (1)$$

where:  $E_m$  is the energy produced by the PV system per month (kWh),  $\beta$  indicates the position 1–7 (-) and  $t$  is the time (month)

### Acknowledgement:

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## **Properties of soil and agro-environment**



## Applications of *Hermetia illucens* in industrial and agricultural fields

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**Keywords:** *Hermetia illucens*, waste bioutilization, animal feed, frass, biodiesel, antimicrobial activity, chitin, entomoremediation

*Hermetia illucens*, also known as the black soldier fly (BSF), belongs to the family Stratiomyidae in the Diptera order. In the natural environment, it feeds on dead organic biomass and is currently found over wide geographical extents [1]. This fly has received considerable attention due to its characteristics, useful in multiple industrial and agricultural applications. The aim of the presentation is to bring closer the wide scope of current *H. illucens* applications. One of the features of *H. illucens* is its ability to grow rapidly on even a nutrient-poor diet such as manure or sewage sludge. The use of the larvae may become an example of a solution to the problem of huge amounts of backlogged waste, such as expired food or agricultural waste. They become an environmentally friendly “carrier” of nutrients due to the use of BSF larvae as feed in aquaculture or for livestock. Also, lipids are a sizeable component of their bodies; therefore, these larvae can be used to produce biofuel as an alternative to petroleum-based fuel. Another way to use BSF is to produce chitin and chitosan [2]. In addition, post-production residues of *H. illucens* such as digested feed, feces, and all microbial content from the so-called frass, act as a biological fertilizer. The use of this fertilizer can contribute to recirculation of elements, such as nitrogen or phosphorus, already contained in the feed given to BSF larvae. This action has an extremely positive effect on the environment [3]. Moreover, microbial activities improving soil quality and reducing pathogen and microbial growth are recorded [4]. It has also been shown that *Hermetia illucens* larvae have the ability to bioaccumulate heavy metals as well as other contaminants, which renders the insect as a good entomoremediation agent [5].

The presentation is based on literature research done in the frame of the project no. 2019/35/D/NZ9/01835 founded by National Science Centre, Poland.

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## Methane uptake potential of biochars produced from selected plant wastes

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**Keywords:** biochar, methane uptake, potato stems, raspberry stems

Climate changes strongly affects the environmental conditions and puts agriculture in the face of new challenges. One of the most important issues, which could inhibit those negative changes is reduction of greenhouse gases (GHGs) emission, such as CO<sub>2</sub> and CH<sub>4</sub>. Modern agriculture is looking for ways to beneficial management of post-harvest plant waste. Biochar production from plant debris could be helpful in both issues. Biochar addition to the soil was suggested as a way to carbon sequestration and mitigation of GHGs emission [1]. For this reason, biochars produced from widely available waste materials with useful qualities are still being sought.

Purpose of our study was to determine the potential of CH<sub>4</sub> uptake and CO<sub>2</sub> production by four biochars prepared from plant waste materials (wood offcuts, sunflower husk, raspberry and potato stems). In our experiment, the methanotrophy potential of selected biochars incubated at 60 and 100% water holding capacity (WHC) with the addition of 1% CH<sub>4</sub> (v/v) was investigated for 28 days at 25°C. Potato stem biochar showed highest potential for CH<sub>4</sub> uptake in both moisture levels. Moreover, new biochars from potato and raspberry stem produced significantly less CO<sub>2</sub> than wood offcuts biochar. Consequently, we obtained negative net global warming potential (GWP) calculated for these biochars [2].

Since the potato is one of the main global crops (ca. 17.5 million ha in 2018, FAOSTAT), the amount of stems as a plant waste is enormous. It should also be noted that the stems are often a habitat for pathogens and parasites and for this reason they should be disposed of properly [3]. Those facts could be the economic and environmental justification for the application of newly prepared biochars from potato and raspberry stems as a tool to reduce GHGs emission and limitation of plant diseases and pests.

### Acknowledgement

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## Factors affecting ammonia volatilization

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**Keywords:** ammonia volatilization

There are plenty of publications on the subject of ammonia volatilization from soils. This topic is very important according to new legal regulations that require adaptation to new rules not only by fertilizer producers, but also by their users. Excessive ammonia emission could lead to losses of nitrogen and adverse changes in the environment.

There are several factors affecting ammonia volatilization: soil pH, CaCO<sub>3</sub> and total salt content, but the most important factor is soil pH [1,2]. Another important factor that directly affects ammonia emission is temperature. The optimum temperature for mineralization is around 30°C. When the temperature drops by 10°C, its intensity drops by 50%. Mineralization is very low at temperatures and almost stops around 0°C [3]. Explanation of this phenomenon results from the fact that the increase of soil temperature causes increase of the solubility of urea, what in turn causes growth of the rate of NH<sub>3</sub> volatilization.

Other factors worth mentioning when talking about this topic can be divided into two groups. The first group consists of biological and chemical parameters like: cation exchange capacity, soil organic matter, moisture content of the soil. The second group contains factors such as: method of fertilizer application and used cultivation system.

It is important to analyze all of these factors to understand the whole mechanism of the process of ammonia volatilization.

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## Seasonal variations in the genetic diversity of fungal communities in the degraded soil amended with phosphorus biofertilizer

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**Keywords:** biofertilizers, degraded soil, genetic diversity, fungal microbiome, NGS

Research on the genetic diversity of fungal communities inhabiting arable and degraded soils fits into the growing societal interest towards improving the quality of agroecosystems. The fungal microbiome performs multiple roles that are essential for the proper functioning of the belowground environment, so maintaining its welfare is one of the principles of sustainable and organic agriculture (1).

The aim of the studies was to determine the influence of microbiologically enriched mineral phosphorus fertilizer on the seasonal changes in the genetic diversity of fungal communities inhabiting arable soil degraded as a result of inappropriate cultivation and fertilization.

The studies were conducted under the field experiment and included the following fertilization treatments: FC-optimal dose of phosphorus fertilizer without microbial enrichment, FA100-optimal dose containing microorganisms and FA60-dose of phosphorus fertilizer reduced by 40% and microbiologically enriched. Soil samples were collected in autumn 2018 (A18), summer 2019 (S19) and autumn 2019 (A19). A next generation sequencing (NGS) approach was used to evaluate seasonal shifts in the genetic diversity of soil fungal microbiota (2).

The obtained results indicate that not only the biofertilizers application, but also sampling term affected the fungal community composition. FA100 and FC treatments were characterized by the presence of 120 fungal orders, whereas in FA60 this number accounted for 115, with some orders specific for a particular fertilization method. The tested soil was dominated by representatives of the following orders: Eurotiales, Hypocreales and Mortierellales, with differences in their relative abundance between treatments. UPGMA dendrograms and PCoA plots showed the evident clustering of treatments according to sampling term.

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## Soil microorganisms in forest gully soil show various activity along a topographical gradient

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**Keywords:** soil microbial activity, forest gully, forest soil, enzymatic activity

Soil microorganisms play a very important role in carbon (C) and nitrogen (N) cycling, and their activity also influences climate change. Forests cover about 30% of the terrestrial global area and forests soils are the habitat of a great variety of microbes, which results in the storage of much more C than other forms of land use [1]. Therefore, the determination of microbial activity in forest soils is very important to better understand climate change [2]. Moreover, by studying the activity of soil microbes, we can obtain a lot of information about the functionality, fertility, productivity or health of the soil [3].

Gullies are landforms formed as a result of erosion and they are common in farmed lands and forests of Poland and Europe [4]. As a result of the processes associated with soil water erosion (leaching, displacement, and accumulation of surface material during run-off), several soil properties of different gully layers vary from each other.

The aim of this study was to determine selected microbial parameters in soils from different positions (top, mid-slope and bottom) in a deciduous forest gully and to evaluate the relationships among the examined parameters. The analysis was conducted in laboratory conditions (under controlled temperature).

The results of the experiment showed that the position of the forest gully had a significant effect on microbial parameters. Dehydrogenase activity (DHA) was the lowest in soil from the mid-slope, possibly due to the low pH in this part of gully. The highest catalase activity (CAT) was recorded at the bottom of the gully, as well as the highest values of microbial biomass ( $C_{mic}$ ) and basal respiration (BR).  $C_{mic}$  and BR are probably associated with higher SOC and pH in this gully part, due to their significant influence on soil microorganisms activity and growth.

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## The effect of N-(n-butyl)thiophosphoric triamide on the selected physical and physicochemical properties of Urea-Ammonium Nitrate solutions

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**Keywords:** liquid fertilizers, nitrogen fertilizers, urease inhibitor

The growth of the world's population increases the global demand for large amounts of high-quality food. An intensive agricultural use of land leads to the depletion of nutrients in the soil. Therefore, the use of appropriate fertilizers is necessary.

Liquid mineral fertilizers are widely used in agriculture, affecting the yield of crops [1]. Urea-ammonium nitrate (UAN) solution is one of the commonly used liquid fertilizers. It contains all forms of nitrogen available to plants, i.e. amide, nitrate and ammonium form. However, the conversions of fertilizers, taking place in the soil, apart from being beneficial to the yield, may result in the nitrogen losses through e.g. greenhouse gas emissions or leaching of nitrates from the soil (Fig. 1). The urea hydrolysis in the soil, which is catalyzed by urease, causes CO<sub>2</sub> emission, an increase in the soil pH and, finally, the volatilization of ammonia. In order to limit these processes, the urease inhibitors are used. N-(n-butyl)thiophosphoric triamide (NBPT) is one of the best known and most often used inhibitor [2].

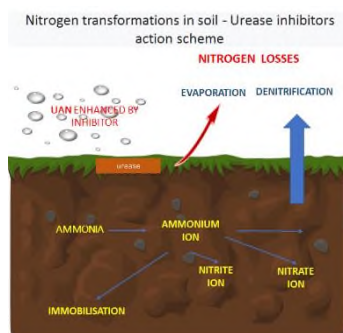


Fig. 1. Scheme of nitrogen transformation in soil.

The aim of this work was determination of the NBPT solubility in UAN solution at different nitrogen content and characterization of the basic physical and physicochemical properties (e.g. density, wettability of the hydrophilic and hydrophobic surfaces, pH and activity of ammonium and nitrate ions) of saturated solutions at 20 °C.

### Acknowledgements:

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## **Quality of environment**



## Environmental measurements in the framework of the CanSat Student Satellite Development Project

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**Keywords:** CO<sub>2</sub>, radioactivity, vertical distribution, CanSat project

The Cansat project is a secondary school project of the European Space Agency (ESA), in the framework of the program a small satellite has to be developed and built by secondary school teams. The developed Cansats are launched by a rocket into the atmosphere, to the height of about 1000 meters. The Cansats after deployed from the rocket have to perform measurements of the atmosphere during the landing with a parachute. Beside compulsory measuring tasks as the units as the pressure and the temperature of the atmosphere, secondary missions have to be developed as well [1].

There is a lot of physics and engineering knowledges in the development of a Cansat from the structural design, through the sizing of the parachute system till the development and realisation of the electric circuits, but the most interesting part is the development of the secondary missions.

In the recent year with the pupils of the Premontrei Grammar School from Gödöllő, as one topic of the secondary mission, we want to measure the vertical distribution of the air pollution. It is known, that because of the higher molar weight of the CO<sub>2</sub>, the CO<sub>2</sub> has a vertical distribution which is a decreasing function with the height [2]. The same has to be valid for the small particle pollutions (PM10 and PM2.5), based on the same physical reasons. However researchers made predictions and experiments for finding the vertical distribution functions [3], we decided to carry out our own measurements to find out the relationship.

For that we are using different air quality sensors which are calibrated in the Environmental laboratory of the Hungarian University of Agriculture and Life Sciences, such as MQ 135 air quality sensor and Adafruit CCS811 sensor (CO<sub>2</sub> measuring range from 400 ppm to 8192 ppm).

It is planned to measure another vertical effect as well, that how the origin of the nuclear radiation changes vertically. It is taught at school, that in the surface of the earth the main source of the radiation (directly, or indirectly, by the food, radon, etc.), but in the higher atmosphere the main source of the radiation is the cosmic radiation. It is planned to install two GM tubes in our CanSat, one insulated from the top, the other from below, and as the CanSat is descending, the changes indicated by the two GM tubes will be measured.

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## Comparison of heavy metal concentrations measured in the hair samples of residents of “Csepel” and “Erzsébet” districts

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**Keywords:** heavy metal content, GFAAS method, environmental pollution

As a result of our developing world, the level of pollution caused by heavy metals has increased. The following heavy metals were measured from the collected hair samples: Cu, Se, Fe, Mn, Cd. The aim of our research was to see, that hair samples from more polluted environments actually have higher concentrations of heavy metals. The concentration of heavy metals in the hair of "Csepel" and "Erzsébet" residents were performed by a Unicam 923 QZ AA spectrometer. Preparation of hair samples was the next: 1. After collecting the hair samples from the residents, they were chopped into 2-3 mm pieces, and then the chopped samples were washed first in bidistilled water and then three times in diethyl ether and then once again in bidistilled water in an ultrasonic water bath for 5-5 minutes at each washing phase. The washed samples were placed in a drying chamber at 70°C for 24 h. 2. The samples were digested in a Milestone 1200 MEGA type microwave oven. The approx. 0.5 g of hair sample was weighted into Teflon bombs and 5 cm<sup>3</sup> of 65% nitric acid and 2 cm<sup>3</sup> of 30% hydrogen peroxide were weighed and placed in the microwave. The aim of the study was to support the hypothesis, that the hair metal concentration of the hair samples from the "Csepel" area is higher than that of the "Erzsébet" from the results of the heavy metal concentration measured in the hair. In “Csepel” district, the heavy industry previously operating there was a potential source of pollution and therefore it was assumed that the people living here were exposed to higher heavy metal emissions.

In the case of heavy metal pollutants studied from the point of view of dwellings, with the exception of copper and manganese, all tested substances occurred in higher concentrations in the Csepel area compared to Erzsébet (Fig. 1a and Fig. 1b).

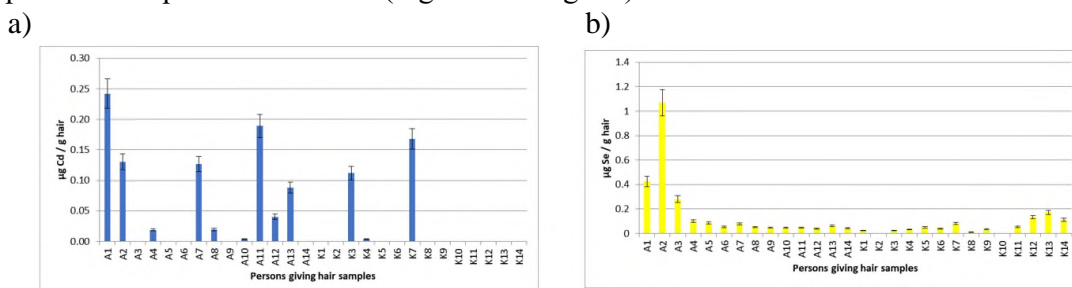


Fig.1. a) Concentration of Cd in hair samples b) Concentration of Se in hair samples

We came to the conclusion that the people living not far from Csepel Works and those working there, were polluted with heavy metals in larger quantities than those living in other parts of the city (e.g., the examined “Erzsébet” samples). This may be due to Csepel's manufacturing past. From the end of the 1800s, there was a great deal of metal processing in this area, the pollution of which could also benefit the people living here.

## Screening of lipase-producing microorganisms

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**Keywords:** lipase, microorganisms, agar plate assay, colorimetric assay

Lipases (EC 3.1.1.3) are ubiquitous enzymes of important physiological role and industrial potential, because they catalyze hydrolysis and synthesis reactions. The most significant industrial applications of lipases have been mainly found in food, detergent, pharmaceutical, leather, textile, cosmetic, paper industries and other synthetic chemistry. Lipases can be produced by a wide range of organisms including animals, plants and microorganisms. Microbial lipases are more stable, substrate specificity and with lower production cost as compared to other sources of these enzymes [1]. Purpose of this study was to screening of lipolytic microbial strains and select the best enzymatic activities.

Two strains from American Type Culture Collection (ATCC), ten strains from German Collection of Microorganisms and Cell Cultures GmbH (DSMZ) and five strains isolated from the environment from Grupa Azoty Zakłady Azotowe „Puławy” S.A. were maintained on agar plates and test tubes.

The lipolytic activities of all isolates were assessed both qualitatively by agar plates supplemented with olive oil and Rhodamine B, Tributyrin, Tween 80 and quantitatively by liquid cultures using colorimetric assay with measuring the release of *p*-nitrophenol (*p*-NP) [2]. Moreover, the units of lipolytic activity per microgram of extra cellular protein expressed the specific activity of lipases following Bradford's method [3]. Lipolytic enzyme activity rates were obtained after 72 hours of incubation.

The best lipase production among the seventeen isolates using agar plates showed *Staphylococcus* and *Candida* strains. The highest lipolytic activity and specific activity of lipases in liquid cultures using colorimetric assay showed *Pseudomonas* strains.

This work was supported by the Ministry of Science and Higher Education under contract no. DWD / 3/51/2019 of October 22, 2019.

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## Modification of nitrogen fertilizers as a way to reduce ammonia emissions

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**Keywords:** SRF, NH<sub>3</sub> emissions, emissions measurements

Improper adjustment of the release characteristics of commonly used mineral fertilizers to the nutritional requirements of plants results in the loss of a significant part of them by infiltration into the soil profile or by emission of gaseous nitrogen derivatives into the atmosphere [1,2]. Legal regulations including National Emission Ceilings (NEC) Directive, require from the Member States of European Union to limit ammonia emissions from agriculture [3]. Apparently, the new emission limits may result in a reduction or even a complete ban on the use of urea-based fertilizers. To avoid this, it is necessary to find new solutions and technologies in agriculture.

The research is aimed at developing new urea fertilizers with limited ammonia emissions, as well as developing measuring methods confirming the reduction of emissivity. A possible path to increase the efficiency of fertilization without loss of nitrogen and to avoid the adverse impact of ammonia on the environment is to adapt the rate of nutrients uptake by plants. This can be achieved by temporarily limiting - in a staggered manner - the solubility of urea. The research is focused on obtaining urea fertilizer, whose granules will be surrounded by biodegradable polymeric material. The shell are to constitute a physical barrier, which will result in slow release of nutrients. Currently conducted step is related with testing the materials in the soil conditions to check the real emission levels from new slow release fertilizers.

*This work is carried out as part of the " Implementation Ph. D " program of the Polish Ministry of Science and Higher Education, contract number: 006/DW/2018/OZ*

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## **Physical properties of materials**



## Optics of water droplets on living and non-living materials

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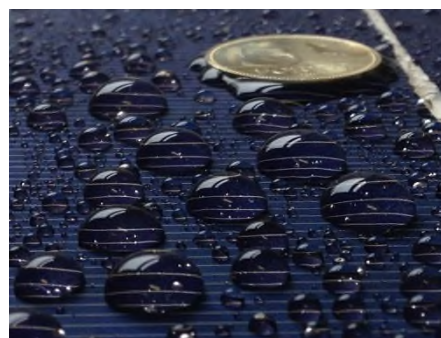
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**Keywords:** water, modelling, RayTracer, refraction, antireflexive

One of the most important life-giving elements of our environment is water e.g. photosynthesis of plants, and the detoxification of higher organisms is essential. In addition to this internal use, another important role of water is that it helps to clean when placed on a surface. However, a drop of water on a leaf or skin surface also changes the optics of solar radiation. The work is related to this topic.

The phenomenon is important for any surface that utilizes the effects of solar radiation. Nanotechnological coatings used in the artificial realization of the lotus effect, which helps the self-cleaning of plant surfaces, are becoming more and more widespread, and thin layers applied to the surface of solar energy utilization devices are a common application. Thus, in addition to the leaves e.g. this topic is also important in the study of the energy of radiation reaching the watery surface of solar cells and solar collectors.



Among the optical effects of water droplets appearing on the surface, the present work deals with the study of the antireflective effect. These phenomena were examined with the model created in the RayTracer framework. The bases of the operation of the model are the laws of refraction, reflection, and the Fresnel equations, which give the intensity relations. The results were obtained by using a refined, improved version of our previous model [1].

Initially, the energy of light rays arriving in parallel decreases during refractions and reflections. The path of each light beam is tracked to an adjustable energy ratio and the energy transferred to the surface during the encounters is summed. During the simulation, it is determined that the light rays incident or reflected from the surface transfer the part of their energy to the surface.

The model is suitable for studying the effect of spherical or ellipsoidal droplets resulting from different surface tensions. In addition to the shape, is also taken into account the fit to the surface by moving the drop in a direction perpendicular to the surface. The spectral dependence can be examined in the model by adjusting the refractive index of the water droplet appropriately. The presentation details the results obtained using the model.

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Víg P. and Tóth J. 2019. Optical effects of water drops at photovoltaic modules. Book of abstracts: BioPhys Spring 2019 - 18th International Workshop for Young Scientists, Gödöllő, Hungary, Szent István University, p. 41.

## Quality assessment of selected organic oils by physical methods

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This work deals with study of physical properties of biolubricant. Physical properties – density and viscosity are measured as a function of temperature. Viscosity is an important fluid property when analyzing liquid behavior and fluid motion near solid boundaries. Present data have been obtained from measurements performed on laboratory viscometer DV2T by Brookfield. We used densimeter Mettler Toledo DM40 to measure density. Temperature range in which both physical properties were measured is from 20 °C to 100 °C. Viscosity and density of materials changes with the temperature. The difference in the effect of temperature on viscosity of fluids and gases can be related to the difference in their molecular structure. Viscosity and density of majority of the liquids decreases with increasing temperature [1]. We compare two biodegradable hydraulic fluids - STOU Super Tractor Oil Universal, SHELL SPIRAX S4 TX and one mineral oil MOL Traktol NH Ultra.

a)

Sample	Regression equation	Determination coefficients
Super Tractor Oil Universal	$y = 318,03e^{-0,036x}$	0,9948
SHELL SPIRAX S4 TX	$y = 318,03e^{-0,036x}$	0,9933
MOL Traktol NH Ultra	$y = 291,9e^{-0,03x}$	0,995

b)

Sample	Regression equation	Determination coefficients
Super Tractor Oil Universal	$y = -0,0006x^2 - 0,6121x + 911,24$	0,995
SHELL SPIRAX S4 TX	$y = 0,0002x^2 - 0,6597x + 880,31$	0,9977
MOL Traktol NH Ultra	$y = -0,0007x + 0,9002$	0,9986

Fig. 1. a) Dynamic viscosity dependencies on temperature, b) Density dependencies on temperature

Dynamic and kinematic viscosity of hydraulic oils is decreasing exponentially with increasing of temperature. The determination coefficients for all the samples are very high, which also confirms strong exponentially decreasing dependence. It is shown that density linearly decreases with temperature of oil. Measured temperature dependencies of density, dynamic viscosity show good accordance with published results [1,2,3]. Presented linear and exponential dependencies of physical properties on the temperature indicate significant impact of the temperature on oils thermal properties. All lubricants have the same use and the results presented by our measurements prove only small differences between the mineral and ecological lubricants.

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## Determination of degree of agglomeration and strength of consolidated powder materials

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**Keywords:** caking, strength, powder materials

In recent years, there has been increasing interest in caking in bulk materials. Hence, there is a need to develop research methods to identify this phenomenon. The aim of this study was to design a new measuring device to assess the phenomenon of caking, as well as the degree of strength of free-flowing powders. In the experiment, wheat flour and potato starch were used, which were placed in perforated vessels with a centrally placed measuring rod, and then loaded with 5kPa and 10kPa. The new method is based on measuring the force through a sensor when pulling out measuring rods made of plastic and steel from the powder sample.

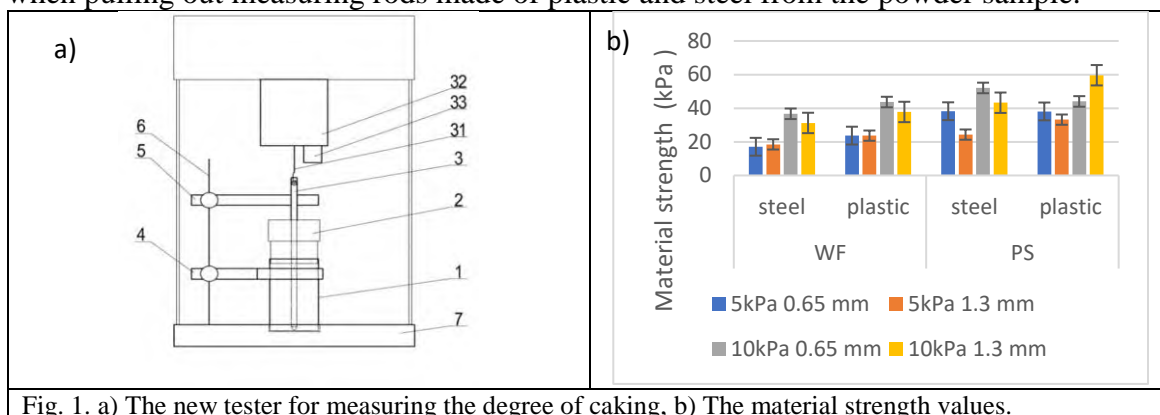


Fig. 1. a) The new tester for measuring the degree of caking, b) The material strength values.

It was shown that higher strength values were obtained for powders loaded with 10 kPa, and that groove depth was not significant for wheat flour. In the case of steel rod and potato starch, it was observed that for smaller gouges the material shows higher strength, while for plastic rod the strength results for 10 kPa and deep gouges show significant deviation from the others. Additionally, a difference was observed in the graphs recorded by the sensor for wheat flour and starch, where slip-stick was present in the case of potato starch.

Based on the study, it can be concluded that the newly developed device for evaluating the degree of flowability and caking of food powders can be used to determine changes in strength during storage. Results obtained with the device for wheat flour and potato starch give high repeatability and can be used to assess the degree of caking of these powders. The results obtained with the device can also be used to characterize the slip-stick phenomenon in starch.

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## Volume specific heat, combustion heat and calorific value of straw pellets and rape waste pellets

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**Keywords:** thermo-energetic parameters, thermal parameters, measurements, energy recovery

For energetic quality determination is necessary to know basic thermal and thermo-energetic parameters. This research was focused on the combustion heat, calorific value and volume specific heat identification of rape waste pellets and straw pellets. Pellets are very specific biomaterial with variable chemical and physical properties. In generally pellets are classified as solid biofuel with consistent quality and low moisture content. For pellets is typical high energy density. From the macroscopic point of view, they consist of many components and they have non homogenous structure. For thermo-energetic parameters identification was used calorimetric system IKA C5000. In this calorimetric system heat created during the burning process can be determined by adiabatic measurement procedure. Thermal parameters were measured by thermal analyser – Isomet 2104 by application of Extended dynamic plane source method. The values of pellets volume specific heat were calculated from thermal conductivity and thermal diffusivity. For each sample of pellets were made two series of measurements. In the first series were measured thermal parameters at constant laboratory temperature 20 °C. Every thermophysical parameter was measured 100 times. The results were statistically processed, and final values are presented in Table 1. Low percentage error was caused by stabilisation of measurement settings and precise application of measurement methodology. The second series of measurements was focused on the combustion heat and calorific value determination. All presented results are in good agreement with literature (Oberberger – Thek, 2010) and (Gravalos et al., 2010). In general, was confirmed fact that pelleting process has positive influence on energetic parameters of rape waste pellets and straw pellets. Compaction of agricultural waste on pellets is one of the best ways of their energy recovery.

Table 1 Results for thermal and thermo-energetic parameters of straw and rape waste pellets

	Straw pellets	Rape waste pellets
Dimensions, moisture cont.	$d = (10 - 14) \text{ mm}, h = 20 \text{ mm}, 7.52\%$	$d = (10 - 14) \text{ mm}, h = 20 \text{ mm}, 8.20\%$
Ash/Sulphur/Chlorine cont.	4.10%, 0.15%, 0.56%	4.60%, 0.24%, 0.26%
Arithmetic average of volume specific heat	$\bar{c}_p = 0.660 \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}$	$\bar{c}_p = 0.706 \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}$
Final value of volume specific heat	$c_p = (0.660 \pm 0.004) \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}$ $c_p = 0.660 \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1} \pm 0.61\%$	$c_p = (0.706 \pm 0.003) \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}$ $c_p = 0.51 \cdot 10^7 \text{ J} \cdot \text{m}^{-3} \cdot \text{K}^{-1} \pm 0.42\%$
Combustion heat	18.4 MJ·kg <sup>-1</sup>	18.7 MJ·kg <sup>-1</sup>
Caloric value	16.5 MJ·kg <sup>-1</sup>	16.8 MJ·kg <sup>-1</sup>

**Acknowledgement:** This publication was supported by OP- the project Drive4SIFood 313011V336, cofinanced by ERDF.

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## Tensile strength of sawdust pellets. Measurements and Discrete Element Method modeling

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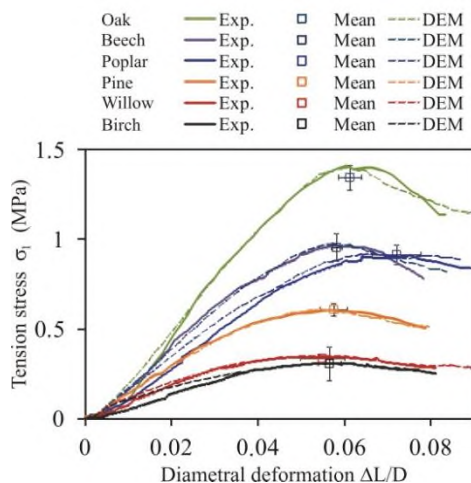
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**Keywords:** sawdust pellets; diametral compression test; tensile strength

Wood residues have become an important renewable energy resource. Mechanical strength is one of the crucial properties of biomass fuel pellets. The tensile strength pellets produced of beech, birch, oak, pine, poplar and willow sawdust was determined in the diametral compression test. Sawdust of the moisture content (*MC*) of 8% and 20% was compacted in the die up to 60 and 120 MPa. The highest tensile strength was obtained for oak and the lowest for birch pellets. For all materials the tensile strength was the highest for *MC* = 8% of sawdust compacted under the pressure of 120 MPa.

Discrete Element Method (DEM) simulations were performed to investigate the possibility of numerically reproducing the pelletization process of sawdust and then the stress-deformation response of pellets to the diametral compression [1]. Results of simulations reproduced well results of laboratory testing and provided some deeper insight into particle-particle bonding mechanisms. Breakage process of pellets was successfully simulated using DEM with the Bonded Particle Model (BPM) [2]. All pellets revealed the ductile breakage mode characterized by the smooth and round stress-deformation relationship without any sudden drops. Cracks were initiated in locations close to the centre of the pellet and developed in the direction of loading and towards interior of the pellet. Breakage process of pellets of all tested wood materials was successfully simulated using the DEM with BPM for the ratio of the elastic modulus to the tensile strength of bonds higher than 0.25.



**Fig. 1. Fitting the  $\sigma_t(\Delta L/D)$  relationships of the diametral compression of pellets. The bars indicate the standard deviation of the mean value.**

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## Determination of the compressive and colour properties of the straw fuel pellets

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**Keywords:** straw pellets, failure strength, modulus of elasticity, colour, CIE L\*a\*b\*

The aim of the study was the evaluation of the compressive properties of the straw pellets and the colour differences between them. Modulus of elasticity and failure strength of the pellets at the compression were determined from compression diagrams (Fig. 1). A testing machine Andilog Stentor 1000 (Andilog Technologies, Vitrolles, France) was employed for uniaxial compression tests. Two sorts of pellets were measured: made from wheat straw and made from the mixed wheat and barley straw. The diameter of the pellets was 12 mm. The length was different from 5 mm to 40 mm.

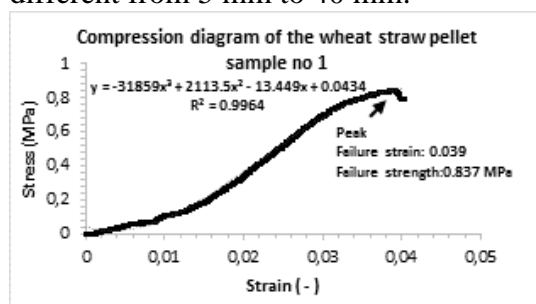


Fig. 1. Compression diagram.

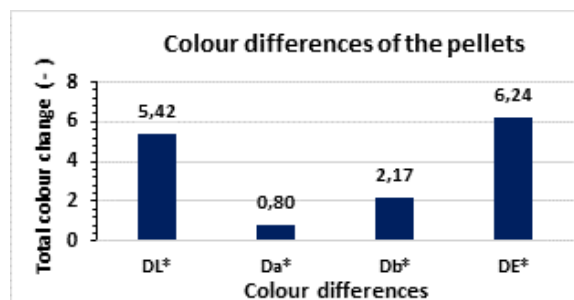


Fig. 2 Comparison of colour differences.

Samples were measured by a spectrophotometer 3NH YS3020 (Shenzhen 3nh Technology CO., LTD, China) and computed as the mean of twenty samples. L\*, a\* and b\* were used to define a three-dimensional color space and interpreted L\*, the lightness, the values ranging from 0 to 100, a\*, redness and greenness, b\*, yellowness and blueness. Cylindrical model CIELCh or CIEHLC space is a color space based on CIELAB, which uses the polar coordinates C\* (chroma, relative saturation) and h° (hue angle, angle of the hue in the CIELAB color wheel) instead of the Cartesian coordinates a\* and b\* were also used [1,2,3]. The color differences  $\Delta a^*$ ,  $\Delta b^*$  and  $\Delta L^*$  were determined by the spectrophotometer for the couples created of both sorts of the pellets. The wheat pellet compressive parameters were better than the mixed pellets. The failure strength of the wheat pellets was greater than the failure strength of mixed pellets. The color parameters of both sorts of pellets were very similar. The differences of the colour between both sorts of the pellets reached values  $\Delta L^* = 5.419$ ,  $\Delta a^* = 0.803$ ,  $\Delta b^* = 2.169$  and  $\Delta E = 6.235$  (Fig. 2). The pellets were distinguishable also by the eye.

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## Evaluating of dielectric properties of 3D printing materials: ASA and ABS

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**Keywords:** FDM, 3D printing, loss factor, relative permittivity

3D printing is a very widespread technology, which has found its application in a number of regions such as agriculture, aerospace, automotive, healthcare, especially for the possibility of rapid prototyping [1, 2]. 3D printing is also currently used for automated production of electrical and electromechanical equipment and for this reason, it is appropriate to know the dielectric properties of these materials [3]. This work is aimed on the evaluation of relative permittivity and loss factor of materials for 3D printing - ABS (acrylonitrile butadiene styrene) and ASA (acrylonitrile styrene acrylate). The samples were made by a 3D printing method called FDM (Fused Deposit Modelling). Total capacity and Q factor of the tested samples were measured in frequency range 100 Hz - 100 MHz: range 100 Hz - 100 kHz by device Motech MT 4080A RLC meter and in the range 1-100 MHz by Agilent 4991A Impedance / Material analyzer. The relative permittivity of the sample is calculated from the capacity of samples comparing with capacity of the Teflon control sample. The loss factor is determined from the Q factor. In terms of relative permittivity, the values of both of the tested materials were very close to each other. The average permittivity of the ASA was determined at 3.19 and the ABS 2.95. Both of the materials showed a slight decrease of permittivity with increasing frequency, this decrease was stronger at lower frequencies. The frequency dependence of ASA loss factor displayed sharp increase up to 10 MHz. At the higher frequency, this dependence was decreasing. On the other hand, the ABS frequency dependence was decreasing on the entire measuring range. The loss factor of the ASA ranged between 1.27% (80 MHz) - 1.93% (5 MHz) and the ABS was in the range 0.17% (76 MHz) - 1.6% (100 Hz). The ABS material showed significantly lower values of the tested parameters over the whole measuring range, and due to, it can be concluded it appears to be a more suitable for usage in electrotechnical applications.

### Acknowledgement

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## Strength of shaped adhesive bonds with epoxy-glass fiber composite layer

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**Keywords:** tensile strength, fiber composite, overlap bonds, SEM

The adhesive bonding technology is a perspective method of bonding various materials where single overlap bonds are most common. There is a problem with stress transmission through the adhesive layer [1,2]. The stress transmission can be improved by a bond construction and reinforcing of the adhesive layer [3,4].

The research dealt with reinforcing of epoxy adhesive bond with glass fiber and modified shape of bond. The angle of overlap bond was 5°, 10°, 15°, 20° and straight (0°) bond was the etalon. The reinforcing glass fiber was used in weight 80, 110, 160 g.m<sup>-2</sup>. The adhered for bonds was aluminum alloy EN AW 2024 T3 (AlCu4Mg1) with size 1.6 x 1000 x 2000 mm and overlap length was 25 mm, see Fig.1 A.

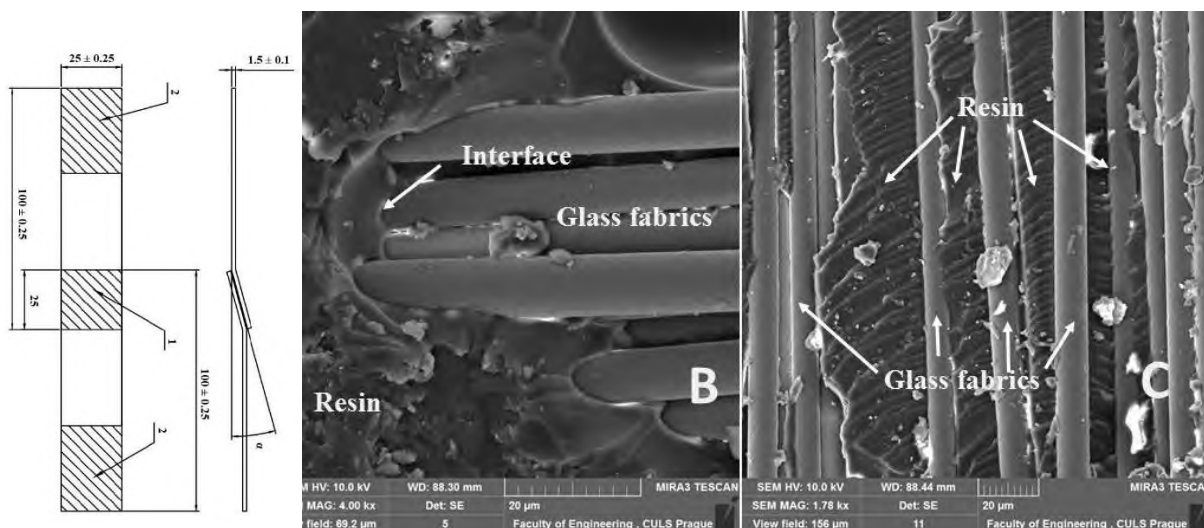


Fig. 1. A) Overlap bond, B) fracture surface of adhesive bond with reinforcing fabric 160 g.m<sup>-2</sup>, C) fracture surface of adhesive bond with reinforcing fabric 160 g.m<sup>-2</sup>.

The Anova F-test proved significant difference of the adhesive bond strength with adherent angle on significant level 0.05 i.e., the adhesive bond strength was improved with the shaped adherent angle. Significant difference of the adhesive bond strength with glass fabric on significant level 0.05 i.e., the glass fabric significantly influences the strength. The adhesive bond strength increase depends on good wettability of reinforcing fiber (fig. 1 B and C). The maximal strength  $13.1 \pm 0.25$  MPa was achieved by adherend angle 5° and reinforcing glass fabric 80 g.m<sup>-2</sup>. The strength of bond increases up to 48.50 % against the non-modified adhesive bond. The non-reinforced adhesive with angle 20° and has lowest strength  $6.29 \pm 1.51$  MPa. The strength decreases up to 28.69 % against the non-modified adhesive bond. The reinforcing glass fabric and adherend angle of adhesive bond had a positive effect on mechanical properties and changed the failure type of adhesive bond from adhesion to cohesion failure.

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## **Quality of food materials**



## Food quality assessment and electrical properties

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**Keywords:** electrical properties, influencing factors, food materials

Food quality is the overall set of binding properties and characteristics of a product that give it the ability to meet the specific needs of the consumer [1]. Foods have very complex molecular structure, they are very complicated in their composition, properties and behavior. They are nonhomogeneous from microscopic and also macroscopic points of view.

The measurements of electrical properties in most cases has no effect on foods, it is a nondestructive measurement. Measuring with electrical sensors is quick, easy, reliable and no operator is required, while the resulting data can be directly processed into required electronic form. Dielectric spectroscopy techniques enable non-destructive and non-invasive measurements of the agricultural materials and foods, therefore providing tools for rapid evaluation of their water content and quality [2,3].

As factors influencing electrical properties of foods, we can state that the dominant role has moisture content, other chemical composition, value-added components to foods, temperature and frequency (polarization mechanisms). Specifically, the electrical properties depend on the distribution of electric charges, which are either constantly embedded within the molecules or become temporarily induced on their surfaces [2].

In the literature, we found information about electrical properties of liquid foods utilized at its quality determination. For example, they can be used at the detection of chemical substitutes in liquid food products, e.g. quality of tea, at the detection of oil adulteration, chemical composition for UHT milks, the water content in milk and so on. We also measured electrical properties of cow's and sheep's milks, juices, mineral waters Mitická, wine, also time dependence of conductivity during must maturation, ...

Electrical properties measurement of fruits and vegetables are also described in many scientific papers, at the determination of fruit ripeness (bananas, apples, ...), at fruits and vegetables drying, at the description of degradation processes.

In case of loose materials, we can find information about utilization of these properties at the moisture content determination in grains and seeds [4], mechanical damage detection, germination assessment, presence of insects in grains and seeds detection, ...

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## Cadmium and lead adsorption on microalgal exopolysaccharide

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**Keywords:** cadmium, lead, exopolysaccharide, microalgae

Exopolysaccharide (EPS) are macromolecules produced by microorganisms, e.g. unicellular algae. Their soluble form is released by microalgal cells to the environment in response to various environmental factors. EPS plays mainly a cell protective role against environmental stresses. One of the important properties of EPS is its capability of metal binding. These properties are related to the negative charge of the exopolysaccharide. These biopolymers contain acidic groups derived mainly from uronic acids ( $\text{COO}^-$ ), pyruvate, and inorganic residues ( $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ). With its ability to bind metal ions, EPS can be applied in wastewater bioremediation. The presence of toxic heavy metals in wastewater is one of the major threats to the environment. Extracellular polymeric substances seem to be good biomaterials for metal removal from aquatic solutions, especially due to their effectiveness even at low concentrations of metal ions. Additionally, EPS are biodegradable and do not cause extra pollution.

The capability of cadmium and lead adsorption on EPS has been measured by dissolving lyophilized EPS in metal salt solutions. Next, the exopolysaccharide with adsorbed metal ions was separated by centrifugation and filtration from the metal solution. The pellet was lyophilized and the FTIR spectrum was measured, while the supernatant was used for measurements of the metal content. The amount of metal ions was determined using ICP-OES.

The results have shown that EPS have better binding capacity in the case of lead.

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## Impact of selected phenolic acids on the secondary structure of gluten network studied by infrared spectroscopy

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**Keywords:** Phenolic acids, Gluten network, Infrared spectroscopy

Baked products, especially wheat bread, are one of the basic components of the diet. Thus they can be regarded as an appropriate carrier of valuable substances for the human body. Bread quality is strictly related to the structure of gluten, which is continuous and viscoelastic network that is formed during dough mixing process [1].

Plant polyphenols can be used as supplements of a wheat bread. These compounds are natural antioxidants that inhibit the process of food spoilage and generally improve its quality [2]. However, too high content of polyphenols may reduce the organoleptic properties by increasing the astringency and bitter taste of the bread [3].

The aim of the research was to determine changes in the secondary structure of gluten network influenced by selected phenolic acids (*p*-hydroxybenzoic acid, protocatechuic acid, vanillic acid, syringic acid, *p*-coumaric acid, caffeic acid, ferulic acid, sinapic acid). The samples of the model dough supplemented with the phenolic acids were prepared in the farinograph. Phenolic acids were added to the dough in amounts of 0.05%, 0.1% and 0.2% (w/w). The process of mixing supplemented dough lasted 1 hour (overmixing). After that, the gluten was washed out, frozen, lyophilized and pulverized. Samples were moisturized by 10% aqueous solution of D<sub>2</sub>O by 4 hours and then the secondary structure of gluten network was studied with the FT-IR. FT-IR was used to determine changes in the secondary structure by analysis of the amide I (1570-1720 cm<sup>-1</sup>), and amide III (1200-1330 cm<sup>-1</sup>) bands. Moreover, the water population were studied by analysis of changes in OH stretching region (2800-4000 cm<sup>-1</sup>).

Analysis of the amide bands showed incorporation of the phenolic acids into gluten network. Moreover, overmixing in the presence of phenolic acids led to dough breakdown and partial dehydration of the gluten network.

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The research was financed under the OPUS 18 Project obtained from National Science Centre, Poland, grant no. 2019/35/B/NZ9/02854.



## **Influence of selected flavonoids and their glycosides on the secondary structure of gluten proteins in a model wheat dough**

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**Keywords:** gluten, polyphenols, FT-IR spectroscopy, secondary structure

Currently, people's awareness of proper nutrition is increasing. Their food preferences are also changing. Therefore, there is a need to improve and enrich the consumed food with ingredients that could positively affect the human body. Bread, which is still widely consumed, can be an appropriate carrier of valuable nutrients for the body. This additive can be phenolic compounds, which are characterized by "pro-health" properties. Consumed in the daily diet, they could have anti-cancer, anti-diabetic and anti-allergic properties [1].

However, enriching bread dough with additional ingredients significantly degenerate 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 [2, 3].

The aim of the research was to examine the effect of selected flavonoids and their glycosides (quercetin, naringenin, hesperetin and rutin, naringin, hesperidin) on the structure and properties of a model wheat dough. These compounds were added in concentrations of 0.05%, 0.1% and 0.2% to the model flour consisting of wheat starch and wheat gluten in a proportion 80:15 (w/w). The samples obtained as a result of kneading, washing out and lyophilization were tested using FTIR spectroscopy. FTIR spectroscopy provides an insight into the secondary structure of proteins by analyzing the amide I ( $1570\text{--}1720\text{ cm}^{-1}$ ) and amide III bands ( $1200\text{--}1340\text{ cm}^{-1}$ ) and observing changes in water populations (OH stretching  $2800\text{--}4000\text{ cm}^{-1}$ ).

Analysis of the difference spectra in the amide I band showed that all spectra can be divided into two spectral regions. The range from  $1570$  to  $1650\text{ cm}^{-1}$  with negative bands and the range from  $1650$  to  $1720\text{ cm}^{-1}$  with positive bands. A similar arrangement of the bands in the positive range, related to  $\beta$ -sheets and anti-parallel  $\beta$ -sheets after the addition of quercetin, naringin and their glycosides, indicates that these compounds react with gluten proteins with the OH group present at the B ring. However, a different arrangement of the bands in the case of hesperetin and its glycoside is bound to an additional OCH<sub>3</sub> functional group present in the structure of these compounds.

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## **Energy from renewable sources – part 2**



## Lessons learn from research activities in photovoltaic field – scientific and academic collaborations of ITENAS and MATE

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**Keywords:** Solar power plant, 1 and 2 diode model, SARIMA, FTS, machine learning

The Hungarian University of Agriculture and Life Sciences (MATE), Godollo – Hungary as the legal successor of former Szent István University (SZIU) has been a partner of the Institut Teknologi Nasional (ITENAS), Bandung – Indonesia in the field of research and academic since 2006 (official MoU was just signed in 2013). During the years of cooperation, the implementation of several research projects, student and staff mobility programmes have been executed fluently, while considering the interests of both parties.

In the field of research, a focus was emphasized on the photovoltaic (PV) field. Several of researchs activities have been performed at ITENAS campus, as a follow up that ITENAS has installed and operated a small scale of solar power plant (SPP), 1 kWp, as a research equipment's in the PV field, since beginning of 2018 [1].

Mostly of the PV research activities devote on the modeling aspects, and the current research topics are as follow [2]:

- Modelling of the PV modules characteristics by single and double diode model using visual basic for application (VBA) Microsoft Excel;
- Modelling of the PV energy production using the statistic linear (time series): Seasonal Autoregressive Integrated Moving Average (SARIMA) and Fuzzy Time Series;
- Modelling of the PV Energy production using machine learning: Naive Bayes classification and suport vector machine (SVM).

One of the result from a modeling of PV characteristic using Visual Basic for Application (VBA) Microsoft Exel is illustrated in Fig. 1.

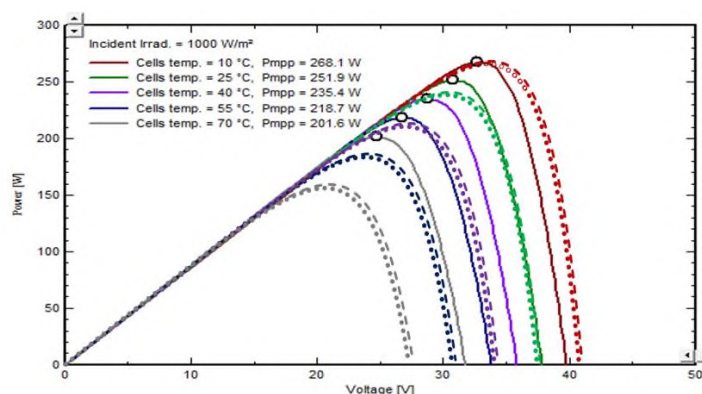


Fig. 1. The results of PV modeling characteristics using VBA Microsoft Excel

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## Forecasting of PV energy production using time series and machine learning modeling

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**Keywords:** solar energy, root mean square error, mean absolute error, naïve bayes

Integration of energy produced by the photovoltaic (PV) into electrical networks is a new challenge. To facilitate PV penetration, the forecasting of solar energy is required. This paper proposes the forecast of PV energy production using the statistical linear (time series) and the machine learning approach and compares it, in order to find the best forecasting model in view of Root Mean Square Error (RMSE) and Mean Absolute Error (MEA). Python language is used to identify both models.

The SARIMA (Seasonal Autoregressive Integrated Moving Average) and FTS (Fuzzy Time Series) models are statistical linear models. The SARIMA class of model is an important forecasting tools, and is the basis of many fundamental ideas in time-series analysis [1] whereas the FTS forecasting methods have become attractive due to their simplicity, model transparency, and forecasting accuracy. Both models are used to predict energy production characteristics for next year's observation. The data used for examination were collected since Augustus 2018 until March 2021. Fig. 1 shows the sample of forecasting using Sarima model.

The tasking performance of machine learning is employed due to its data-driven and ability to model non-linear patterns [2]. The basic principle of supervised machine learning is based on probabilistic theory on the fact of randomness in classifying future events. Some critical issues which are data pre-processing, model hyperparameter setting, data selection, and performance evaluation will be discussed, followed by the Naïve Bayes (NB) Classification and support vector machine (SVM) methods implementation to obtain the accuracy of PV energy production forecasting.

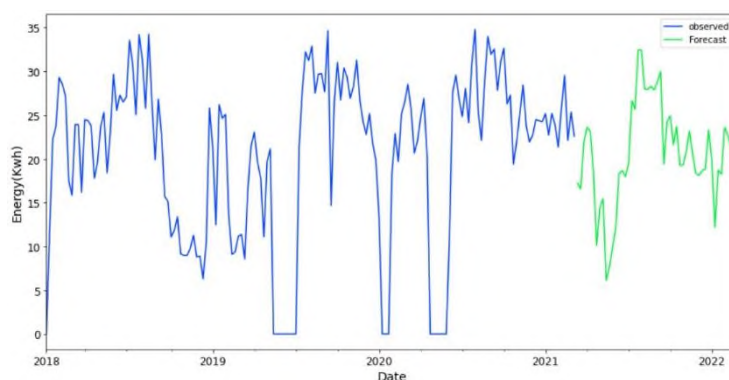


Fig. 1. The sample of forecasting resulted by SARIMA model

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## Thermal enhancement in parabolic trough solar collector using receiver geometry design and nanofluids

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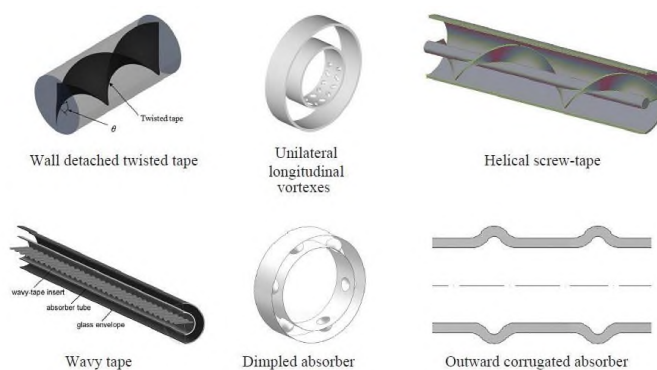
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**Keywords:** parabolic collector, receiver tube, nanofluid

Parabolic trough collector (PTC) is the most mature and widely deployed concentrated solar power technology. Receiver consists of a metal tube surrounding with or without glass cover in order to reduce the thermal losses and maintain the solar energy transfer to the working fluid producing heat at high temperatures up to 400 °C [1].

The goal of this research is increasing the thermal performance of PTC by improvement of the receiver geometry and the absorber tube by modifying the design (Fig. 1) [2]. For example, the various inserts in use are regularly spaced, simple twisted tape, helical screw tape, helical twisted tape, helical fins, protrusion, dimples, perforated louvered twisted tape, wire coil, longitudinal strip and butterfly tube insert. Nanofluids are using to increase the thermo-physical properties of working fluid such as the enthalpy, specific heat capacity, thermal conductivity and density [3]. In addition, nanoparticle volume fraction increase enhances heat transfer coefficient. Therefore, receiver design and nanofluid could raise the heat transfer coefficient and improving thermal conductivity.



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## Power quality performance assessment of grid-connected microinverter and string inverter photovoltaic systems

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**Keywords:** performance, quality, solar PV

Solar PV has experienced almost an exponential growth and has evolved from an unknown technology applied only in small-scale applications in the 1990s to becoming one of the significant non-traditional energy sources for use in active power generation ancillary purposes in the power distribution network. The bulk of the installed PV capacity is in the area of grid-connected systems [1]. As a result, the awareness of power quality issues has risen in recent years due to the massive power electronics in their composition integrated into the utility grid [2]. The purpose of this study was to investigate the power quality output of microinverter and string inverter grid-connected solar PV systems applied in a low voltage distribution network.

Analysis of the harmonic current and harmonic voltage distortion for each harmonic order and system was undertaken and comparisons made according to the acceptable grid standards. Experimental results showed that the current harmonic distortions for microinverters far exceeded that for the string inverter systems for all operating scenarios. The generated current harmonic distortions by microinverter systems ranged between 4.55% to 387.69%, while it was 1.80% to 77.70% for string inverter systems. The string inverter systems recorded a 3.45% power factor that failed to meet the specified standards for the worst operating condition scenario, while it was 100% for the microinverter systems.

### Acknowledgement

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## Various typical solar collectors in ORC applications

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**Keywords:** solar collector, organic rankine cycle, bibliometric, vosviewer

Organic Rankine Cycle (ORC) is similar as the conventional Steam process but uses low boiling temperature of organic fluids instead of water. At the same time, there are several advantages of ORC system as no superheating, lower turbine inlet temperature, higher condensing pressure, no water-treatment system, compact size and the most important one is the environmental-friendly solution (Quoilin et al., 2013). Although, ORC can generate electricity in low range temperature, it still needs heat from another system. The solar thermal resources can be successfully combined with ORC.

Solar collectors with good optical performance and thermal storage are the two core components in solar thermal applications. The growth of interest in research of solar-ORC technology is increase in the last 10 years which can be seen from the publications contained in databases such as "Science Direct" and "Web of Science" with the keywords of "solar AND ORC" or "solar collector AND ORC" is presented by Fig. 1.

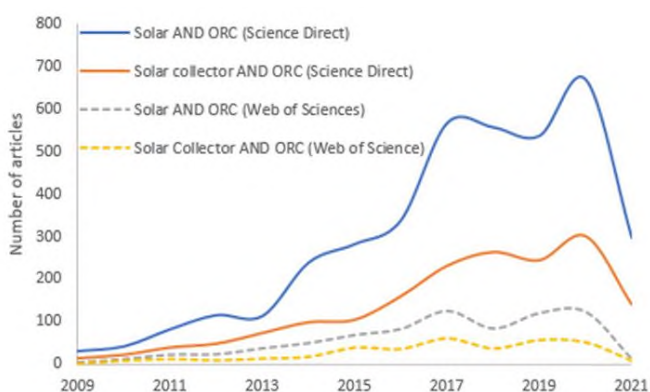


Fig. 1. Number of publications for selective topics in different database

This paper is presented a detailed framework and to report the novelty of the newest trends on the research of organic Rankine cycle, evaluating its role in a wider context extended to different levels of solar collector as a heat source. Currently, the analysis of bibliometric through VOSviewer software was known as a fascinating technique in the last five years and can provide a research gap related to solar collector and ORC.

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This work was supported by the Stipendium Hungaricum Programme by the Doctoral School of Mechanical Engineering, Hungarian University of Agriculture and Life Science, Gödöllő, Hungary and the Department Mechanical Engineering, Institut Teknologi Nasional, Bandung, Indonesia.

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## Impact a combination of solar energy and geothermal systems on PV output power

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**Keywords:** PV output power, solar energy, earth-air heat exchanger, solar chimney

The output power of the PV solar cell is affected by the rise of the PV solar cell temperature, particularly, in hot climates. The rise in the temperature of the PV solar cells causes the reduction in their electricity. A solar chimney is a form of passive solar design that can be used to produce electricity. A chimney operates by increasing the buoyancy force to aid the air flow through a structure [1]. This reason motivated me to investigate and study various aspects of the renewable energy systems more focusing on the output power of PV solar cell, solar chimney, earth-air heat exchanger, design performance and also the study extended to deal with the performance and economic feasibility of the system.

Some researchers were improving the output power of PV solar cell by using solar chimney, some numerical results show that the PV system output power has positively been affected by increasing the chimney height [2]. Others carried out an experimental analysis of the solar chimney which integrated the solar panels to increase the efficiency of the solar panel by increasing the chimney height [3]. Other researchers were improving the output power of the PV solar cell by using solar chimney and Geothermal energy, they are presenting a new idea of hybrid geothermal/PV/Solar chimney which was suggested to be built in the south region of Libya. Geothermal hot water was pumped and circulated through pipes on the soil under the collector roof. PV was added to the system to replace the glass roof [4].

This work aims to enhance the output power of PV solar cell by using Geothermal energy (EAHE) to supply relatively cold air for cooling PV solar cell in order to increase the total useful power produced by the system with assist solar chimney. The purpose of using a solar chimney is to increase air velocity (Kinetic power) without energy consumption, as a result, it is lead to enhance the efficiency of the PV solar cell by using hybrid system.

### Acknowledgment:

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## Operation of PV power plants located in different climatic conditions

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**Keywords:** photovoltaics, PV power plant, data monitoring

The amount of electricity generated is significantly influenced by the design of the photovoltaic (PV) power plant and its location. We have developed our own monitoring system Solarmon-2.0 [1]. We compare advanced PV system with tracking stand of PV panels installed in Chile (Cuz Cuz, southern hemisphere) and two PV systems of conventional construction with fixed PV panels installed in Central Europe (Prague) [2].

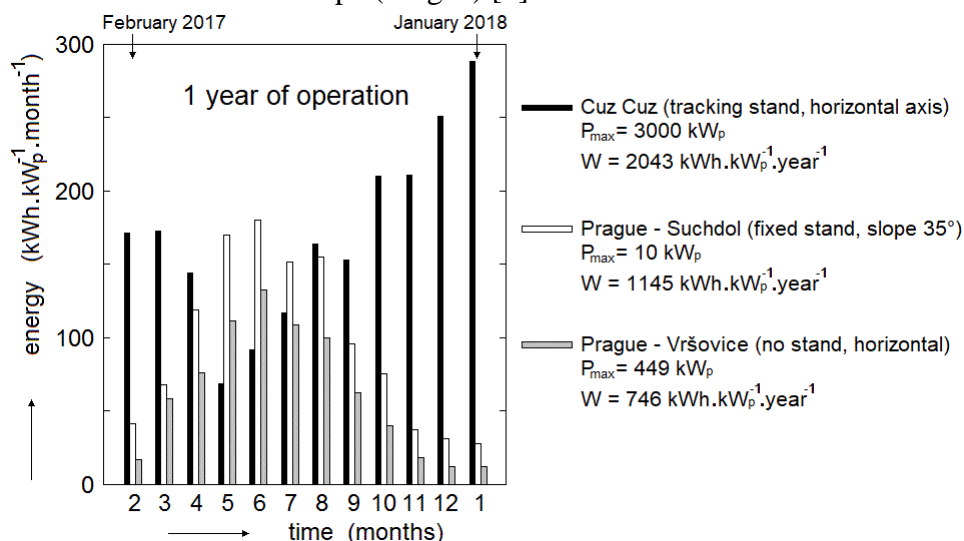


Fig. 1 The amount of electricity produced in the said PV systems during one year

Our monitoring system Solarmon-2.0 monitors about 80 PV power plants in different parts of the world. In this work, we compared and discussed the evaluated data from power plants in locations with very different solar conditions. The location in the half-desert area in northern Chile is, according to all forecasts, one of the places with excellent solar conditions, as confirmed by our data. Sun tracking stands slightly increase the amount of electrical energy produced, but at higher latitudes they must have an inclined polar axis. The individual racks must be set apart from each other so that they do not shield each other. In this way, however, the use of the area of the PV power plant is reduced and the price of the area is high in Central Europe. Conversely, in subtropical half-desert regions, the rotational axis can be oriented horizontally, thereby minimizing shielding. In addition, the price of the power plant area is lower.

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## **Physical properties of plant materials**



## Visualization and structural characterization of plant cell wall hemicelluloses

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**Keywords:** hemicellulose, bacterial cellulose, network, AFM, nanostructure

The firmness of fruits and vegetables is mainly generated by the cellulose-hemicellulose domain of plant cell walls (PCW). An ideal way to explore vital processes in PCW is to provide experimental non-invasive observation. Molecular dynamics (MD) simulation significantly decreases time of experiments, especially when dependences from variables need to be provided. The purpose of this study was to visualize and characterize distribution of fiber diameters, length and shape parameters of hemicelluloses (xyloglucan XG, xylan XYL, arabinoxylan AX and Konjac glucomannan KGM) for further development of PCW computational model. Hemicelluloses were spin-coated on mica from aqueous solution and visualized with AFM (*MultiMode 8-HR, Bruker, Santa Barbara, USA*).

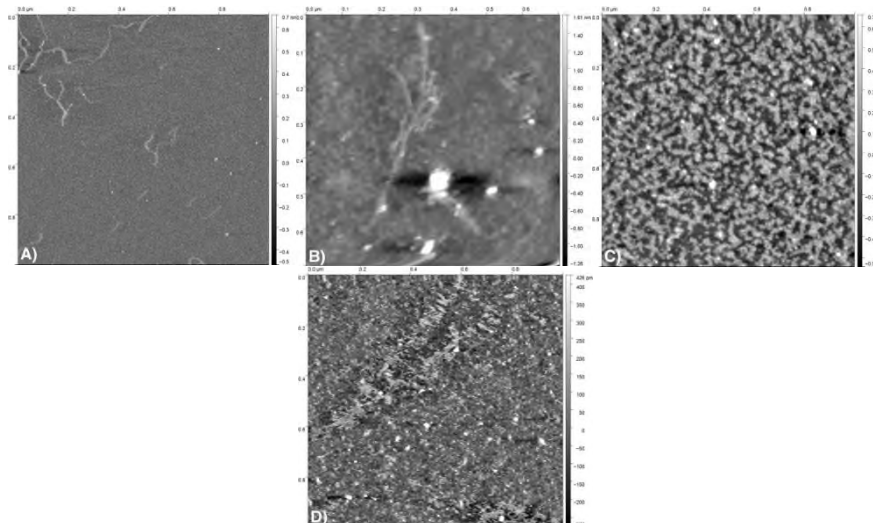


Fig. 1. An overview of hemicelluloses, spin-coated from its solutions – A) xyloglucan  $10^{-3}$  mg/ml; B) xylan  $2 \times 10^{-7}$  mg/ml; C) arabinoxylan  $2 \times 10^{-5}$  mg/ml; D) Konjac glucomannan  $10^{-3}$  mg/ml.

	Length, nm	Height, nm	Lowest persistence length, nm	Average persistence length, nm	Bending angles, °	Complexing angles, °
Xyloglucan	324(182) <sup>a</sup> N = 48	0,77(0,49) N = 48 N <sub>p</sub> = 15586	7,96±0,75	18,05(6,64) N = 8	121,1(18,0) N <sub>p</sub> = 121 N = 28	98,2(37,6) N <sub>p</sub> = 18 N = 12

Table 1. Structural characterization of hemicelluloses. N<sub>p</sub> – number of data used for mean calculation; N – number of analyzed chains; <sup>a</sup> – standard deviation in parentheses.

Lengths of fibrils correlate with earlier experiments. XG is randomly distributed on mica surface, being observed as a single chain, beam of chains, packed dense or with some intrafibril chain splits. It showed rope-like structure, with characteristic spoiled chain ends. Fiber height distribution is somehow in middle to values, obtained for plant-extracted fibrils and single chain, simulated with MD. Obtained data is necessary for modern biomechanical hotspot PCW model, which declare some XG quantities to create amalgam-like structures with periodic cellulose fibril kinks. XG bending and complexing angles describe xyloglucan as quite deformable flexible structure, which may signal about low persistence length values.

Lowest persistence length data somehow correlates with previous experimental results. Being coiled-structured polysaccharide, stiff, but still deformable, the binary role of XG as load-bearing and pectin-gathering component is crucial in PCW mechanical behavior. Obtained data will be used as a starting point for further creation and validation of single hemicellulose fiber numerical model.

This study is supported by the National Science Centre, Poland (Project no. 2019/35/D/NZ9/00555).

## **Influence of the phenolic acids addition on the structure and properties of microfibrillar cellulose and nanocellulose-based composites**

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**Keywords:** phenolic acid, cellulose, nanocellulose

Phenolic acids are a group of organic chemical compounds naturally occurring in plants. They perform a number of functions: they are antioxidants and natural insecticides, fungicides. However, these compounds structures are relatively unstable and prone to oxidation when isolated from plants. This makes it difficult to take advantage of the properties of polyphenols in the food industry without a permanent carrier [1]. A solution to this situation can be the production of composites based on nanocellulose and cellulose as a matrix material enabling the adsorption of this type of compounds. Cellulose due to its biocompatibility, high mechanical strength and relatively low density provides the possibility to produce completely biodegradable, durable and safe food packaging [2,3]. Phenolic acids adsorbed on the surface of such a composite allow to improve these packages with antioxidant properties and limit the development of microorganisms in food, which are particularly dangerous to human health. The properties of cellulose composites fortified by phenolic acids were measured by TEAC (trolox equivalent antioxidant capacity), (Folin–Ciocâlteu reagent) FCR, Raman and FTIR spectroscopy, contact angle measurement and differential scanning calorimetry (DSC) method.

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## LAMP - efficient detection of *Phytophthora* spp. found in organic strawberry plantations

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**Keywords:** fungal pathogens, molecular detection, organic strawberries

Pathogenic microorganisms cause severe reduction of harvest in the agriculture. Soft fruits, such as strawberries and raspberries, are especially susceptible to diseases. Their delicate fruits are prone to mechanical damage, creating a gateway to infection by pathogens present in the environment. *Phytophthora* spp. are widely known for attacking many ornamental plants, fruits and vegetables, critically reducing the yield [1,2].



Fig. 1. A) Strawberry fruits with fungal and bacterial diseases, B) Diseased strawberry root.

Molecular methods of the detection enable identification of pathogenic organisms present in the field, before manifestation of the disease on plants. However, PCR-based molecular techniques, widely used for the identification of microorganisms, require expensive thermocyclers, which provide the appropriate temperature cycles necessary to ensure reaction conditions. Nonetheless, for the modification of the technique, Loop-Mediated Isothermal Amplification (LAMP) [3], simple thermoblock is sufficient to carry out the reaction.

The aim of the research was to design primers sets and develop, and optimize the LAMP method for the detection of *Phytophthora* spp. and *Phytophthora cactorum*.

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## Relative permittivity measurement of chickpea (*Cicer arietinum* L.)

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**Keywords:** relative permittivity, electric properties, chickpea

This paper contains the results of measuring the relative permittivity (dielectric constant) of chickpea (*Cicer arietinum* L.) set. Chickpea (*Cicer arietinum* L.) is grown on low input marginal lands and represents an important component of the subsistence farming. It is the second most important grain legume globally cultivated on an area of 13.20 million hectare (Mha) with an annual production of 11.62 million tons [1]. This crop has been intensively researched in work of Varshney [1]. The research and determination of physical properties of agricultural materials has also resulted in the development of many instruments. The study of electrical properties is important for predicting the behaviour of a material in electric field or for knowing of how the presence of material can influence the field or associated electrical circuit [2]. Electrical measurements on these materials are of fundamental importance in relation to the analysis of quantity of absorbed water and dielectric heating characteristics. The research of electric properties is utilised in many technical applications. Measurements results are used for determination of moisture content, the surface level of liquid and grainy materials, controlling the presence of pests in seed storage, the quantitative determination of mechanical damage, and in many other cases [3]. The relative permittivity is one of the main parameters of dielectric material electrical properties. The electrical properties of chickpea samples had not been sufficiently measured, and the aim of this work was to perform the measurements of this property. Measurements were performed under variable moisture content and the frequency of electric field from 1 MHz till 16 MHz, using Q meter. It was concluded that relative permittivity increased with increase of moisture content, and relative permittivity decreased as the frequency of electric field increased. The measurement results indicate that most suitable frequencies of alternating electric field for dielectric heating of chickpea are higher than 10 MHz. The relationships of the relative permittivity of chickpea set samples provide the basis for the design of many commercial moisture-testing instruments. In the future, the performance of additional measurements at a wider frequency range would be desirable.

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## Plant photosynthesis under fluctuating light

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**Keywords:** photosynthesis, light fluctuation, drought, carotenoids

Photosynthesis is the process by which plants convert inorganic compounds into chemical energy and carbohydrates, creating the base of global food chain. Many environmental conditions influence the productivity of crops. Among them, the most important factors directly affecting the photosynthesis are water availability, abundance and quality of light. Slow enzyme activation reduces the efficiency of photosynthesis at rapid increase in light intensity and the specific dynamic of photoprotection lowers the efficiency upon light decrease. In field conditions, during vegetative season, plants deal with excessive, fluctuating light, often at limited water availability.

Excessive light intensity stimulates generation of very toxic, reactive oxygen species (ROS). One of the main adaptations to such stress is based on xanthophyll cycle, where violaxanthin is transformed by violaxanthin de-epoxidase (VDE) to zeaxanthin, a carotenoid form that allows plant to dissipate the excessive energy of excitation and protects from ROS formation [1]. Leaves shading occurring on windy days results in rapid light changes, that reduce CO<sub>2</sub> assimilation rate and overall productivity, as photosynthetic adaptation to light fluctuations is not instantaneous. Soil drought is another stressor, that is becoming more often within climate warming. One of relatively rapid response to drought is stomatal closure that limits water losses, but at the same time reduces CO<sub>2</sub> availability and dysregulates photosynthesis. As a result, increased generation of ROS may damage PSII components.

The aim of the study was to recognize how plants response to fluctuating light is altered by water deficit.

Plant material consisted of NPQ1 and NPQ4 single mutants and wild type (WT) plants of *Arabidopsis thaliana*. NPQ1 mutant is VDE deficient and thus, exhibits reduced nonphotochemical quenching of chlorophyll fluorescence, while NPQ4 mutant is protein PsbS deficient and defective in pH-dependent nonphotochemical quenching of chlorophyll fluorescence [2]. Plants were grown under controlled conditions. Water stress of increasing intensity was applied to 10 weeks old plants. Plants response to combined action of the stresses were evaluated using chlorophyll fluorometer IMAGING PAM Maxi (Walz GmbH). The measurements taken under condition of light fluctuations included quantum yield and nonphotochemical quenching of PSII. Leaf relative water content (RWC) was also measured as an indicator of leaf water status.

The results show that the frequency and duration of light fluctuations but also the intensity of water deficit has impact on plant ability to use and dissipate excessive irradiation. Further studies are needed to evaluate impact of enhanced PSI cyclic electron flow (CEF), rate of building up of the proton gradient at thylakoid membrane ( $\Delta pH$ ) and resulting conversion of xanthophylls.

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## Early effect of bacterial inoculum on the growth of raspberry plants and the soil enzymatic activity

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**Keywords:** biopreparations, raspberry growth, naturalisation, bacterial inoculum

Current trends in ecology and farming show growing demand for new ecological biopreparations to be used both in organic and conventional farming. European Strategy for Biodiversity for 2030 states that using chemical pesticides leads to soil microbial degradation and lowering overall soil quality. Biopreparations composed of naturally occurring microorganisms might be a solution to this problem. This type of biopreparation might not only directly improve soil quality but also if using strains that are inhibiting the growth of pathogenic microorganisms can provide a beneficial effect on plants [1].

In this research, we examined the early effect of 4 bacterial strains on the growth of raspberry plants during 8 week-long pot experiment. Isolated strains belong to genera *Arthrobacter*, *Pseudomonas* and *Rhodococcus* and were isolated from wild raspberry roots and rhizosphere. Those strains were proved to be effective in inhibiting the growth of phytopathogenic fungi and fungal-like organism belonging to genera *Botrytis*, *Colletotrichum*, *Verticillium* and *Phytophthora*. Raspberries Polana variety were used in the experiment due to their popularity in Poland, easy access to seedlings and good growth in enclosed conditions. Three naturalization strategies were tested including roots treatment, watering treatment and combined treatment. Each treatment strategy represents a particular situation in farming. Roots treatment represent newly set up raspberry plantations where it is possible to apply biopreparation before or during seedling planting. Watering treatment represents applying biopreparation to already existing plantations via a micro-irrigation system and combined treatment represent both strategies applied together. The pathogens were applied separately and all together to examine the influence of biopreparation in different contamination variants.

Application of microbial inoculum affected both plants growth expressed as dry mass of stems and leaves, and roots growth measured as the wet mass of roots. Certain naturalization strategies increased plants mass when compared to objects without the naturalization applied, but when no pathogens were present naturalization resulted in the decrease of plants mass regarding application type. Furthermore, the application of microorganisms resulted in differences in soil enzymatic activity by causing the increase of activity in objects without pathogens.

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## **Energy production and consumption**



## Production of maize-based biofuels and ammonia emissions

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**Keywords:** urea, inhibitor urease, maize, biofuels, ammonia emissions.

Agriculture as an important element of the world economy has a significant potential to mitigate the negative human impact on the progressive climate change [1], [2]. One such area where this can be expected is the reduction of ammonia emissions from crop production [3] [4]. At the same time, the growing world population and the need to feed the world, pose the challenge for agriculture to increase food production on a limited area of agricultural land. FAO predicts that by 2050 food production should be increased by 70% [5]. One of the ways of environment protection at increased soil fertilisation is introducing urease inhibitors into fertilisers (mainly urea) [6], [3].

Currently, the production of biofuels (especially first-generation liquid bioethanol and biodiesel) creates a real conflict between food and energy production, simultaneously GHG and ammonia emissions are enhanced. Maize is an example important crop and raw material for the production food and biofuels on a global scale. The dynamically growing production of biofuels from energy crops, especially maize, has very high fertilization needs and at the same time takes place on the area that could be used for food production [7] [8]. Applying urease inhibitors with urea fertilisation for maize cultivation significantly decreases nitrogen losses following the application of fertilizers. The variability and ambiguity of the published data on efficiency of N fertilisers use is caused by the heterogeneity of the soil and the variability of the conditions in the agricultural environment of the farmland, but also indicates the need for further research

The presentation will include an analysis of the possibilities of reducing ammonia emissions by commercial urease inhibitors, especially for agricultural maize cultivation for the production of biofuels. Issues related to the dynamics of biofuel production growth and the challenges faced by scientists and industry will also be discussed.

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## Performance evaluation of chimney dependent solar dryer for apple drying

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One of the most critical factors in successful crop storage is the water content of the product. When required to preserve food for storage, a dry alternative applied using solar radiation as energy input. There are several solar dryers used to achieve proper drying [1]. In this study, an Indirect type of solar dryer (ITSD) has been designed and experimentally tested at Hungarian Agricultural and Life Science University, Gödöllő, Hungary (47°35'51" N; 19°20'53" E). It consists of a flat plate solar air collector, a drying chamber with a chimney at the top, and measuring instruments for different parameters. 1 kg of apple slices has been used to evaluate this dryer.

During the tests, different properties such as solar incident, temperature, air velocity were measured to analyse the drying performance of the system. Mass of the product was measured at each hour by taken out from the dryer. The Table bellow shows different apparatus and their specifications for the measurment of diiferent paprameters.

Instruments	Equipment	Specification	Accuracy
Pyranometer	CM-11, Kipp & Zonen	Max: 4000 W. m <sup>-2</sup>	±0.1 W.m <sup>-2</sup>
Thermocouple	T-type		±0.5 °C
Handheld Anemometer	EC-MR 330 Eurochron GmbH	0 to 30 m.s <sup>-1</sup>	±0.3%
Weight scale	Hualitai		3 kg/0.1 g

Thermal efficiency of solar air collector and dryer were estimated using the following equations:

$$\eta_c = \frac{\dot{m}C_p(T_{co}-T_{ci})}{A_c I_c}, \eta_d = \frac{(m_i-m_f)[\gamma+C_{pw}(T_{do}-T_a)]}{Q_a}$$

The average thermal efficiency of the collector was 33% and overall drying efficiency of the system was found 22%. The final weight of apple slice was 600 g while 850 g for open sun dryer for the same drying period. This result revealed that fast drying time was observed compared with open sun method.

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## Enhancement techniques of solar air collector performance

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**Keywords:** solar air heaters, collector performance, thermal efficiency

Solar air collectors are used for applications, including space heating and drying of agricultural products. It simple in terms of construction and operation with low fabrication costs. It has many advantages over liquid solar collectors, such as corrosion, boiling, leakage, and freezing problems. The key drawback of air heaters is the inefficient heat transfer rates between the collector absorber and the air that passes through it. Additionally, the collector's thermal efficiency is low due to the weak thermal conductivity and heat capacity of the air (El-Sebaai *et al.*, 2011). This work aims to review the attempts of enhancing the solar air collector thermal performance using several techniques adopted by a different researcher.

Many researchers indicate that great efforts are required to improve solar air heater thermal efficiency by making different modifications, which includes using multiple passes instead of a single pass. That will improve the performance significantly as the air will take a longer path to collect the heat from the absorber, leading to an increase in the collector's final efficiency. Also, some research has shown that paying attention to the thermal insulation of the air heaters and reducing losses by using suitable insulating materials leads to considerably improving these heaters' performance. On the other hand, using a double glass cover reduces thermal losses to the external environment, as the air gap between the two layers creates excellent thermal insulation.

A significant point in improving thermal performance that using fins or obstacles in various configurations and positions will increase the area of the absorbing surface and develop turbulence inside the air pass, which improves the thermal performance significantly.

In the past few years, interest has begun to use phase change materials (PCM) as energy storage that is recovered after sunset to improve the thermal efficiency of the collector, mainly when used for drying purposes of crops. The efficiency of the heater with PCM enhanced by 12% over the ordinary collector, as was reported by Kabeel *et al.* (2016).

It can be concluded that there are opportunities to develop the solar air heaters' thermal performance through combining more than one technique to obtain the best results and raise its thermal efficiency as it is the main factor for measuring the performance of the collector.

### Acknowledgement

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# Influence of rotating machines on the stability of the electrical distribution network

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**Keywords:** angle swinging; grid frequency oscillations; electromechanical system; inertial masses, microgrids

The influence of grid frequency oscillations on synchronous machines coupled to masses with large moments of inertia is not neglectable. It is possible to calculate the maximum permissible value of a moment of inertia on the shaft of a synchronous machine considering the oscillation of grid frequency.

Grid frequency variation causes a load angle to swing on the synchronous machines connected to the grid [1,2]. It is necessary to consider a synchronous machine as a complex electro-mechanical system with some vibration properties. The electro-mechanical swinging system consists of the rigidity of a synchronous machine magnetic field, the damping effects, and the moment of inertia, which are connected with a shaft [3].

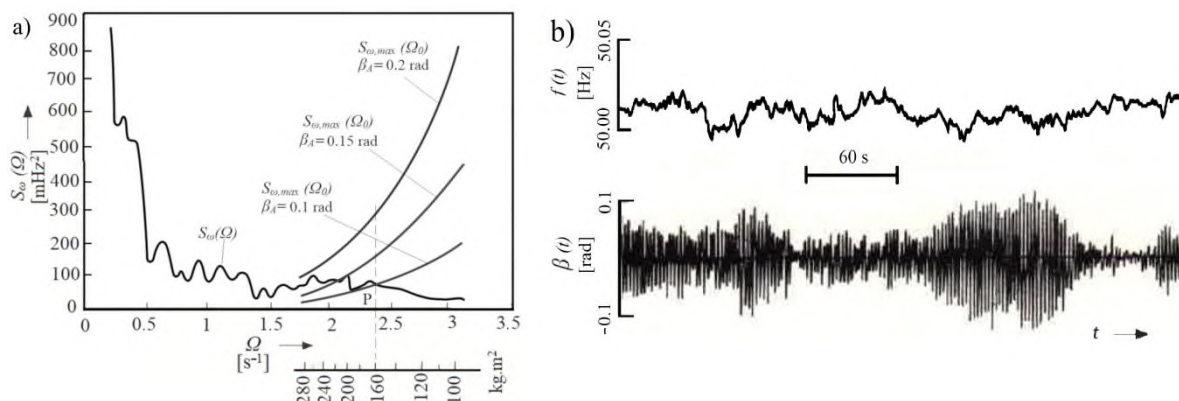


Fig. 1. a) Influence of grid fluctuations and inertial momentum on load angle, b) Grid frequency changes and load angle

Considering these properties, the maximum possible moment of inertia can be determined with the model of the electro-mechanical system and the use of statistical dynamics, at which there is no significant fluctuation of the load angle  $\beta$ . For the selected maximum values of  $\beta$ , the connection with the values of the inertial momentum and oscillations of the grid can be seen in the figure. This calculation was applied to a machine with a power of 50kVA and verified by measurement. Fig. 1b) shows that the average value of  $\beta$  remained in the required interval (-0.1; 0.1) rad.

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## Comparison of energy consumption of electric vehicle on different road profiles

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Electromobility is currently considered to be the successor of conventional vehicles with combustion engines. This is associated with reducing of local emissions production from transport and improving of environment not only in urban agglomerations, but also outside [1, 2]. This article is thematically focused on the comparison of energy consumption on three parts of the route of one selected electric vehicle.

The tested electric vehicle BMW i3s had weight 1365 kg, electric motor power of 135 kW and a torque of 270 Nm. The battery capacity is 37.9 kWh and the range of the vehicle is declared at 300 km [3]. The average speed reached 42.2 km.h<sup>-1</sup> on these three tested sections. Measurement of consumption was performed using diagnostic instrument (TEXA Navigator TXTs). External GPS module with recording was used for accurate determine of speed, rise of road and position. The testing route consisted of three parts: a road with defined slope in the length 1 km, the consumption was measured in both directions, and on the flat road of the same length. The measured parameters were speed, elevation, GPS coordinates and charging / discharging current.

The first measuring was realized going upwards with an elevation of 43.8 m. The average discharged / charged capacity was 0.94 / 0.02 Ah. Actual loss of battery capacity 0.92 Ah. The second tested part of the route was nearly flat with elevation of 2.5 m. The average discharged / charged energy was 0.33 / 0.17 Ah actual loss of battery capacity 0.16 Ah. The third part of the route was the descent, where the elevation was 42.3 m. The average discharged / charged energy was 0.13 / 0.30 Ah. The actual increase in battery capacity was 0.17 Ah.

The measurements show that driving uphill, the batteries were discharged by 0.92 Ah whereas driving downhill the source recharged by only 0.17 Ah. That means, only 18% of energy used going up was recuperated driving downhill. Energetic balance going on flat road was consumption 0.16 Ah which is by 83% lower than on the run up.

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## Comparison of electricity production in the Czech Republic in March 2020 and 2021

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**Keywords:** electricity production, energy mix, carbon intensity

### Abstract

The aim of this study is to compare the production of electricity in March 2020 and March 2021. The reason for choosing March is the fact that in 2020, there was a shutdown of many companies and factories which led to a reduction in electricity production. This study contains data collected in real time during the day - 6 am, 12 pm, 6 pm and 12 am. Figure 1 shows the amount of electricity production at 6 am. At this time The average monthly electricity production was 9,97 GW (2020) a 10,53 GW (2021).

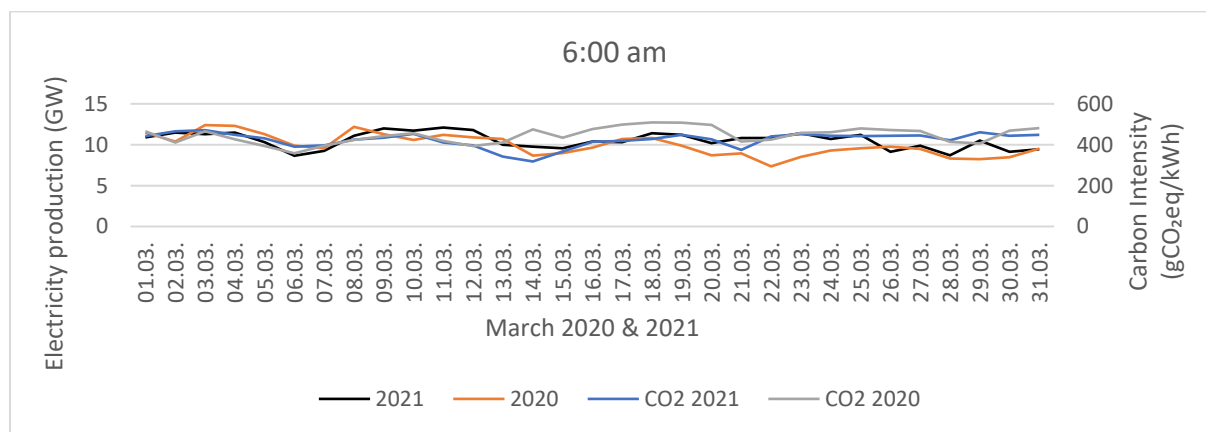


Fig. 1 Electricity production and Carbon Intensity

Figure 1 also shows a carbon intensity depends on the composition of the energy mix. The more we produce electricity from renewable sources, the less CO<sub>2</sub> is produced in the production of electricity.

Data is obtained in real time. Some low-carbon electricity sources like solar and wind energy are dependent on the weather. As we add more and more capacity of wind and solar energy, the carbon intensity of our electricity fluctuates more: when it is windy and sunny, the electricity is greener. But the reality is more complex than simply looking at the weather forecast; other low-carbon sources like nuclear power or hydropower are less weather dependent, and most grids are connected to other grids.

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