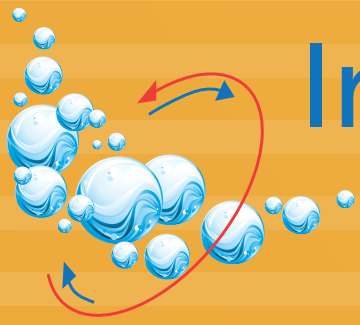

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14th CONFERENCE ON THERMOGRAPHY

Zagreb, Croatia, 11 – 12 April 2019

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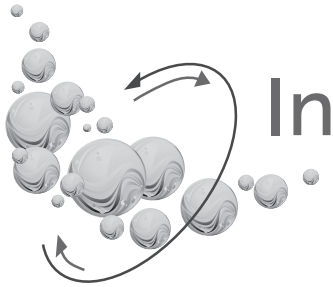

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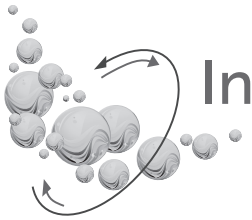

Interklima 2019

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Conference schedule – 1st day

Fran Bošnjaković Day

08:30 – 09:00 **Registration of participants**

09:00 – 09:10 **Greetings and introductory words**

09:10 – 09:30 **Plenary lecture**
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Alternative Refrigeration and Heat Pumping Technologies

09:30 – 09:45 **Luka Boban, Iva Bertović, Vladimir Soldo:**
Thermal resistance of asymmetrical borehole heat exchanger

09:45 – 10:00 **Matej Đuranović, Martina Rauch, Marija Živić, Antun Galović:**
Exergy analysis of the air conditioning process

10:00 – 10:15 **Antun Galović, Alen Cukrov, Ivanka Boras, Željko Tuković:**
The influence of spacing in convective heat transfer between two vertical surfaces at different temperatures

10:15 – 10:30 **Netice Duman, Ertan Buyruk, Halil İbrahim Acar, Mustafa Caner, Ferhat Kilinc, Ahmet Can:**
Exergy analysis of a ground source heat pump system for cold climatic condition of Sivas, Turkey

10:30 – 10:45 **Mustafa Caner, Ertan Buyruk, Ferhat Kilinc, Netice Duman, Ahmet Can:**
Daily performance analysis of ground source heat pump system in Sivas, Turkey

10:45 – 11:00 **Šefik Behrem, Bahrudin Hrnjica:**
Results of optimisation heat transfer coefficient during the quenching of cylindrical samples in aqueous solutions

11:00 – 11:15 **Koray Karabulut, Ertan Buyruk, Ahmet Can, Deniz Golbasi, Ferhat Kilinc:**
Experimental and Numerical Study of Heat Transfer for Graphene Oxide (GO)-Distilled Water Nanofluid Flowing Through a Copper Circular Tube

11:15 – 11:30 **Mihael Gruden, Boris Dekleva, Viktor Gryban:**
Control of a recuperative ventilation system in case of ice formation from condensate

11:30 – 11:45 **Rok Koželj, Eva Zavrl, Uroš Stritih:**
Improvement of thermal energy storage with PCM within EU project Holistic Energy and Architectural Retrofit Toolkit (HEART)

11:45 – 12:00 **Coffee Break**

12:00 – 12:15 **Deniz Golbasi, Ertan Buyruk, Ahmet Can, Koray Karabulut, M. Musab Bayat:**
Experimental Investigation of the Effect of Building Distances on the Flow Configuration in Triple Placed Buildings

12:15 – 12:30 **Krešimir Osman, Dennis Jankovich:**
Approach to the Mechanical Design Projects in the Field of Cooling Plants

12:30 – 12:45 **Ahmet Can, Hasan Özgüç Divarcı, Ertan Buyruk:**
Design Principles of the Hospital Clean Rooms

12:45 – 13:00 **Žiga Lampret, Matjaž Prek:**
Thermal requirements for the elderly in indoor environment

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Phase change materials as passive overheating protection in solar collectors

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14:45 – 15:00 **Marko Mančić, Mirjana Laković, Jelena Janevski, Ivan Pavlović:**
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15:00 – 15:15 **Borjan Ranilović, Alen Cukrov, Ivanka Boras, Srećko Švaić, Monika Zovko:**
Infrared thermography as a predicting tool for the need of irrigation in agriculture

15:15 – 15:30 **Ivan Horvat, Stjepan Ćurić, Petar Filipović, Ivan Kodvanj, Srećko Sabalić, Damir Dović:**
Use of IR thermography for determining human skin surface temperature when applying medicaments in a form of spray

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Conference schedule – 2nd day

Energy Efficient Buildings and Renewable Energy Sources

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09:00 – 09:10 **Greetings and introductory words**

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Comparison of EN ISO 13790 and numerical dynamic simulations on annual heating and cooling energy need calculations

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11:05 – 11:20 **Jana Bendžalová:**
High quality professional skills – The CEN-CE scheme

11:05 – 11:20 **Jana Bendžalová:**
High quality professional skills – The CEN-CE scheme

11:20 – 11:40 **Coffee Break**

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11:40 – 12:00 **Emilien Paron:**
Overarching standards (EN/ISO 52000-1)

12:00 – 12:15 **Vladimir Soldo:**
Heat-pump systems (EN 15316-4-2)

12:15 – 12:30 **Damir Dović:**
Assessment of technical solutions in nZEBs (EN 15316 standards)

12:30 – 12:45 **Laurent Socal:**
Measured energy (EN 15378)

12:45 – 13:00 **Johann Zirngibl:**
EPB center

13:00 – 13:15 **Debriefing**

13:15 – 14:30 **Banquet**

Foreword

The 25th International Conference INTERKLIMA 2019 has been held in the context of the International Fair of Heating, Refrigeration, Air Conditioning and Potable Water Treatment as an event of the Zagreb Fair since 1969.

Held since 1969, INTERKLIMA is the oldest conference of its kind in this part of Europe. Over years it has grown into an international venue for meetings of scientists and experts in the field of heating, refrigeration, air conditioning, and, generally, energy conversion in buildings and industry.

Co-organized by two Universities and supported by the relevant international scientific organizations and journals, as well as the EU projects, Interklima 2019 brings many new and actual topics such are:

- Nearly zero energy buildings
- Smart building technologies
- Advances in EU regulation (EPBD, EED, RES, F-Gas, ErP)
- Low GWP refrigerants
- Cooling from renewable sources
- Energy from waste biomass
- Phase change materials in buildings
- Smart meters/cities

INTERKLIMA 2019 is composed of three sections:

- Fran Bošnjaković Day
- Energy efficient buildings and renewable energy sources
- 14th conference on Thermography

Among the others, the dedicated lectures will be given by the experts participated in development of the new set of EPBD related CEN standards (EC Mandate to CEN M/480)

All papers are written and presented in English. The Scientific Committee will select papers for oral presentation and they will be published in electronic form in addition to the Book of Abstracts.

Scientific papers selected for publishing in partner journals will be submitted to an appropriate international review.

- Transactions of Famena (WoS, SCI Exp.)
- Tehnički vjesnik (WoS, SCI Exp.)
- Thermal Science (WoS, SCI Exp.)
- JSDEWES (SCOPUS)
- REHVA Journal

We expect Interklima 2019 to gather prominent scientist and experts of various professions – mechanical, civil, architectural. electrical and agricultural engineering and others. During the conference they will be given the opportunity to exchange their research and practical experiences within the fields covered by this event.

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Alternative Refrigeration and Heat Pump Technologies

Andrej Kitanovski

University of Ljubljana, Faculty of Mechanical Engineering

Vapour compression has been dominating the field of refrigeration, air conditioning and heat pumping since the year 1835, when the first working vapour compression refrigerating system was built and patented by Jacob Perkins. This rather old, but well established technology still holds dominant position due to the low investment and operating costs, reliability and a broad refrigeration power range.

Despite of the fact, that many different refrigeration technologies have coexisted with the vapour compression, the serious search for alternatives begun with the Montreal Protocol in 1987, as the result of the environmental problems of refrigerants.

This presentation gives a short overview of the most important historical milestones in refrigeration and heat pumping. The problems of existing technologies are addressed and several emerging technologies are presented and discussed. A special emphasis is given to technologies, which regard the alternatives to vapour-compression or sorption refrigeration and heat pumping. The advantages and disadvantages of alternative technologies are presented, including their technology readiness level and the environmental impact.

Key words: *refrigeration, heat pumping, energy efficiency, refrigerant*

Exergy Analysis of an Air Conditioning Process

Matej Đuranović[1], Martina Rauch[2], Marija Živić[3], Antun Galović[2]

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The exergy analysis of an air conditioning process in wintertime is presented in this paper. This process consists of mixing outdoor air with conditioned air, heating, humidifying, and reheating the air mixture. The air is heated in the heat exchangers by warm water at a temperature of 80/60 °C and humidified by spraying water at a temperature of 12 °C. The ratio of the mass flow rates of outdoor and conditioned air is varied, and it is upon this variable that the exergy analysis is performed. It is shown that the heat transfer rate in the heat exchangers is the smallest at the ratio of mass flow rates of outdoor and conditioned air $g_1 = 0{,}45$. The greatest exergy destruction is apparent on the air heaters, and the maximum exergy efficiency of the whole process $\varepsilon_{ex} = 0{,}71$ is achieved at the ratio $g_1 = 0{,}45$. According to the exergy criterion, this air conditioning is a relatively efficient process.

Key words: *air conditioning, exergy destruction, exergy efficiency*

The Influence of Spacing in Convective Heat Transfer Between Two Vertical Surfaces at Different Temperatures

Antun Galović, Alen Cukrov, Ivanka Boras, Željko Tuković

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The goal of this paper is to investigate the influence of spacing between two vertical surfaces at different temperatures on resulting wall heat flux. The numerical analysis is carried out using Finite Volume Method (FVM), and the results are compared to the data obtained with the expression for heat flux derived for steady state heat conduction in a stagnant medium. The mathematical model is composed of mass, momentum and energy equations, where the momentum and energy are being coupled due to existence of buoyancy driven flow in the domain. The medium used in computation is air, while the variations in fluid density are taken into account by application of ideal gas law. From the obtained results, it is evident that increase of distance between the surfaces increases the influence of convection, and a correction of analytical expression for heat flux computation is required by inclusion of so-called effective thermal conductivity.

Key words: *Natural convection heat transfer, Finite Volume Method, wall heat flux*

Exergy Analysis of a Ground Source Heat Pump System for Cold Climatic Condition of Sivas, Turkey

Netice Duman[1], Ertan Buyruk[2], Halil İbrahim Acar[3], Mustafa Caner[4], Ferhat Kilinc[5], Ahmet Can[6]

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In the present study, exergy analysis of a ground source heat pump (GSHP) is performed. For this purpose, a horizontal type GSHP test system is installed at Sivas Cumhuriyet University in Sivas Province. GSHP system is consist of three main circuits. These are the ground heat exchanger (GHE), the heat pump (HP) and the heating circuit. The temperatures and pressures are measured at the various points of the system. Besides, the mass flow rate the working fluid circulating in the GHE, heat pump and heat circuit are measured. In addition, power consumption of the compressor and the pumps are measured. Measured datas are recorded every minute. The test datas used in the calculations are related to the coldest day, December 18, 2016. Exergy loss, exergy efficiency, exergy loss ratio and thermodynamic perfect degree for each elements of the system are computed. Exergy efficiency and thermodynamic perfect degree of the system are calculated as 0.27 and 0.86 respectively.

Key words: *Ground source heat pump, exergy, exergy efficiency, exergy loss, exergy loss ratio, thermodynamic perfect degree*

Daily Performance Analysis of Ground Source Heat Pump System in Sivas, Turkey

Mustafa Caner[1], Ertan Buyruk[2], Ferhat Kilinc[3], Netice Duman[4], Ahmet Can[5]

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This study presents an investigation of Ground Source Heat Pump (GSHP) system for using of space heating in cold regions in Turkey. Sivas is known for its harsh climate conditions and has never been studied in there before. Therefore, a horizontal ground source heat pump system has been installed in a building which called energy home in Sivas Cumhuriyet University. The underground heat exchanger with a length of approximately 370 m was placed at a depth of 2.5 m. As a result of daily measurements, the efficiency of the heat pump and the whole system were determined. In addition, changes in soil temperature at different depths were obtained. The performance coefficients of heat pump and system were obtained in the range value of 2.13-2.16 and 1.84-1.89, respectively.

Key words: *Ground source heat pump, experimental study, performance analysis, cold climate, heating, coefficient of performance.*

Results of Heat Transfer Coefficient Estimation During the Quenching of Cylindrical Samples in Aqueous Solutions

Šefik Behrem, Bahrudin Hrnjica

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The paper presented the results the heat transfer coefficient estimation in the process of two-dimensional axially symmetric quenching of cylindrical steel samples in aqueous 40 °C solutions. One aqueous solution had 5 % and the other one 25 % of Aquatensid BW. Such solutions allow the rate of cooling of steel quenching less than the one in clean water, and higher than the one in thermal oils. This paper presented a logical continuation of work with [1]. The experimental setup consisted of quenching three dimensionally different cylindrical probes into two different quenchants. The set mathematical model describes two-dimensional axially symmetric inverse conduction of heat through a cylinder. The computer model of the solution uses experimental results of temperature measurement by minimising the error between the calculated and measured values of the temperature at the same point.

Key words: *Probe, thermocouple, quenching, estimation, heat transfer coefficient*

Experimental and Numerical Study of Heat Transfer for Graphene Oxide (GO)-Distilled Water Nanofluid Flowing Through a Copper Circular Tube

Koray Karabulut[1], Ertan Buyruk[2], Ahmet Can[3], Deniz Golbasi[2], Ferhat Kilinc[2]

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In this study, enhancement of convective heat transfer and pressure drop of graphene oxide (GO)/distilled water (DW) nanofluid with volumetric concentrations of 0,01 % and 0,02 % in circular copper straight tube having inner diameter of 12 mm, length of 1830 mm and with constant wall heat fluxes of 2717,8 W/m^2 and 3804,93 W/m^2 was experimentally investigated. In addition, numerical calculations were performed as 3D and steady by solving Navier-Stokes and energy equations using ANSYS-FLUENT program with the assuming of single phase fluid. The effects of volumetric flow rate, heat flux and nanofluid concentration were experimentally researched on h, Nu number and ΔP of the GO/DW nanofluid and the obtained values of h for DW were compared with determined results from corresponding correlations. And also, variations of T_s and h of the tubes were examined as numerical and experimental comparison. The increment value of average Nu of the 0,02 % GO/DW nanofluid was 25 % at 1,5 l/min. and 3804,93 W/m^2.

Key words: *Nanofluid, Graphen oxide nanoparticle, Convective heat transfer coefficient, Pressure drop*

Control of a Recuperative Ventilation System in Case of Ice Formation From Condensate

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The welcome energy saving from a recuperative ventilation system is the most valuable during cold periods. Unfortunately, the vapour coming from the inside of the dwelling is subcooled below the condensation condition – thus creating the possibility of freezing the liquid within the coldest area of the heat exchanger. How to avoid this malfunction and how to keep the ventilation in service?

A clever AKVAVENT control solution with the corresponding sensors and motor drives can resolve this situation with very little loss of efficiency. Introducing up-to date technology solutions can be successfully implemented on small household units.

Key words: *Air heat recuperation, frost build-up, flow control, comfort parameters, seasonal parameter adaptation, energy harvesting*

Improvement of Thermal Energy Storage with PCM Within EU Project Holistic Energy and Architectural Retrofit Toolkit (HEART)

Rok Koželj, Davor Švajger, Vid Vidic, Eva Zavrl, Uroš Stritih[1]

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Prudent and efficient utilization of renewable energy sources is needed in order to meet demands from European directive on the energy performance of buildings and to comply with Paris agreement for global clean energy transition. This urge Europe towards several incentives among with subsidies to renovate the building sector where 30 % of EU's final energy use is used for heating and cooling of residential building stock where majority of buildings are only partially renovated. Within present paper the toolkit with holistic approach to energy retrofit of residential buildings and its energy performance optimization is presented which is developed under EU funded project entitled HEART. Objectives of this project is step towards sustainability where thermal energy storage has a great role in effectiveness of the system. With integrating phase change materials in sensible thermal energy storage a higher energy density of thermal storage unit is achievable what is presented in present paper.

Key words: *retrofit, building energy performance, phase change materials, latent thermal energy storage*

Experimental Investigation of the Effect of Building Distances on the Flow Configuration in Triple Placed Buildings

Deniz Golbasi[1], Ertan Buyruk[1], Ahmet Can[2], Koray Karabulut[3], M. Musab Bayat[4]

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Aerodynamic is an important factor in interaction of noxious aerosols, gases and particles emitted into the atmosphere with terrain, vegetation and buildings by affecting flow structure around the buildings. In this study, the flow around the placed diagonally three building models having same dimension and geometry was examined experimentally. Three buildings with roofs of 5 × 5 × 5 cm and 30° slope were used and the flow structure around the building environment was examined for the cases of 6.25 cm and 7.5 cm distances between the buildings by using PIV. As a result of the experiments, the instantaneous velocity fields <V> were firstly obtained and the time-mean velocity fields <V>, stream lines <Ψ> and vortex peer curves <ω> were drawn using these datas. It was seen that jet flow formed between the two buildings placed in the front of building models and the dimensions and places of the vortexes occurred behind the buildings changed depending on the variation in building distance.

Key words: *Building Aerodynamic, Flow Separation, Particle Image Velocimetry (PIV)*

An Approach to the Mechanical Design Projects in the Field of Cooling Plants

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The research presented in the article represents an approach to be taken in making mechanical detail engineering design projects for cooling plant systems. The approach includes a description of all its steps, as well as evaluation analyses to be conducted for the purpose of achieving optimal cooling plant system architecture. Optimal system architecture refers to such architecture that will provide maximum energy efficiency by reducing electricity consumption to a minimum, with a minimal noise level as required by the relevant professional rules applicable to the installation site, with minimal installation dimensions and weight of the device, offered at minimum cost.

The approach is presented through system verification performed on a sample cooling plant for interior installation, featuring chillers with water-cooled condensers, cooling towers, dry coolers, circulating pumps and other equipment in the pharmaceutical industry.

Key words: *Mechanical detail design project, evaluation, energy efficiency, cooling plant, optimal system architecture*

Desing Principles of the Hospital Clean Rooms

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Clean rooms can be defined as areas that are specifically controlled for particulate and microbial contamination and where they are constructed and used to reduce the number of infectious disease agents settling and multiplying and accessing from outside.

In this study, the design and implementation of the air conditioning system in accordance with international standards, in particular DIN 1946-4, has been explained for an operating room in hospitals which is in the clean room and has the highest risk of infection. The tasks of physicians, engineers and architects in operating room design were mentioned and finally the cleaning, testing, adjustment and balancing (TAB) and validation process of the air conditioning system were mentioned.

In particular, the risks of infections that may arise during the surgical intervention in the operating room and its relation to the air conditioning system have been mentioned and it has been emphasized that the biggest responsibility for hospital infections falls to engineers and architects, especially doctors and medical staff.

Key words: *Clean room, operating room, air conditioning, testing, adjusting, balancing, DIN 1946-4*

Thermal Requirements for the Elderly in Indoor Environment

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Microclimate conditions in the indoor environment have a significant impact on the health and well-being of individuals. This is especially the case for the elderly who spend most of their time indoors. Thermal comfort is one of the main aspects for ensuring comfortable and healthy indoor climate. Elderly thermal requirements differ from those of young adults due to the aging induced decreased human ability for thermoregulation. Consequently, the current thermal comfort models insufficiently capture differences in thermal requirements for different age groups. If we want to provide quality living environment for the elderly, it is necessary to define accurately thermal environment preferences and needs of the elderly. This paper gives an overview of the physiological changes occurring in the elderly and the implications on the thermal sensation and perception of thermal comfort, based on an evaluation of published field studies on the subject of elderly thermal sensation.

Key words: *Thermal comfort, thermal sensation, indoor environment quality, elderly, aging*

Phase Change Materials as Passive Overheating Protection in Solar Collectors

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Phase change materials have been considered as a form of energy storage in buildings, but this research has mostly been limited to space heating applications. However, solar thermal applications operate at a higher temperature than is necessary for modern hydronic heating systems. This is both due to the need to achieve a set minimum temperature of domestic hot water in its storage tank to avoid health risks and by the high temperature of stagnation of solar collectors. In order to evaluate the applicability of various phase change materials as mediums for energy storage and as passive protection mechanisms for collectors in stagnation, an overview of available materials was made and individual materials were evaluated and ranked based on their performance in comparison to a classic purely hydronic system, as well as the economic feasibility of the proposed system. The performance of such a system was then simulated for a typical family house solar domestic hot water system.

Key words: *solar collector, overheating, phase change materials*

Influence of Different Cover Plates Configuration on Thermal Performances of a Polymer Solar Collector

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This paper presents numerical analysis of influence of different configurations on thermal performances of a polymer solar collector. Numerical simulations are performed with software package FLUENT. Firstly, two configurations including single cover plate and single cover plate with channels are assessed. Results showed that collector with single cover plate is more efficient than collector with cover plate with channels at lower reduced temperature values. Single cover plate with channels behave like insulator, reducing convective heat loses which results in higher thermal efficiency at higher reduced temperature values. Furthermore, passive overheating protection based on natural convection is examined. Channels inside cover plate relate to channels inside absorber plate allowing for air to flow inside collector. Three different channel widths are considered 4.25, 10, and 20 mm. With such passive method, it is possible to reduce average absorber temperature up to ~20 °C. Present work is a part of the research focused at development of a low-cost polymer solar collector that operates in a drain back system.

Key words: *numerical simulation, FLUENT, heat transfer, polymer solar collector, overheating protection*

Influence of Electrical Yield on Temperature Drop of the Photovoltaic Panel: Numerical and Experimental Findings

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This paper deals in confirmation of drop in photovoltaic panel temperature under load. Two panels are compared, one with the load and other without the load. The panel under load should have larger heat dissipation (i.e. be cooler), when electrical yield is taken as an outgoing heat flow. During the experiment, a thermovision of the panels under solar irradiance was made with the FLIR camera. The results show reduced temperature of loaded panel, by up to 5 °C. Previously developed numerical model is updated with the measured data in the experiment. A measured electrical yield is taken into the account when the solar irradiance was modeled. Numerical model confirms the temperature drop and corresponds with infrared thermography data. Gained results can help in design of the photovoltaic systems, where more variants of operating conditions can be used in order to keep the panel on desired operating temperature.

Key words: *photovoltaic, operating temperature, thermal imaging*

Forecasting of Energy Consumption Based on Simulation and Statistical Methods

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The prediction of energy use in building is important in order to maximize their energy performance. In this paper, a simple model for forecasting energy consumption is presented and the most influential parameters on building properties and thermal response were analysed using TRNSYS and R software. The analysis was conducted on one of the subsection of a largest residential building in Zagreb for a typical meteorological year. The impact of technical and non-technical parameters on energy consumption was analyzed where the results obtained were used as a basis for the model for analyzing of the actual energy consumption data on buildings of similar characteristics and meteorological conditions.

Key words: *Energy consumption, simulation and statistical method*

Assesment of Possibilities of Waste Utilization in Small Wood Treatment Enterprises in the Niš Region

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There are 185 enterprises in the business of wood and wood product treatment or production in the Niš region. As per the national register of enterprise activity classification, 22.7 % is in the business of wood, cutting and processing, 27.03 % in the business of production of building carpentry, 29.73 % is in the business of production of wood packaging, 2.7 % is in the business of pellet production and 32.43 % accounts for the rest of wood treatment production or services. This paper, addresses the problems of potential improvement of competitiveness, energy efficiency and waste wood biomass utilization potentials by application of preliminary energy audit assessment method in the selected representatives of the mentioned enterprise groups from the Niš region. Energy consumption benchmarks are determined for the chosen small enterprises from the sector and potentials and possible issues for utilization of wood and wood-based treatment processes are analysed, discussed and determined. The results and measures defined for the chosen enterprises are transferable to the relevant enterprises with the same type of production in the region.

Key words: *Energy audit, waste wood, wood treatment enterprises, Niš region*

Infrared Thermography as a Prediction Tool for the Irrigation Requirement in Agriculture

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During the last decades, irrigation management has increasingly become the subject of interest because of climate change induced lack of water and increase in its price. At the same time, more precise irrigation results in a better harvest. Today, we have different systems that provide information about the irrigation requirements of a field. These systems are aimed at special types of plants or crops (cotton, vines, strawberries, asparagus, etc.). A unifying feature of all these systems is that they are rely on sampling on specific locations within a larger field, which means their effectiveness depends on the experience of the installer in selecting proper sampling locations. An improvement over this system would be if the entire surface of the field could be monitored, which could be achieved by using infrared thermography.

This paper deals with the possibility of using infrared thermography to determine the irrigation requirement for a given field depending on the water stress level of the plants. The experiments were performed on vines at the site in the municipality of Jadrtovac near Šibenik, Croatia.

The water stress level of plants was determined through leaf temperature measurements and measurements of potential evapotranspiration. Leaf temperature measurements were performed using infrared thermography. Based on these measurements the relationship between two derived factors: Crop Water Stress Index (CWSI) and Leaf Water Potential (LWP) was investigated.

The results obtained show that infrared thermography could be successfully used to measure the leaf and soil temperatures which are the input parameters for calculating the CWSI.

Key words: *Irrigation, crop water stress index, leaf water potential, infrared thermography*

Energy Savings by Insulation

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Energy demand continuously increases in parallel to world population growth. However, energy resources decrease with each passing day. Although energy dependency to the foreign countries grows up and it is very well known that many countries can not be able to consume their energies efficiently. Important amount of total energy of countries is used in buildings. The energy consumption of heating, ventilation, and air conditioning accounts for about 50–60% of total in residential buildings and will increase dramatically in the future. Moreover, the level of energy efficiency in residential buildings remains low.

- There are three precautions to save energy without compromising the quality and comfort of people.

These are,

- use of highly efficient devices
- automation systems
- and thermal insulation.

The first of these three precautions is thermal insulation. The energy consumption is very high in buildings without effective thermal insulation. The calculations show that with an effective thermal insulation, an average of 50 percent energy savings can be achieved in buildings.

We can define the process of heat loss and heat gain in buildings and installations as thermal insulation. Technically, thermal insulation is applied to reduce the heat transfer between two environments at different temperatures.

Most Important Benefits of the Thermal Insulation

1. Reducing the heating cost
2. Creating the condition of thermal comfort
3. Avoiding condensation to take place on building elements
4. Reduced cost for heating or air-conditioning

5. Sound insulation achieved when using fibrous insulation material
6. Environmental protection
7. Fire protection

The insulation of the outer wall is applied in 4 different systems according to the location of the thermal insulation material:

- Thermal Insulation Applications on Exterior of Walls (jacketing)
- Heat Insulation Applications on the Inner Surface of Walls
- Double Wall Heat Insulation Applications (Sandwich Wall)
- Ventilated Exterior Wall Insulation Applications

Comparison of EN ISO 13790 and Numerical Dynamic Simulations on Annual Heating and Cooling Energy Need Calculations

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This paper presents comparison of calculations performed by a numerical dynamic simulations software IDA ICE and those according to EN ISO 13790, widely used for determining building energy need (as implemented in Croatian national Algorithms used for energy certification, as a modification of simple hourly method from EN ISO 13790) performed by "Energetski certifikator" software. A simple model of a nearly-zero energy building was created and all heat gains and set-points that could lead to a mismatch in initial or boundary conditions were eliminated. The impact of those on the annual heating and cooling energy need was examined by adding and removing every single one of them. Numerical dynamic simulations were set up to match the boundary conditions of simple hourly method. Such an approach enables evaluation of the differences in annual heating and cooling energy need and definition of their origin. The comparison of results has shown that in most cases, annual energy need for heating and cooling calculated using numerical dynamic simulations software differs from that calculated using EN ISO 13790. Among the others, more detailed heat accumulation model of building's envelope in IDA ICE software was marked as the main reason. Fact that solar heat gains seem to be underestimated by EN ISO 13790 and differences in heat transfer towards ground contribute to results as well.

Key words: *building energy need, simple hourly method, dynamic simulation, nearly-zero energy buildings, heat energy accumulation, heat gains, heat transfer towards the ground*

New Trends in Development of Solar Hot Water Systems with Focus on Nearly Zero Energy Buildings

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Since the year 2008., a number of annually installed solar hot water systems in the EU has been continuously decreasing, indicating certain crisis undergoing in the solar sector. On the other hand, the newly installed solar thermal systems capacity grows at the annual rate of 4% (while in the EU it decreases by 4%). In order to revert these negative trends, the European Technology Platform on Renewable Heating and Cooling (RHC-Platform) and its part European Solar Thermal Technology Panel (ESSTP) financed by EC released the document 'Strategic Research Priorities'. In this document a significant potential for development of solar technologies by the year 2050. is emphasized. Also the document implies need for urgent intensification of the research and development activities (H2020 programs). The plans are divided in the following groups:

a) the development of solar compact hybrid systems (SCOHYS), solar heat costs reduction by 50%
b) technological improvements in Solar-Active-Houses (SAH) – e.g. solutions to meet requirements on Nearly Zero Energy Buildings (nZEBs)
c) development of systems providing heat for industrial processes (SHIP)

It is expected that the new requirements from Directive (EU) 2018/844 of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, concerning obligation that all new and renovated buildings of public sector shall reach the nZEB standard after 2019., and after 2021. all the other buildings, will additionally stipulate installation of new solar hot water systems. The calculations performed so far indicate that in a single family building with $Q_{H,nd}$<25 kWh/m^{2}a, nZEB standard can be achieved by installing 4-6 m^2 of solar hot water collectors, with 30% of renewable energy share.

Such technical solutions shall be carefully evaluated at the design process against the other alternative solutions such are e.g. biomass boiler, PV system and heat pumps.

Key words: *solar thermal systems, research and development, nZEB*

Supports for National Implementation of Revised EPBD

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The **European Union is committed** to developing a sustainable, competitive, secure and **decarbonised energy system by 2050**. Member States should seek a **cost-efficient equilibrium** between decarbonising energy **supplies** and reducing **final energy consumption.**

To **reach** the ambitious EU commitments complementary **actions must be made at the same time** and **coordinated with different actors**: the development of tools, capacity building, providing a consultancy support. **New challenges** and **requirements are stated** in the revised EPPD (amended 30 May 2018) which Member States shall **bring into force by 10 March 2020**.

The revised EPBD and the required transposition by the Member States offers the **possibility** for **common** and **appropriate implementation**, considering the **technical progress**, and new challenges and requirements.

To **support Member States** and **building professionals** in common and appropriate implementation, the Commission initiated the following actions:

- **European standards** were developed under the Commission Mandate M/480 given to the CEN for the assessment of the energy performance of buildings;
- **European projects** were started as support actions for common implementation and to promote skills development and education in the construction and energy efficiency sectors.

In this conference the results and services of **three European projects** (**EPB center**, ALliance for Deep RENovation in buildings – **ALDREN**, CEN standard Certified Experts – **CEN-CE**) will be presented**,** providing policy support to the revised EPBD. The projects are **complementary** but have as common point that all three projects are **based on European standards**.

Revised EPBD requires that each Member State shall establish a **long-term renovation strategy** to support the renovation of the national stock of residential and non-residential buildings, both public and private, **into highly energy efficient buildings.**

To enable cost-effective transformation of existing buildings into **nearly zero-energy buildings**;

- qualified professionals are needed. The CEN-CE project provide support.
- qualified professionals needs quality assessment tools. The ALDREN project provide support

The revised EPBD provide the chance for a common and appropriate implementation at EU level. **This chance should not be missed**.

Join ALDREN (www.aldren.eu), **join CEN-CE** (www.CEN-CE.eu)

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