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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 Foundation of the Polish Academy of Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Czech University of Life Sciences, Prague, Czech Republic, Slovak University of Agriculture in Nitra, Slovak Republic** and **Institut Teknologi Nasional Bandung, Indonesia** – to participate in the 23rd International Workshop for Young Scientists "BioPhys Spring 2024" to be held in Lublin on **23rd – 24th May 2024**.

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 2024 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.** Abstracts of contributions will be published in the Book of Abstracts of the BPS 2024 Workshop.

Artur Nosalewicz
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INNOVATIONS IN IMMOBILIZATION TECHNIQUES FOR ENZYMES AND MICROORGANISMS IN BIOPROCESSES

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Keywords: immobilization, stability improvement, surface functionalization, biocatalysis

Immobilization techniques are crucial in enhancing the efficiency, stability, and reusability of enzymes and microorganisms in bioprocesses. Recent innovations in immobilization technology have led to significant advancements in various industries, including pharmaceuticals, food processing, biofuels, and environmental bioremediation.

There are basically four methods to immobilize either microorganisms or isolated enzymes: (i) on an insoluble organic or inorganic carrier (support), (ii) entrapment in a carrier such as hydrogel or polymer matrix which is generated in the presence of the cells or free enzyme, (iii) carrier-free self-immobilisation by cross-linking of enzymes or whole cells, and (iv) encapsulation the free enzyme (which remains a homogeneous water-soluble catalyst) in the intracellular environment, confined behind a biocompatible polymers or nanogels which are permeable to substrate and product [1].

By improving the immobilization methods, researchers strive to overcome challenges and unlock the full potential of bioprocesses for sustainable production and innovation. Scaling up immobilization techniques from laboratory to industrial scale remains challenging due to mass transfer, heterogeneity, and cost-effectiveness issues. Integrating immobilization techniques with emerging bioprocess technologies such as continuous processing and biorefinery concepts holds promise for further enhancing process efficiency and sustainability. Innovations in immobilization techniques for enzymes and microorganisms have revolutionized bioprocessing by improving efficiency, stability, and reusability. Continued research efforts to address scalability, biocompatibility, and integration challenges will further propel the adoption of immobilization technologies across diverse biotechnological applications [2, 3].

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RELIABILITY CENTERED MAINTENANCE STUDY ON DIESEL ENGINE

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Keywords : RCM, Diesel Engine, FMECA, FMEA

At the Jambi Gas Compression Station (PGN), the electricity supply that uses a gas engine is dead or experiencing problems, so the station needs to replace the electricity supply using a generator driven by a Diesel Engine. Diesel engines are engines that use a combustion engine for compression ignition [1]. The Diesel engine driving the generator used at the Jambi Gas Compression Station (PGN) is of the WÄRTSILÄ DEUTZ MARINE ENGINES brand with type TBD616V12. Diesel engines are very susceptible to malfunction, where many causes of malfunction are caused by human error, age factors, maintenance systems and equipment operation. The cause of this failure was also due to a lack of planning on the part of management to create a strategic plan for the maintenance program.

It is necessary to apply a reliability-based maintenance method (RCM) with qualitative analysis with the following steps: Determining machine characteristics, System Functional Separation Diagram, Developing System Block Diagram, Determining Functions and Functional Failures, Making a List of Functions and Functional Failures, Implementation/guidance on Failure Modes, Effect and Criticality Analysis (FMECA), Failure Mode Effect Analysis (FMEA), Selection of Failure Management Strategy or maintenance tasks, Summary of Maintenance Tasks [2].

This analysis is carried out on the basics of the motor drive system, namely the cylinder block, lubrication and governor. With this method, management can make policies and decisions on critical components to carry out preparation orders for critical components.
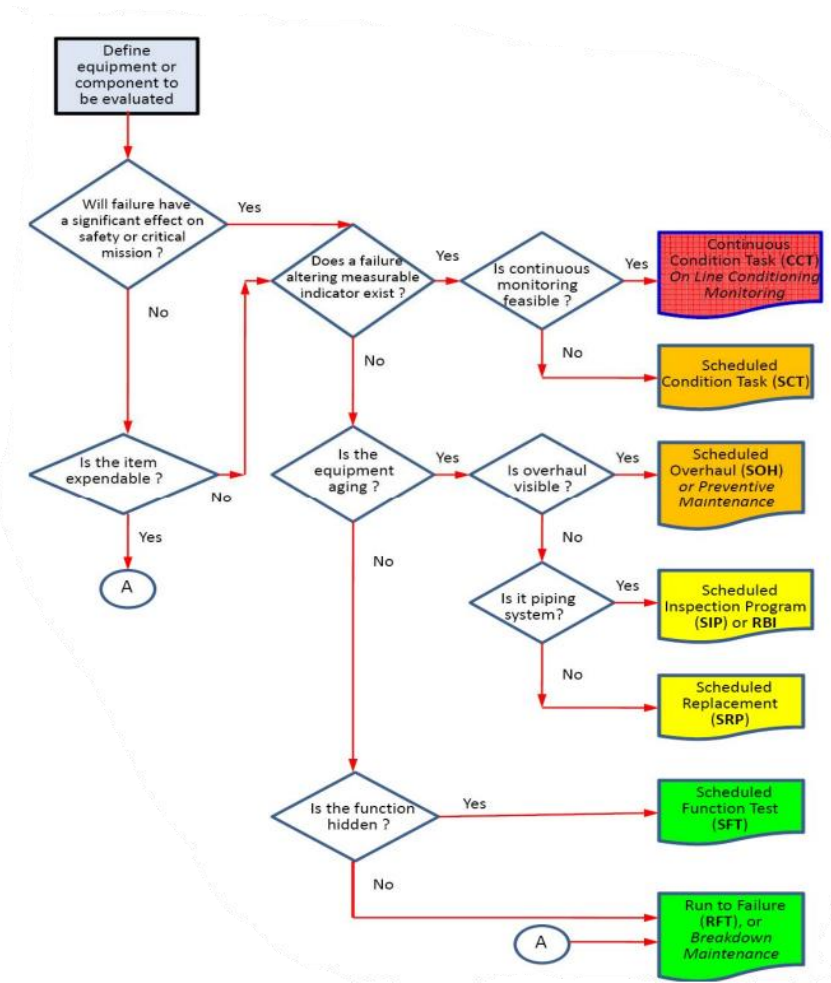
Fig. 1. Decision Logic Diagram

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THE IMPACT OF THE DISTANCE BETWEEN THE WALL AND THE PHOTOVOLTAIC MODULE ON THE POWER OUTPUT IT GENERATES

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Keywords: photovoltaic module temperature, photovoltaic module power, depth of photovoltaic module, distance behind the photovoltaic module

Photovoltaic (PV) modules play a crucial role in harnessing renewable energy from sunlight (Hao et al., 2022)(Ali et al., 2023). As we strive to optimize their performance, understanding how various factors affect their efficiency becomes essential (Reimann et al., 2010). One such factor is the distance between the PV module and the wall behind it (Herrando et al., 2023). In this study, I investigate how this distance influences the temperature of the PV module. This research combines practical experiments with simulated analyses to provide new insights into panel behavior.
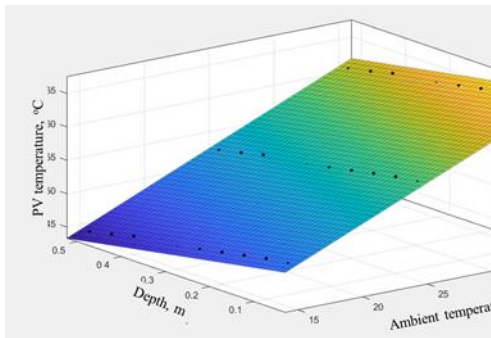
Fig. 1. Temperature of the PV module as a function of the ambient temperature and the distance behind the PV module.
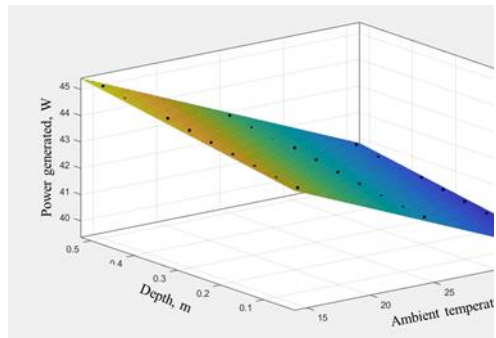
Fig. 2. Power generated by the PV module as a function of the ambient temperature and the distance behind the PV module.

Fig. 1 illustrates the relationship between the temperature of the PV module and two key factors: the distance between the module and the wall behind it (referred to as "Depth") and the ambient temperature. Specifically, it shows how the PV module temperature responds to changes in these variables. It has been shown that the temperature of the PV module is subject to the following equation:

$$T_{pv} = 37.94 + 0.8352 * T_{amb} - 12.05 * d_{pv} \quad , \quad R2 = 0.9994 \tag{1}$$

Accordingly, the PV module temperature decreases with increasing depth (distance from the wall) and increases with rising ambient temperature. These insights are valuable for optimizing solar panel performance and determining the optimal spacing between panels and walls.

Fig. 2 demonstrates how the power generated by the PV module varies based on the distance between the PV module and the wall behind it and the ambient temperature. Specifically, it shows that the power output increases with greater distance and decreases as the ambient temperature rises. It has been shown that the temperature of the PV module is subject to the following equation:

$$P_{pv} = 46.77 - 0.2089 * T_{amb} + 3.017 * d_{pv} \quad , \quad R^2 = 0.9994 \tag{2}$$

Accordingly, optimizing the spacing between PV modules and walls can enhance power generation, while considering ambient temperature is crucial for efficient PV module performance.

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EXAMINING THE PERFORMANCE OF COUNTERFLOW HEAT EXCHANGER FOR DIFFERENT GEOMETRIES WITH ANSYS CFX

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Keywords: double pipe, fluid dynamics, counter flow, simulation, ANSYS CFX

Heat exchangers are considered as the principal apparatus employed for thermal regulation in industrial settings, as highlighted by Mohammadi et al. (2020). Furthermore, the heat exchanger assumes a crucial role as a fundamental component in the transfer of energy and heat, with prospective enhancements in its effectiveness aimed at reducing energy consumption (Gugulothu et al., 2017). Moreover, there exists a variety of heat exchanger types, including shell and tube heat exchangers designed for both mixed and unmixed fluids featuring baffles, alongside parallel flow, cross flow, counter-current flow, and fin configurations (José et al., 2017). Based on the flow characteristics exhibited, heat exchangers can be categorized into parallel, S-type, or zigzag flow arrangements (Kishan et al., 2020). The present study applies CFX for the examination of shell tube, and double-pipe exchangers, as depicted in Fig. 1.
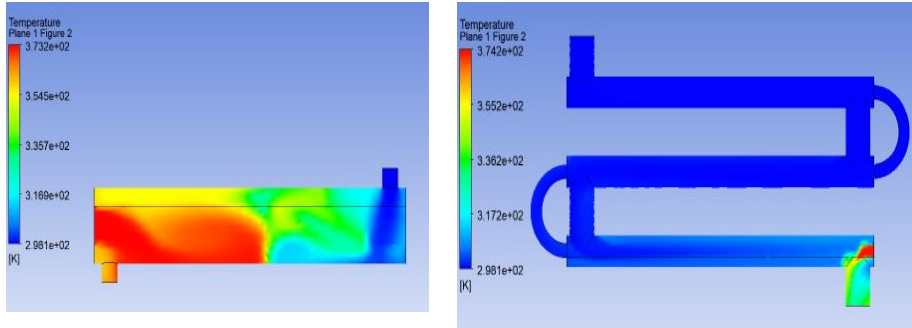
Fig. 1. a) Single tube shell and tube heat exchanger, b) Double pipe heat exchanger, simulation using CFX

In this investigation, the double pipe heat exchanger and shell and tube heat exchangers were replicated using the computational fluid dynamics software (ANSYS CFX). The findings from the simulation indicate that the double pipe heat exchanger exhibits a superior heat exchange efficiency compared to the shell and tube heat exchanger.

Furthermore, the results of the simulation are illustrated in Fig. 1, specifically in Fig. 1 (a) for the shell and tube heat exchanger where the exit temperature is 373.2 K, and in Fig. 1 (b) for the double pipe heat exchanger where the exit temperature is 374.2 K under the same working conditions.

The utilisation of this particular heat exchanger is pertinent within photovoltaic thermal systems to facilitate heat transfer from the high-temperature fluid emanating from the photovoltaic array, previously employed for the cooling process. Consequently, optimising a proficient heat exchanger within this framework serves to augment the thermal efficiency of the overall system.

Acknowledgement

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VIBRATION ANALYSIS ON GAS TURBINE

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Keywords: Vibration, Gas Turbine, Condition Monitoring, Maintenance

The gas turbine is a machine that converts chemical energy into mechanical energy in the form of shaft power or kinetic energy. Every mechanical equipment, especially gas turbines, definitely produces vibrations that reflect the operating conditions and health condition of the machine.

Mechanical vibration is one of the easiest signals to determine the condition of the engine. Machine component failures that may occur can be monitored with several sensors placed on each piece of equipment so that each sensor is configured to measure machine condition parameters. Schematic of vibration measurement can be seen in Fig. 1.
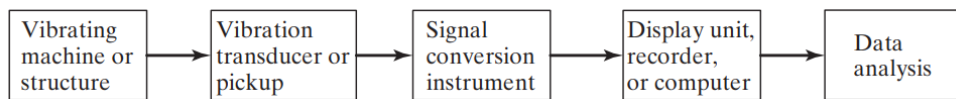
Fig 1. Vibration Measurement Schematic Illustration

Vibration measurements usually consist of measuring amplitude, velocity, and acceleration. These measurements are made with probes, such as seismic probes that measure amplitude, proximity probes that primarily measure velocity, and acceleration probes or accelerometers that measure acceleration. The samples of vibration characteristics are shown in Figs. 2-3.

Maintenance costs can be minimized with good operation. Good operation can be achieved when the equipment is under the control of a planned

maintenance program. Improper operation of mechanical equipment can be a cause of equipment damage and failure as can wear of any component.
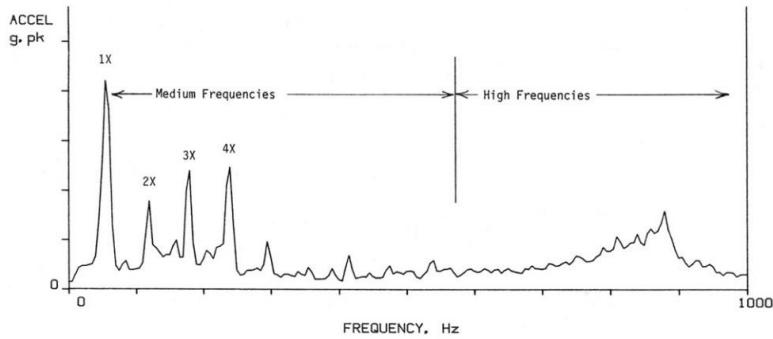
Fig 2. An example FFT spectrum of common machinery vibration.
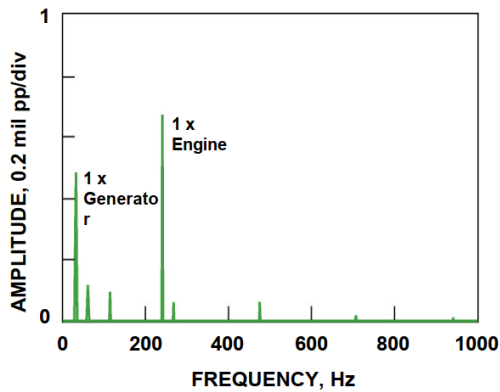
Fig 3. Typical Spectrum Plot

Maintenance costs can be minimized with good operation. Good operation can be achieved when the equipment is under the control of a planned maintenance program. Improper operation of mechanical equipment can be a cause of equipment damage and failure as can wear of any component.

Acknowledgments:

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MEASURING LIGHT SPECTRUM IN SEMI-TRANSPARENT PHOTOVOLTAIC TO OPTIMISE ENERGY CONVERSION

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Keywords: solar energy, spectral use of sunlight, improve photovoltaic efficiency

The significance of using the light spectrum to maximise plant development in agriculture cannot be emphasised. It is the primary energy source for photosynthesis, the process by which plants transform light energy into chemical energy to power their growth and development. Both natural sunshine and artificial lighting sources play critical roles in providing this vital spectrum of light wavelengths. In recent years, there has been an increased interest in using semi-transparent photovoltaic (PV) materials in agricultural settings to improve crop cultivation and generate sustainable energy. These unique materials, designed to allow partial light transmission while gathering solar energy for power production, represent a fascinating convergence between agriculture and renewable energy technology.
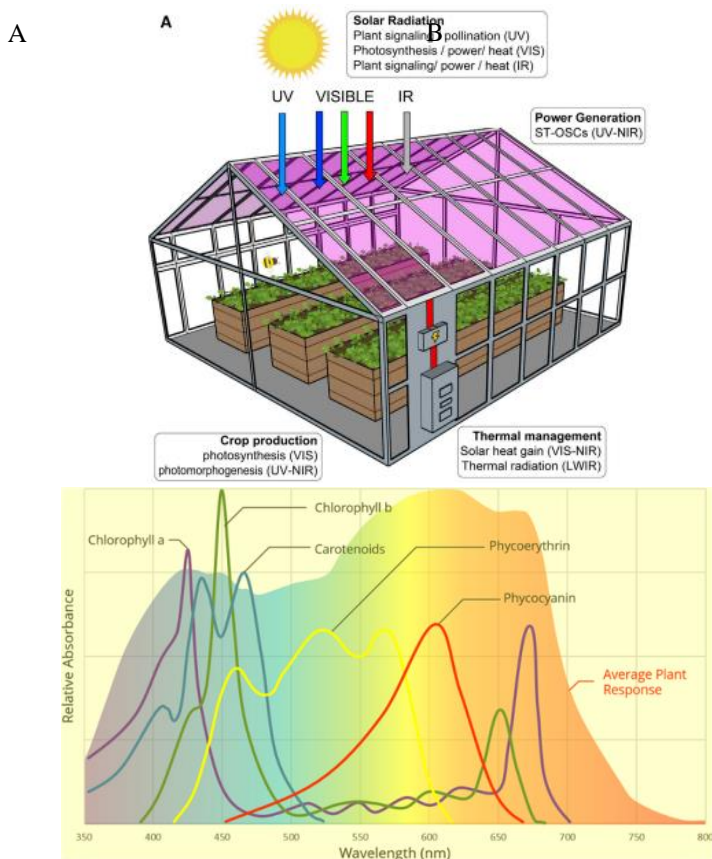
Fig. 1. A) An overview of an OSC-integrated greenhouse demonstrating spectral use of sunlight [1]. B) The average plant photosynthesis responds to each wavelength of light [2]

Researchers and engineers can delve into the delicate nuances of light absorption and conversion efficiency by thoroughly analysing the spectrum response of semi-transparent PV materials. By intelligently altering the material composition and thickness, they can optimise the absorption of specific light wavelengths that promote plant growth and energy generation. This interdisciplinary approach has enormous potential to transform agricultural practices by providing sustainable solutions that combine crop growing and clean energy production. As advances continue to emerge in this arena, the synergistic benefits of merging photovoltaic technology with agriculture promise to pave the way for a greener, more efficient future.

By measuring the light spectrum, farmers and researchers can optimise lighting conditions in greenhouses and indoor farming setups to promote photosynthesis, increase yields, and improve the quality of crops. Measuring

the light spectrum in photovoltaic systems enables efficiency optimisation, material selection, performance monitoring, predictive modelling, quality control, technology development, and system integration, improving the reliability, performance, and sustainability of solar energy generation. The results of these measurements can be utilised to improve semi-transparent photovoltaic efficiency. These findings can also be applied to improve the quality of crops cultivated with semi-transparent photovoltaics. It can thus help explain the optical properties of semi-transparent photovoltaics [3].

Acknowledgements:

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RELIABILITY ASSESSMENT OF GAS TURBINE

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Keywords: reliability, gas turbine, Weibull distribution, extend the life

Gas turbine is a device capable of converting chemical energy into motion energy. In brief, the concept of a gas turbine is that the turbine will suck air which will be mixed with fuel which will then be used in the combustion process. The result of this combustion process is high pressure gas which will be used to rotate the turbine and produce rotational motion [1].

Ensuring the reliability of the gas turbine is very important in to keep the gas turbine working effectively. In this scientific work, the reliability study on gas turbines was carried out using the 2-parameter Weibull distribution method, which is the Shape parameter and Scale parameter.

Shape parameter is a parameter that affects the shape of the slope on the failure rate curve of a device if the value is less than one then the curve will experience a negative slope, if it is greater than one then the curve will experience a positive slope, and if the value is equal to one then there will be no slope. A typical bathtub curve (hypothetical failure rate vs. time) can be seen in Fig.1.
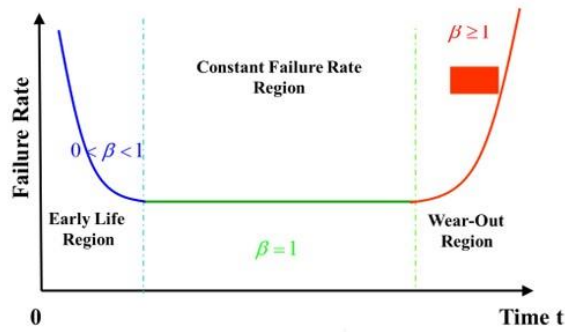
Fig 1. Effect of Shape parameter on curve

The scale parameter of the eibull distribution is a parameter that determines how long the distribution of the data is. In simple terms, the larger the value, the longer the expected time before a failure occurs.[2]

Cumulative Distribution Function (CDF) is a function that describes the cumulative probability of failure over time. CDF can provide information about the remaining life of a component by showing the probability of failure at a certain time. A high Scale parameter value indicates a long data distribution, thus making the CDF curve increase slowly. An illustration of the CDF can be seen in Fig. 2
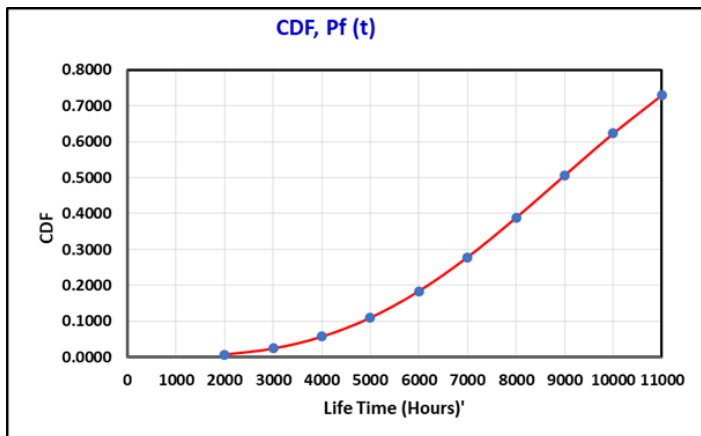
Fig 2. Effect of Scale parameter on CDF curve

After knowing the remaining life of the gas turbine, a suitable maintenance schedule can be proposed so that it can keep the gas turbine working reliably and extend the life of the gas turbine.

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EXPLORING BACTERIAL STRAINS FOR IMPROVEMENT OF QUALITY, SHELF-LIFE, AND RESISTANCE OF MICROGREENS

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Keywords: microgreens, abiotic stress, inoculation

Microorganisms plays a fundamental role in the multiple processes within the plant, and their presence is essential for maintaining its wellnes. The plant and its microbiome collectively constitute a holobiont, which demonstrate a set of symbiotic, interconnected, and intricate interactions and dynamics among these organisms, crucial in numerous vital processes [1]. Microgreens, known as young seedlings of edible plant species, harvested after development of first cotyledary leaves, offer various health benefits and attract consumer interest because of their distinctive appearance and appealing flavor [2;3;4]. Those tiny plants should also be considered as a holobiont, however there is currently a dearth of literature exploring this aspect. Microgreens, despite their many benefits, are highly susceptible to abiotic stresses, especially the drought stress. Consequently, they lose their freshness relatively quickly and are affected by rotting and wilting processes [5]. Currently, the literature data provides little information on how to deal with this microgreens issue, and mainly focuses on treatment with different light spectra, modified atmosphere packaging, and biofortification. However, there are numerous studies on bacterial and fungal species assesing plants in adapting to drought conditions by employing various mechanisms, both directly and undirectly [6]. Bacteria associated with drought-tolerant plants often include species of *Bacillus*. Numerous studies conducted on the certain *Bacillus* species in improving the quality of crop plants in the presence of drought stress revealed their highly positive impact on yields, which provides an opportunity for further exploration and investigation [7]. Our research within the project focuses on the selection and identification of a strains of *Bacillus subtilis* and *Bacillus coagulans* species isolated from dairy and fermented products, which, when used as an inoculate,

will significantly improve the quality, shelf-life and resistance of microgreens to drought stress, providing a completely new perspective on the currently largest problem associated with microgreens cultivation. The presented results shows the path followed for isolating, identifying, and selecting the final strain intended to be used as an inoculant in microgreen cultivation.

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POSSIBILITY OF USING THE CONTACTLESS NIR MOISTURE SENSOR TO MONITOR SURFACE SOIL MOISTURE

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Keywords: surface soil moisture, moisture sensor, NIR

Soil moisture is a critical factor affecting many environmental processes such as the water cycle, plant growth, soil erosion and many others. There are many methods to determine soil moisture, among them we can mention: gravimetric, oven drying technique, neutron scattering method, TDR or remote sensing methods. However, these methods either interfere with the soil sample: they destroy it, change its structure, measure moisture in some bulk volume or were designed for large-scale measurements. Therefore there is
a lack of a method that allows moisture content to be measured in the very surface layer without affecting the sample, needed for example in soil erosion experiments.

Here we present the results of surface moisture measurements using the CCS-3000 moisture analyser (MoistTech Corp., USA) It is a device that uses near-infrared (NIR) spectroscopy for immediate, surface, non-contact measurement which involves the analysis of the amount of light reflected from the sample.

The test was conducted on sandy and silty soil. After the soil sample was brought to saturation with water (pF 0), the change in moisture content was measured using the device and the weighing method. The aim of the study was to validate the moisture analyser measurement with the actual moisture content of the soil sample from the weighting method.

THE CURRENT STATE OF KNOWLEDGE ON HOW MICROORGANISMS ARE TRANSPORTED BY SPLASH

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Keywords: soil splash, soil microbiology, drop impact, microorganisms

Soil, as the natural outer layer of the lithosphere, plays a central role in supporting life and is home to an unimaginable diversity of microorganisms. It is the basis for the functioning of most terrestrial ecosystems, participates in part in biomass production and in the soil, organic matter decomposition processes take place and humus is stored. It is the habitat of a huge number of microorganisms and other living organisms. The role of soil microorganisms cannot be overestimated - without them, plant growth and development, among other things, could not exist. However, soil also harbors pathogenic microorganisms (for plants, animals and humans).

Soil bacteria, regardless of the origin or function, spread in the environment in a variety of ways, including active transport (e.g., movement driven by growth or cell organelles) or passive transport (e.g., transport driven by soil water or wind). One type of passive transport is a splash phenomenon. Splash is caused by the raindrops hitting various surfaces such as soil or plant parts e.g. fruits or leaves. Splash it is second to wind in importance as a means of microorganism dispersal. The aim of this work is to present the current state of knowledge of the ways in which microorganisms are transported by splash affected the drop impacts.

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MECHANICAL PROPERTIES OF POLYMER COMPOSITE EFFECTED BY HEAT TREATMENT

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In modern engineering, composite materials have become increasingly favored over traditional metals such as aluminum and steel. However, despite their numerous advantages, composite materials also possess certain limitations, particularly in terms of heat resistance (Ain et. al.,2022). Composite materials, especially those with a thermoplastic matrix, may undergo permanent structural and mechanical changes at relatively low temperatures, compromising their integrity(Carlos et.al.,2021;Tábi et. al.,2010).

Due to this fact presented paper is focused to applying heat treatment to specimens manufacture from composite material PA6 CF15. Specimens used for laboratory tests were manufactured according to ISO standard, using additive technologies. Samples were annealed in laboratory furnace at 185 °C. The selection of annealing temepratures was based on our preliminary research (Baráth et.al., 2022). The tensile tests of annealed and unannealed specimens were repeated five times.

Applying of heat treatment had positive effect to tensile strength of specimens, but specimens became more brittle. Annealed specimens had higher maximal force but they had smaller elongation. Tensile strength was increased by 53% related to unannealed specimens. Standard deviation of unannealed specimens was 0.69 and standard deviation of annealed specimens was 7.9.

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RECENT DEVELOPMENTS IN SOLAR THERMAL ENERGY: A GLOBAL PERSPECTIVE

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Keywords: global market, thermal capacity, energy yield, hybrid systems, solar energy.

Solar thermal energy, a renewable and sustainable energy source, has gained significant attention in recent years due to its potential to mitigate climate change and reduce dependence on fossil fuels. This paper provides an overview of the main characteristics and current status of solar thermal energy technologies, focusing on advancements, challenges, and potential opportunities. The worldwide situation is analysed based on the topics discussed intensively at the at the EuroSun 2022 Solar Conference organized in Kassel, Germany and the Solar World Congress (SWC 2023) to be organised by the International Solar Energy Society in New Delhi, India. Additionally, insights from the most recently published books in this field contribute to the overview of recent developments.

The analysis focuses on key thematic questions related to solar thermal energy, including solar buildings and architecture, solar thermal heat for industrial processes, solar thermal collectors, solar heating and cooling, energy storage, solar-assisted district heating and cooling, large-scale applications, and the solar energy market.

The Fig. 1 presents data on the global solar thermal capacity and energy yield from 2000 to 2022, sourced from the IEA Solar Heating and Cooling Programme, May 2023.
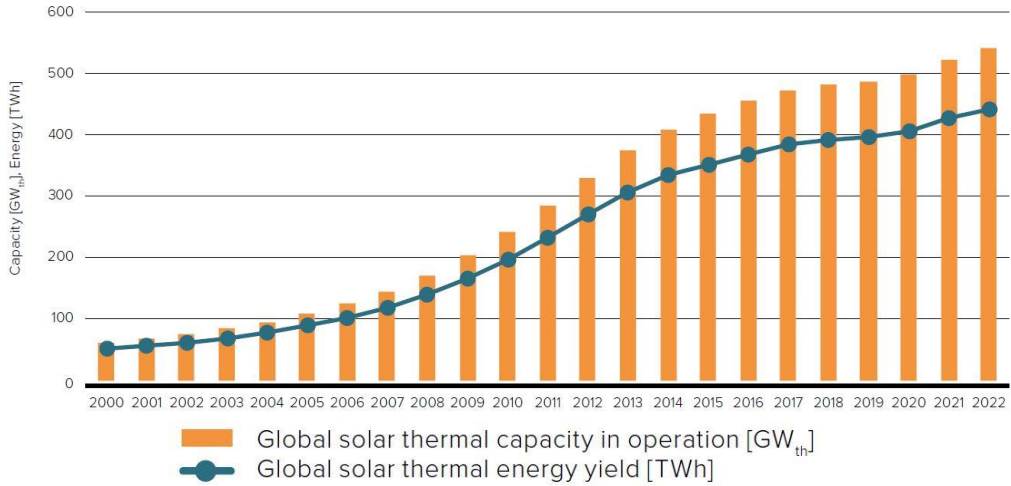
Fig. 1. Global solar thermal capacity and energy yield (2000-2022)

The main characteristics of the recent solar thermal energy status can be summarized as:

The cumulated solar thermal capacity in operation by the end of 2022 was 542 GWth, corresponding to 774 million square meters of collector area. This represents a net increase of 19 GWth or 27.1 million square meters of collector area in 2022.

Despite the generally positive development, especially in some strong European markets, the global solar thermal market shrank by 9.3% in 2022 compared to 2021. This was mainly due to the massive market slumps in China (-12.4%) and India (-21%).

The annual solar thermal energy yield amounted to 442 TWh, which correlates to savings of 47.48 million tons of oil and 153.3 million tons of CO_2.

The main issues of the use of solar thermal energy applications including the further challenges and opportunities are as follows:

Applied technologies: Solar thermal energy systems encompass various technologies such as parabolic troughs, solar towers, and dish collectors.

Efficiency and performance: Recent advancements in solar thermal technology have led to improvements in efficiency and performance. Enhanced materials, better tracking systems, and optimized designs have contributed to increased energy conversion rates and overall system performance.

Storage solutions: Recent developments in Thermal Energy Storage (TES) technologies have focused on improving storage capacity, efficiency, and cost-effectiveness.

Integration with other technologies: Integration of solar thermal with other renewable energy technologies especially with photovoltaics (PV) and conventional power plants. These hybrid systems offer improved reliability, flexibility, and overall energy output.

Cost reduction and market trends: Cost reduction remains a significant challenge for widespread adoption of solar thermal energy. Market trends indicate increasing deployment of solar thermal projects globally, particularly in regions with abundant sunlight and supportive policy frameworks.

In conclusion, recent advancements in solar thermal energy underscore its potential to emerge as a leading renewable energy solution in the transition towards a sustainable and low-carbon future. While challenges remain, ongoing technological innovation, cost reduction efforts, and supportive policies are paving the way for the widespread adoption of solar thermal energy on a global scale. With continued research, investment, and collaboration, solar thermal energy holds immense promise in reshaping the global energy landscape and mitigating the impacts of climate change.

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MORE THAN JUST AN ACTIVE INGREDIENT - THE ROLE OF ADJUVANTS IN SHAPING THE RESPONSE OF THE SOIL MICROBIOTA TO A HERBICIDE

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Keywords: soil microbiota, glyphosate, adjuvant

The use of herbicides is one of the means of securing food production levels that meet increasing demand. Commercially available herbicides are formulations that, next to the active ingredient, also contain adjuvants, used to increase its efficacy. The mechanism of action of adjuvants is by e.g. reducing surface tension, water conditioning, pH buffering or acting as a humectant [1]. Due to direct and indirect application, adjuvants can be found in the soil where they interact with non-target organisms such as microbiota [2]. The vast majority of research concerned on the environmental effects of herbicides application focus on the active ingredients, often omitting the role of adjuvants. Whereas these compounds not only boost the performance of the main active ingredient, but also exhibit bioactive properties themselves. Unfortunately, studying the role of adjuvants is difficult due to the fact that commercial formulation labels systematically neglect information on their names and concentration. This work presents the differences in effects of a commercial glyphosate formulation (Rodundup 360 Plus^{TM}) and pure active ingredient on the activity and composition of soil microbiota. The results of microbial respiration, community composition and cell count indicate an important role for adjuvants in shaping soil microbiota response to commercial herbicide.

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THE EFFECT OF DIFFERENT PYROLYSIS TEMPERATURES AND BIOMASS TYPES ON THE ELEMENTAL COMPOSITION OF BIOCHAR

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Keywords: biochar, temperature, pyrolysis, elemental composition

Biochar is a material produced by heating biomass, such as agricultural waste, with little or no oxygen. This material is widely used because it has several favorable properties, such as a high potential for adsorption and ion exchange, a large surface area, and significant porosity. The above properties depend on the type of biomass used and the conditions of the pyrolysis, including the temperature [1]. There is a growing need to determine the potential impact of various types of biochar as a soil improver and carbon sequester. Therefore, detailed studies from preliminary analysis and moving on to surface morphology, mineral content, heavy metal analysis, and biochar thermal behavior are desirable.

Our research aims to determine the effect of the pyrolysis temperature on the content of selected components in biochars. The materials used in the studies were biochars produced at three temperatures: 300℃, 450℃ and 600℃ from different substrates: sludges constituting waste from fruit and vegetable processing, dairy production and biogas plants (post-fermentation sludge). Total forms of elements were extracted using acid digestion with HNO_3-H_2O_2-HCl solutions [2], and the available forms using the Mehlich-3 method [3]. The content of lead (Pb), copper (Cu), zinc (Zn), potassium (K), calcium (Ca), and magnesium (Mg) was determined spectrometrically on an AAS contr AA 300 analyzer (Analytik Jena). The content of phosphorus (P) available to plants was determined by spectrophotometry using SPECORD 50 PLUS (Analytik Jena). Measurements were performed in triplicate.

The study's findings indicate that the and biomass type and temperature of the pyrolysis process plays a significant role in the content of elements in biochar. In general, an increase in process temperature led to an increase in the content of total forms of metals. In turn, changes in the content of available

forms of metals depended on pyrolysis temperature and the type of substrate used for biochar production and were positive or negative. Different trends in the content of available elements were probably caused by the compounds thermal stability and differences in the composition and chemical structure of the tested biochars after the pyrolysis process [4].

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INVESTIGATING THE TRIBOLOGICAL BEHAVIOR OF VARIOUS HARDFACING ALLOYS

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Wear significantly impacts the lifespan of machinery and its components, leading to degradation and increased maintenance expenses. It results from a combination of internal and external factors, with adhesive, abrasive, fatigue wear, fretting, and erosion being the primary types encountered in real-world scenarios. Hardfacing offers a solution to combat wear by applying specialized alloy deposits onto surfaces, enhancing their resistance to deterioration (Slota et.al. (2022). This study aims to investigate the properties of four hardfacing materials: Ok 86.08, Ok 86.28, Fluxofil 54, and Fluxofil 58, focusing on their abrasive wear behavior. A two-body abrasion test was employed to evaluate wear resistance, with average weight loss serving as the metric. Results were subjected to statistical analysis.The findings indicate that wear resistance is not solely dictated by hardness; rather, the chemical composition plays a crucial role. Elements such as Cr and Mo significantly enhance material resistance to wear. Despite comparable hardness, Fluxofil 54 exhibited 43% less weight loss compared to Ok 86.08 and Ok 86.28. These results underscore the importance of chemical composition and the synergistic effects of chemical elements in determining material wear resistance.

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ENHANCING VEGETATIVE GROWTH AND YIELD OF RICE PLANTS THROUGH THE INCLUSION OF BIOACTIVATOR, BIOREMEDIATION AGENTS, N-FIXING BACTERIA, AND P-SOLUBILIZING BACTERIA

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Biofertilizers play a dual role in enhancing plant nutrition, either by directly supplying essential nutrients or by indirectly fostering plant vigour and health. Their indirect contribution is particularly vital in agricultural settings challenged by various biotic and abiotic factors, including nutrient deficiencies and environmental stressors, ensuring optimal nutrient utilization by plants.

Experiments have been undertaken on rice crops, utilizing a combination of 50% reduced chemical fertilizers alongside a biofertilizer blend containing a bioactivator, bioremediation agents, nitrogen-fixing bacteria, and phosphorus-solubilizing bacteria, applied at a rate of 25 liters per hectare. The control group consists of rice cultivated with the full standard dosage of chemical fertilizers, comprising 153 kg of nitrogen, 61 kg of phosphorus pentoxide (P_2O_5), and 61 kg of potassium oxide (K_2O) per hectare.

In this trial, the variables examined included various aspects of rice vegetative growth, such as plant height and number of tillers, measured at intervals of 14 days, 28 days, 42 days, and 56 days, along with the harvest yield variable, represented by Harvested Dry Grain Weight (tons per hectare).

Observations revealed that the average height of rice plants in the treatment group was 127.4 cm, compared to 114.5 cm in the control group. Similarly, the average number of tillers per plant in the treatment group was 26.11, while in the control group, it was 12.03. Additionally, the rice yield in the treatment group was 10,986 tons per hectare, whereas in the control group, it stood at 7,480 tons per hectare.

The study concluded that incorporating a 50% standard dosage of chemical fertilizer supplemented with bioactivator, bioremediation agents, nitrogen-fixing bacteria, and phosphorus-solubilizing bacteria positively impacted the vegetative growth of rice crops. Additionally, the harvest outcomes indicated a substantial 46.87% increase in the weight of harvested dry grain.

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INCREASING COMMUNICATION RANGE OF AUTOMATIC SPRINKLER

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Keywords: soil moisture, WEMOS D1 mini, solenoid valve, nRF24l01

Automatic Sprinklers for agricultural land that have been built, use WiFi technology as the communication path [1]. Wireless coverage using WiFi technology limits the use of automatic sprinklers on agricultural land. The Agriculture Wireless Monitoring Unit (AWMU) built by Lova et al., uses the nRF24l01 transceiver module for long-distance communication to monitor agricultural parameters [2]. The purpose of this study is to increase the range of automatic sprinkler data communication for agricultural field coverage. For this study, the microcontroller on the Automatic Sprinkler uses Arduino NANO, nRF24l01 as a transmitter from the field, and on the receiver side uses WEMOS D1 mini and nRF24l01, as can be seen in Fig. 1. The nRF24l01 without antenna type was used in this study.
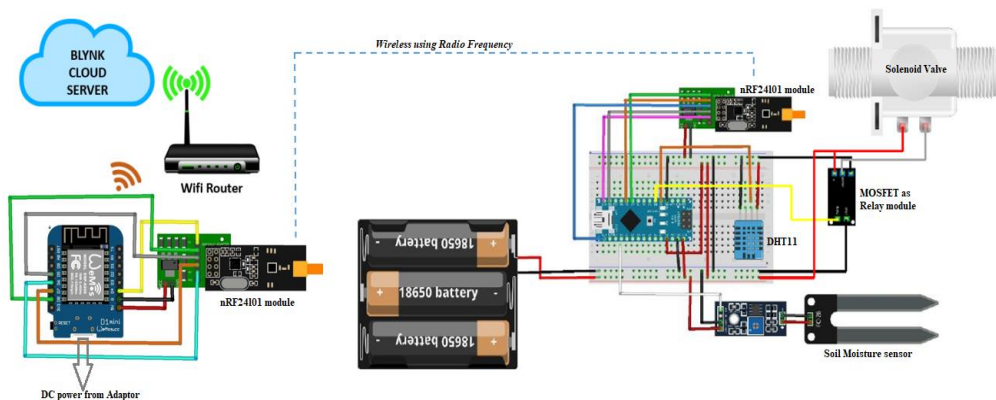
Fig. 1. Wiring Diagram on Receiver and Transmitter side.

Data from the field is sent to the receiver with nRFl01. From the receiver, data is sent to the internet via WiFi Router using WEMOS D1 mini. Data can be monitored on the BLYNK online platform [3].

From testing the distance between the Automatic Sprinkler as Transmitter and Receiver, the data still reception at only roughly 20 meters. The environment (such as walls) and module orientation greatly influence this range due to the antenna design.

Furthermore, a redesign of the placement nRF24l01 on the Automatic Sprinkler or nRF24l01 antenna type can be considered to increase wider coverage.

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EXPERIMENTAL STUDY INFRASTRUCTURE OF POLYSILAZANE TEMPERED MONOCRYSTALLINE PHOTOVOLTAIC MODULE 50 WP: INITIAL DESIGN IMPLEMENTATION

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Keywords: Photovoltaic, Nanocoating, Polysilazane**.**

Photovoltaic (PV) module is generally placed on the roof of a building or above a height to obtain maximum sunlight intensity. Because it is placed in the ambient air, the PV module is often covered with dust and exposed to rain, causing Photovoltaicto rust. The PV module that are placed in special areas such as coastal areas or industrial areas, are often covered with flour dust, charcoal dust, or even covered with salt particles. All of these things can cause a decrease in the power generated, so the PV module must always be cleaned [1].

The process of cleaning of the PV module that are placed on the roof of the building or above the altitude, of course, is not easy, and there are cleaning costs. One solution so that solar panels do not need to be cleaned regularly is to coat them with a liquid that can prevent dust from sticking and prevent mould, and prevent rust. In this research, polysilazane liquid will be used to coat PV with the nano coating method. Polysilazane is not only

expected to cause the effect of easy cleaning, and self-cleaning, but also expected to prevent rust, especially due to acidic rainwater, so that solar panels can be more durable. Based on this information, testing, and test equipment in the form of laboratory-scale solar panels are needed to evaluate the effect of polysilazane nanocoating on the photovoltaic module performance [2].

The purpose of this research is to design and realize a prototype of polysilazane coating experimental equipment on monocrystalline photovoltaic with a capacity of 50 Wp and conduct tests to analyze the effect of polysilazane on the performance of monocrystalline photovoltaic module. The schematic of the experimental rig can be seen in Fig. 1.
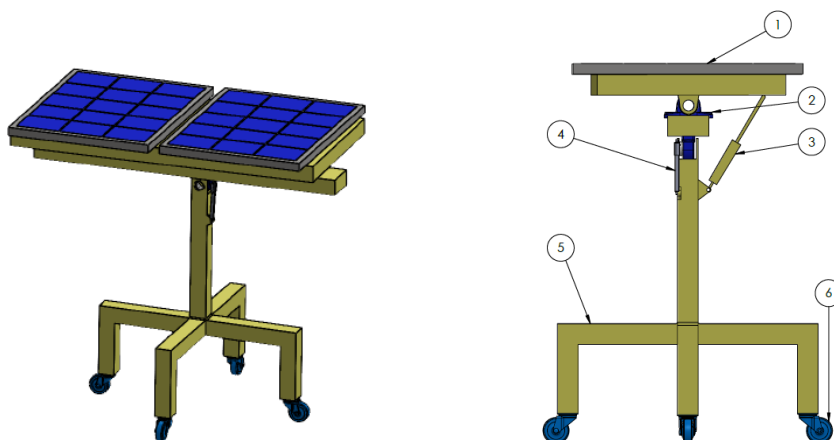
Fig. 1. The Photovoltaic Module Infrastructure for Experimentals

Description: 1. 50 Wp PV module, 2. Pillow Block, 3. 50 cm Linear Actuator, 4. 50 cm Linear Actuator, 5. Frame, 6. Locking wheel

The test will be carried out by installing 2 PV modules with 50 Wp capacity of each PV module. One of the PV module is coated with polysilazane, and the other of PV module is uncoated.

The series of tests will be carried out, such evaluate the effect of easy cleaning or self-cleaning on the coated PV module. The surface of both coated and uncoated PV modules will be conditioned by dust in the ambient air for several weeks. The effect of coating on the PV module surface with dust particles on the surface of photovoltaic will be analyzed after several weeks and compared with uncoated photovoltaic. The performance characteristics of both two PV modules will be evaluated, as well. Other parameters of the coated

PV module, such as durability, the thickness of polysilazane nanocoating, hydrophobic effect, hardness of, and cross-cut tests to see the nanocoating adhesion will be performed.

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INTEGRITY ASSESSMENT OF PIPING VIBRATION

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In the oil and gas industry, offshore platforms serve as critical infrastructure for the extraction of natural resources. Within these offshore platforms, piping plays a crucial role as a tubular structure engineered to withstand internal or external pressure, confronting potential stressors such as external forces and direct heat [1]. This stress can lead to vibration, defined as a continuous periodic change in displacement relative to a fixed reference point [2]. The intensification of sea wave movement around offshore platforms, compounded by the absence of nearby rotating equipment, can induce low-frequency vibrations in piping systems, indicating resonance. This resonance occurs when the frequency of the source vibration coincides with or falls within the natural frequency range of the piping, increasing the risk of structural instability. An illustration of piping vibration criteria can be seen in Fig. 1.
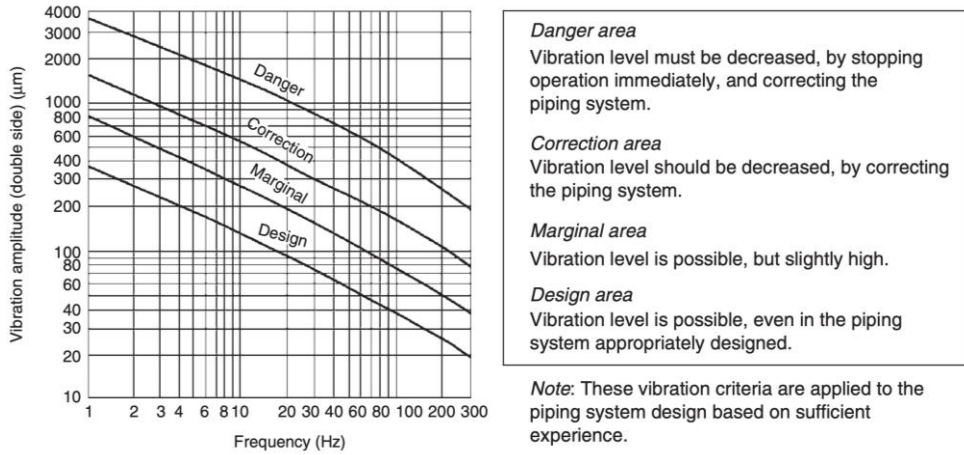
Fig. 4. Acceptance criterion for Piping Vibration-Displacement

Moreover, continuous piping vibration can lead to fatigue, a material or pipe failure due to cyclic stresses below their yield strength. These cyclic stresses may be induced by cyclic pressure or cyclic loading resulting from vibration. Fig. 2 shows S-N Curve depicting cyclic stress amplitude versus cycles to failure for a material.
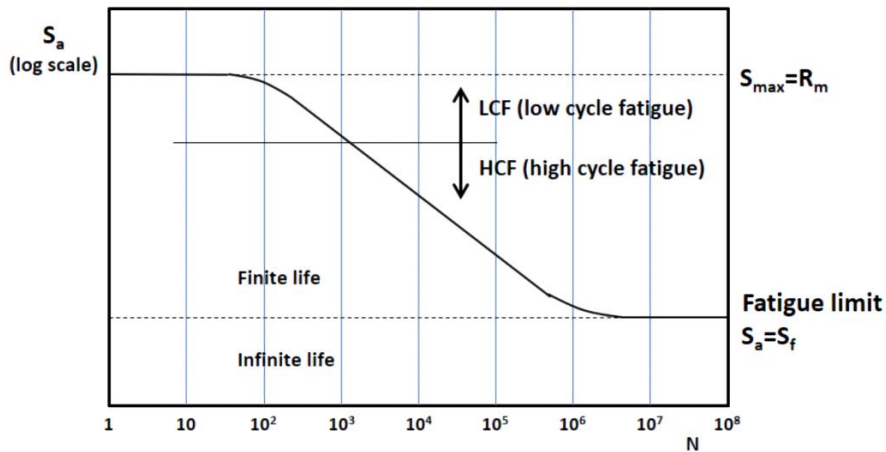
Fig. 5. Graph: S-N Curve depicting cyclic stress amplitude versus cycles to failure for a material.

To mitigate the risk of piping failure, it is imperative to evaluate vibration in piping systems, as excessive dynamics or cyclic stresses exceeding

the fatigue limit of piping materials can lead to fatigue damage. These stresses are particularly problematic, especially in welding areas where stress concentration points may occur.

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DEVELOPMENT OF INTERCONNECTION DYE-SENSITIZED SOLAR MODULES

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Keywords: solar cells, series, parallel, monolithic, modules

Dye-sensitized solar modules (DSMs) represent an emerging generation of photovoltaic technology, converting sunlight directly into electricity as an alternative energy source. They are desirable because of their easy fabrication, excellent transparency, and potential for wide application. However, further development of the design and fabrication is still required for practical implementation on a larger scale. Upscaling DSMs presents challenges, including interconnecting modules. In this study, we explore parallel, series, and monolithic connections for DSMs as shown in Fig 1 [1,2,3]. We observed that parallel interconnection enhances active area of the solar module [1]. Conversely, Z-type series connections exhibited a photoconversion efficiency of up to 3.47% [2]. Furthermore, the monolithic structure for DSMs can increase photocurrent generation [3].
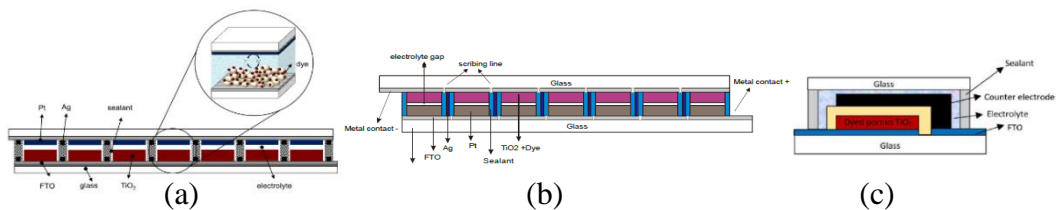
Fig 1. Configuration of DSMs in (a) parallel [1] (b) series [2] and (c) monolithic structure [3].

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EVALUATION OF THE IMPACT OF RG-I SEGMENTS ON THE PROPERTIES OF PECTIN OBTAINED BY ENZYMATIC AND CHEMICAL MODIFICATIONS OF APPLE AND CARROT DILUTED ALKALI-SOLUBLE PECTIN (DASP) FRACTION

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Keywords: pectin, DASP, enzymatic modifications, rhamnogalacturonan I

Rhamnogalacturonan I (RG-I) constitutes one of the pectin building blocks and plays significant role in the cell wall. The variability in the structure of RG-I between different plant sources and the physiological state is higher than in the case of smooth homogalacturonan (HG). This is one of the reasons why structure-function relations for RG-I are still less well understood. Atomic force microscopy (AFM) data on diluted alkali-extractable fraction of pectin (DASP) obtained from carrot, rich in RG-I, deposited on mica shows a regular network with characteristic kinked rods-resembled structures[1], which are probably caused by rhamnose-units or short RG-I segments creating interspersions in HG chains. It was hypothesized, that the higher mobility of the linear sections in DASP network increases the number of possible interactions with surrounding molecules and thus improves its ability to form gels [2].

The aim of the study was to investigate the influence of RG-I segments on the structure and rheology of DASP pectin fractions. Pectin obtained from apple (*Malus domestica* Borkh.) and carrot (*Daucus carota* subsp. *sativus*) by a dilute alkali extraction as the final step of a sequential pectin extraction were

chemically characterized and subsequently used as starting materials for selective enzymatic (RG-I acetyl esterase, rhamnogalacturonan endolyase, arabinofuranosidase, galactosidase) and chemical (acid hydrolysis) modifications. The composition and structure of the samples were analysed with chromatographic, spectrophotometric and AFM imaging methods.

Native DASP fractions from both sources were polymers of medium molecular mass with the skeleton length of 75-100 nm, rich in side chains. Both enzymatic and chemical modifications resulted in clear structural changes. A decrease in the average skeleton length and molar mass, combined with the loss of monosaccharides, that constitute side chains, indicated that the enzymatic treatment resulted in more linear pectin with reduced molecular mass. In the case of acid hydrolysis, a bimodal molar mass distribution was observed for both pectin sources. Results indicate the presence of both galacturonic acid linear polymers as well as short chain polymers sAFM observations showed changes in the organization of DASP molecules on mica as a result of the degradation of the RG-I region suggesting its important role in shaping the structural properties and, consequently, the functionality of pectins, as confirmed by observed changes in viscosity.

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CHARACTERIZATION OF ELEMENTS IN FRASSES AFTER BEAN AND PEA WASTE BIOCONVERSION BY *H. ILLUCENS*

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Keywords: black soldier fly, waste revalorization, macro- and microelements

Insect production is increasingly expanding in the industrial market. One of the most common species chosen for production is *Hermetia illucens*, usually destined for the feed industry [1]. Among the many characteristics of *H. illucens* larvae most important is the ability to revalorize organic matter into larval biomass rich in protein and nutrients. The second product of the larvae production is the so-called frass, which is the residue of undigested substrate mixed with larval feces, larval moults and dead individuals. Frass can potentially be used as an organic fertilizer [2]. The experiment consisted of investigating the elemental profile in the frass generated after bioconversion of bean seed and pea post-production waste by *H. illucens* larvae. The goal was to characterize macro-, micronutrients, and determine the concentrations of heavy metals in the context of the suitability and safety of using frass as a soil additive.

One thousand *H. illucens* larvae were used for the experiment, reared on substrates at a rate of 150 mg of dry matter per larva. The culture lasted 30 days, during which time more than half of the number of insects were obtained to pupate. The frasses were then analyzed by inductively coupled plasma optical emission spectrometry (ICP-OES). Waste from pea and bean production is a suitable substrate for the rearing of *H. illucens* larvae and has been significantly utilized. In a fertilizer context, it was the frass from bean waste that had higher contents of NPK macronutrients than the frass from pea waste, as well as other elements needed for plant development, i.e. B, Ca, Cu, Mg, Mo, S. Both frasses are suitable as a soil additive used in the fall due to their properties.

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ENHANCING SOLAR AIR HEATER EFFICIENCY THROUGH COMPUTATIONAL FLUID DYNAMICS ANALYSIS

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Keywords: Finned surface, fluid dynamics, experimental, heat transfer, Reynolds number

In recent years CFD has become increasingly popular as a substitute for traditional fluid dynamics branches, especially experimental fluid dynamics, in the analysis of fluid flow [1]. CFD can be used to better understand the physical events or processes that occur in fluid flow around and within the selected objects. CFD serves as a research instrument for conducting numerical experiments, akin to studies conducted in wind tunnels [2]. Computational fluid dynamics is widely employed due to its ability to utilize numerical techniques to solve equations governing the conservation of mass, momentum, and energy. This enables the prediction of temperature, velocity, and pressure profiles [3], as an example shown for velocity streamlines in Fig. 1.
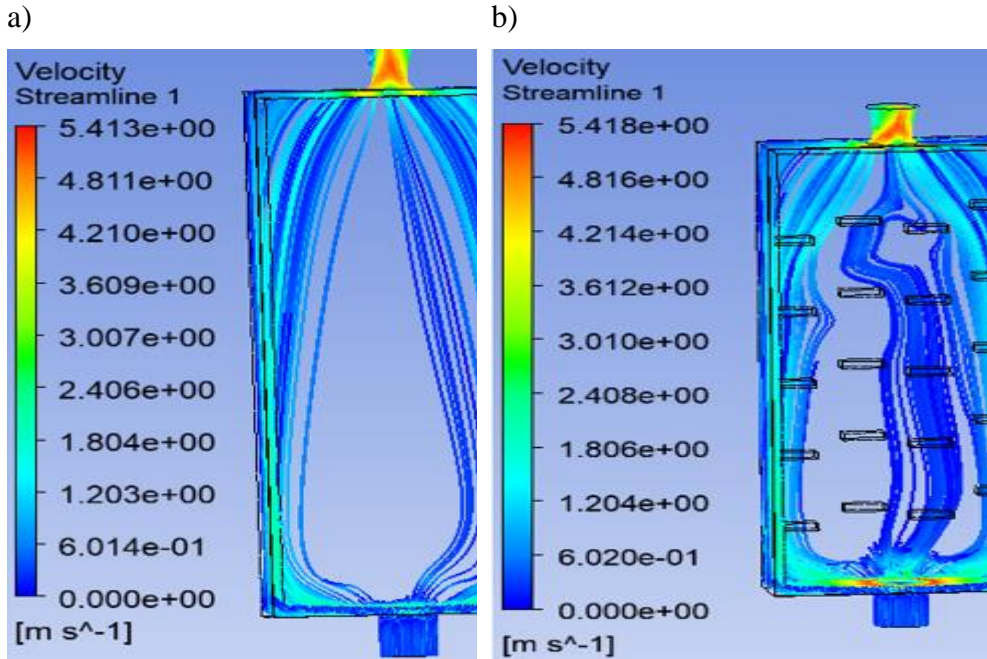
Fig. 1. a) Velocity trajectory unfinned, b) Baffled absorber surfaces

The CFD analysis of the solar air heater system demonstrates that the addition of fins significantly improves thermal performance by facilitating more efficient heat transfer and airflow distribution. Temperature gradient mapping reveals a broader and more uniform temperature range on the finned surface compared to the unfinned counterpart, indicating enhanced heat dissipation. Pressure contour analysis shows slightly higher pressure drops in the finned configuration, suggesting increased fluid flow resistance but improved heat transfer efficiency.

Velocity streamlines illustrate how fins mitigate dead zones and promote more consistent airflow, optimizing thermal exchange. Furthermore, a comparison between finned and unfinned systems reveals a tangible increase in heat transfer efficiency with fins, as validated by experimental data. This comprehensive analysis underscores the critical role of fins in maximizing energy utilization and guiding system design for enhanced performance in real-world applications. In essence, the CFD simulation provides precise guidance for engineers to optimize system design, ensuring efficient heat transfer and overall performance in real-world applications.

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STUDY OF THE ELECTRICITY SOURCES EFFECTIVENESS TO REDUCE POLYESTER PRODUCTION COSTS

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Keywords: polyester production, decline, policies, efficient source, electrical energy.

The polyester production process requires a fairly large source of electrical energy. Currently the Textile and Textile Products (TPT) industry is contracting and experiencing a decline in exports. This condition can't be separated from the world economic situation, whose growth is predicted by the International Monetary Fund (IMF) to slow to 2.9% in 2023. Bank Indonesia also predicts a slowdown in the United States Gross Domestic Product (GDP) in 2023 of 0.9% compared to the previous year. The same thing also happens in Europe and other export destination countries. This condition has an impact on the performance of the national textile industry, which has the main goal of exporting to the United States and Europe.

The decline in the value of TPT exports in the January-April 2023 period was recorded at USD 3.7 billion, down 28.44% compared to the same period the previous year of USD 5.1 billion. Furthermore, the TPT product market is also experiencing an invasion of imports from China. The country is experiencing a buildup of inventory due to declining demand from the United States and Europe, so it is starting to look for new market countries to accommodate its production, including Indonesia. This situation poses a threat to the domestic textile industry, so the government and textile industry players need to immediately adopt policies to safeguard the domestic market to

minimize the impact of declining demand and potential dumping from China [1].

The aim and objective of this electricity source effectiveness comparison is to find out the most efficient source of electrical energy to support the smooth running of the polyester production process in the company, as can be seen in Table 1.

Table 1. Comparison of polyester cost production for various generators.

No	Generator Type	Unit	Cost of Production	
			2022 (January-Desember)	2023 (January-September)
1	Electric Steam Power Plant	USD/kWh	0,0970	0,0959
2	Gas Power Plant	USD/kWh	0,7459	0,9650
3	Diesel Power Plant	USD/kWh	0,2765	0,4282

Based on the table above, the cheapest basic production costs for each generator are Electric Steam Power Plant [2].

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IMPACT OF PHENOLIC ACID MOLECULAR STRUCTURE ON THE STRUCTURAL CHARACTERISTICS OF GLIADINS AND GLUTENINS

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Keywords: gliadins, glutenins, FTIR, secondary structure, phenolic acids

Common wheat (*Triticum aestivum* L.) is a significant food crop, accounting for 20% of all calories consumed by humans. Gluten, the viscoelastic storage proteins found in wheat, consists of two protein types: gliadin and glutenin. Glutenin molecules, which are larger, have intra- and intermolecular disulfide cross-links, and contribute significantly to the elasticity of gluten. Gliadins, on the other hand, are smaller monomeric proteins with intramolecular disulfide bonds. They primarily contribute to the viscosity of gluten. [1].

Polyphenols are naturally occurring compounds found in plants that impart colour and taste. Dietary polyphenols have attracted attention due to their numerous beneficial biological functions. Interestingly, polyphenols form complexes with proteins rich in proline, such as gluten proteins. Interactions between polyphenols and gluten can be either reversible (hydrogen bonds, hydrophobic bonds or Van der Waals forces) or irreversible (covalent bonds) [2].

In our study, Fourier Transform Infrared (FTIR) spectroscopy was used to assess the changes in the secondary structure of gliadins and glutenins within a model dough following the addition of selected phenolic acids at concentrations of 0.05%, 0.1%, and 0.2% (w/w). The study examines hydroxycinnamic (caffeic, ferulic, coumaric, sinapic), as well as hydroxybenzoic phenolic acids (4-hydroxybenzoic, protocatechuic, vanillic, syringic). Each of these derivatives is distinguished by its unique structural features and the functional groups present on the aromatic ring.

The results of this study demonstrate that incorporating phenolic acids into the dough induces changes in the secondary structure of gliadins and glutenins. The extent of this interaction is contingent upon the molecular structure and concentration of the phenolic acids. Our research indicates that the presence of phenolic acids may influence the formation of hydrogen bonds in gliadins and glutenin proteins. It can be hypothesised that alterations in the glutenin structure caused by these acids may have an impact on the allergenicity of gluten proteins, particularly in relation to changes in the β-turn structure.

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GUIDANCE OF AUTONOMOUS ROBOTIC SYSTEMS USING SIGNALS FROM SENSORS

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Keywords: autonomous vehicles, sensor fusion, LiDAR, artificial intelligence, navigation, agriculture

The dissertation titled "Guidance of autonomous robotic systems using signals from sensors" delves into the enhancement of autonomous ground vehicle (Fig. 1a) navigation within agricultural settings, with a focus on row crops like hops. This study aims to modify a navigation and mapping software that utilizes data from a range of sensors including Inertial Measurement Units (IMUs), LiDAR (Fig. 1b), ultrasonic sensors, and cameras. The primary objective is to achieve robust map localization and sensor fusion that elevates precision and reliability in challenging environments.

Fig. 1. a) Robot with LiDar sensor, b) LiDar sensor used for navigation.

A thorough literature analysis forms the foundation of the methodology, building upon insights from current sensor technologies and their integration techniques used in autonomous vehicles (AVs). Particular emphasis is laid on

LiDAR and AI technologies for processing sensor data, with references to key studies highlighting their potential and limitations in AV navigation [1, 2, 3].

The dissertation explores various sensor fusion techniques—High-Level Fusion (HLF), Low-Level Fusion (LLF), and Mid-Level Fusion (MLF)—to determine their efficacy in precise obstacle detection and navigation under diverse environmental conditions [2, 4].

This research hypothesizes that AI-enhanced sensor fusion can achieve navigation accuracy comparable or superior to conventional methods, particularly under the complex conditions of agricultural fields.

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ENHANCING DRIVER WELL-BEING: INNOVATIONS IN VEHICLE MICROCLIMATE CONTROL

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Keywords: microclimate, psychogalvanic, HVAC, comfort

Modern technology and innovations in the field of vehicle microclimate control play a crucial role in optimizing driver comfort, health, and safety during journeys. Research shows that drivers often waste time and attention manually adjusting microclimate parameters, which can have a negative impact on their physiological and psychological well-being, and consequently, on road safety [2].

In practice, drivers may unintentionally select a cabin environment that can have similar negative effects to mild alcohol intoxication. For example, at temperatures inside the vehicle exceeding 27 °C, a driver's reactions can be comparable to a blood alcohol level of 0.5%. This fact underscores the severity of the problem and the need for effective solutions [1].

An innovative device for measuring psychogalvanic reflexes in vehicles enables automatic optimization of microclimate conditions in real-time. Sensors placed directly on the steering wheel can monitor the driver's skin resistance, providing important insights into their physiological state and reactions to the surrounding environment.
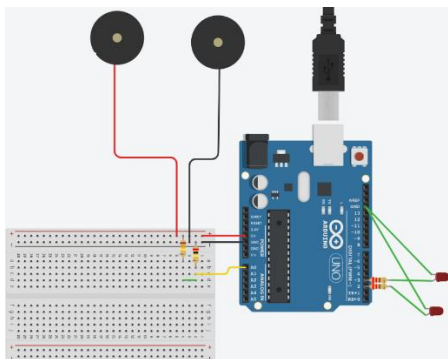
Fig. 1. Experimental setup of measuring device

This device, shown in *Fig. 1*, operates based on a programmed microcontroller, such as the Arduino Mini, which reads sensor values and calculates skin resistance to assess the driver's physiological response. By integrating this technology with an infrared system for monitoring facial temperature, the device can intelligently control heating, ventilation, and air conditioning (HVAC) settings based on the driver's physiological needs.

Furthermore, the collaboration of this device with an infrared system for monitoring the driver's facial temperature in the cabin allows intelligent control of heating, ventilation, and air conditioning. This comprehensive solution not only addresses the driver's physiological needs but also adheres to strict safety and comfort standards based on state regulations.

The implementation of this technological solution delivers more than just time savings for drivers. It ensures optimal microclimate conditions that are essential for maintaining the health, concentration, and safety of drivers and overall traffic. This innovative solution pushes the boundaries in vehicle environmental control and contributes to a better driving experience for every driver [3].

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AGRIVOLTAICS: A POSSIBILITY FOR SUSTAINABLE DEVELOPMENT

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Electricity from photovoltaic (PV) systems has an important place in the energy mix today. Already in 1992, A. Shahbazi proposed a more significant use of energy from renewable sources in agriculture [1]. In connection with renewable energy sources, the courtyards of the buildings provide space for the installation of agrivoltaics for sustainable development. This paper proposes the use of courtyards of low-rise buildings for agrivoltaics. This will increase the area for installing photovoltaic systems, which have so far only been installed on roofs or facades or on open fields. The advanced design of the photovoltaic systems will enable the dual use of the area both for the cultivation of crops and for the production of electricity at the same time. The increased amount of electricity produced in photovoltaic systems also contributes to reducing the carbon footprint. On the courtyard as well as on the open fields, it is possible to grow agricultural crops between rows of photovoltaic panels. The partial shading of seedlings during summer sunny days reduces their heat stress and slows down soil drying. Fig. 1. Shows an example of the agrivoltaic system on the courtyard in the Czech Republic. The contribution of agrivoltaics to reducing the carbon footprint is also significant.

Fig. 1 An example of the agrivoltaic system
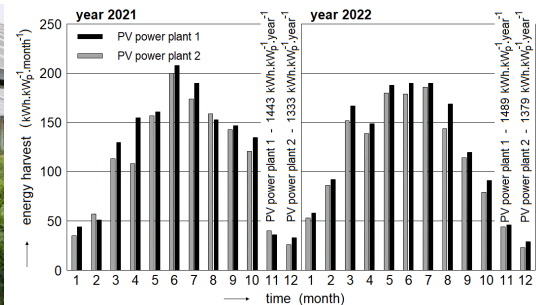
Fig. 2 Electricity production during the last two years

In this article, we present the evaluation of data from two selected PV power

plants in the Czech Republic (south Moravia) during long-term operation. The Solarmon (2.0) monitoring system was used to data monitoring. Fig. 2 shows the electricity production in the PV power plants during the last two years. The comparison of the annual electricity production in two selected PV power plants with the expected values according to PVGIS testifies to the quality of the construction and the PV panels used in both power plants. Tab. 1 shows the expected values.

Tab. 1 Expected values of produced electricity according to the Photovoltaic Geographical Information System (PVGIS), available from: https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html

Month	1	2	3	4	5	6	7	8	9	10	11	12	Σ
Electricity production (kWh.kWp^{-1}.month^{-1})	41.9	61.8	100.9	132.6	132.0	135.0	139.2	132.0	112.0	81.0	47.9	38.4	**1154.7**

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COMPARISON OF DENOISING METHODS FOR UNSATURATED HYDRAULIC CONDUCTIVITY CALCULATED BY THE INSTANTANEOUS PROFILE METHOD USING REFERENCE DATA

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Keywords: unsaturated soil water conductivity, instantaneous profile method

Experiments utilizing Time Domain Reflectometry (TDR) are commonly employed for soil moisture analysis. However, the results obtained from such experiments are often affected by noise, which can hinder the accurate calculation of unsaturated hydraulic conductivity by IPM. In this study, we compare the effectiveness of four different denoising methods using reference data generated by the Hydrus 1D Simulator with noise based on TDR experiments.

The denoising methods investigated in this study include moving average, Savitzky-Golay method, Bezier method and Fourier transform. A series of experiments were conducted where a known level of noise, based on TDR experiments was imposed on the reference results obtained from the Hydrus 1D simulator. Subsequently, each of the denoising methods was applied and the resulting denoised outcomes were compared with the reference values using quality assessment metrics such as root mean square error (RMSE) and coefficient of determination (R^2).

In summary, the choice of an appropriate denoising method shows us which method works best. The added value of these studies lies in providing a better understanding of the effectiveness of different denoising methods in the context of TDR experiment data and their potential practical applications. Furthermore, the comparison of RMSE and R^2 values across various denoising techniques offers valuable guidance for researchers in selecting the most suitable method for their specific analysis requirements.

Additionally, the comparison of RMSE and R^2 values for moisture smoothing data across different smoothing methods for an arbitrarily selected

layer: moving average method: RMSE= 0.06, R^2= 1; Savitzky-Golay method: RMSE = 0.02, R^2= 1; Bezier method: RMSE= 0.006, R^2= 1; Fourier method: RMSE= 0.08, R^2= 0.99.

The moisture smoothed data derived from the methods described earlier along with water pressure is utilized to compute the Unsaturated Hydraulic Conductivity (UHC) employing the Instant Profile Method (IPM). The comparison of RMSE and R^2 values for UHC across different smoothing moisture methods for an arbitrarily selected layer: moving average method: RMSE $= 1.64 \times 10^{-8}$, R^2= 0.63; Savitzky-Golay method: RMSE $= 8.54 \times 10^{-9}$, R^2= 0.84; Bezier method: RMSE $= 1.22 \times 10^{-9}$, R^2= 0.99; Fourier method: RMSE $=4.19 \times 10^{-8}$, R^2= 0.17.

It becomes evident that Bezier method excels in calculating UHC. Unlike other methods, generation of UHC vs. time graph closely approximates the simulated one.

Acknowledgments:

SMART FOOD PACKAGING – PH RESPONSIVE BIOCOMPOSITES

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Keywords: biocomposites, polyphenols, anthocyanin, environmental friendly

ABSTRACT

Anthocyanins, natural antioxidants derived from plants, are renowned for their health-promoting properties [1]. However, their inherent instability and limited bioavailability have posed significant challenges to their utilization in various applications. To address these issues, researchers have devised innovative strategies, including the integration of anthocyanins into biocomposite materials composed of natural polymers like nanocellulose, starch, inulin or chitosan [2,3,4]. These biocomposites exhibit immense potential in diverse fields such as pharmaceuticals, food packaging, and functional foods due to their enhanced functionalities [2,3]. Furthermore, advancements in nanotechnology have been harnessed to augment the properties of anthocyanin-containing biocomposite films, such as bolstered antioxidant activity and UV protection [2]. This concerted effort aims to overcome the obstacles associated with anthocyanins, paving the way for their widespread utilization across various industries, including food, pharmaceuticals, and healthcare. This study aims to present the potential of composites in the context of their application as intelligent food packaging.

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FRACTAL ANALYSIS OF THE PELLET STRUCTURE

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Keywords: fractal, pellet, structure

The work focuses on the evaluation of the mechanical properties of pellets produced from three types of biomasses: grass, clover and oilseed rape. The pellets were measured in the form of cylindrical rolls of 8 mm in diameter and 16 mm height on an experimental tearing device by the compression method. The equipment for this measurement was designed and constructed in the premises of the Technical Faculty of SPU in Nitra. The specimens were loaded in the axial direction. We were measured the modulus of elasticity and the strength and deformation of the specimens. Compress curve of the grass pelles sample are presented in the Fig.1a.
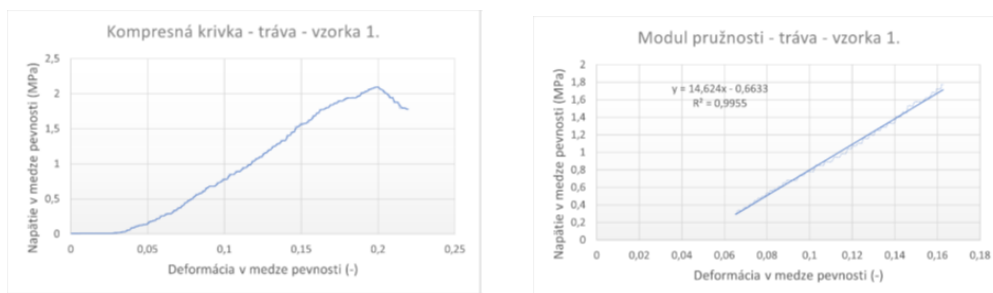
Fig. 1. a) Compress curve of the grass pelles sample, b) Determination of the modulus of elasticity of the grass pellet sample at the compression
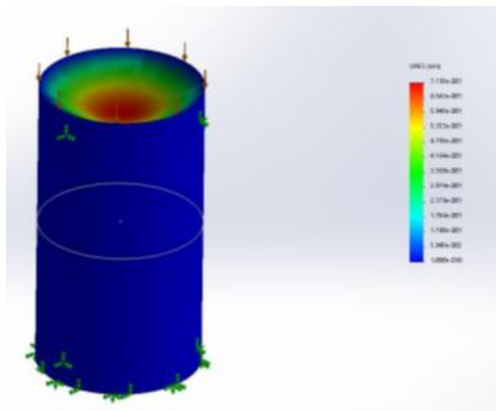
Fig. 2. Deformation of the clover pelet sample in Solidworks ver. 2017

Determination of the modulus of elasticity of the grass pellet sample at the compression is showed in the Fig.1b. The data obtained were used for experimental modelling of the specimens in Solidworks ver. 2017 and then the mechanical properties were compared between the model and the real specimens. Deformation of the clover pelet sample in Solidworks software is presented in the Fig. 2. Values of deformation for pellets from the grass were 0.148, the strength limit of 2.531 MPa and the modulus of elasticity 36.368 MPa. Values of deformation for pellets from the clover were 0.109, the strength limit of 4.146 MPa and the modulus of elasticity 76.608 MPa. Values of deformation for pellets from the oilseed were 0.119, the strength limit of 0.858 MPa and the modulus of elasticity 14.198 MPa.

Solidworks simulations were performed with use of the linear elastic isotropic model [1]. Simulations reproduced well the stress-strain relationship during the uniaxial compression test. The maximum shortening for the clover pellet model obtained by the model was 0.714 mm compared to the resulting values of real samples, where the arithmetic diameter of shortening between the strength was 0.874 mm (Fig. 2).

Acknowledgements:

physical laboratories by means of the control and automation systems in the field of Machinery Engineering**.**

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SIMULTANEOUS ADSORPTION OF METALS, METALOIDS, AND HERBICIDES ON ORANGE PEELS-DERIVED ACTIVATED CARBON

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Keywords: waste management, physical direct activation, microwave heating

A significant amount of peel waste is produced by the processing of fruit and vegetables, both in industrial plants and home kitchens, leading to significant nutritional, economic, and environmental impacts. Processing of fruits generates large amount of waste, accounting for approximately 25–30% of the total product [1]. For instance, worldwide orange production is estimated to reach about 60 million tons each year, generating orange peel waste at up to 50% of this value [2]. That is why proper management of waste from the fruit and vegetable industry is so important.

The main aim of the study was to produce orange peel-derived activated carbon via pyrolysis (800°C) and CO_2-assisted physical activation using microwave heating (microwave muffle furnace, Phoenix, CEM Corporation), as well as to apply it as an adsorbent of arsenate (As(V)) and cadmium (Cd(II)) ions in the mixed systems with diuron herbicide. The obtained product was marked as OFM800.
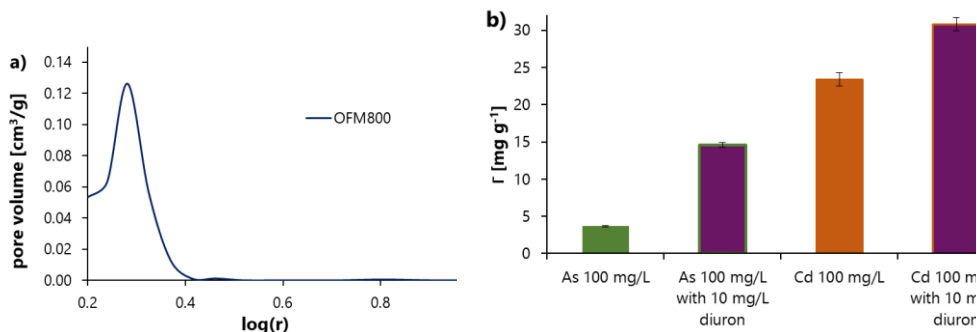
Fig. 1. a) Pore size distribution of OFM800, b) adsorption capacity of OFM800 towards As(V) and Cd(II) in the one- and two-adsorbate systems.

Textural parameters of the obtained material were determined by the low-temperature nitrogen adsorption/desorption method (Sorptomat Quadrasorb Si, Quantachrome). Elemental composition of the solid was determined using a CHNS analyzer (Series II CHNS/O Analyzer 2400, Perkin Elmer). During sorption study, initial concentration of As(V) and Cd(II) ions was 100 mg/L, whereas that of diuron, 10 mg/L. The concentration of metal/metalloid ions was determined using atomic absorption spectrometer (ContrAA 800, Analytik Jena) working in graphite cuvette technique. Diuron concentration after adsorption was not determined, only its effect on metal/metalloid adsorption was investigated.

Specific surface area (S_{BET}) of OFM800 was 266 m^2/g. According to International Union of Pure and Applied Chemistry (IUPAC) classification of pore size, the micropore width is taken to not exceed 2 nm [3]. Therefore, OFM800 was classified as a mesoporous solid. Its average pore diameter was 2.33 nm (Fig. 1a). The content of micropores within the OFM800 stucture was high, i.e., the ratio of micropore surface area (S_m) to S_{BET} was 0.76. The content of carbon (C), hydrogen (H), nitrogen (N), sulphur (S), and oxygen (O) in OFM800 was 77.05, 0.83, 2.7, 0.05, and 19.37%, respectively. According to European BC Certificate, the O:C ratio should be less than 0.4, and the H:C one, less than 0.7, when biochar/activated carbon is suitable for environmental applications [4]. This criterions were fulfilled for OFM800. The O:C ratio was 0.25, whereas the H:C one, 0.01. As(V) and Cd(II) ions were better adsorbed in the solutions containing also diuron molecules (Fig. 1b). For example, the adsorption capacity of OFM800 towards As(V) ions increased almost 4 times, from 3.7 to 14.6 mg/g, when diuron was present in the solution. For Cd(II), there was a smaller increase in adsorption in the mixed system, from 23.4 to 30.8 mg/g. This means that

the prepared material is a very promising agent for remediation of soils and waters contaminated with metals, metaloids, and herbicides at the same time.

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ENERGY ASSESSMENT OF THE SELECTED HAZARDOUS WASTE

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Keywords: pyrolysis, thermogravimetric analysis, activation energy, calorific Value

There is growing interest in biomass fuels because of problems associated with climate change and energy dependence. The thermal decomposition reactions play a crucial role during several of the biomass utilization processes. One of these process could by pyrolysis. The process of pyrolysis is evaluated via thermogravimetric analysis. Thermogravimetric analysis (TGA) is a high-precision method for the study of pyrolysis at low heating rates, under well-defined conditions in the kinetic regime. A simple kinetic thermal decomposition samples was investigation with isoconversional methods, such as Kisinger - Akahira - Sunose and Flyn - Ozawa - Wall model. The goal of this research is to description of the thermal behaviour of the straw versus Polypropylene during pyrolysis using TGA.

The sample was dangerous waste as Engine Oil new and used. Each sample was analysed three times, at heating rates of 10, 20 and 30 °C.min^{-1}. The output of these analyses were thermogram, from which we were able to determine the changes at what temperature were the largest weight losses and DTA curves. The largest mass losses sample occurred in the Engine Oil between 200 °C and 450 °C in one step. Capturing device for vapor hydrocarbons compounds should be placed under flue gas discharge pipe. Maximum efficiency should be within these temperatures. Calculated E_a the largest mass losses sample occurred in the Engine Oil between 250 °C and 420 °C in one step. This mass loss for follows that all EO decomposes at temperature range 300 °C. Activation Energy for EO was calculated in the point of start decomposition, the inflection point, and for the ending point of decomposition. We calculated the activation energy for each conversion rate

from 0.1 to 0.9 for oil. Its value increased with the degree of conversion. The average activation energy of EO new obtained from the FWO method was 104.89 kJ.mol^{-1} and EO used was 107,06 kJ.mol^{-1}. For oil was maximally Ea in conversion 90 % in both cases new and used samples. Average value of activation energy answered middle range of temperature between 320 °C to 390 °C. The caloric value was determined by calculation based on the modification equation by the author Malucelli (2019). HHV for our samples was calculated below 35 MJ.kg-1. This research should be more investigated. The results of our work show that values of activation energy were comparable than the valuesreported by author Mishra (2020), who analyzed used oil. Authors Soudai, (2007) and Park (2009) using thermal analysis for determination Ea biomass and polymeric samples establish similar Ea for PVC and oak wood. Thermogravimetric analysis is good method for examination contents of soot in oil (Deshmukh, 2024). In our exam was proven soot only in used sample.

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PHYSIOLOGICAL CHANGES IN TOMATO FRUIT DURING STORAGE IN STRESSFUL OXYGEN CONDITION

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Keywords: cell wall, fruit, hypoxia, anoxia, storage

The concentration of oxygen is critically important in the storage of fruits, including tomatoes, where the optimal oxygen levels are considered to range between 1.5-3%. These levels help extend fruit storage by minimising post-harvest respiration and ripening, while maintaining lower levels of ethylene production. Changes in oxygen concentration can have negative effects on fruit quality. Anoxia is characterised by the absence of oxygen, and hypoxia is characterised by an increased concentration of oxygen during storage [1,2].

The aim of this study was to determine physiological changes in tomato fruit (*Solanum lycopersicum* cv. 'Moneymaker') during storage under non-optimal conditions. Fruits were stored for 24 and 72 hours under conditions of anoxia (0% O_2), hypoxia (5% O_2), and normoxia (21% O_2). After storage, the fruits were tested using immunocytochemical [3] and biochemical assays [4].

Storage under oxygen stress conditions resulted in visible anatomical changes in the fruits, such as skin cracking. Analysis of the individual components of the fruit cell wall identified several significant modifications associated with storage under stress conditions. These modifications were mainly related to the localisation, spatio-temporal distribution, and number of epitopes analysed. Storage under hypoxia resulted in increased immunofluorescence intensity after reaction with antibody against

arabinogalactan proteins (LM2) and a decrease in intensity after reaction with antibodies against homogalacturonan (LM19 and LM20).

Enzyme analyses, which catalyse the hydrolysis of glycosidic bonds in polysaccharides and reconstruction of the cell wall, showed modifications in their activities. For example, β-1,3-glucanase exhibited higher activity under 0% oxygen than under 5% and 21% oxygen concentrations. The activity of β-1,3-glucanase was correlated with increased secretion of callose. This can be considered as a way to respond to non-optimal conditions. The activity of guaiacol peroxidase, an antioxidant enzyme, was two-fold higher under condition of hypoxia than in anoxia and normoxia. The guaiacol peroxidase activity increased in the fruits at the BR stage and decreased in the fruits at the RR stage. Condition of hypoxia may cause the ripening process to slow down while condition of anoxia can accelerate the changes to occur more quickly.

The molecular analyses confirmed the results obtained *in situ*. Quantitative analyses using ELISA showed that the content of HGs with different levels of esterification was clearly changed in the fruits stored under low oxygen conditions. The fruits stored under condition with 5% of oxygen for 72 hours had significantly higher concentrations of LM19 and LM20 than the control. In addition, in the hypoxia experiment, a clearly lower rate of HG degradation in the fruits was observed at the RR stage. Western blotting studies on arabinogalactan proteins and extensin indicated that low oxygen stress had an impact on their occurrence in cell walls, but the changes were less than in tha case HG. Western blotting using the LM1 antibody demonstrated degradation of extensin in the samples after storage under condition of 0% oxygen for 72 hours. Consequently, the bands at 120–85 kDa decreased. In all samples, rhamnogalacturonan type I with a low molecular mass (approximately 20 kDa) was observed. The changes of oxygen conditions did not have affect the presence of LM16 epitope. LM2 epitopes were observed like smear bands along the whole lanes with a molecular weight in the range of 120 kDa-20 kDa. In the case of this epitope, the low oxygen concentration did not affect on bands indification. The analyses of the LM19 and LM20 epitopes indicated changes in the molecular weights of the HG. Additionally, bands with low molecular weights (~30 kDa) were the most intense.

The results elucidated the impact of low oxygen concentrations on fruit structure at both *in situ* and *ex situ* levels. The observed changes in tomato cell walls under hypoxia and anoxia conditions are probably the result of some protective mechanisms. The results after storage under hypoxia seems to be a

beneficial during the fruit postharvest storage, which may have an economical effect.

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POSSIBILITIES OF USING SAR DATA WITH NDVI

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The integration of Synthetic Aperture Radar (SAR) and Normalized Difference Vegetation Index (NDVI) presents a potent approach for environmental monitoring, particularly in agriculture and precision farming. By synergizing SAR's weather-resilient imaging with NDVI's vegetation health assessment, this integration offers unparalleled insights into crop monitoring, yield prediction, and soil health evaluation (Kordi & Yousefi, 2022).
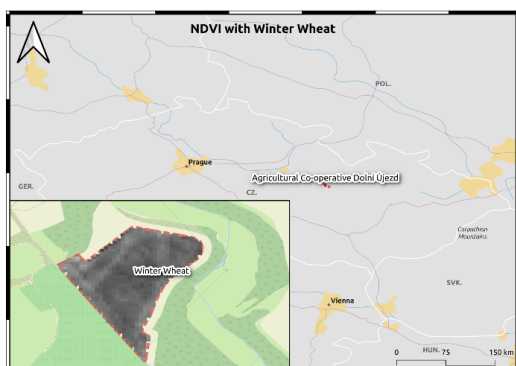
Figure 1 Map location of the Agri Co-operative

Figure 2 Field of winter wheat taking the samples

In this article we present our findings from combining NDVI with SAR in Czech Republic. Data was taken in the year 2022 from April to July. Thanks to Agricultural Co-operative Dolní Újez (fig. 1) the study case was on their winter wheat field shown on fig. 2. Satellite data was taken from Sentinel1 (SAR data) and Sentinel2 (optical data) of the European Space Agency (ESA). Graph 1 shows how NDVI with SAR data can benefit from each other with regards to vegetation growth of winter wheat. By using SAR data with NDVI a more precise result was obtained.

Graph 1 Monitoring the growth of winter Wheat by a variety of indexes and their effectiveness
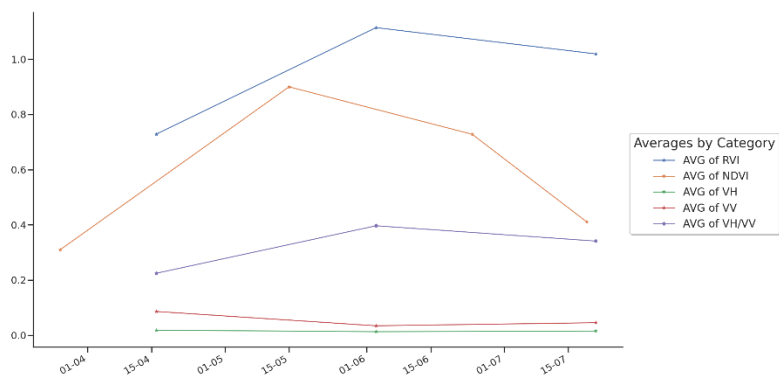
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MODELLING THE PERFORMANCE OF DOUBLE PASS SOLAR AIR COLLECTORS

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Keywords: solar air collector, mathematical modelling, air heater, thermal efficiency

The solar air collector functions as a heat exchanger that converts solar energy into thermal energy, which is utilised in applications such as heating and drying. However, these collectors often exhibit low thermal efficiency, primarily due to the thermal properties of air [1]. The objectives of this study are to develop a mathematical model to estimate and analyse the factors influencing the overall performance of double-pass solar air collectors (DPSAC). This model will facilitate the identification of the most significant factors impacting efficiency, thereby enabling more targeted improvements.

After establishing several theoretical assumptions, the study outlined five heat balance correlations [2]. These correlations are solvable by utilising MATLAB R2023a as the modeling software. The thermal network and the heat transfer coefficients are depicted in Fig. 1.
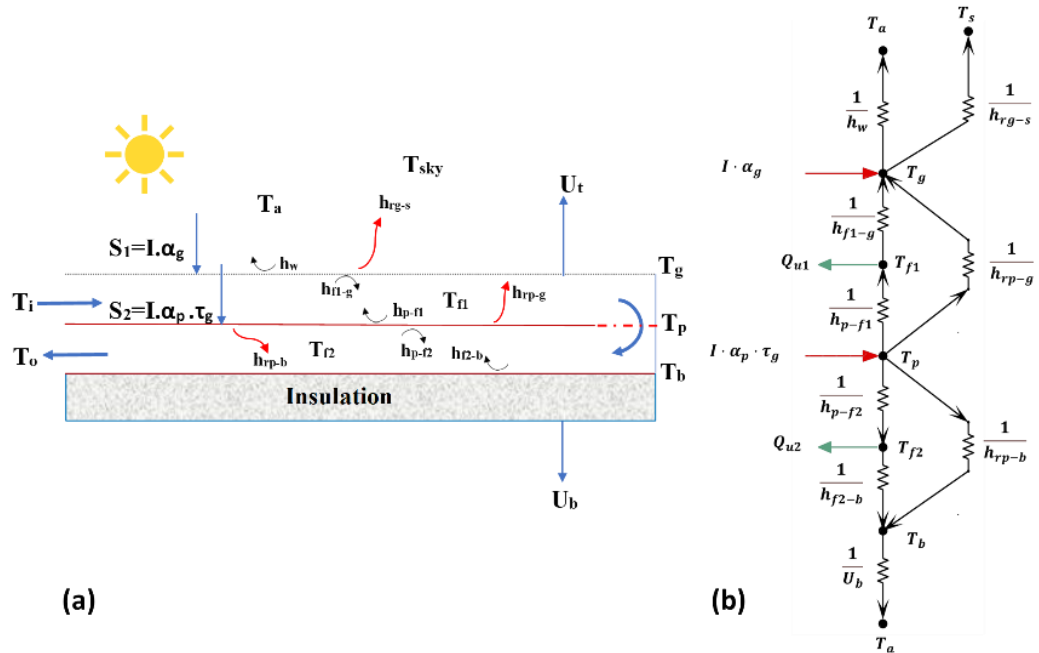
Fig. 1. Diagrammatic representations: a) heat transfer coefficient, b) thermal resistance network for DPSAC

The model has been validated against experimental results conducted on Agust 2023 in the Solar Laboratory of the Hungarian University of Agriculture and Life Sciences in Gödöllő, Hungary. The outcomes from the proposed model demonstrated strong concordance with the data obtained from laboratory experiments. Based on these results, it is evident that airflow rate is a critical factor influencing the performance of DPSACs. Increasing the airflow rate enhances the heat transfer rate, lowers the plate temperature, and consequently reduces heat loss while elevating the air temperature. Additionally, the collector outlet temperature was found to be highly sensitive to variations in solar radiation intensity and ambient conditions. The efficiency of the collector can be further improved by minimizing heat losses through the use of high-quality thermal insulation materials.

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THE POTENTIAL OF INDUSTRY 4.0 IN PHYSICS RESEARCH

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Keywords: IoT, VNC server, electric properties, filament

The role of IoT is to integrate computer systems into a unified controlled entity. This contribution presents the possibilities of integrating a VNC-server at a device which records the temperatures of a laboratory experiment. Together with the application of machine learning in modelling mechanical properties based on the electrical properties of a composite, they create a perspective in Industry 4.0 learning in technical physics.

The measurement system has been designed on the platform of an 8-bit Silabs microcontroller. The temperature measurement was realized via a 4-20 mA current signal. The target range was set at -20 to +120 °C with a mean absolute percentage error which does not exceed 2.1 %. The subject problem was solved in the thesis [1].

An application of machine learning to the field of materials classification and characterization is crucial measurement uncertainty. The series resistance and series capacitance were measured. The frequency range was set to 2.75 MHz to 110 MHz. The value of the coefficient of variation was a maximum of 1.88% for the series resistance. For the series capacitance, the coefficient of variation with a value of 143.9 % was highest at a frequency of 96.8 MHz. Away from that frequency, the value of the coefficient of variation was below 8.1 %. A PET-G material was selected to experimental evaluation of electric properties. Manufacturing temperature of printed material was set to value of 235 °C.

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NEOSARTORYA SPP. (TELEOMORPH OF *ASPERGILLUS* SPP.) SENSITIVITY TO CHELATORS AVAILABLE IN BIOLOG™ PM21-25 MICROPLATES

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Keywords: heat resistant fungi, chemical sensitivity, chelating agents, fungal metabolism

Chelators are compounds that form complexes with metal ions [1] by attaching two or more donor atoms (or sites) to the same metal ion simultaneously [2]. Chelating agents naturally occur in many plants as parts of their metabolism [3]. Due to innate synthesis of chelators, some plants develop hyperaccumulating tendencies and therefore can be used in bioremediation meant for sustainable clean-up of metal-contaminated soils [4]. Furthermore, chelation of microelements such as Fe, Mn, Cu or Zn is used in production of crop fertilizers [5] or in plant and crop protection [6].

The purpose of this research was to evaluate whether a group of chelators (pyrithione, 2,2′-dipyridyl, EDTA, BAPTA, EGTA and tetrasodium pyrophosphate) of known agricultural applications can influence a common soil-borne food contaminant, *Neosartorya* spp. (*Aspergillus* spp.) fungus [7]. To test this, 10 fungal isolates were grown on Potato Dextrose Agar for 10 days at 30°C. These isolates exhibited varying sensitivity to stress-inducing agents like natural plant extracts and food preservatives according to previous tests. After incubation, spores and mycelial fragments were transferred into sterile Biolog® FF inoculation fluid. The suspension's turbidity was adjusted to a transmittance of 62%, with additional nutrients added at a concentration of 480X. The inoculum was then applied (100µl) to Biolog® PM 21-25 microplate wells that contain an array of chemical substances which permitted an observation of metabolic alterations. Plates were incubated at 30°C for 192 hours, with readings taken every 24 hours using a Biolog® MicroStation reader

at 490 nm (Average Fungal Respiration Intensity) and 750 nm (Average Fungal Growth Intensity).

Chelators had a negative effect on *Neosartorya* spp. growth intensity up until the 72 hour of the experiment. After 144 hours the AFGI of isolates coincubated with chelators surpassed that of the control, with 2,2′-dipyridyl, pyrithione and EGTA being the most stimulatory. Isolates did not respond uniformly, creating three main groups of sensitivity comparable with those obtained from previous experiments. Although 2,2′-dipyridyl caused high Average Fungal Growth Intensity values of most isolates after 144 hours of incubation, it was not favored by the most resilient isolate (G135/14). For most isolates, the least growth was observable under the influence of sodium pyrophosphate decahydrate.

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EXPLORING OF CONTEXT BETWEEN GROWING PLANTS AND CHANGE IN SOIL WITH USING INTERNET OF THING

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Keywords: Internet of Things, soil sensor, agriculture, precision agriculture

In the realm of agriculture, the Internet of Things (IoT) is revolutionizing how we monitor and manage crop production (Yin et al., 2021; Fan et al. 2022). This study specifically investigates how changes in soil properties can be meticulously monitored during plant growth using IoT technologies. By integrating a network of advanced soil sensors, this research captures real-time data on chemical and physical soil dynamics, linking these changes directly to plant health and productivity (Fischer et al., 2007). The objective is to compare these real-time data streams against traditional, time-consuming soil sampling methods that typically require extensive laboratory analysis (Phupattanasilp, 2019).Our methodology involves the deployment of IoT-connected sensors across various soil types and under different crop conditions (Fig. 1a). These sensors continuously record vital soil parameters such as temperature, moisture content, pH levels, and nutrient profiles (Fig. 1b). The experiment is designed to test both the accuracy and reliability of these sensors in providing actionable insights that can lead to more informed agricultural decisions.

Figure 1 a) multifunction soil sensor, b) soil sensor values

The expected outcomes of this research include a significant advancement in smart farming techniques. By offering farmers real-time insights into soil conditions, IoT technology enables more precise irrigation, fertilization, and crop management practices. This can lead to enhanced crop yields, reduced resource waste, and improved sustainability in agricultural practices.

Ultimately, this study aims to demonstrate the potential of IoT in transforming agricultural methodologies, making them more responsive and efficient. This will not only support farmers in optimizing their operations but also contribute to broader environmental conservation efforts.

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BEHAVIOUR OF MACROMOLECULES OF WATER-SOLUBLE ONION POLYSACCHARIDES IN THE AQUEOUS SOLUTION

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The plant cell wall is an intricate structure built of macromolecules of biopolymers, mainly polysaccharides. It is a kind of skeleton, that gives the cell its shape, enables contact with the external medium and protects against the adverse effects of the external factors action [1]. Polymeric constituents of the plant cell wall are a subject of interest of science and industry due to their unique properties. In the case of onion (*Allium cepa* L.), this is bioactivity and a pro-health effect [2]. However, one of the most important functional properties of polysaccharides is the ability of their macromolecules to self-assemble in the solution and form a gel under specified conditions [3].

The aim of research was, therefore, to check the ability of the water-soluble polysaccharide (WSP) fraction to self-organize its macromolecules in the aqueous solution. This fraction is the easiest to isolate from the onion cell wall.

WSP was extracted with the ultrapure water from the cell wall material of bulbs and assimilation leaves of two varieties of onion at the ambient temperature (20 ± 2 °C). An effect of increasing WSP concentration on the properties of aqueous dispersion was studied using the electrochemical and spectroscopic methods. Simultaneously, the measurements of viscosity were performed.

The macromolecules of WSP fraction extracted from the cell wall of the onion bulbs showed better self-organization abilities than those of assimilation leaves.

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CHARACTERISTICS OF NDFEB BONDED MAGNETS FOR LOW SPEED GENERATORS

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Development of bonded NdFeB magnets made from commercial magnet powder MQEP 16-7 Magnequench by compacting green compact at a pressure of 5 tons and heating at a temperature of 150OC for 2 hours, which produces bonded NdFeB magnets with dimensions of diameter = 25 mm, thickness = 5 mm and density = 4.9 gr/cm-3 for 36 samples. Characterization of the properties of bonded magnets has been measured using the Permagraph Magnet Physyk instrument with remanence induction results (Br) = 0.57 Tesla, coercivity (Hc) = 345 kA/m and maximum energy product (BH)max = 35.17 kJ/m. After the magnet sample was magnetized using a Phisyk Magnetizer with a voltage of 1000 Volts, the result of measuring the surface flux density or surface gauss using the Yokogawa Gauss Meter was 1280 Gauss. The NdFeB MQEP 16-7 bonded permanent magnet has magnetic strength characteristics of 1280 Gauss and can be applied to 3 phase axial flux permanent magnet generators. The main phase characteristics of NdFeB bonded permanent magnets is Nd2Fe14B. Then a prototype axial flux generator was made which was designed to consist of 3 rotors and 2 stators. 36 magnetic samples were attached to 3 rotor plates made of acrylic. Each rotor is filled with 12 magnets which form 12 poles alternating between the north pole and the south pole. 18 coils have been made of 100 coils each which are attached to 2 stator plates which are also made of acrylic. Each stator is filled with 9 windings for 3 phases, where each phase consists of three windings connected in a star (Y) configuration. The generator prototype has been tested by rotating it using a DC motor coupled to the rotor axle. The rotation is varied

from 300 to 1000 rpm with 100 rpm intervals. The results of testing the sinusoidal waveform of the output voltage per phase with an angle difference of 120O have been obtained. The output voltage value without load between phases increases linearly and at 1000 rpm the output voltage is obtained at 40 Volts or 97% of the calculated results. When the generator is given a resistive load, the maximum current obtained at 1000 rpm is 0.150 amperes and the power is 5.25 Watts.

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THE ROLE OF RESIDENTIAL PV ON LARGE-SCALE PHOTOVOLTAIC INTEGRATION

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Keywords: Residential PV, battery storage, feed-in limit, distribution network

Over the past few decades, residential PV has experienced remarkable global growth, driven by declining PV-battery costs and policy support [1]. This trend is particularly evident in the integration of residential PV into low-voltage distribution grids, which has become common practice in many countries and is even spurring grid reinforcement and expansion [2] . However, the rising adoption of residential PV has led to voltage congestion in low-voltage distribution networks, necessitating management strategies to mitigate these impacts. One of the primary strategies employed to control the impact of residential PV is the implementation of feed-in limits in conjunction with home battery storage [3].

Examining different combinations of residential PV capacities (PV-Cap) and battery storage capacities (Bat-Cap), this study evaluates the influence of feed-in limits on enhancing the stability of energy flow within the distribution network. Through simulations, the research seeks to uncover the optimal balance between PV capacity, battery storage, and feed-in limits, as well. Fig.1. presents an illustrative diagram detailing the methodology employed along with some key results.
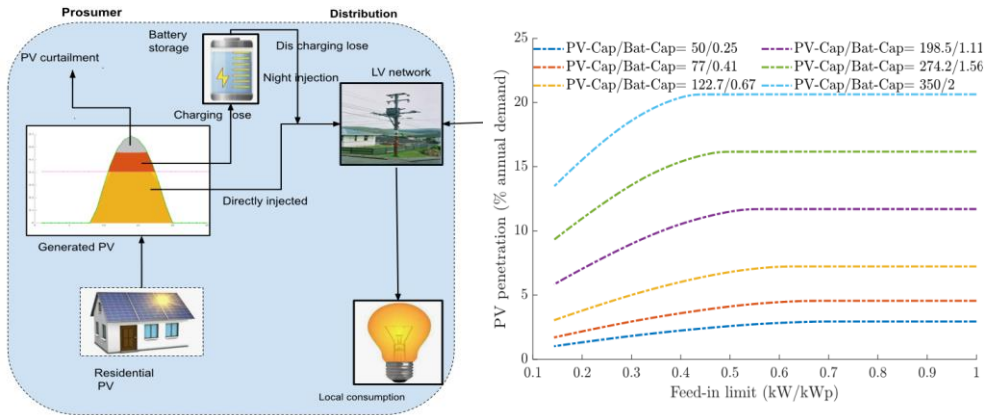
Fig. 1. a) Schematic diagram illustrating the employed methodology, b) Penetration as a function of the feed-in limit for different PV capacities (MW) and battery (kWh) combination

As depicted in the figure, penetration increases with rising feed-in limits until a certain threshold, after which the rate of increase diminishes. The point at which penetration begins to flatten varies depending on the combination of PV capacity and battery. At low PV capacities, the feed-in limit has negligible effects, but as PV capacity increases, there is a sharp rise up to a feed-in limit of approximately 0.5 kW/kWp, beyond which further increases in the feed-in limit yield minimal benefits to the system. This suggests that installing larger inverter sizes has little impact on the overall annual energy generation for residential PV-battery combinations.

A comprehensive analysis of the data reveals a trade-off between increasing renewable energy utilization and the losses incurred when imposing PV feed-in limits. A lower feed-in limit results in higher losses but ensures compliance with local distribution network requirements. Conversely, a higher feed-in limit facilitates greater system penetration but raises the risk of network congestion and non-compliance with grid requirements. Overall, the results indicate that an injection limit of around 0.5 kW/kWp achieves a balance by reducing losses while enabling higher penetration.

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CHLOROPHYLL FLUOESCECE AS AN INDICATOR OF PHOTOSYNTHETIC PERFORMANCE OF BARLEY CULTIVARS UNDER VARIABLE GROWTH CONDITIONS

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Keywords: barley, photosynthetic performance, drought, light fluctuations

Barley (*Hordeum vulgare* L.) is cultivated across the globe for various purposes, including human consumption, industrial use and animal feed. It holds the fourth position worldwide in terms of cultivation area, following wheat, maize, and rice. Europe accounts for nearly half of the global barley cultivation area, where it is the second most cultivated cereal crop after wheat. In comparison to wheat, barley demonstrates highre yield potential in dry climates, because it flowers and mature faster, while also exhibiting quicker rates of leaf canopy development and root growth during the initial stages of the growing season. The advantage of barley is it's tolerance to the late sowing and moderate drought stress, which makes barley a valuable crop in changing climate [1].

The intention of presented experiment was to evaluate photosynthetic performance of two commonly used cultivars of barley, LG Diablo (LD) and Ellinor (E), under condition induced drought and light fluctuations.

The experiment was conducted on crops cultivated in growth chambers, under controlled environmental condtions. Measuements were conducted on leaves detached from plants, at two growth stages. For a representation of young leaves we choosed the youngest (3ʳᵈ), fully developed leaf and as an old leaf we choosed one of the lower leaves (4ᵗʰ-5ᵗʰ). Half of leaves were left to dry, in growth chambers, for four hours before starting the measurement, to achieve conditions of moderate drought. Level of drought was determined by relative water content (RWC).

Measurements (n=4) of chlorophyll fluorescence on dark adapted leaves were taken by ImagingPAM (Walz GmbH). During measurements light fluctuations of intensity 55 and 530 $\mu mol \cdot m^{-2} \cdot s^{-1}$ changing every 20s were induced. We evaluated photosynthetic parameters, such as effective quantum yield of photosystem II Y(II) and quantum yield of regulated energy dissipation Y(NPQ). Additionally we measured chlorophyll content in leaves using chlorophyllometer CCM 300 (OPTISCIENCE).

Leaf air drying allowed to simulate drought stress and resulted in significant deacreaase of RWC in both cultivars. Significantly higher photosynthetic performance in LD cultivar, reflected by Y(II) parameter, was observed in young control leaves, than in older leaves both control and drought stressed. In E only old and drought stressed leaves achieved significantly lower rates of Y(II). We didn't observe any differences in NPQ efficiency in examined leaves of both cultivars, however some differences in NPQ trends suggest lowering of crop plasticity in older leaves.

Our results demostarte, that depending on the age and water status, barley leaves responds differently to FL, what is of importance in evaluation of crop photosynthetic productivity in dense canopies.

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SYSTEM OF AGRIVOLTAIC: DEVELOPMENT OF SUB-SYSTEM ARDUINO MICROCONTROLLER AND PROGRAMMABLE LOGIC CONTROLLER

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Keywords: equator, agrivoltaic, photovoltaic, hydroponic, soil moisture

Indonesia is a country that crosses the equator, and this condition makes Indonesia special compared to countries that are far from the equator. In Indonesia, the sun continues to shine over the year, and by specific Indonesia receives $3.6 – 6$ kWh/m^2/day of solar irradiation intensity, equivalent to an annual power output of $1,170 – 1,530$ kWh/kWp [1].

Seasonal changes between the dry season and the rainy season will have an impact on soil moisture which will vary, therefore the plants can grow well throughout the year. It is necessary to regulate/control watering based on soil moisture. Based on the statement above, it is necessary to utilize unlimited solar energy (4.5 kW/m^2) by photovoltaic which is used to create a smart garden so that if the soil moisture is below the value expected by the plants, then the irrigation system for watering the plants can be controlled with input over time, such as morning, afternoon or evening. The schematic diagram of the photovoltaic support directly the plants is shown in Fig. 1. The soil moisture value sensed by the soil moisture sensor will be controlled using an Arduino or Programmable Logic Controller [2][3][4].
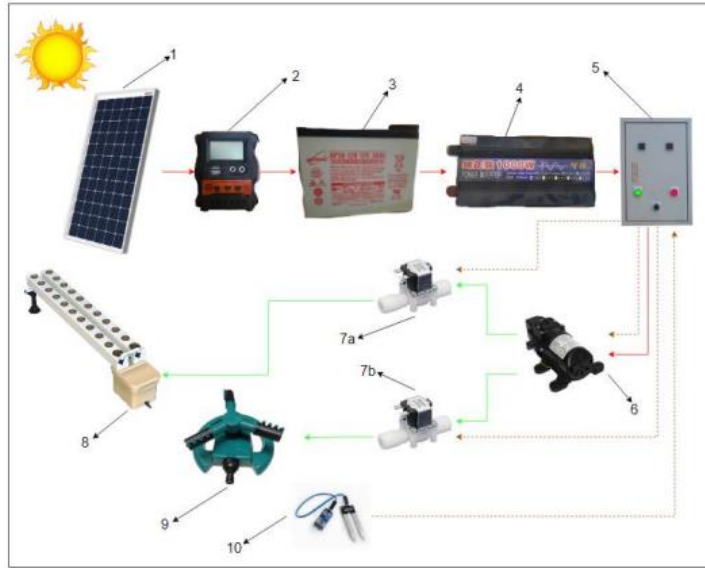
Fig. 1. The concept of agrivoltaic components

The schematic diagram of the soil moisture controller is shown in Fig. 2.
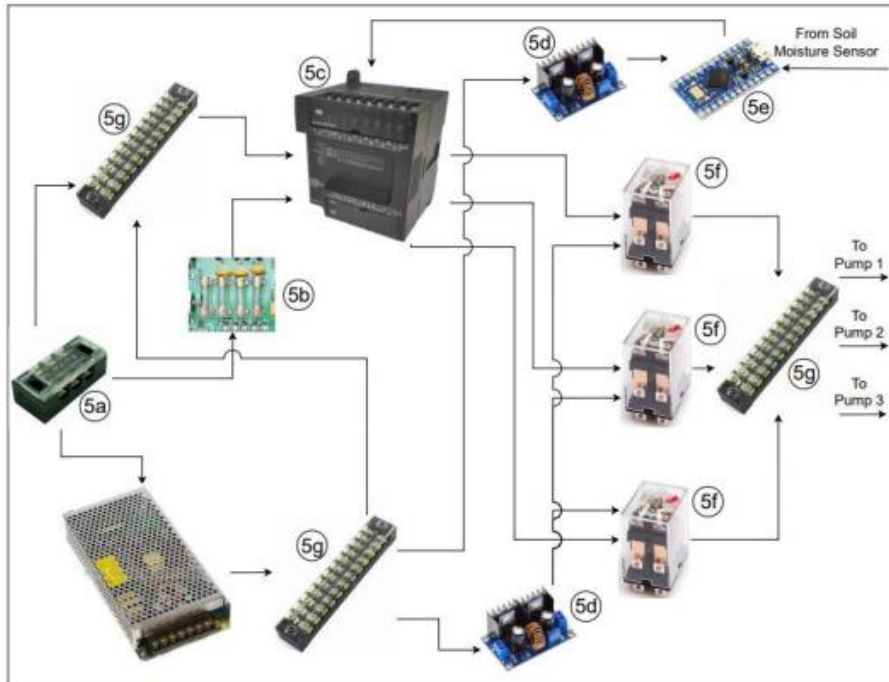
Fig 2. Soil moisture controller concept schematic

Figs 1 and 2 image description:

1. Photovoltaic, 2. Solar Charge Controller, 3. Battery, 4. Inverter
5. Panel Box
    a. Terminal Block 3 Pole, b. Fuse, c. Programmable Logic Controller
    d. Trafo Step Down, e. Arduino, f. Relay, g. Terminal Block 12 Pole, h. Power supply
6. Pump, 7. Valve, 8. Hydroponic, 9. Sprinkler, 10. Moisture sensor.

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FULL-TIME OPERATION OF PCM INTEGRATED SOLAR ORGANIC RANKINE CYCLE

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Keywords: solar energy, performance and exergy analysis, thermal enery storage, Indonesia's potential.

The Indonesian government is attempting to boost the use of renewable energy, with a target of around 25 GW in 2025 and 149 GW in 2050. Specifically, in the solar energy usage sector, Indonesia has a daily total of around 3.6 to 6.5 kWh/m^2 and an annual total of around 1314 to 2191 kWh/m^2 (Solargis, 2023). It makes a proper location for building solar energy employing an organic Rankine cycle (ORC). In this study, it is examined how much power and efficiency solar collectors produce using energy, exergy, and environmental analysis with different working fluids (R245fa, R134a, Propane, R32, R410a) by taking advantage of the weather in Bandung, Indonesia, to provide backup electricity during high-load hours. Because solar heat is the only heat source in this study, the selection, sizing, and methods of thermal energy storage (TES) with various phase change materials (PCM) were analysed.

Fig. 1 show the result that in July 2021, R134a produced the highest average energy, around 685 W.h/day and R245fa produced the highest thermal efficiency of 7.45%.
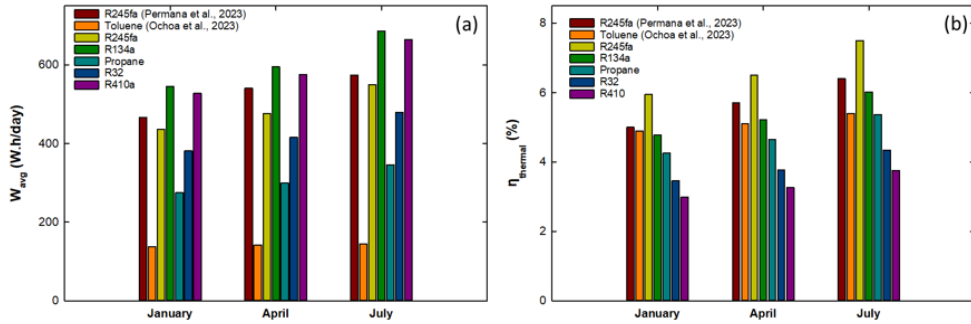
Fig. 1. Daily profile of the performance of solar-ORC in different working fluids:

a) W_{avg}, b) $\eta_{thermal}$

Meanwhile, to store the heat that will be used, inorganic PCM was chosen as the TES-evaporator material for low melting temperature (~ 313 K) and high volumetric heating (~ 389 MJ/m^3) with a capacity of 300 L (Fig. 2a), which can store heat optimally and can running the ORC for about 500 W. Moreover, Fig. 2c shows the difference in melting temperature of each PCM, we can see the temperature of the PCM when filling with heat starts when solar radiation begins, and it is from 5.00 to 18.00 with temperatures from 293.15 - 393.15 K and in the same period, the heat stored by the PCM increases to 75,000 kJ. After the PCM is fully charged until 18.00, then the ORC starts working at night, so it can be seen in Fig. 2c, the TES temperature decrease and the power used by the ORC begins to be used starting from 18.00 with the highest power reaching 600 W and slowly decreases in terms of power, heat and PCM temperature. due to enhanced superheating at the expander intake, higher TES temperatures result in more significant initial power outputs at the start of the ORC operation period (Fig. 2b).
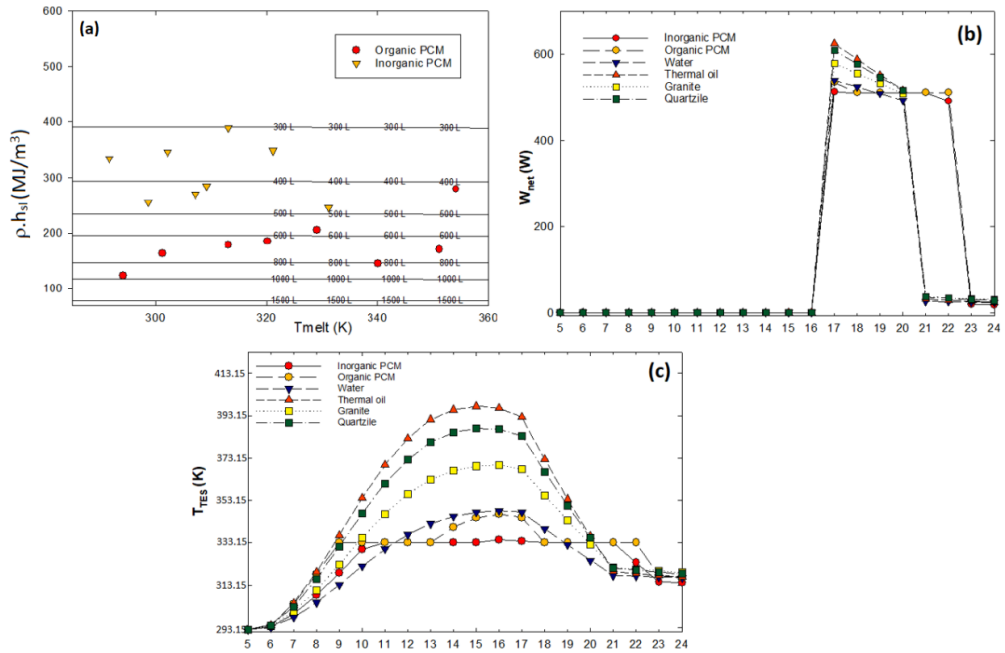
Fig. 2. Characteristic of PCM in full-storage: a) TES capacity, b) W_{net}, c) T_{TES}

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DEGREE OF ACETYLATION OF PLANT CELL WALL POLYSACCHARIDES DURING APPLE RIPENING AND STORAGE

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Keywords: degree of acetylation, plant cell wall polysaccharides, firmness

Apples are of great interest to consumers, who make their choices taking into account the external appearance of the fruit (colour, size, shape) but, above all, internal quality factors such as texture, firmness, amount of juice, and soluble solid content[1]. As apples are a storage fruit, it is crucial to maintain their high quality for consumption for a given post-harvest storage period. One of the main problems in the storage of fruit is softening. Therefore, as the composition of the plant cell wall determines its mechanical properties[2], research into the structure of fruit cell wall polysaccharides during ripening and post-harvest storage is important. Hence, the main objective of this study was to analyse cell wall composition, changes in the degree of acetylation of non-cellulosic polysaccharides and their correlation with apple firmness during ripening and storage.

Idared and Pinova apples were studied at 7 terms: during ripening on the tree (T1-T4) and post-harvest three-month cold storage (T5-T7). For apples from all terms, firmness was measured and cell wall material was isolated, followed by sequential extraction to obtain pectin-rich fractions: water-soluble pectin WSP and imidazole-soluble pectin ISP, and hemicellulose-rich fractions: natively acetylated hemicelluloses soluble in LiCl-DMSO, deacetylated hemicelluloses soluble in 4M KOH. For the obtained polysaccharide fractions, monosaccharide composition and degree of acetylation (DAc) were determined by HPLC chromatography. Studies of polysaccharide structure were complemented by FT-IR spectroscopy.

The study showed that the degree of acetylation increased during ripening and three-month storage of apples only for LiCl-DMSO-extracted hemicellulose fractions. There was also a statistically significant negative correlation of DAc with apple firmness, and thus the effect of DAc of polysaccharides on apple texture properties.

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EXTRACTION METHOD INFLUENCE ON THERMAL PROPERTIES OF BLACKBERRY SEED OIL

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Keywords: thermal properties, berry seeds, ultrasound-assisted extraction, oil, DSC

Berry seeds are considered as a waste product from fruit industry. However, seeds can be a source of oils and bioactive compounds. The extraction of oils can be conducted in a conventional procedure or using alternative techniques [1]. The alternative extraction method can be beneficial in terms of decreased time and solvent consumption but it may influence properties of obtained fat. In the following study, oils extracted from blackberry seeds in conventional extraction procedure, ultrasound-assisted extraction and cold-pressed oil were analyzed. Thermal properties: melting and crystallization characteristics were assessed in differential scanning calorimetry procedure. Additionally, oxidation induction time was determined in pressure differential scanning calorimetry.

Based on DSC curves, crystallization and melting temperatures in all samples were determined. The differences between oils were slight, however noticeable. Crystallization curves were characterized by one peak below -60ºC and melting curves were characterized by two peaks around -40ºC and around -20ºC. Oxidation induction times were significantly influenced by the extraction method which can be associatied with enhanced extraction of antioxidant properties during ultrasound-assisted procedure [2].

The results prove that time consuming and harmful to natural environment conventional extraction methods can be easily replaced by

alternative processes. The changes in thermal properties can be observed however, they are not considered as negative.

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DISSOLVED ORGANIC CARBON IN CROPLAND SOILS: A GLOBAL META-ANALYSIS OF MANAGEMENT EFFECTS

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Dissolved organic carbon (DOC) in agriculture soils, serving as a conduit for substance transport, energy transfer, and information exchange, is regarded as a highly sensitive indicator of how soil carbon responds to management practices. However, the effect of management practices on the magnitude, drivers, and function of soil DOC has not been systematically quantified globally. Here, a comprehensive dataset of 3539 paired soil DOC, 196 paired soil carbon dioxide (CO_2) emissions, and 1424 paired crop yields were developed from 286 targeted papers to fill this knowledge gap. Management practices included conservation tillage (CT), nitrogen fertilizer (N), straw (S), manure (M), N combined with S (NS), N combined with M (NM), and biochar (BC). We found that management practices significantly increased soil DOC compared with control, ranging from 9.74% to 78.21%. BC significantly decreased the ratio of soil DOC to total soil organic carbon by 25.02% compared with no BC. Experimental intensity under M, NM, and BC was identified as the main driving factor influencing the effect size of soil DOC, and experimental duration under CT, N, S, and NS was identified as the main driving factor influencing the effect size of soil DOC. Furthermore, the variations in the effect size of soil DOC were also influenced by soil available nitrogen, clay content, and microbial properties (biomass, structure, and enzyme activity). Each unit increase of the effect size of soil DOC under N, S,

and NM not only effectively mitigated soil CO_2, but also increased crop yields in contrast to CT, M, NS, and BC. Taken together, our findings indicated that for an effective enhancement of crop yields and reduction in soil CO_2 through increased soil DOC in croplands, it was necessary to consider the long-term application of N and S and increase the amount of NM, as well as local environmental factors.
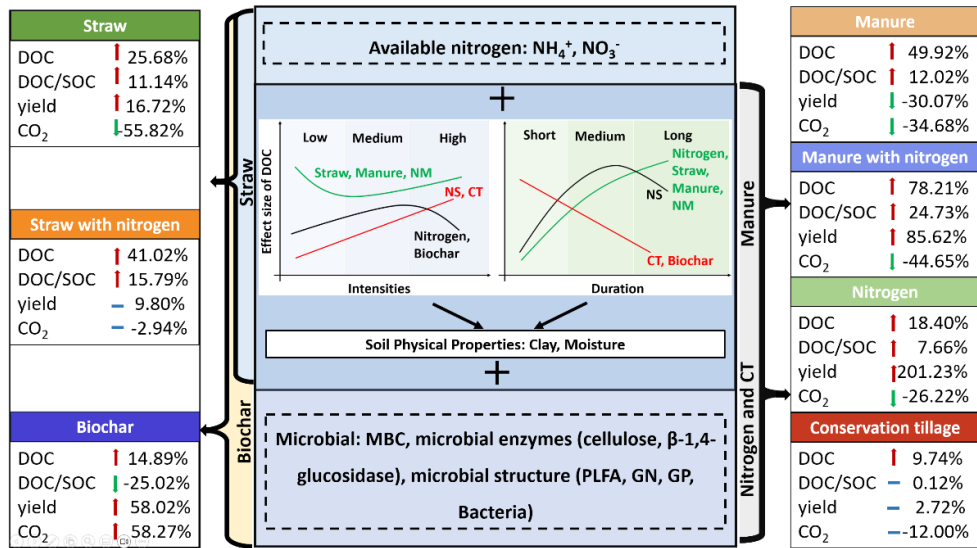
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INDONESIA RENEWABLE ENERGY SITUATION: REVIEW ON SOLAR ENERGY AND ITS CURRENT UTILIZATION

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Keywords: electricity generation, photovoltaic, share of renewable energy, research activities

Presently, the renewable energy (RE) theme has been a major target focus for Southeast Asian nations, including Indonesia. Data in 2020 shows that 33.5% of ASEAN's electricity capacity was generated by RE, and this condition arises as an impact of the increased solar photovoltaic (PV) energy. Indonesia's target by 2030 is to increase solar power capacity to 4.68 GW, and refer to a new national master plan, the power capacity produced by RE is targeted is 51.6 %. In addition, by 2060, over 60% of the nation's total energy generation, is projected by solar energy. Currently, the realization of solar power generation is less than 1 percent of its total potential, therefore there is a possibility to maximize it, significantly [1].

Referring to the Indonesian government's RE mix target, as stipulated in the National Electricity General Planning Document 2018-2037, the target share of RE in Indonesia is 23% by 2025, and it can be supplied by available RE resources in Indonesia: hydro, solar, wind, bioenergy, and geothermal energies. By the end of 2023, Indonesia's share of renewable energy was achieved only 13.1% of the target of 17.9%. To accelerate in achieving the RE mix target, the Ministry of Energy and Mineral Resources put forward the eight strategies as Work Program in 2024, including the construction of 10.6 GW of new RE plants, the construction of 3.6 GW of rooftop solar power plants (SPP), the implementation of the 13.9 million kL B35 (kilo liters of Biodiesel 35%) program, and biomass co-firing of 10.2 million tons in 2025 [2].

A lot of implementation and applied research activities are needed to accelerate the utilization of the RE, including solar energy utilization, especially in solar power plants (SPP). Regarding the National program of SPP, the Cirata floating photovoltaic power plant located in Cirata Reservoir, West Java, with a capacity of 145 MW (ac) or 195 MW(p), was inaugurated on November 9, 2023, and this is a milestone for Indonesia, as later this plant can be said as the largest floating SPP in Southeast Asia (previously the largest is the Tengeh floating solar power plant in Singapore. Cirata floating photovoltaic power plant needs a land area of 200 hectares. The system total uses a smart grid concept, which combines smart power plants, smart transmission, smart distribution, and smart control systems [3].

On the other side, research activities of solar energy at research institutes or universities, like Institut Teknologi Nasional Bandung (ITENAS Bandung) simultaneous was carried out, as a response to the global challenges in the environmental issue and depletion of conventional (fossil) energy. At the ITENAS Bandung, research intensively in this field was enlarged since the partnership with the Hungarian University of Agriculture and Life Sciences (MATE), Godollo campus. By 2018, ITENAS Bandung has operated a 1 kWp solar power plant (SPP), as a research facility for the PV thematic field. Until the present, some research work activities, for BSc & MSC students in ITENAS Bandung and Ph.D students in Godollo campus of MATE, have been implemented, and were summarized as follows [4]:

– Modeling of the PV modules of the SPP by single and double diode model using Visual Basic for Application (VBA) Microsoft Excel and SIMULINK;
– Modeling of the PV module characteristics using Fuzzy Time Series (FTS) Algorithm, Seasonal Autoregressive Integrated Moving Average (SARIMA) Algorithm;
– Development of the SPP cooling system prototype to increase the SPP performance;
– Modeling of the SPP energy production using Machine Learning (Naive Bayes and Support Vector Machine Algorithms);
– Development of a prototype Security System Based on IoT for village protection;
– Development of the PV and the Internet of Things (IoT) systems in the farming field;
– Development of the Organic Rankine System using solar energy;

- Development of the microprocessor and programmable logic controller (PLC) based prototype solar tracker system;
- The feasibility study of retrofitting the steam power plant to the solar power plant;
- Study, design, and realization of the agrivoltaics for the tropical climates.

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RELIABILITY CENTERED MAINTENANCE STUDY ON GAS ENGINE

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Keywords: reliability centered maintenance (RCM), gas engine, electric generator,

Gas engine is a propulsion machine that uses natural gas as fuel. Natural gas is an alternative fuel used due to increased vehicle pollution from vehicles using conventional liquid fuels [1]. The gas engine studied is a gas engine that drives an electric generator that operates continuously, which can cause the engine to stop suddenly. This situation is due to a lack of proper maintenance strategies.

Reliability Centered Maintenance (RCM) is an application of measurable reliability techniques to optimize the usage time of a component by planning or managing maintenance more proactively in preventing failure of a functional system [2]. Fig. 1 shows ~~is~~ a decision logic diagram. The diagram will systematically depict the sequence of decisions or actions taken in response to the detection of a failure mode.

After knowing the results of the sequence of decisions or actions taken, the risk priority number is calculated to determine the highest value indicating that the failure has a high risk and needs to be prioritized for corrective action. This calculation is equipped with severity, occurrence and detection level values.

Acknowledgments:

The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.
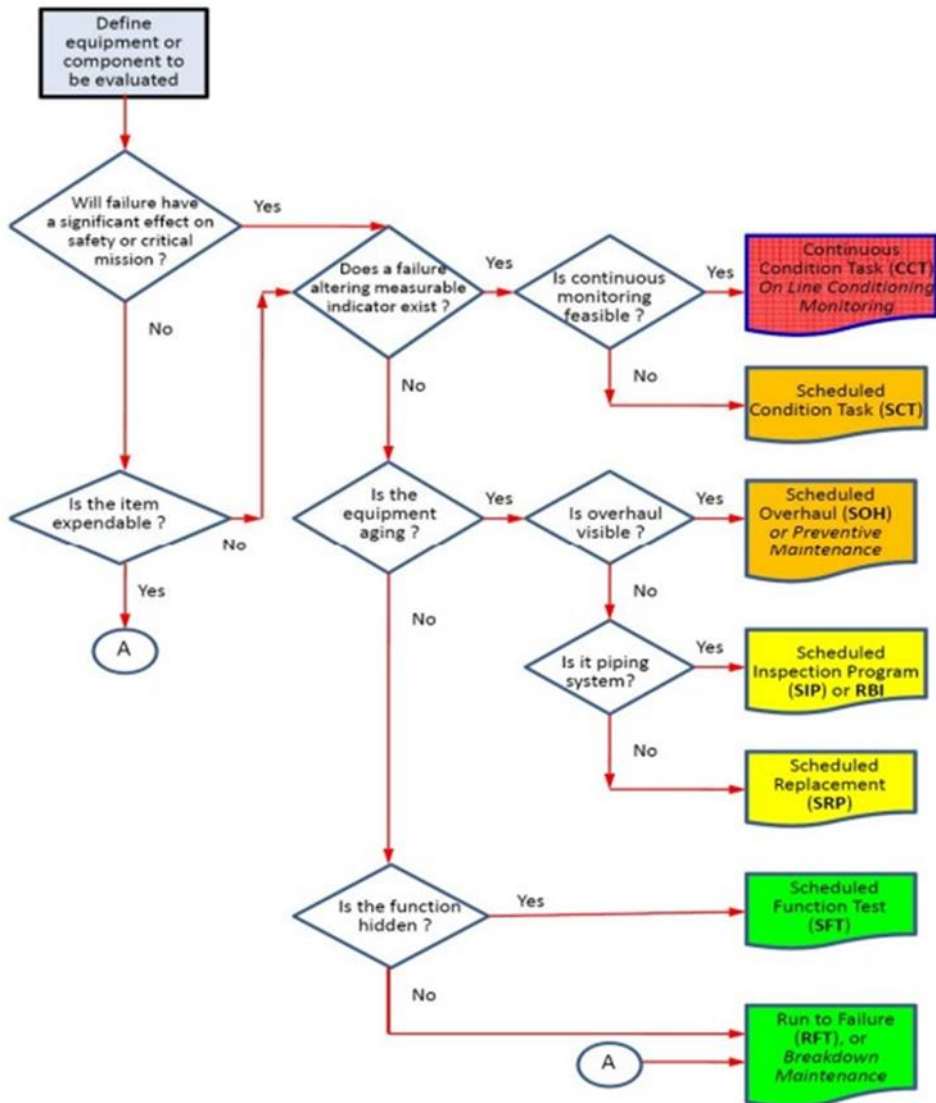

Fig. 1. Decision Logic Diagram

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EXPERIMENTS WITH ELECTROMAGNETISM

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Keywords: magnetic field, Lorentz force, magnetic induction, Eddy current

Living organisms use electrical signals during their operation. In higher organisms, the nervous system and the circulatoring system communicate via mV scale signals. A characteristic electrical potential difference can also be measured between the two sides of the cell walls. However, it has also been proven that some birds can detect the magnetic field, which helps them in their orientation. In addition, evidence has been found in many animal species that they rely on sensing the magnetic field during their activity. All of these support the importance of the topic from a biophysical point of view. At the same time, it is also important to note that the role of electromagnetism is gaining more and more emphasis these days, also due to the spread of devices that work with electricity.

In this experimental presentation, we are also connected to this topic. Basic electromagnetic phenomena and special applications are presented. Fig. 1 shows the tools used to present the basic phenomena.

Fig. 1. Van de Graaff generator for basic experiment

Beside the electricity, the magnetic field is an important „participant" of our experiments. We will introduce experiments with neodymium magnets and with electromagnets, as well, demonstrating the Lorentz force by a CRT monitor.

We want to demonstrate the mutual influence of electric current and magnetic field with several experiments, among others, a teapot speaker and a skull speaker (Fig. 2) will be built, the working principle of a wireless charger is planned to demonstrate by using an induction cooker (Fig. 3), and a musical solar panel will be presented of the presentation among lot of other ones.

Fig. 2. Teapot speaker and speaker with skull bone

Fig. 2. Wireless charger based on an induction hob

We hope, the experiments with electromagnetism are not just interesting, but very spectacular and useful to understand the working different processes from the everyday life.

SHAPING THE BACTERIAL AND FUNGAL MICROBIOME IN LEGUME-CEREAL INTERCROPPING

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Modern agriculture, which relies on chemical inputs and nonrenewable energy sources for high yields, is under fire owing to its negative effects on public health and the environment. Recent disclosures highlight the need to transition to a more sustainable model that incorporates ecological principles and ecosystem services while decreasing the usage of chemicals and non-renewable energy. This alternate method, known as 'agroecology,' focuses on designing cropping systems to improve sustainability and production efficiency [1].

Agroecological principles entail a wide range of methods, including intercropping, crop rotations, cover cropping, green manure, reduced tillage, and agroforestry. With its ability to significantly improve the cropping system through diversification, intercropping is one of these approaches that shows the most promise. In these systems, legumes constitute an important functional group, highly regarded for their agroecological benefits [2,3]. Legume-based intercropping systems can promote rhizobacterial community diversity and soil health by enhancing symbiotic and non-symbiotic beneficial populations. In the rhizosphere, the bacterial community is required to improve the growth and health of both intercrops due to several "direct and indirect" mechanisms involving plant growth-promoting rhizobacteria (PGPR) [5].

Exudation from the roots greatly influences the composition of microbial communities and is essential for maintaining interactions between plants and microorganisms. The composition of plant root exudates changes qualitatively and quantitatively according to the plant's nutritional status, growth stage, and even the root position in time and space. These secretions

produce strong selection pressures in the rhizosphere, prompting plants to drive the selection of specific rhizosphere microbial communities [4]. As a result, changes in plant communities may promote specific functional features in soil microbial populations [3,4].

Despite the recognized importance of these mechanisms, there has been insufficient exploration into the functional and genetic diversity of soil microorganisms within legume-cereal intercropped systems. The complex interactions between the soil microbiome and the plant holobiont generate substantial uncertainties about how various crop species impact the development of soil microbial communities, especially concerning the bacterial and fungal microbiomes in such intercropping settings. Consequently, the objective of the forthcoming research is to investigate the functional and genetic diversity of microbial communities present in the soil, rhizosphere, and plant compartments in legume-cereal intercropping systems.

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THE INFLUENCE OF BACTERIAL EXTRACELLULAR POLYMERIC SUBSTANCES ON THE GROWTH PROCESSES OF UNICELLULAR ALGAE

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Keywords: extracellular polimeric substances, unicellular algae, growth processes

Extracellular polymeric substances (EPS) are metabolites synthesised and released into the environment by microorganisms such as bacteria, fungi and algae. Their composition varies depending on living conditions and species of microorganisms. These are large molecules, consisting mainly of proteins, polysaccharides, glycoproteins, nucleic acids, humic and uronic acids. One of the most important functions of EPS is to protect microorganisms against harmful environmental impact [1]. For example, they can protect cells from the toxicity of heavy metals due to their adsorption ability [1, 2]. They are a source of dissolved organic carbon [3].

The aim of the study was to investigate the influence of extracellular polymeric substances synthesized by bacteria on growth processes of unicellular algae.

Algae were cultivated in Erlenmeyer flasks in BG11 liquid medium. The cultures were illuminated at 16 h light/ 8 h dark cycle, aerated with sterile air and subjected to orbital shaking. The microalgal cells were grown for 13 days. In order to study the effect of the bacterial EPS on the microalgae, different amounts of EPS were used. Algal growth was monitored by

spectrophotometric measurements of OD 680 and by gravimetric determination of dry biomass. The parameters of growth kinetics (specific growth rate and biomass doubling time) were analysed during algal growth. The specific growth rate (μ) of the algae was determined based on the optical density measurement. The biomass doubling time (T_d) was determined based on the specific growth rate. Biomass productivity ($P_{biomass}$) was determined based on the measurement of biomass dry weight.

The results indicated that the presence of bacterial EPS affected the growth of microalgae. It was also shown that the amount of biomass was dependent on the concentration of EPS in the algal culture.

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ADVANCING SOLAR DESALINATION THROUGH A PORTABLE THERMOSOLAR CYLINDRO-PARABOLIC COLLECTOR

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Keywords: cylindro-parabolic concentrator, solar energy, thermal receiver, optical, thermal and mechanical designs, distilled water, water desalination.

Renewable energies, like solar, offer sustainable solutions. Solar energy, adaptable for water desalination, addresses freshwater scarcity. Yet, conventional solar systems for desalination are bulky and costly. Portable thermo-solar cylindro-parabolic concentrator (CPC) presents an efficient, lightweight, and affordable alternative for arid regions [1].

As shown in Fig. 1., this type of solar collectors, according to previous studies [2], have many obstacles and problems making its efficiency weak in this field, so it is not used much in the field of water desalination, including:

1. Earth's movement causes optical losses in fixed parabolic solar collectors, with a 53% loss in reflected rays, reducing thermal efficiency significantly (Fig. 1a, b).
2. Environmental and atmospheric phenomena impact his performance and productivity.
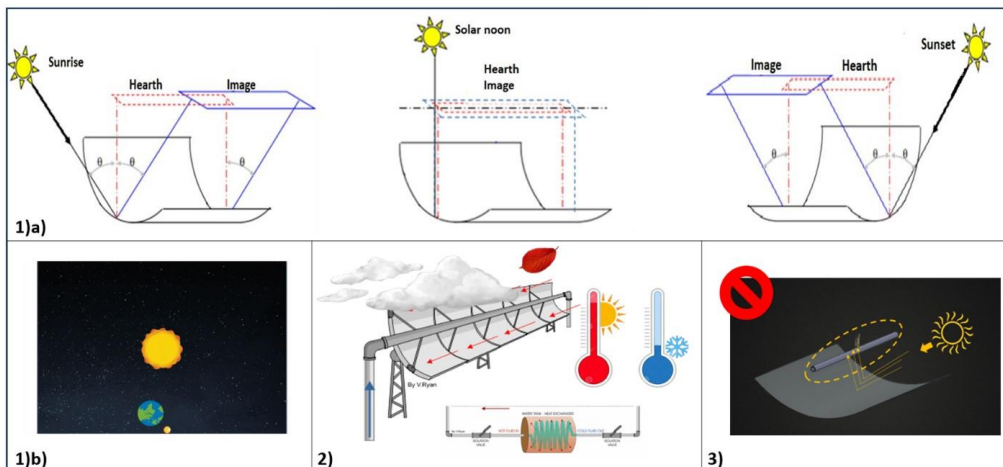3. It doesn't work at night due to the absence of sunlight.

Fig. 1. Obstacles and problems of portable CPC collectors

The implementation employs on a CPC solar collector with solar tracking technology, utilising MPPT technology with an Arduino UNO. It's linked to a data logger, micro-computer, and electronic board for continuous solar tracking powered by 5 V (morning period condition: presence of sun). For nighttime operation utilizes thermal electric generators at the thermal receiver, backed by a 12 V solar battery in a hybrid system. A cleaning system ensures readiness for sunrise, with platinum for the thermal receiver and aluminium for the thermal reflector, optimizing thermal solar energy efficiency. Additionally, there will also be a thermal storage system and a water filtration system (pH).

As shown in Fig. 2 solar recovery alignment, where automated system aligns reflections with focal point for solar recovery. Fig. 3 shows an example for evolution of temperatures. In Fig. 3b, the timing and the value of water evaporation temperature have been determined. The temperature was taken (°C) with respect time (h or min), and measurements are taken every quarter of an hour (15 min). For a 24 h period the CPC performance resulted 197-315°C temperatures yield constant desalinated water of 5 L over 10 min.
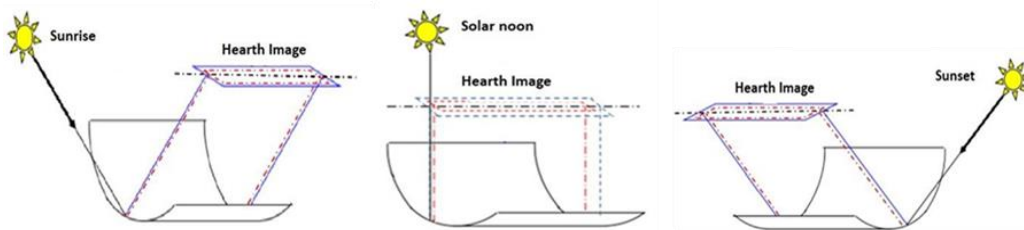
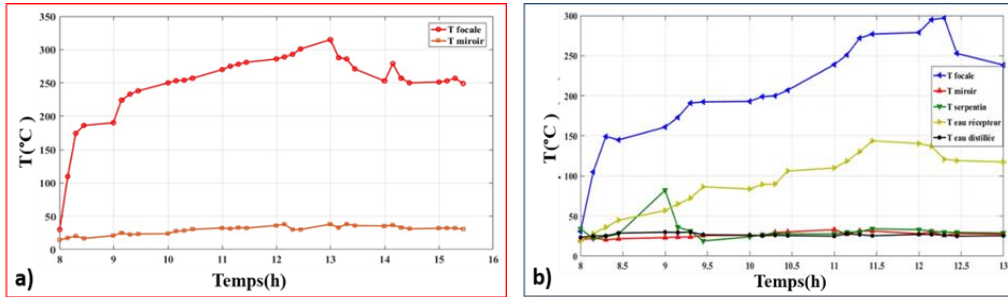Fig. 2. Schematically illustrates the solution of the solar recovery

Fig. 3. Evolution of temperatures, a) temperatures value of a thermal receiver and reflector without water, b) temperatures value of a thermal receiver and reflector with water

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IMPACT OF SELECTED COLOURS MATERIAL TYPES ON THE MEASURED DISTANCE BY THE URG04LX LASER SCANNER

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Keywords: Agriculture 4.0, laser scanner, measured distance

The use of the laser scanner in Agriculture 4.0 conditions is currently possible in the case of determining the characteristics of the vegetation, thereby obtaining key data about the vegetation such as height, spatial distribution and in the case of determining the intensity of the laser beam, it is possible to detect the colour in a certain wavelength range.

This paper provides partial information on the study of the impact of selected material types and different colours on the measured distance by the URG04LX laser scanner, which is used in agricultural conditions to locate and navigate mobile, robotic equipment. Based on the obtained results, in association with current machine learning methods, it is possible to modelling the environments in which the robotic device is potentially to operate [1].

The experiment to determine the properties of the URG04LX laser scanner with respect to the environment in which it is used to acquire environmental data was carried out under controlled illumination: 5 lx and 650 lx, where the reflectivity of the tested materials was based on the assumption of materials occurring in agricultural conditions. The colours of the materials were: red, blue, yellow, green, white and black.

Since it is assumed that the waveform of the measured distance by the laser scanner is linear, the given values for the tested distance of 1000 mm are approximated by a linear relationship. The largest average value of the measured distance in 650 lx was for the red and yellow colors, which represents an increase of 6.276% and 4.29% for the red and yellow colors, respectively, compared to the original value. Materials of similar characteristics with the

same colour may have the same properties, which is reflected by a positive linear offset from the tested value.

With the light intensity reduced to 5 lx, it was possible to approximate the measured data by a linear dependence, similar to the previous experiments, in this case there is a linear shift from the actual measured value, which varies depending on the colour of the material used. In this case, the best results are the measurement against the material with the red colour, where the linear shift is the smallest: 0.043%. Across all materials tested, the value of the t-test criterion is greater than the critical value, at a significance level of $\alpha = 0.05$. This indicates a statistically significant difference in the measured distances by the laser scanner against different selected materials of different colour at a given illumination intensity. A change in the residuals can occur when measuring distance with a laser scanner if the object's distance changes and also the angular rotation of the object varies [2]. Possibilities to compensate for residuals consist in the use of machine learning with supervised learning techniques, also applied in Agriculture 4.0.

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RELIABILITY CENTERED MAINTENANCE (RCM) FOR STEAM TURBINE

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Keywords: reliability, Reliability Centered Maintenance (RCM), Fault Tree Analysis (FTA), steam turbine, blade

Steam Turbines are important equipment in the energy industry, used to generate electricity from heat energy. Steam turbine failure can cause production disruptions, equipment damage, and even serious accidents. Reliability Centered Maintenance (RCM) can be used to determine the most effective and efficient maintenance activities to maintain the reliability and availability of steam turbines.

RCM is a systematic approach to determining maintenance activities that must be carried out on a system or equipment to maintain its reliability and availability.

RCM identifies failure modes, causes of failure, and the impact of failure on the system or equipment. Then, based on this analysis, RCM determines the most effective and efficient maintenance activities to prevent or reduce the impact of these failures. One of methods is the Fault Tree Analysis (FTA), which is a method for finding the cause of an existing system.

In this work, an evaluation of the failure steam turbine (type SST 110) will be elaborated, using FTA diagram. Based on the diagram, the probable cause of the failure can be identified. Once the probable cause is known, the next step is to make a Failure Mode Effect and Critical Analysis (FMECA). By using the FMECA, it can be found that the main cause of the SST-110 steam turbine system damage was the blade. The blade deformed due to

inappropriate fluid distribution and a lubrication system (a condition was below specified standards), that caused worn bearings and a gearbox that lacked the oil.

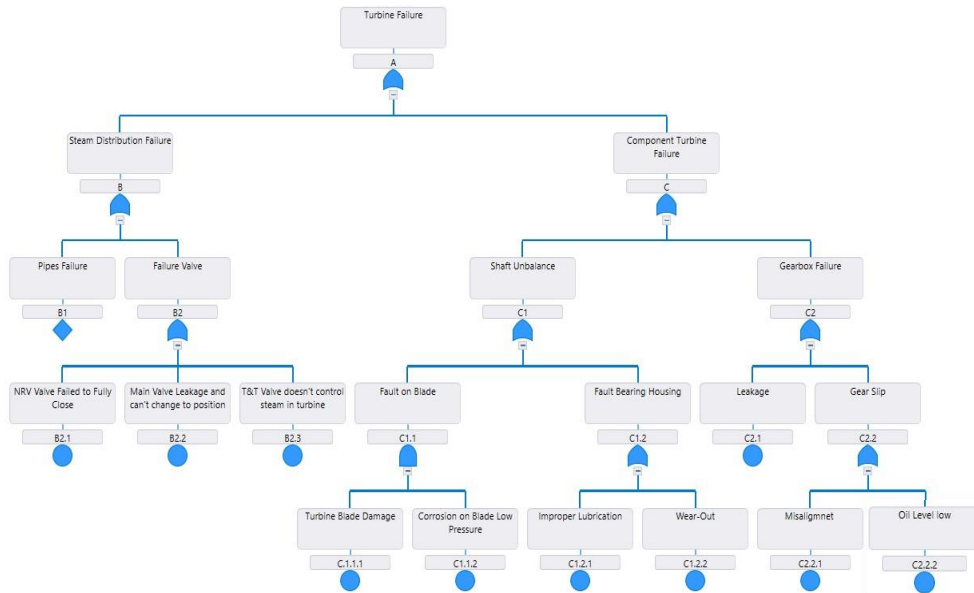The schematic of FTA steam turbine failure is shown in Fig. 1.

Fig. 2. Fault Tree Analysis

Acknowledgments:

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EXAMINATION OF THE POLARIZATION AND SPECTRUM OF REFLECTED LIGHT AT SOLAR CELL

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Keywords: light polarization, spectrum analysis, illumination measurement

From the earth's surface, surfaces with different coverage result in different light reflections. It is interesting that in the visible spectrum, the reflection ratio on the surface of solar modules and solar collectors can be described with the same range as water (5-10%) [1]. The light rays can become polarized during reflection. In nature, this is typical at a given angle for water surfaces. Nowadays, however many artificial surfaces are produced and placed in the environment, which can be a source of polarized reflected light. Such are glass surfaces, asphalt, black films used in agriculture, black car bodies and the surfaces of solar moduls and alos solar collectors.

The increasingly appearing artificial surfaces, are as polarization light sources, represent a new form of light pollution. While the human eye is barely sensitive to polarization, insects, octopus, squid, cuttlefish, and mantis shrimp are sensitive to it in the animal world, and insects mainly use polarization to find water [2], [3]. Insects lay their eggs on surfaces perceived as water and fall into an ecological trap, at the same time, e.g. in the case of solar moduls and solar collectors, the energy-producing efficiency of these surfaces can be significantly reduced due to the contaminating effect of eggs that have dried on the surface. This is why it is important to examine the solar cells, which are becoming more widespread and playing an increasingly important role in the energy supply, from this optical and biophysical point of view.

In connection with this, the present work examines two properties of reflected light, polarization and spectrum, in relation to a solar cell. The polarization was tested using a polarizing filter. By examining the intensity of the light passing through a polarizing filter perpendicular to the reflected light and the polarizing filter in its own plane relative to the original positions

rotated at 45° and 90°, information on the polarization can be obtained from the data. By performing the intensity measurements at different angles of incidence, a result of the polarization effect of the solar cell can be determined.

In the other part of the work, the spectrum of the reflected light was determined. The reflection is direction and wavelength dependent quantity. The measurements were made at the settings used for the polarization measurement. The module's reflected light spectrum was determined by the Ocean Optics spectrometer. Based on the signal coming into the spectrometer via the optical cable, the spectrometer gives intensity every 0.36 nm between 340 and 1026 nm, which can be measured and recorded using the Overture program which run on the connected computer.

Fig. 1 shows the Lux meter for illumination measurement and measurement setup used during the polarization measurement, and Fig. 2 shows the arrangement used for the reflected spectrum analysis.

Fig. 1. Lux meter and experimental layout for measuring the reflected light polarization
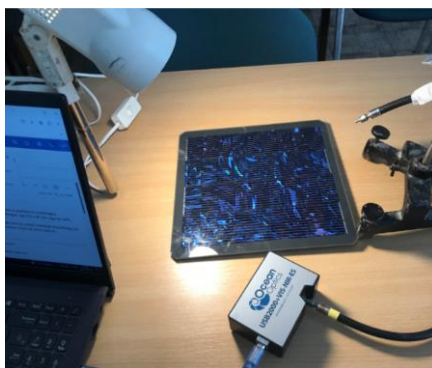

Fig. 2. Experimental layout for measuring the reflected spectrum

The presentation details and analyses the results obtained for the polarization and spectrum of the reflected light for an amorphous silicon solar cell under artificial illumination with a traditional 40 W light bulb.

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PHENOTYPIC ANALYSIS OF MICROBIAL COMMUNITIES IN APPLES AFFECTED BY BULL'S EYE ROT CAUSED BY *NEOFABRAEA* SP.

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Keywords: BiologTM, apple, phenotypic analyses, Neofabraea, apple, Bull's Eye Rot

Understanding the dynamic interactions between microbial communities inhabiting apples affected by *Neofabraea* genus fungi (syn. *Pezicula* sp., *Phlyctema* sp.) is crucial for managing Bull's Eye Rot disease (BER). In this study, we conducted phenotypic analyses of microbial communities using the Biolog™ EcoPlate system to compare the responses of apple varieties ('Rubinstar', 'Champion', 'Boskoop', 'Pinova', 'Golden Delicious', and 'Honeycrisp') to the presence of different substrates.

Apple fragments with symptoms of the disease were used for analyses. 1 g of rotten part of the apple was added to 99 ml of saline peptone water. The suspension was shaken (180 rpm) for 20 minutes at room temperature and then incubated for 30 minutes at 4°C. EcoPlates™ (Biolog™) were then inoculated with 120 µl of the supernatant. For 10 consecutive days, the plates were incubated at 24°C and spectrophotometric measurements were made at two wavelengths (λ) at 24-hour intervals. The values obtained at a wavelength of λ_{590} nm indicate the level of substrate consumption and are related to the respiratory processes of microorganisms. Whereas λ_{750} nm informs about the optical density resulting from the growth of microorganism biomass in the presence of a given substrate. The obtained data from individual hours were averaged and then presented in the form of α-biodiversity indices such as:

Richness (R), Shannon (H), Avreage Well Color Development (AWCD), Avreage Well Density Development (AWDD) and the substrate stress index (SST).

There was variation in the response of communities depending on the apple variety. It was found, among others: the highest values of the tested indicators in the 'Pinova' and 'Honeycrisp' varieties, while the lowest for the 'Rubinstar' variety. There was also a predominance of respiratory processes over biomass production in the communities in the 'Honeycrisp' and 'Golden delicious' varieties, which indicates the occurrence of a situation of metabolic stress for the communities in these two varieties.

Overall, our findings underscore the complex interplay between apple variety, microbial community composition, and substrate utilization in the context of the BER infection. This research contributes to a better understanding of host-microbe interactions in diseased apples, offering insights that could inform strategies for disease management and fruit quality preservation.

Acknowledgements:

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EXPERIMENTAL EVALUATION OF THE PERFORMANCE OF AN INDIRECT SOLAR DRYER

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Keywords: drying process, efficiency, system components

Solar dryers are widely used for drying a variety of foods such as fruits, vegetables, etc. By placing these foods in the drying chamber and utilizing the heat from solar radiation, the moisture in the food can be quickly evaporated, extending its shelf life and preventing decay [1,2]. The indirect solar dryer for experiments consists of a solar air collector, drying chamber, and chimney. The solar radiation is a key factor in the experiment, and its intensity is influenced by geographical location. This research was conducted in the Solar Energy Laboratory at the Hungarian University of Agriculture and Life Sciences in Gödöllő, Hungary. The experimental location is shown in Fig. 1.
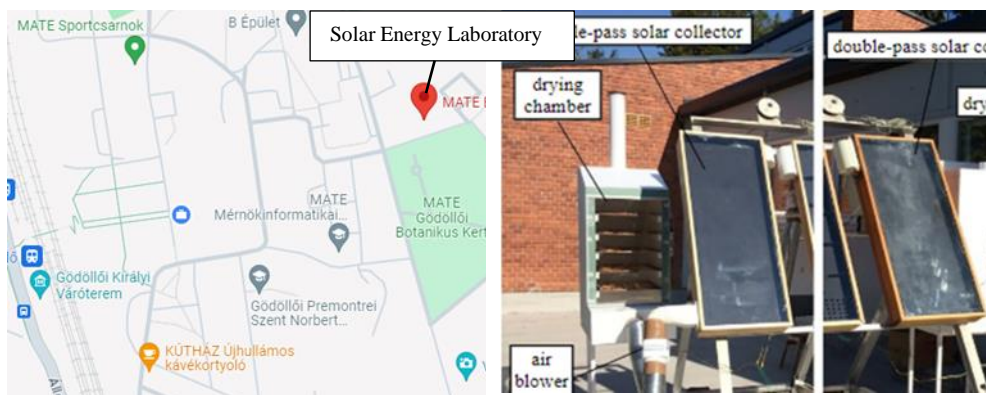

Fig. 1. Experiment location (47.59° N, 19.36° E) and solar drying system

Solar air collectors are the core components of soalr dryer and have a significant impact on the efficiency of solar dryer during the drying process.

Many studies have focused on the impact of air collectors on the performance of dryers. The aim of this experiment is to investigate the comparison of the effect of single-channel collector and double-channel collector on the drying process under the same conditions [3]. The solar drying system is shown in Fig. 1.

The experimentally recorded data can be analyzed to calculate the relevant parameters. The efficiency of a solar collector is calculated as the useful energy gain ratio to the incident solar energy. The efficiency during the drying process is determined by calculating the ratio of the amount of water removed from the sample to the total water content in the sample [4]. By comparing the values of collectors and drying efficiencies, the analysis draws relevant conclusions.

Acknowledgement

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