5th International Conference on Polygeneration (ICP 2019), May 15–17, 2019
Venue: I²CNER, Kyushu University, Fukuoka, Japan

Final Program

Day 1, May 15, 2019

Venue: 1st Floor Lobby, I²CNER Building 1

14:00 – 15:00 Registration

Venue: Room A, 1st Floor, I²CNER Building 1

15:00 – 15:20 Opening Remarks

15:20 – 16:00 Keynote 1
Prof. Fu Lin
Title: A Novel Approach of Thermo-Electric Coordination for CHP System
Session Chair: Prof. S. Srinivasa Murthy

16:00 – 16:40 **Panel Discussion 1**
Title: Polygeneration Technologies: Present Status and Future Perspectives
Panel members: *Prof. T. Kashiwagi, Prof. A. Coronas, Prof. Tingxian Li, , Dr. Angelo Freni, Prof. Y. Hamamoto*
Session Chair: Prof. Bidyut Baran Saha

Venue: 1st Floor Lobby, I²CNER Building 1

16:40 – 17:00 Coffee break

Venue: 1st Floor Lobby, I²CNER Building 1

17:00 – 19:00 Poster session

Session Chairs: Dr. Sivasankaran Harish, Dr. Kazushi Miyata

List of Posters

1. LES/Flamelet Simulation of Turbulent Partially Premixed Hydrogen-nitrogen Lifted Jet Flame, *Hu Y, Murakami T, Li J, Kurose R.*
2. The Electrochemical Properties of ZnO-loaded Carbon Nanotube Electrode for Zinc -Air Battery, *Nakabayashi K, Ikeda M, Miyawaki J, Yoon S-H.*
3. Innovation Engineering Design, Experimental Characterization Comparison, Calculation Simulation and Economic Analysis of Adsorption Cooling-Expanding Power Generation Systems Driven by Waste Heat and Solar Energy, *Lu Z.Z.*
4. Modelling of Photovoltaic based Peltier Air-Conditioners for Remote Shelter Bases, *Raiker G A, Umanand L, Subba Reddy B*
5. An Experiment on Flow Boiling Heat Transfer of R410A Heated Non-Uniformly Between Two Parallel Mini-Channels, *Noboritae W, Kurose K, Miyata K, Hamamoto Y.*
6. Effect of Mass Flux on Condensation Heat Transfer of a Refrigerant Flowing in a Rectangular Mini-Channel in Low Mass Flux Region, *Kutsunoya K, Arata Y, Miyata K, Hamamoto Y.*
7. Heat and Mass Transfer Characteristics of Ionic Liquid based Working Fluids in an Absorber of Absorption Cooling Machines, *Ariyadi H.M, Yamaguchi S, Saito K.*
8. Measurement of Time Constants for Water Vapor Adsorption Rate to Silica-gel Micro Particles Below Atmospheric Pressure by Using a Quartz Crystal Microbalance, *K. Furuya, Y. Hamamoto, K. Miyata*
9. Measurement of Water Vapor Adsorption Rate of Consolidated Silica-gel Particle Layer on a Commercially Available Heat Exchanger, *Adachi Y,Hamamoto Y, Miyata K.*
10. Performance Evaluation of a Loop Heat Pipe using Different Wick Materials, *K. Z. Htoo, H. P. Hien, K. Kariya, A. Miyara*
11. Simulation for the Steam Flow Meter Using a Circumferential Heater, *Okamura M, Miyata K, Hamamoto Y, Mori H, Umezawa S, Sugita K.*
12. Study on Heat and Mass Transfer Enhancement by CO_2 Nanoemulsion Absorbents, *Lee W, Xu. R, Kim S, Kang Y. T.*

13. Low-carbon Power Generation from Geothermal Resources in Japan, a Techno-economic Analysis by TIMES-Japan Framework, *Farabi-Asl H, Chapman A, Itaoka K, Jalilinasrabady S, Kato E, Kurosawa A.*
14. Temperature Elevation of Carbon Materials during Magic-angle-spinning Solid-state NMR, *K. Hata, K. Ideta, S. Toda, R. Harada, K. Nakabayashi, I. Mochida, S.-H. Yoon, J. Miyawaki*
15. Measurement and Evaluation of the Specific Heat Capacity of Silica Gels for Adsorption Heat Pump Applications, *Islam M. A, Uddin K, Pal A, Thu K, Nasruddin, Alhamid M. I, Saha B. B.*
16. Operation of an Ammonia-Water Absorption Refrigeration System for Food Preservation, Air Conditioning and Seawater Desalination Applications, *F. Hernandez-Tamayo, R. Best y Brown, I. Pilatowsky*
17. Comparison of Heating Performance of Heat pump using Electronic and Thermostatic Expansion Valve, *J.H. Lee, J.I. Yoon, K. H. Choi, S. J. Ha, M. J. Jeon, D. H. Choi, C. H. Son*
18. Experimental Study of Mixed Refrigerant Joule-Thomson Cycle Using R600a, R23 and R14, *K. S. Lee, C. H. Son, K. H. Choi, C. G. Moon, J. I. Yoon*
19. Game Theory as a Tool for Improving Operation and Durability of a Central Air-Conditioning System, *Rupa M. J, Islam M. A, Pal A, Uddin K, Thu K, Saha B. B.*
20. Performance Analysis of a Dual Component Generator - Condenser of an Absorption Heat Transformer for Water Desalination, *J. Delgado-Gonzaga, R. Saravanan, D. Juárez-Romero, A. Huicochea-Rodriguez, I. Ortiz*
21. Development of Thermal Conductive Composite Adsorbents for Cooling Applications, *Kaiser Ahmed Rocky, Animesh Pal, Kutub Uddin, Kyaw Thu, Bidyut Baran Saha*
22. Dynamic Simulation of a CO_2 Refrigeration System with Outdoor Temperature Fluctuation in Simscape, *J. Ko, T. Miyazaki*
23. Exergetic Analysis of a Vapour Compression Chiller using R410A, *Perera C. U. A, Higashi Y, Miyazaki T, Takata N, Saha B.B, Thu K.*
24. Heat Pump Cycle using Refrigerant Mixtures of HFC32 and HFO1234yf, *K. Takezato, S. Senba, K. Thu, T. Miyazaki, N. Takata, Y. Higashi*
25. Measurement of Thermodynamic Properties of New Low-GWP Working Fluids for High-Temperature Heat Pump Systems, *Sakoda N, Nagaoka M, Oono T, Higashi Y, Takata Y.*

26. A Statistical Approach Employing Bootstrap Sample to Determine Optimum Models for IUPAC Type-I and Type-V Isotherms, *Rahman M. M, Pal A, Muttakin M, Uddin K, Thu K, Saha B. B.*

27. Study on Surface Characteristics of Various Adsorbents using Inverse Gas Chromatography, *Palash M. L, Pal A, Thu K, Saha B. B.*

28. Thermoelectric Properties of Graphene Nanoplatelets Reinforced Cement Composites for Energy Harnessing, *Sampad Ghosh, Sivasankaran Harish, Kyaw Thu, Bidyut Baran Saha*

29. Influence of Air Flow Velocity on Equivalent Mass Transfer Coefficient for A Desiccant Rotor Regenerated by Concentrated Solar Irradiation, *Nakamura Y, Hamamoto Y, Miyata K.*

30. Experimental Investigation on the Performance of An Aluminium Honeycomb Solar Air Heaters, *X. H. Meng , C. J. Jing, T. Miyazaki*

31. Theoretical Analysis of a Thermal Pump for Solar Water Pumping Application, *Y. T. Abirham, T. Miyazaki, N.Takata , K. Thu*

32. Thermal Management of Concentrated Photovoltaics using Graphene based Nanocomposites, *Sivashankar M, Manikandan S, Selvam C, Sivasankaran Harish*

33. Study on Quasi-Two-Dimensional Flamelet Model for a Three-Feed Non-Premixed Combustion System, *Panlong Yu, Watanabe Hiroaki, Ryoichi Kurose, Toshiaki Kitagawa*

34. Unconventional Mass Market Applications in Low Grade Heat Recovery, Storage and Pumping: Industrial Gas-Fired Tumble Dryers, *Bachir El Fil, Srinivas Garimella*

35. Adsorption Thermodynamics for Different Adsorbent/Refrigerant Pairs for Cooling Applications, *T. H. Rupam, M. A. Islam, A. Pal, K. Uddin, K. Thu, B. B. Saha*

36. Potential Evaluation of Heat Exchange and Prediction of Water Absorbing Rate of a Fin Tube Heat Exchanger Flocked by Rayon Fibers, Yamashita *Y,Hamamoto Y,Miyata K.*

37. Vapor Absorption into Hygroscopic Liquid Desiccant Droplets and Guidance for Packed Tower Design, *Wang Z, Orejon D, Takata Y, Sefiane K.*

38. Solar Collector and Cascade Heat Pump Combi Water Heating Systems for Continental Climates, *A. Kaltayev, Ye. Belyayev, Ye. Yerdesh, M. Mohanraj, Ye. Shakir, A. Aliuly*

39. Solar-Assisted Auto-Cascade Heat Pump for Space Heating and Domestic Hot Water Application in Continental Climates, *Ye. Belyayev, Z. Abdulina, A. Rattner, Ye. Yerdesh, M. Mohanraj, A. Kaltayev*
40. Numerical Investigation of Gasification Characteristics on an Oxy-fuel Gasifier, *Ahn S, Tanno K, Watanabe H.*
41. Dynamic Simulation of a Novel Thermal Driven Integrated Adsorption-Absorption Cooling System, *Nikbakhti R, Wang X.*
42. Performance Evaluation of Ejector Based CO_2 System for Simultaneous Heating and Cooling Application in an Indian Dairy Industry, *Dasi Koti, Simarpreet Singh, Guruchethan A.M, M.P. Maiya, Armin Hafner, Krzysztof Banasiak, Petter Neksa.*

18:00 – 19.40 Welcome reception

Day 2, May 16, 2019

Venue: 1st Floor Lobby, I²CNER Building 1

9:00 – 9:30 Registration

Venue: Room A, 1st Floor, I²CNER Building 1

9:30 – 10:10 Keynote 2, On the memory of Prof. Shigeru Koyama
Prof. Akio Miyara
Title: Expanded Study on Heat Pump and Refrigeration Systems for Low GWP Refrigerants
Session Chair: Prof. Bidyut Baran Saha

Venue: 1st Floor Lobby, I²CNER Building 1

10:10 – 10:30 Coffee Break

Parallel Sessions

Session 1: Materials for Electric and Thermal Energy Conversion and Storage
Session Chair: Prof. Masamichi Kohno
Venue: Room A, 1st Floor, I²CNER Building 1, Hall (2/3)

10.30 – 10.50 Effect of ZrO_2 Nano Particle Coated Heater Surface on Heat Transfer Coefficient under Pool Boiling, *Bhaumik S, Bandurkar A, Gajghate S. S, Das S.*

10.50 – 11.10 Experimental Investigation of Pool Boiling Heat Transfer over Different Thickness of Graphene Layers on Heater Surface, *Gajghate S. S, Vashistha S, Das S, Bhaumik S.*

11.10 – 11.30 Methyl-Functionalised Fumarate-based MOFs for Heat Transmission Applications: Fabrication, Characterisation and Water Adsorption Performances, *Bo Han, Anutosh Chakraborty.*

11.30 – 11.50 Tuning Sorption Characteristics of Metal-organic Framework for High Efficient Sorption Thermal Energy Storage, *Xu JX, Li TX, Wang RZ.*

11. 50 – 12.10 Ultrafast Charging/discharging of Highly Conductive Phase Change Composites for Electrothermal Conversion and Storage, *Wu S, Li T.X, Wu M.Q, Wang R.Z.*

12. 10 – 12.30 Water Adsorption on Parent and Alkali-ions Doped Aluminium Fumarate MOFs and Al-Fumarate-Zeolite Composites Employing Grand Canonical Monte Carlo (GCMC), *Han B, Chakraborty A.*

Session 2: Heat and Mass Transfer Analysis

Session Chair: Prof. Yoshinori Hamamoto

Venue: Room B, 1st Floor, I²CNER Building 1, Hall (1/3)

10.30 – 10.50 Analytical Model for Sorber Bed Heat Exchangers of Sorption Cooling Systems, *Bahrehmand, H, Bahrami, M.*

10.50 – 11.10 Condensation Heat Transfer and Pressure Drop Characteristics of a Low GWP Refrigerant in a Plate Heat Exchanger, *J. H. Jung, O. J. Kwon, Y. T. Kang*

11.10 – 11.30 Temperature- and Pressure-Initiated Adsorptive Cycles for Heat Conversion, *Yu. I. Aristov, I. S. Girnik, A. Sapienza*

11.30 – 11.50 Mapping of Heat Gains from a Flat Heater Measured Using Telescopic Multi-Axis Heat Flux Sensor on Various Orientation, *Sigalingging J. A, Ratnasari N.G, Fauzan A, Ega H. M, Nugroho Y.S.*

11. 50 – 12.10 Numerical Simulation of the Multi-Region Coupled Heat Transfer in a Shell and Tube Reactor for CO_2 Methanation, *W. Zhang, H. Machida, H. Takano, K. Izumiya, K. Norinaga*.

12. 10 – 12.30 Heat Recovery Ventilators for Dehumidification of Greenhouses: Analytical Modelling, *N. Mohammadaliha, S. Foroushani, M. Bahrami.*

Session 3: District Heating and Cooling
Networks Session Chair: Prof. P. Muthukumar
Venue: Room 2F, 2nd Floor, I²CNER Building 1

10.30 – 10.50 Enhancement of District Heating Networks Performance using Sorption Heat Pumps and Chillers, *A. Coronas, J.C. Bruno, J. Prieto, D.S. Ayou*

10.50 – 11.10 Integration of Micro-Cogeneration into a Solar Heating Network Operating with a Seasonal Borehole Thermal Energy Storage while Serving a Small-Scale Italian Residential District, *Ciervo A, Rosato A, Sibilio S, Ciampi G, Scorpio M.*

11.10 – 11.30 Thermal Modelling of District Heating Networks: A Data-Driven Approach, *Foroushani S, Lapczak I, Owen J, Bahrami M.*

Session 4: Heat Pumps
Session Chair: Prof. Khairul Habib
Venue: Room 2F, 2nd Floor, I²CNER Building 1

11.30 – 11.50 The Effect of Heat Exchanger Geometry on Adsorption Chiller Performance, *Wojciech Nowak, Marta Wesolowska, Marcin Sosnowski, Karolina Grabowska, Jarosław Krzywański*

11.50 – 12.10 Combinations of Halide Salts for Heat-Recovery Resorption System, *Jivrakh K. B, Sharma R, Anil Kumar E.*

12.30 – 12.50 Experimental Studies on Endothermic Reversible Reaction of Salts for Cooling, *Desai F.J, A. Atayo A, Muthukumar P, Rahman M*

12.30 – 13.30 Lunch Break, Venue: Building 1, Lobby (Lunch will be provided)

Venue: Room A, 1st Floor, I²CNER Building 1

13:30 – 14:10 Keynote 3
Prof. Pradip Dutta
Title: Multi-Scale Approach Towards Development of a Two-Stage Air Cooled Water/Silica Gel Adsorption System
Session Chair: Prof. Yuri Aristov

Venue: 1st Floor Lobby, I²CNER Building 1

14:10 – 14:30 Coffee Break

Parallel Sessions

Session 5: Energy Storage Systems
Session Chair: Prof. M. Prakash Maiya
Venue: Room A, 1st Floor, I²CNER Building 1, Hall (2/3)

14.30 – 14.50 Concrete based Sensible Heat Storage System: Experimental Investigations, *Vigneshwaran K, Sodhi G. S, Muthukumar P, Senthilmurugan S.*

14.50 – 15.10 A Review on the Numerical Studies to Predict the Transient Thermal Behaviours of the Latent Heat Thermal Energy Storage Systems, *G. Shen, X. Wang, A. Chan*

15.10 – 15.30 Thermodynamic Studies on Metal Hydride based Tri-generation System for Cooling, Thermal Storage and Thermal Upgradation, *Sunku Prasad J, Sayantan Jana, Muthukumar P.*

15.30 – 15.50 Numerical Investigation of Thermal Behaviour of a Shell-and-Tube Latent Heat Thermal Energy Storage System, *Zhishun Yang, Lihua Chen, Zhenhua Xia, Xiaolin Wang.*

15. 50 – 16.10 Performance Evaluation of Adsorption Cooling System: A Comparative Study, *Singh V. K, Anil Kumar E, B. B. Saha.*

16. 10 – 16.30 Studies on Magnesium and Lanthanum based Composite for Metal Hydride based Thermal Energy Storage, *Anil Kumar E, Yogesh Madaria, Srinivasa Murthy S.*

Session 6: Solar Thermal Applications

Session Chair: Prof. Sanjeev Jain

Venue: Room B, 1st Floor, I^{2}CNER Building 1, Hall (1/3)

14.30 – 14.50 Design and Performance Evaluation of a Wall Mounted Solar Concentrating Collector, *Mboup A, Nakayama M, Akisawa A.*

14.50 – 15.10 Solar-LP gas Hybrid Plant for Dehydration of Food, *García-Valladares O, Pilatowsky-Figueroa I, Ortiz-Rodríguez N, Menchaca-Valdez, C.*

15.10 – 15.30 Experimental Investigations of the Dehumidifier Performance Evaluation using Aqueous LiBr-HCOOK Blends, *Bhowmik M, Naik B.K, Anandalakshmi R, Muthukumar P*

15.30 – 15.50 Experimental Study on the Performance of Heat Pump Water Heating System coupled with Air Type PV/T, *Choi H. U, Son C. H, Yoon J. I, Kim Y. B, Kim E. C, An B. H, Choi K. H.*

15. 50 – 16.10 Performance Evaluation of a Modified CPC Collector with Variable Concentration ratio along the Length, *Akhter, J, Gilani, S. I, Al Kayiem, H, Ali, M.*

16. 10 – 16.30 Determination of Heat Transfer Coefficient and Drying Kinetics of Red Chilli Dried in a Mixed Mode Forced Convection Solar dryer, *Jasinta P.K, Muthukumar P.*

Session 7: Thermal Energy Utilization

Session Chair: Prof. Majid Bahrami

Venue: Room C, 2nd Floor, I²CNER Building 1

14.30 – 14.50 Comparative Evaluation on the Thermal Conductivity and Stability of a MWCNT Nanofluid with Conventional Surfactants and Ionic Liquid, *Balaji, B, Habib. K, Cecilia, D.W, Saidur, R, Irshad. K.*

14.50 – 15.10 Effect of Steam Addition on Coal Tar Reforming under the Presence of Char, *Hosokai S, Matasuoka K, Kuramoto K.*

15.10 – 15.30 Experimental Investigation of a Domestic Adsorption Refrigerator Driven by Hot Water, *Hurtig K, Düwel K, Jäger M, Kühn R.*

15.30 – 15.50 Modelling and Performance Assessment of a Cascade Adsorption Cycle Suitable for Cooling Applications Driven by Industrial Waste Heat, *Aprile M, Freni A, Toppi T, Motta M.*

15. 50 – 16.10 Performance Efficiency of Ionic Liquid Polymer Composites in CO_2 Separation, *A. Vijaya Bhaskar Reddy, Muhammad Moniruzzaman, Azmi Bustam, Bidyut Baran Saha*

16. 10 – 16.30 Waste Cold Recovery from LNG-Regasification in Satellite Plants, *Atienza-Márquez A, Bruno J. C, Coronas A.*

16:30 – 16:40 Break

16.40 – 18.00 Transportation to Hakata port for the Banquet

18.30 Boarding the cruise MARIERA

19.00 – 21.00 Banquet Cruising on the MARIERA

Day 3, May 17, 2019

Venue: 1st Floor Lobby, I²CNER Building 1

9:00 – 9:30 Registration

Venue: Room A, 1st Floor, I²CNER Building 1

9:30 – 10:10 Keynote 4

Prof. Christos Markides
Title: Solar Hybrid PV-Thermal Combined Cooling, Heating and Power Systems.

Session Chair: Prof. Kim Choon Ng

Venue: 1st Floor Lobby, I²CNER Building 1

10:10 – 10:30 Coffee Break

Parallel Sessions

Session 8: Trigeneration Systems for Energy Services and Water - Desalination and Water Treatment Process/ Technologies
Session Chair: Prof. Anutosh Chakraborty
Venue: Room A, 1st Floor, I²CNER Building 1, Hall (2/3)

10.30 – 10.50 A Novel Absorption Refrigeration System with Membrane Dehumidifier for Air Conditioning, Refrigeration and Freshwater, *A. Gurubalan, M.P. Maiya, Patrick J Geoghegan*

10.50 – 11.10 Evaluation of a Novel Hollow Fiber Module Design for Air Gap Membrane Distillation, *Alpatova, A, Alsaadi A.S, Alharthi, M, Lee J.-G,Ghaffour, N.*

11.10 – 11.30 Fresh Water Extraction from the Atmosphere Employing MOFs as the Adsorbents, *L. G. Gordeeva, M. V. Solovyeva, Yu. I. Aristov.*

11.30 – 11.50 Parametric Studies and Performance Investigation on Novel Multipurpose Liquid Desiccant Drying/Desalination System, *Naik B.K, Muthukumar P.*

11. 50 – 12.10 Symmetric Feed Spacer Design for Enhanced Membrane Filtration, *Adnan Qamar, Sarah Kerdi and Noreddine Ghaffour*

Session 9: Advanced Cogeneration Technologies

Session Chair: Prof. Takahiko Miyazaki

Venue: Room B, 1st Floor, I²CNER Building 1, Hall (1/3)

10.30 – 10.50 Analysis of a Hybrid CO_2 Vapor Compression and Vapor Ejector Refrigeration System, *Gupta H.K, Kumar K, Kumar P.*

10.50 – 11.10 Combined Cold, Heat and Power (CCHP) Systems with Exergy Recovery from LNG-Regasification, *Atienza-Márquez A, Bruno J. C, Akisawa, A, Coronas A.*

11.10 – 11.30 Experimental Analysis of a Novel Multi-ejector CO_2 Cooling System for Supermarkets, *Simarpreet Singh, M.P. Maiya, Armin Hafner, Krzysztof Banasiak, Petter Neksa*

11.30 – 11.50 Multi-objective Optimization: Exergetic Efficiency, Exergoeconomic and Exergoenvironment Analysis for Geothermal Binary Cycle Power Plant at Ampallas West Sulawesi, Indonesia, *N. Nasruddin, I. D. Saputra, T. Mentari, L. C. Bunnenberg, O. Marcelina, S. Berlin*

11. 50 – 12.10 Steady and Dynamical Analysis of a Combined Cooling and Power Cycle, *Voeltzel N, Phan H.T, Gonzalez N, Tauveron N.*

Session 10: Energy Systems in Buildings

Session Chair: Prof. Kyaw Thu

Venue: Room C, 2nd Floor, I²CNER Building 1

10.30 – 10.50	Experiment of Adsorption Cooling Module's Performance with Variant Adsorbents (Natural zeolite, Silica Gel Type RD, and Silica Gel Type A), *Djubaedah E, Alius Q.H, Gurky R, Nasruddin.*
10.50 – 11.10	Experimental Study of Thermoelectric Air Duct Dehumidification System for Tropical Climate, *Irshad K, Habib K, Saha B.B, Islam S.*
11.10 – 11.30	Study of an Adsorption Chiller that Incorporates Mass and Heat Recovery Schemes, *Muttakin M, Uddin K, Thu K, Ito K, Saha B. B.*
11.30 – 11.50	Thermal comfort analysis of A Room Equipped with Photo Thermoelectric Air Duct System Under Tropical Climate Condition, *K. K. Looi, K. Habib, Aklilu T B*
11. 50 – 12.10	High-efficiency Air-conditioning Systems for Hot and Humid Climates, *Anurag Goyal, Srinivas Garimella.*
12.10 – 13.10	Lunch Break, Venue: Building 1, Lobby (Lunch will be provided)

Venue: Room A, 1st Floor, I²CNER Building 1

13:10 – 13:50	**Panel Discussion 2** **Title:** Research Trends in Sorption for Heat Pump Applications **Panel members:** *Prof. S. Srinivasa Murthy, Prof. Y. Aristov, Prof. Y.T. Kang, Prof. S. Garimella, Prof. M. Brahmi, Prof. Kim Choon Ng* **Session Chair:** Prof. Alberto Coronas
13:50 – 14:10	Coffee break

Parallel Sessions

Session 11: Trigeneration Systems for Energy Services and Water - Desalination and Water Treatment Process/ Technologies
Session Chair: Prof. Muhammad Aziz
Venue: Room A, 1st Floor, I²CNER Building 1, Hall (2/3)

14.10 – 14.30	Pressure Swing Adsorption Cycle Integration with Combined Power and Desalination, *Muhammad Wakil Shahzad, Doskhan Ybyraiymkul, Muhammad Burhan and Kim Choon Ng*
14.30 – 14.50	Small-Scale Renewable Polygeneration System for Off-Grid Applications: Desalination, Power Generation and Space Cooling, *Ayou D. S, Zaragoza G, Coronas A.*
14.50 – 15.10	Thermodynamic Analysis of a Green Multiple Effect Evaporator- A Holistic Approach, *Soundaram Ramanathan, Dibakar Rakshit.*
15.10 – 15.30	The Fallacy of Energy Efficiency for Seawater Desalination Processes for Sustainable Development, *Kim Choon Ng, Muhammad Wakil Shahzad, Muhammad Burhan*

Session 12: Polygeneration of Energy and Energy Integration
Session Chair: Prof. Larisa Gordeeva
Venue: Room B, 1st Floor, I²CNER Building 1, Hall (1/3)

14.10 – 14.30	A Solar Biomass Hybrid System for Cooking and Cooling Applications, *Sai Yagnamurthy, Dibakar Rakshit, Sanjeev Jain, Ravi Kumar*
14.30 – 14.50	Coproduction of Power and Ammonia: Energy-Efficient Recovery from Black Liquor, *Arif Darmawan, Muhammad W. Ajiwibowo, Koji Tokimatsu, Muhammad Aziz.*
14.50 – 15.10	Integrated Polygeneration System for Coastal Areas, *G. Praveen Kumar, R.Saravanan, Joan Carles Bruno, Alberto Coronas*

15.10 – 15.30 Performance Analysis of a Renewable Energy Polygeneration Plant in a Rural Hotel aimed towards the nZEB Standard, *Pulido T, Bruno J. C.*

Session 13: Low Carbon Technologies - 1
Session Chair: Prof. MD. Akhtaruzzaman
Venue: Room C, 2nd Floor, I²CNER Building 1

14.10 – 14.30 Drying Technology of Wood Chips for using Bamboo as Biomass Fuel, *Hiroyuki Asou, Yukito Kawakami*

14.30 – 14.50 Numerical Study on NO Production of NH3/City Gas Flameless Combustion, *Honzawa T, Kurose R.*

14.50 – 15.10 Online Process Analysis of Phase Separation Solvent for Carbon Dioxide Capture, Tran K.V.B, Sato M, Yamaguchi T, Machida H, Norinaga K.

15.10 – 15.30 Strategy Development of Methanol Vehicles in China based on Life-Cycle Assessment of Greenhouse Gas Emissions, *C.Li, M. Negnevitsky, X Wang*

15.30 – 15.40 Break

Parallel Sessions

Session 14: Low Carbon Technologies - 2
Session Chair: Prof. Hiroaki Watanabe
Venue: Room A, 1st Floor, I²CNER Building 1, Hall (2/3)

15.40 – 16.00 Toward Efficient Hydrogen Utilization: Combined Dehydrogenation of Methylcyclohexane and Power Generation, *Aziz, M, Juangsa, F.B, Oda, T, Kashiwagi, T.*

16.00 – 16.20 Performance Evaluation of ANN Techniques in Daily Net Radiation Modelling Based on Climatic Data in Semi-Arid Region Abha, *Islam S, Abdullah R.A.B, Irshad K, Saha B.B.*

16.20 – 16.40 Societal Penetration of Hydrogen in a Carbon-Constrained World: A Techno-Economical Analysis of Global Hydrogen Economy Scenarios, *Chapman, A. Farabi-Asl, H. Itaoka, K.*

Session 15: Polygeneration of Energy and Energy Integration
Session Chair: Prof. Rajagopal Saravanan
Venue: Room B, 1st Floor, I²CNER Building 1, Hall (1/3)

15.40 – 16.00 Performance Analysis of a Stand-alone Polygeneration Microgrid, *Rao B. Murthy S. S., Dutta P.*

16.00 – 16.20 The Behaviour of an Ejector Cooling System Operating at its Critical Mode and using Secondary Heat Exchangers, *Hernandez J, Best R, Roman R.*

16.20 – 16.40 Efficiency of the Reversible Honigmann Energy Storage, *Thiele E, Jahnke A, Ziegler F.*

Session 16: Energy and Environmental Studies
Session Chair: Prof. Swapan Bhaumik
Venue: Room C, 2nd Floor, I²CNER Building 1

15.40 – 16.00 A Comprehensive Study of Solution and Vacuum Processed NiOx as Hole Transport Material for Perovskite Solar Cell, *Hasan A. K. M, Raifuku I, Chowdhury T. H, Jamal M.S, Ishikawa Y, Uraoka Y, Sopian K, Akhtaruzzaman MD.*

16.00 – 16.20 Exery Destruction Comparison Between Pumped Hydro Compressed Air Energy Storage System and Compressed Air Energy Storage System, *Mozayeni H, Wang X, Negnevitsky M*

16.20 – 16.40 Effect of Substrate Temperature on the Structural and Electrical Properties of Un-doped NiO Thin Film by Vacuum Deposition Technique, *Jamal M. S, Shahahmadi S. A, Chelvanathan Puvaneswaran, Hasan A. K. M, Sopian K, Tiong S.K, Amin Nowshad, Akhtaruzzaman Md.*

16.40 – 17.20 Closing ceremony

Solar Collector and Cascade Heat Pump Combi Water Heating Systems for Continental Climates

A. Kaltayev[1,2], Ye. Belyayev[1,2*], Ye. Yerdesh[2*], M. Mohanraj[3], Ye. Shakir[2], A. Aliuly[1,2]
*Email: yerzhan.belyayev@gmail.com, yelnaryerdesh@gmail.com

[1]Department of Applied Mechanics and Engineering Graphics, Satbayev University, Almaty, Kazakhstan,
[2]Department of Mechanics, Al-Farabi Kazakh National University, Almaty, Kazakhstan
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Summary: In continental climate regions the ambient temperature drops below -20 ^{o}C during winter seasons. The heating capacity of a single stage vapour-compression heat pump cycle has significantly reduced when the operating temperatures difference between the condenser and evaporator operating temperatures are more than 40 ^{o}C. The two stage cascade heat pump cycle operating with two different refrigerants (one with low boiling point and another with high boiling point) provide a sustainable solution to lift the temperature above 70 ^{o}C. A numerical simulation model has been developed for predicting the performance of a solar collector and two stage cascade heat pump combi water heating systems under Kazakhstan climatic conditions.

Keywords: Cascade air source heat pump; Solar water heating; Continental climate

Introduction

Presently, the conventional energy resources (such as, hydrocarbon, coal, diesel, gas and electricity) have been widely used for space heating in residences of continental climatic conditions of Kazakhstan. The fast depletion of these energy resources and its environmental impacts has created research interest on developing an environment friendly space heating system. The heat pump assisted space heating systems are energy efficient devices due to its capability to deliver more heat output than electric input it takes for compression of working fluid. The single stage compression heat pump systems are not suitable for the continental climatic regions like, Russia, Ukraine, Kazakhstan, Uzbekistan, Mongolia, Canada and North part of USA. The ambient temperature in these regions falls below -20 ℃ during winter climates. The solar and geothermal heat pump systems are more expensive to meet the heating demand in continental climatic conditions. The two stage cascade heat pump systems are operating efficiently in continental climatic conditions. This paper proposes a two-stage cascade air source heat pump (CASHP) that operates with high efficiency at below -20 ℃ ambient air. Kazakhstan is one of the leading countries in the Central Asian region with the average annual solar radiation potential. Annual duration of sunshine is 2200-3000 hours, and the estimated capacity of 1300-1700 kW per 1 m^2 per year, which exceeds that of Europe. The available solar irradiation in Kazakhstan is harvested with the help of solar collectors, which can be integrated with the heat output of the heat pump. In this context, the use of solar water heating (SWH), combined with CASHP system will provide space heating and domestic hot water (DHW) in continental climate regions.

Method and Results

The schematic diagram of the solar collector (SC) and cascade heat pump (CASHP) system is depicted in Fig.1. The system has three circuits namely: (a) SC; (b) CASHP water heating and (c) space heating and domestic hot water (DHW). The performance of proposed configuration was assessed for the climatic conditions of Almaty (latitude of 43.25 ^{o}N, longitude of 76.91 ^{o}E) city in Kazakhstan. The performance was evaluated under the influence of ambient parameters (such as, solar irradiation and ambient temperature) and the system operating temperatures (such as, condensing and evaporator temperatures). The meteorological data were obtained by using Davis Instruments weather station Vantage Pro2 Plus.

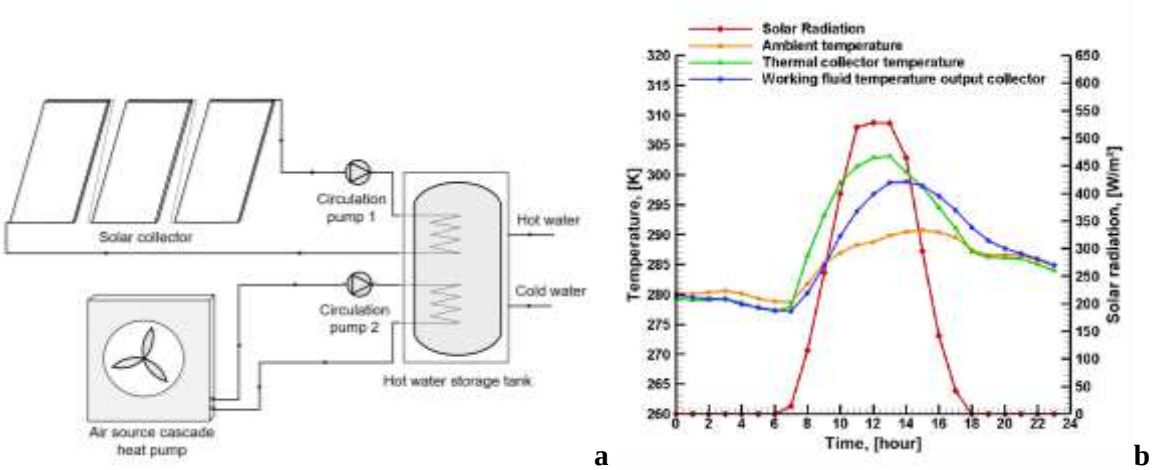

Figure1.a - Schematic diagram of the combi SHW and CASHP system,
b - The daily (22.10.2018) temperature variation in solar thermal collector with reference to the time,

The thermal performance of the SC was evaluated using the computer program developed by the authors[1-4]. The CASHP was solved using the Engineering Equation Solver® (EES) software [5]. The maximum solar collector absorber temperature (Fig.1 b) of about 303.12 K (29.97 ℃) were obtained. The refrigerants pair R410A/R134a COP at -34 ℃ reaches 1.66, at -20 ℃ reaches 1.91.

Conclusions

Based on the simulation results, R32/R134a and R410A/R134A were selected as viable working fluids for cascade heat pumps operated in continental climatic conditions for space heating applications. The solar collector provides auxiliary heat sources to reduce the power consumption of heat pump system. Moreover, the simulation results confirmed that, the solar collector and cascade heat pump combi water heating system are more energy efficient and provided good heating solution in the continental climatic regions. From the most common refrigerants on the market today, the most efficient refrigerant pairs are R410A/R134a and R32/R134a (at -30 ℃ ambient and +60 ℃ heating circuit COP=1.82).

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