ASOCIAȚIA INGINERILOR DE INSTALAȚII DIN ROMÂNIA
Filiala Timișoara

UNIVERSITATEA "POLITEHNICA" DIN TIMIŞOARA
Departamentul de Construcții Civile și Instalații

INSTALAȚII PENTRU CONSTRUCȚII ŞI CONFORTUL AMBIENTAL

CONFERINȚĂ CU PARTICIPARE INTERNAȚIONALĂ

Ediția a 22-a

11-12 aprilie 2013
TIMIŞOARA – ROMÂNIA

EDITURA POLITEHNICA

Colecția "CONFERINȚE"

INSTALAȚII PENTRU CONSTRUCȚII
ŞI
CONFORTUL AMBIENTAL

Lucrările conferinței

Ediția a 22-a

Homo sanus in domo pulchra

ASOCIAŢIA INGINERILOR DE INSTALAŢII DIN ROMÂNIA
Filiala Timişoara

UNIVERSITATEA „POLITEHNICA" DIN TIMIŞOARA
Departamentul de Construcţii Civile şi Instalaţii

INSTALAŢII PENTRU CONSTRUCŢII ŞI CONFORTUL AMBIENTAL

CONFERINŢĂ CU PARTICIPARE INTERNAŢIONALĂ

Ediţia a 22-a

11 – 12 Aprilie, 2013
TIMIŞOARA – ROMANIA

EDITURA POLITEHNICA
TIMIŞOARA – 2013

EDITURA POLITEHNICA
Bd. Republicii nr. 9
300159 Timişoara, România

Tel./Fax: 0256/403.823
E-mail: editura@edipol.upt.ro

Consilier editorial: Prof.dr.ing. Sabin IONEL
Redactor: Claudia MIHALI
Tehnoredactare: Claudia MIHALI
Prof.dr.ing. Adrian RETEZAN

Bun de imprimat: 04.04.2013
Coli de tipar: 33,5
ISSN: 1842 - 9491

Tiparul executat sub comanda nr. 26
la Tipografia Universităţii "Politehnica" din Timişoara

CUVÂNT ÎNAINTE

Calitatea mediului ambiant din clădiri este un domeniu de mare importanţă pentru sănătatea oamenilor. Larga arie de investigare referitoare la confortul termic, ventilare – climatizare şi calitatea aerului, efectul pozitiv/negativ al apei, sănătatea şi siguranţa ocupanţilor/clădirilor, modelarea şi monitorizarea, toate în dinamica schimbărilor climatice şi ţinând seama de sustenabilitatea soluţiilor, precum şi de dezvoltarea socioeconomică, conduce, pe lângă colaborarea cu alte specialităţi, la necesitatea/obligativitatea schimburilor de experienţă a celor ce s-au dedicat ştiinţei instalaţiilor pentru construcţii. Dorinţa de mai bine, experienţa anterioară izvorâtă din dictonul « Homo sanus in domo pulchra » şi din paradigma interdisciplinarităţii, înţelegerea holistică a multitudinii de factori/vectori care influenţează confortul, efectele care rezultă asupra oamenilor şi clădirilor, ne-au determinat şi ne motivează să continuăm. Să continuăm a dezvolta şi motiva teorii, în a oferi soluţii şi tehologii, dar şi în a le impune (aceasta însemnând continuarea solicitării sprijinului legislativ/politic, la toate nivelurile – ca exemplu pozitiv, deşi nu ne aparţine nouă, românilor, menţionăm restricţiile referitoare la fumat). Să continuăm : a căuta soluţii care să răspundă dezvoltării sustenabile ; provocărilor date la schimbările climatice ; a găsi tehnologii şi materiale nepoluante care să protejeze consumatorii ; să promovăm energiile curate/neconvenţionale ; să asigurăm flexibilitatea funcţională a instalaţiilor ; să punem OMUL înaintea altor interese.

În concluzie, continuarea înseamnă aprofundarea cunoştinţelor şi diversificarea preocupărilor, respectiv, ca alternativă, lucru în echipe interdisciplinare, înseamnă oportunităţi şi atragerea de noi specialişti talentaţi, dar şi rezolvarea nevoilor sociale (sau măcar răspunsuri pentru acestea) ; înseamnă a acorda atenţie OMULUI prin confortul ambiental, a-l susţine prin a-i asigura noi surse/resurse de energie, prin a-l sprijini să îmbunătăţească/protejeze mediul înconjurător, prin a-i oferi, gradual, educaţia care să-l îndreptăţescă a se considera stăpân pe toate.

Pentru toate acestea, instalatorii în colaborare cu toţi cei care îşi doresc o viaţă mai bună, dată de confort, siguranţă, performanţă, şi-au unit eforturile (inspirate) în elaborarea a 58 lucrări valoroase, repere pentru activităţile viitoare. Aducem călduroase mulţumiri celor 107 autori/coautori care au înţeles importanţa cuvântului scris în împărtăşirea experienţei.

Prof. Adrian RETEZAN

FOREWORD

The quality of the ambient environment in buildings is a domain of great importance for human health. The wide range of research on thermal comfort, ventilation – airconditioning and air quality, water effect (positive or negative), health and safety of the occupants and buildings, modeling and monitoring, all of these in strong relation with the dynamics of climate changes and taking into account the sustainable solutions, the socioeconomic development, and the collaboration with other specialties, lead to the necessity of experience exchanges of those who have dedicated themselves to the science of building installations. Our desire for improvement, the previous experience that comes from the saying „Homo sanus in domo pulchra" and from an interdisciplinary paradigm, the holistic understanding of the numerous and various factors/vectors that affect comfort, and the resulting effects on people and buildings, have motivated us to go further. We should continue not only to develop and motivate theories or to offer solutions and technologies, but also to implement them (i.e. asking for the legislative / political support at all levels; we should mention –as an example of good practice, which wasthough not initiated by Romanians – therestrictions on smoking). We should continue to identify solutions for sustainable development and challenges of climate changes; to find environmentally friendly technologies and materials which protect the consumers; to promote clean energy/unconventional facilities to ensure operational flexibility of the installations, and above all to placeHUMANS before other interests.

In conclusion, to continue means to improve our knowledge and to vary our further preoccupations, andas far as working in interdisciplinary teams is concerned, it means to find new opportunities and to motivate talented professionals. It also means to solve social needs (or at least to find answers to them), to pay attention to HUMANS through ambient comfort, to provide them with new sources/resources of energy, to encourage them to improve and to protect the environment by offering gradually the knowledge so that theymay consider themselves the masters of everything.

For all theses, the people working in the installation field together with all those who want a better life, ensured by comfort, safety and performance, have joined their inspired efforts in the development of 58 valuable papers, guiding marks for future works. We would like to express our warm thanks to all 107 authors /co-authors who have understood the importance of the written word in sharing their experience.

Prof. Adrian RETEZAN

Conferința națională cu participare internațională

INSTALAȚII PENTRU CONSTRUCȚII ȘI CONFORTUL AMBIENTAL

Ediția a 22–a

11-12 aprilie, 2013 – TIMIȘOARA, ROMÂNIA

DINAMICA INDICATORILOR DE CONFORT TERMIC AI SPAȚIILOR DELIMITATE DE ELEMENTE TERMO-ACTIVE
CONSIDERAȚII REFERITOARE LA CLĂDIRILE TERMO-ACTIVE „ZERO ENERGIE"

Victoria COTOROBAI[1], Theodor MATEESCU[*2],
Ana-Cristina MUSCALU
[*] Technical University Gheorghe Asachi, from Iași, România,
Univ. Prof. Eng. PhD
[1]victora.cotorobai@gmail.com

Rezumat

Promovarea clădirilor cu consum de energie aproape zero - nZBE – este un obiectiv cheie al politicilor energetice ale Comunității Europene, respectiv ale statelor membre. Măsurile propuse sunt multiple și vizează eficiența energetică a anvelopei, a sistemelor de încălzire/răcire, a celorlalte sisteme de utilități aferente (ventilare, climatizare, iluminat, preparare apă caldă de consum....), precum și tipul surselor de energie utilizate. Utilizarea anvelopelor termo-active (cu fațade duble vitrate active; cu pereți trombe; cu ferestre active; cu elemente de construcție opace, verticale și/sau orizontale cu sisteme active integrate) este o măsură integratoare, agreată în special pentru clădirile de birouri, administrative, ... și nu numai. Proiectarea unor astfel de elemente se realizează astfel încât să poată răspunde situațiilor dezavantajate, dar adaptarea flexibilă a acestora la variațiile dinamice ale condițiilor de

Conferinţa naţională cu participare internaţională

INSTALAŢII PENTRU CONSTRUCŢII ŞI CONFORTUL AMBIENTAL

Ediţia a 22–a

11-12 aprilie, 2013 – TIMIŞOARA, ROMÂNIA

ENERGY OPTIMIZATION OF PV PANELS SIZE AT SERBIAN ZNEB AND PNEB

Danijela Nikolic, Jasmina Skerlic, Marko Miletic,
Jasna Radulovic, Milorad Bojic
Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia

Abstract

In this paper, the possibilities to decrease energy consumption of a residential building in Serbian conditions are analyzed. The building with electrical energy generated by PV system is investigated. The major aim of the optimization of PV area is to determine the area of the PV array and to minimize the consumption of energy. The residential buildings with variable hot water consumption and PV embodied energy are investigated to achieve Zero-Net Energy Building or Positive-Net Energy Building. The buildings are simulated in EnergyPlus environment. Open Studio plug-in in Google SketchUp was used for buildings design, Hooke-Jeeves algorithm for optimization, and GENOPT software for software execution control. The obtained results give the optimal value of PV array. On that way, the fossil energy consumption and CO_2 emission is minimized.

Rezumat

În această lucrare sunt analizate condiţiile de reducere a consumului de energie în clădirile rezidenţiale din Serbia. S-a investigat o clădire cu energie electrică generată de un sistem fotovoltaic. Scopul principal al optimizării suprafeţei PV este de a determina suprafaţa panoului fotovoltaic şi de a minimiza consumul de energie. Clădirile rezidenţiale cu un consum variabil de apă caldă şi energia panourilor fotovoltaice sunt studiate să asigure ZNEB sau PNEB.Clădirile sunt simulate cu rpogramul Energy Plus. Open Studio plug-in din Google

SketchUp a fost utilizat pentru desenarea clădirilor, algoritmul de optimizare Hooke-Jeeves şi softul GENOPT pentru automatizare. Rezultatele obţinute dau valorile optime ale panourilor PV. În acest mod, consumul de energie fosilă şi emisiile de CO2 sunt minimizate.

Keywords: ZNEB; PNEB; Photovoltaic; Optimization; Simulation;

1. INTRODUCTION

Today, the renewable energy systems have a significant impact on the environment, so the development of renewable energy resources and the use of renewable energy are essential. One of the most promising renewable energy technologies is photovoltaic (PV) energy conversion[1]. PV energy conversion represents the direct conversion of sunlight into electricity. Commercial PV materials commonly used for PV systems include solar cells of silicium (Si), cadmium-telluride (CdTe), coper-indium-diselenide (CIS) and solar cells made of other thin layer materials[2, 3, 4]. PV systems are still an expensive option for producing electricity compared to other energy sources, but many countries support this technology. Over the last five years, the global PV industry has grown more than 40% each year[5].

In his paper, Kapsalaki[6] says that a radical approach for the mitigation of the energy demand is the concept of the ZNEB. By definition, Zero-Net Energy Building (ZNEB) produces all energy it consumes during year, and yearly electrical energy supplied to the electricity grid balances the amount received from the electricity grid. Positive-Net Energy Building (PNEB) produces more energy than it consumes during year, and yearly electrical energy supplied to the electricity grid is higher than the amount received from the electricity grid, and Negative-Net Energy Building (NNEB) produces less energy than it consumes during year[7,8].

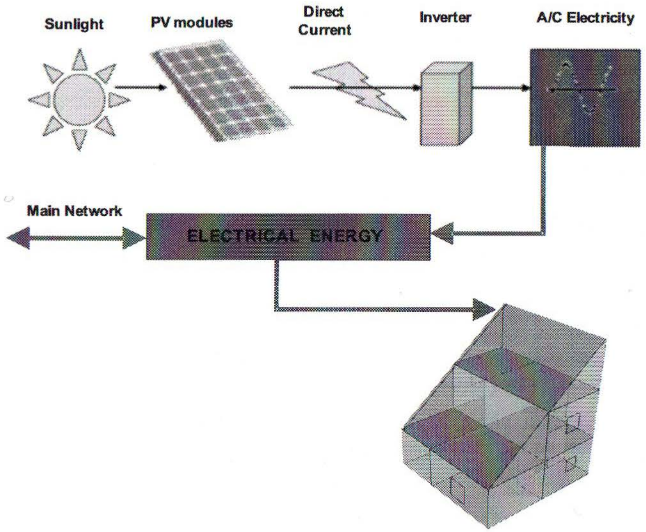

Figure 1 – Positive-Net Energy Building with PV module

In this paper, energy consumption is analyzed for a residential building located in Kragujevac, Serbia. The building is designed with PV panels installed on the roof – Figure 1. Electricity generated by the PV array is limited with the size of PV array. When PV system would not directly satisfy the building needs for electrical energy, then the rest of electricity will be used from the electricity grid. When the PV system would satisfy the building needs for electrical energy, then the rest of PV generated electricity will be fed-in the electricity grid.

The major aim of this investigation is to determine the portion of PV panels on the roof and, on that way, to minimize the consumption of network, primary energy. Network energy refers to the primary energy required to generate and deliver the energy to the site.

2. SIMULATION SOFTWARES AND CLIMATE

EnergyPlus software may be used for simulation of heating, cooling, ventilating, lighting and other energy and mass flows in the buildings[9]. EnergyPlus can simulate the energy use in a building and energy behavior of the building for defined period. In this study, the version 7.0.0 was used. EnergyPlus is made available by the Lawrence Berkley Laboratory in USA[10] and it has been tested using the IEA HVAC BESTEST E100-

E200 series of tests[11]. For PV electricity generation, EnergyPlus uses the different component, like PV array and inverter[12].

Open Studio plug-in in Google SketchUp software - Google SketchUp is a free 3D software tool that combines a tool-set with an intelligent drawing system[13]. The software enables to place models using real world coordinates. The OpenStudio is free plug-in that adds the building energy simulation capabilities of EnergyPlus to the 3D SketchUp environment. The software allows to the user to create, edit and view EnergyPlus input files within SketchUp.

GenOpt is an optimization program for the minimization of a cost function evaluated by an external simulation program[14]. GenOpt serves for optimization problems where the cost function is computationally expensive and its derivatives are not available or may not even exist. It can be coupled to any simulation program that reads its input from text files and writes its output to text files. GenOpt is written in Java so that it is platform independent. It has a library with adaptive Hooke-Jeeves algorithm.

Hooke–Jeeves Optimization Algorithm is used for the optimization, and it is direct search and derivative free optimization algorithm[15,16,17]. In this algorithm, only the objective functions and the constraint values are used to guide the search strategy. The adaptive precision Hooke Jeeves algorithm is used, which main advantage is reducing the compute time.

Climate - It is analyzed the building located in Kragujevac, Serbia. The latitude of Kragujevac is 44.1^{0}N, and the longitude is 20.55^{0}E. The time zone is GMT + 1.0 h. The summers are worm and humid with temperatures as high as 37^{0}C. The winters are cool with snow and temperatures as low as -19^{0}C[7]. The EnergyPlus uses weather data from its own data base with weather file.

3. MATHEMATICAL MODEL

3.1 EnergyPlus Model for the residential building

The investigated building is shown in Figure 2. The building has the south-oriented roof area with the slope angle of 37.5^0. On the roof, the PV array is installed. The building has two floors and 5 conditioned (heated) zones. There are a two attic zones. The building accommodates a family of four and it is not surrounded with any object. The working period of the heating systems is from October 15th to April 14th (07:00–21:00 h). Air temperatures in the rooms that are heated are set to 20 ^{0}C from 07:00 to 09:00 and from 16:00 to 21:00, and to 15^{0}C et the period from 09:00 to 16:00. The simulation time step is 15 min. The amount of infiltration is 1,5 ach^{-1}.

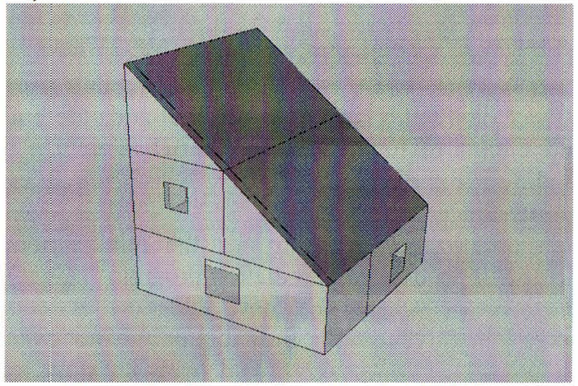

Figure 2 – Modeled residential building

The main part of electrical energy consumption is related to electrical space heating in a building. The second part is lightening and the other used appliance - domestic hot water (DHW), refrigerators, freezers, dishwashers, cloth washers etc. The PV system consists of PV array and an inverter. The operations of the PV array and heating system are together simulated by using EnergyPlus. The life time of PV array is set to 20 years, and the embodied energy of PV panels is set to 3,75 GJ/m^2 [1,3]. The main assumption is that PV system operates and all generated electrical energy would be immediately consumed. The PV panel is represented by the mathematical model of Photovoltaic:Simple from EnergyPlus[11], which describes a simple model of photovoltaic that may be useful for early phase design analysis.

4. SIMULATION AND OPTIMIZATION

4.1 Optimization procedure

In these investigations, the optimization was performed with the aim to determine the optimal value of PV array area, according to the buildings energy needs. On that way, the total energy consumption of a building, i.e. primary energy consumption, can be minimized. The value of PV panel portion in the roof is marked by y. The value of the network energy saving ($E_{S\text{-final},PV}$) is divided into two parts: energy generated by PVs (E_{PV}) and embodied energy of PV panels ($E_{em,PV}$). For the optimization, the following equation was used

$$E_{S-final,PV} = p_{PV}E_{PV} - C_m E_{em,PV}$$

where: $E_{S\text{-final}\,PV}$ – the yearly network energy saving by PV array (J); P_{PV} = 3.04 - primary conversion multiplier[18]; E_{PV} – yearly electrical energy generated by PV array (J); $E_{em,PV}$ – PV array embodied energy (J); C_m=1/LC; where LC is life time, in years.
The value y – ratio between PV panel area and roof area exists in the calculated total embodied energy and electrical energy generated by PV panel.

Alsema[1,3], reports that the energy requirement of crystalline silicon modules vary between 2400 and 7600 MJ/m^2 for mc-Si and between 5300 and 16500 MJ/m^2 for sc-Si technology (module efficiencies 13% and 14%, respectively). Sanchez[19] reports that the total energy requirements of a frameless a-Si module are 710 - 1980 MJ/m^2 (module efficiency 7 %). Alsema[3] reports that the average PV life time is 30 years.

5. RESULTS AND DISCUSSION

5.1 Different hot water consumption and optimization of PV panels area

The building is investigated with the thermal insulation thickness 0.15 m. The hot water consumption is changed, and analyzed cases are with monthly hot water consumptions of 7.5 m^3, 10 m^3, 15 m^3 and 20 m^3. Results are shown in Table 1.

Table 1 - Energy consumption, generated electrical energy by PV and portion of PV panels with different hot water consumption (Yearly values)

	hot water consumption 7.5 m^3	hot water consumption 10m^3	hot water consumption 15m^3	hot water consumption 20 m^3
Total electricity consumption (GJ)	46.29	48.36	52.13	54.86
Total generated PV electricity (GJ)	47.33	48.48	50.27	52.7
Portion of PV panel (-)	0.9	0.92	0.954	1
Network energy saving (GJ)	37.36 **PNEB**	35.69 **PNEB**	34.56 **NNEB**	32.87 **NNEB**

The buildings with the lower hot water consumption (7.5 and 10 m^3) are the PNEB. The PV array generates total energy (47.33 GJ and 48.48 GJ, respectively) more than energy requirements of these buildings (46.29 GJ and 48.36 GJ, respectively). Portion of PV panels are 90 and 92 %. The building with hot water consumption of 10 m^3 is approximately the ZNEB. All energy requirements of this building are covered from the PV array (which covers 92 % of the roof, i.e. 74.15 m^2). When the hot water consumptions of the building are 15 m^3 and 20 m^3, the investigated building would be NNEB (portion of PV is lower).

5.2 Different embodied energy for different types of PV array

The embodied energy (E_{em}) of PV arrays in all the previous analyses was 3.75 GJ/m^2. If the user choose mc-Si PV module, embodied energy with support, frame and inverters is 5.4 GJ/m^2. For sc-Si PV module, embodied energy with support, frame and inverter is 6.9 GJ/m^2, and for thin-film modules it is about 2.4 GJ/m^2.

Table 2 – Energy consumption, generated electricity and y value for different PV arrays

PV embodied energy	E_{em}=2.4 GJ/m^2	E_{em}=3.75 GJ/m^2	E_{em}=5.4 GJ/m^2	E_{em}=6.9 J/m^2
Total energy consumption (GJ)	48.36	48.36	48.36	48.36
Total generated energy (GJ)	48.48	48.48	48.27	48.06
Portion of PV panel (-)	0.92	0.92	0.916	0.912
Network energy saving (GJ)	39.28	35.69	28.34	22.78

Table 2 represents the results for different embodied energy of PV arrays. As it can be seen, when the embodied energy of PV array increase, the network energy saving decrease, and the portion of PV panels on the roof, also a little decrease. When the portion of PV panels has the lower values, then the generated electricity is the lower, too. In these cases, when the PV embodied energy is more than 3.75 GJ/m^2, for investigated buildings, PV array can't generate the electricity for whole building needs, so that buildings are the NNEB.

6.0 CONCLUSION

This paper reports the investigation in low energy Serbian house optimization. The major aim of optimization procedure in this paper was to determine optimal area of PV array and achieving the maximal network energy saving. Depending on the size of the hot water consumption, there is a different portion of PV panel on the roof. With the hot water consumption, the portion of PV panel on the roof increases too and the network energy saving decreases. the case of a building is investigated with different types of PV array, i.e. different embodied energy of these modules. The conclusion is that with the increasing the embodied energy of PV array, the network energy saving decreases, and the portion of PV panels on the roof also has small decrease.

Acknowledgment

This paper is a result of two projects: TR33015 supported by the Ministry of Science and Technological Development of Republic of Serbia and KNEP supported by the Center for Scientific Research of the Serbian Academy of Sciences and Arts and University of Kragujevac. The authors thank these institutions for their financial support.

REFERENCES

[1] Alsema, E.A., Nieuwlaar, E., "Energy viability of photovoltaic systems ", Energy Policy, 28(14), 2000, p. 999–1010

[2] Fthenakis, V.M., Kim H.C., "Photovoltaics: life-cycle analyses", Solar Energy 85, 2011, p. 1609–1628.

[3] Alsema E.A. Energy pay-back time and CO2 emissions of PV systems. Progress in Photovoltaics: Research and Applications 8(1), 2000, p. 17–25

[4] Raugei, M, Bargigli, S., Ulgiati, S., "Life cycle assessment and energy pay-back time of advanced photovoltaic modules:CdTe and CIS compared to poly-Si" Energy, 2007, 32(8):1310–8

[5] Suna D., Haas R., Polo A. L., Analysis of PV system's values beyond energy - by Country and Stakeholder, International Energy Agency - Photovoltaic Power systems programme - Report IEA-PVPS T10-02:2008, Institute of Power Systems and Energy Economics, Energy Economics Group - EEG, Vienna, Austria, March 2008

[6] M. Kapsalaki, V. Leal, M. Santamouris, A methodology for economic efficient design of Net Zero Energy Buildings, Energy and Buildings 55, 2012, p. 765 - 778

[7] M. Bojić, N. Nikolić, D. Nikolić, J. Skerlić, I. Miletić, ``Toward a positive-net-energy residential building in Serbian conditions``, Applied Energy, Volume 88, Issue 7, 2011, p. 2407-2419

[8] A.J. Marszal, P. Heiselberg, J.S. Bourrelle, E. Musall, K. Voss, I. Sartori, A. Napolitano, Zero energy building – a review of definitions and calculation methodologies, Energy and Buildings 43, 2011, p. 971–979

[9] D. Crawley, L. Lawrie, F. Winkelmann, W. Buhl, Y. Joe Huang, C. Pedersen, R. Strand, R. Liesen, D. Fisher, M. Witte, J. Glazer, EnergyPlus: creating a new-generation building energy simulation program, Energy and Buildings 33, 2001, p. 319–331.

[10] Anonymous, ENERGYPLUS, Input Output Reference - The Encyclopedic Reference to EnergyPlus Input and Output, University of Illinois & Ernest Orlando Lawrence Berkeley National Laboratory, 2009

[11] R.H. Henninger, M.J. Witte, D.B. Crawley, Analytical and comparative testing of EnergyPlus using IEA HVAC BESTEST E100-E200 test suite, Energy and Buildings 36 (8), 2004, p. 855–863.
[12] Lawrence Berkeley National Laboratory. EnergyPlus - Engineering documentation: the reference to EnergyPlus calculations. University of Illinois & Ernest Orlando Lawrence Berkeley National Laboratory; 2001.
[13] M. Bojić, J. Skerlić, D. Nikolić, D. Cvetković, M. Miletić, TOWARD FUTURE: POSITIVE NET - ENERGY BUILDINGS, 4th IEEE International Symposium on Exploitation of Renewable Energy Sources, EXPRES 2012, March 9-10, 2012., Subotica, Serbia, p. 49-54
[14] Wetter, M., 2004. GenOpt, Generic Optimization Program. User Manual, Lawrence Berkeley National Laboratory, Technical Report LBNL- 54199, p. 109.
[15] C. Audet, J.E. Dennis Jr., Analysis of generalized pattern searches, SIAM Journal on Optimization 13 (3), 2003, p. 889–903.
[16] M. Wetter, E. Polak, Building design optimization using a convergent pattern search algorithm with adaptive precision simulations, Energy and Buildings, 37, 2005, 603–612.
[17] R. Hooke, T.A. Jeeves, Direct search solution of numerical and statistical problems, Journal of the Association for Computing Machinery 8, 1961, p. 212–229.
[18] M. Bojic, S. Djordjevic, J. Malesevic, M. Miletic, D. Cvetkovic, A simulation appraisal of a switch of district to electric heating due to increased heat efficiency in an office building, Energy and Buildings 50, 2012, p. 324–330
[19] Justine Sanchez, PV Energy Payback, www.homepower.com

Conferința națională cu participare internațională
INSTALAȚII PENTRU CONSTRUCȚII ȘI CONFORTUL AMBIENTAL
Ediția a 22–a
11-12 aprilie, 2013 – TIMIȘOARA, ROMÂNIA

ASPECTE PRIVIND OPTIMIZAREA RECUPERATOARELOR DE CĂLDURĂ ROTATIVE ȘI CU PLĂCI ÎN CONTRACURENT

Conf. univ.dr. ing. Olga BANCEA, Asist.univ.drd.ing. Marius ADAM
Universitatea „Politehnica" din Timișoara

Rezumat

Lucrarea prezintă mai multe variante de recuperare a căldurii cu diferite tipuri de aparate iar din analiza acestora rezultă că aparatele cu rotor desicant realizează o reumidificare mai accentuată iar recuperatorele în plăci ating valori ale randamentului de recuperare de aproximativ 80%. În funcție de randamentul recuperatorului de căldură, aceste aparate sunt clasificate în mai multe clase energetice.

Abstract

The paper presents several heat recoverer with different types of equipments and their analysis shows that the devices with desiccant rotor makes a stronger re-humidification, while the plate heat exchanger reaches the values of recovery rate about 80%. Depending on the rate of heat recovery the devices are classified into several classes of energy.

1. Generalitati

Consumul de energie al instalațiilor de ventilare și climatizare reprezintă o parte importantă din consumul de energie al clădirii. Cercetările actuale urmăresc măsurile pentru creșterea eficienței acestor instalații prin reducerea consumului de energie și implicit a emisiei de