出國報告（出國類別：出席國際會議）

出席再生能源 GRE 2014 國際研討會及展示會(The Grand Renewable Energy 2014 International Conference and Exhibition)

服務機關：國立嘉義大學機械與能源工程學系
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派赴國家：日本 **(**東京**)**
出國期間：**2014** 年 **7** 月 **26** 日至 **8** 月 **2** 日
報告日期：**2014** 年 **8** 月 **11** 日

摘 要

GRE2014 國際研討會含蓋了主要的再生能源議題，包括太陽光電能、太陽熱能、生質能、風力能、氫能與燃料電池、海洋能、動力及儲能、其他非傳統能源等。本次大會同時舉辦 2014 日本光電展示會(PV Japan 2014) 約 150 個展示攤位和第 9 屆世界再生能源展示會約 140 個展示攤位。本次會議內容涵蓋了多元能源之學術議題以及最新的研究成果，我國現有多元再生能源研究領域和課題均符合國際發展趨勢，各單位亦積極參與國際會議並發表相關論文。此次發表論文題目 Thermal performance of an Innovative curtain-Wall-Integrated Solar Heater 爲本人科技部計畫成果之延伸。除了發表論文之外，亦將藉由與不同國家的學者交流，了解國際上不管是學校或業界目前的研究活力，對於筆者未來學術研究或機械與能源工程學系之教學發展將獲益良多

關鍵詞：再生能源、太陽光電能、太陽熱能、生質能、風力能、氫能與燃料電池

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壹、 計畫緣起與目的

GRE2014 國際研討會是由日本再生能源學會主辦 Japan Council for Renewable Energy(JCRE)主辦，本次大會並與國際太陽能學會亞太研討會(International Solar Energy Society Asia Pacific Conference)和 第二屆波浪和潮汐能研討會(The 2nd Asia Wave and Tidal energy Conference)聯合舉行研討會，同時舉辦 2014 日本光電展示會(PV Japan 2014)和第 9 屆世界再生能源展示會。主題含蓋了主要的再生能源議題，包括太陽光電能、太陽熱能、生質能、風力能、氫能與燃料電池、海洋能、動力及儲能、其他非傳統能源等場面非常盛大。包括 60 個國家 12 項主題 800 篇研討會論文，其 12 項主題包括：

1. Policy & Integrated Concept
2. Photovoltaic
3. Solar Thermal Applications
4. Innovative Bioclimatic Architecture
5. Wind Energy
6. Biomass Utilization & Conversion
7. Hydrogen & Fuel Cell
8. Ocean Energy
9. Geothermal Energy & Ground-Source Heat Pump
10. Energy Network & Power Electronics
11. Energy Conservation & Heat Pump
12. Small Hydro & Non-Conventional Energy

GRE2014 自 7 月 27 至-8 月 1 日於 2 日本 東京舉辦。本次會議內容涵蓋了多元能源之學術議題以及最新的研究成果。筆者發表論文題目 Thermal performance of an Innovative curtain-Wall-Integrated Solar Heater 爲科技部計畫成果之延伸，會議論文屬 Area3 Solar Thermal Applications，會議論文接受函如附錄一，會議註冊如附錄二，發表論文如附錄三。除了發表論文之外，與不同國家的學者交流，亦參加 2014 日本光電展示會(PV Japan 2014)和第 9 屆世界再生能源展示會(如附錄四)，以了解國際上不管是學校或工業界目前的研究活力，以及日本太陽能光電發展現況，對於筆者未來學術研究或機械與能源工程學系之教學發展將獲益良多。

貳、參加研討會過程與內容

依據研討會議程，筆者與會行程如表 1 所示。

表 1 出席研討會行程表

日期/星期 活動內容 備註	活動內容	備註
7 月 26 日/星期六	去程(桃園機場-東京)及準備日	
7 月 27 日/星期日	歡迎會	
7 月 28 日/星期二	發表論文、參加分組研討、交流活動	
7 月 29 日/星期三	參加專題講座、分組研討、交流活動	
7 月 30 日/星期四	參加專題講座、分組研討、交流活動、2014 日本光電展示會及第 9 屆世界再生能源展示會	
7 月 31 日/星期五	參加 2014 日本光電展示會及第 9 屆世界再生能源展示會	
8 月 1 日/星期六	參加分組研討及第 9 屆世界再生能源展示會	
8 月 2 日/星期日	回程(東京-桃園機場)	

筆者發表論文題目 Thermal performance of an Innovative curtain-Wall-Integrated Solar Heater 爲科技部計畫成果之延伸，會議論文屬 Area3 Solar Thermal Applications，分組討論日期 7/28 至 7/30。除了發表論文之外，筆者參加與 7/29 Area3 專題演講 (Mr. Werner Weiss)及開幕專題專題講，並與不同國家的學者交流，同時亦參加 2014 日本光電展示會(PV Japan 2014)和第 9 屆世界再生能源展示會，以了解國際上不管是學校或工業界目前的研究活力，以及日本太陽能光電發展現況。筆者在國立嘉義大學機械與能源工程學系講授「能源慨論」、「節能技術導論」、「熱力學」和「流體力學」「機械與能源工程實驗」等課程，均與本次會議主題息息相關。參加

此次盛會對於筆者未來學術研究或機械與能源工程學系之教學發展將獲益良多。

圖 1 筆者報到

圖 2 筆者參與大會之發表論文

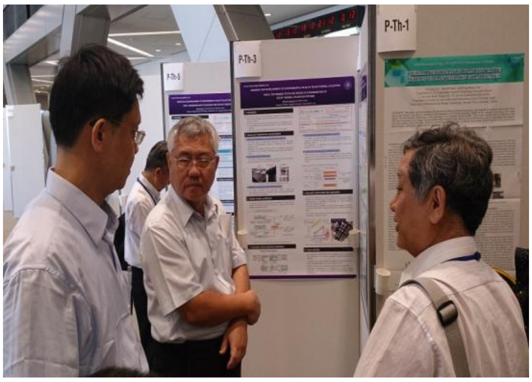

圖 3 筆者參與大會之發表論文

圖 4 筆者參與 2014 日本光電展示會(PV Japan 2014)和第 9 屆世界再生能源展示會

參、心得與建議

(一)本次會議內容涵蓋了最新之再生能源學術議題以及最新的研究成果，研討會議程中，針對本次大會 12 項主題舉辦 12 場專題演講(Plenary sessions)、學術議程(Academic program)及展覽專區(Exhibition)。與會過程中觀察到，台灣學界朋友參與會議的人數不在少數，顯示我國現有節能及再生能源研究領域和課題均符合國際發展趨勢。亦感受到重國際會議「展示台灣的研究能量」與「國際接軌共同合作」，進而「喚起國際社會對台灣的認同」的趨勢。藉由與不同國家的學者交流，可了解國際上不管是學校或工業界目前的研究活力，對於筆者未來學術研究的再啓發深覺獲益良多。感謝國立嘉義大學校務基金計畫結餘款再運用經費對於筆者參與本會議之註冊費用與生活費用之補助。

(二) 當今世界正處於節能減碳和再生能源議題的發展關鍵期，專家學者在太陽熱能應用領域上，近年來主軸很多應用在建築物和工業製程上。太陽熱能應用領域演講者 Werner WEISS director of AEE – Institute for Sustainable Technologies (AEE INTEC) in Austria，其講題正好探討建築物和工業製程之應用，令人印象深刻。而本人發表亦是太陽熱能應用在建築物上，Werner WEISS 先生演講內容之研究趨勢值得參考借鏡，對於筆者未來學術研究的再啓發更是深覺獲益良多。

(三) 本次大會同時舉辦 2014 日本光電展示會(PV Japan 2014) 約 150 個展示攤位和第 9 屆世界再生能源展示會約 140 個展示攤位。此次日本光電展之廠商展示主題大多為家用太陽能電池及其模組，包括：太陽能晶片、晶片系統固定架、智慧電錶及監控模組。再生能源展示會中之風力發電或太陽能發電之商用電能管理系統模組化。在在顯示太陽能發電應用在日本已是生活化甚至適用於海邊家用太陽能晶片系統之木製固定架應有盡有。風力發電或太陽能發電之商用電能管理系統模組化亦顯示再生能源應用普及化。這些再生能源應用發展現況和趨勢值得參考借鏡，對於筆者未來學術研究或機械與能源工程學系之教學發展將獲益良多。

肆、附錄

附錄一: 會議論文接受函

----- Original Message -----
From: "Secretariat of the Grand Renewable Energy 2014"
<grand-re2014.sec@grand-re2014.org>
To: <cmlai@mail.ncku.edu.tw>
Sent: Friday, May 30, 2014 3:24 PM
Subject: Grand Renewable Energy 2014: Information for Your Presentation

> Dear Prof. Chi-Ming Lai,
>
> On behalf of the Program Committee of the Grand Renewable
> Energy 2014 (GRE2014) which will be held from July 27th to August 1st,
> 2014 at Tokyo Big Sight, Tokyo, Japan, it is our great pleasure to
> inform you of your presenting schedule as follows:
>
> Abstract Receipt No.: 00003
> Abstract Title: Thermal Performance of an Innovative
> Curtain-wall-integrated Solar Heater
> Presenter: Prof. Rong-Horng Chen
> Presentation style: Poster Session
> Session category:
> Area III: Solar Thermal Applications
> Poster Session
>
> Session Time & Date(Core Time): 16:10 - 17:30 July 28th, 2014
>
> *Presenters are requested to stand by their poster panel during
> the core time to answer questions and to make discussions with the
> audience.
>
> Mounting Time：July. 28 (Mon.) 8:00-13:00
> Removal Time：July. 29 (Tue.) 18:00-19:00
>
> For more information to prepare for your presentation, please visit
> our website;
> http://www.grand-re2014.org/eng-conf/instructions/index.html
>

> For hotel accommodations, on-line reservation is also available at;
> http://www.grand-re2014.org/eng-conf/accommo/index.html
>
> Should you have any questions, please feel free to contact
> the conference secretariat.
>
>
> Respectfully yours,
>
> Prof. Mitsuhiro Udagawa
> (Program Chairperson)
> Grand Renewable Energy 2014
>
> Inquiries:
> Secretariat for Grand Renewable Energy 2014
> c/o Japan Convention Services, Inc.
> Fax +81-3-5283-5952
> E-mail: grand-re2014.sec@grand-re2014.org
> Prof. Chuichi Arakawa
>
>
>

附錄二 :會議註冊

Receipt

Registration Secretariat for GRE2014
c/o Japan Convention Services, Inc.
Koshin Bldg. 2-2, Kandanishikicho,
Chiyoda-ku, Tokyo 101-0054, Japan
Tel:+81-3-3508-1250 Fax:+81-3-5283-5952
E-mail:gre2014-reg@grand-re2014.org

Date: May. 27. 2014

TO:Rong-Horng Chen

Department of Mechanical and Energy Engineering, National Chiayi University

JPY 55,000-

This is to certify that the above amount has been duly received as your registration fee for GRE2014.

再生可能エネルギー2014国際会議組織委員会之印

Prof. Masayuki Kamimoto, Hirosaki University
Organizing Committee, Deputy Chair of GRE2014

r4300986

附錄三: 發表論文

THERMAL PERFORMANCE OF AN INNOVATIVE CURTAIN-WALL-INTEGRATED SOLAR HEATER

Chi-ming Lai [1] and Shuichi Hokoi [2] and Rong-Horng Chen [3]
[1] Department of Civil Engineering, National Cheng-Kung University, Taiwan.
[2] Department of Architecture and Architectural Engineering, Kyoto University, Japan.
[3] Department of Mechanical and Energy Engineering, National Chiayi University, Taiwan.

SUMMARY: This study combined curtain wall structures, building construction practice, heat transfer mechanism, and natural circulation loop design to develop an innovative wall-integrated solar heating prototype, based on the concept of an energy harvesting façade. The heat transfer performance of this prototype is investigated experimentally. The results showed when the entering water flow rate is decreased, the average Nusselt number and extractable solar radiation heat of the heated section are insignificantly impacted by the entering water flow rate. However, as entering water flow rate is reduced, the average Nusselt number of the cool section also increases, causing the energy harvest ratio to decrease slightly.

Keywords: energy, solar heating, heat transfer, natural circulation loop

INTRODUCTION

An environmental control device capable of "harvesting" solar thermal energy can be integrated with the exterior wall of houses. This device can effectively buffer the solar heat gained and can capture this solar energy and transfer it for use. However, at night, this device also can preserve energy through the use of a hot water system or low wattage thermoelectric material. During winter, such a device is able to absorb a limited amount of heat from the sun during the day, and the preserved heat can then be transferred indoors, where good wall insulation can maintain the heat at night. In our previous study [1], we developed and experimentally tested a wall heat-collection prototype, which was simplified to a natural circulation loop with a rectangular configuration, under practical boundary conditions and heat transfer mechanisms. The Rayleigh number and a Reynolds number correlation based on the experimental data were proposed. In this study, we restored the heated end as an exterior plate of a metal curtain wall. The preliminary prototype tests were carried out first and the principle of repeatability was applied to determine the width of the experimental test cell. Thermal performance of the proposed test cell was experimentally investigated under practical conditions.

RESEARCH METHOD

Application scenarios and prototype development

Based on the heat transfer mechanism, possible construction and application scenario, this prototype was designed as shown in Fig. 1 (b) (d). In order to fundamentally observe the thermal performance, in our previous study [1], the exterior wall for absorbing solar heat was simplified to be a single vertical tube with a constant heat flux boundary, as shown in Fig. 1(c)❶. In daytime during the summer, the loop fluid at the heat source ❶ would absorb the solar heat gain and become a hotter fluid (compared with that at other loop locations). Natural convection, driven by thermal buoyancy, actuates the hot fluid to flow through the horizontal circulation branch ❷ and then into the indoor heat sink ❸. Fluid dissipates its thermal energy at this heat sink. Cooled fluid is forms and would flow downward by gravity into the heat source ❶, via the other horizontal circulation branch ❹. In such a thermal and flow mechanism, a rectangular natural circulation loop would be developed. In the loop, the exterior heat source❶ is a vertical branch with isothermal flux heating, and the interior heat sink❸ is a vertical heat exchanger with an isothermal boundary. When hot water is needed, it is only necessary to input cold water into the heat exchanger❸. In the study, the preliminary prototype (Fig. 1(d)) was first examined, and then the exterior wall was constructed as a representative unit (Fig. 1(e)❺), according to its repeatability.

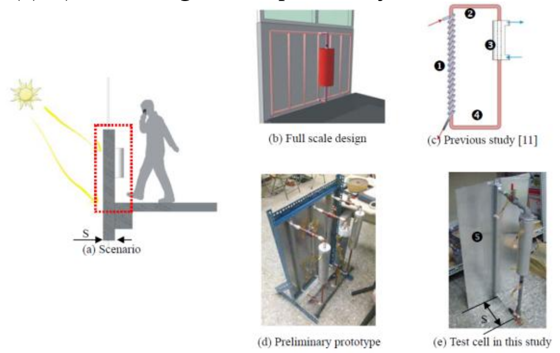

Figure 1. The scenario, prototype development and a photo of the test cell

Experimental test cell

The experimental test cell and thermocouple position used in the study are shown in Fig. 2 (with the insulation material not yet installed). The exterior wall ① width is 40 cm and the height is 80 cm, which is a commonly used curtain wall height. On one side of the wall, a Halogen light is used to heat the wall surface, simulating the solar radiation received by the exterior wall plate; on the other side (inside the curtain wall body), square-shaped vertical flow paths measuring 30 mm in width and 20 mm in height are welded to form a special means of heat exchange. The material used for the circulation loop③ is copper. The angled part of the loop is constructed with fillet joint material and the reaming was modified, resulting in constant water flow area throughout the loop path, i.e., the outer radius is 12.7 mm, the inner radius is 11 mm, and the loop wall thickness is 1.7 mm. To achieve alignment with the exterior wall construction of a typical building (detailed figures in 2(a), (e)), we fixed the length of the horizontal S located both above and below the loop at approximately 200 mm to match the commonly used wall body thickness. Therefore, the overall exterior size for the test cell is 40 cm in width, 2 cm in thickness, and 80 cm in height, which matches the dimensions of the commonly used metal curtain wall.

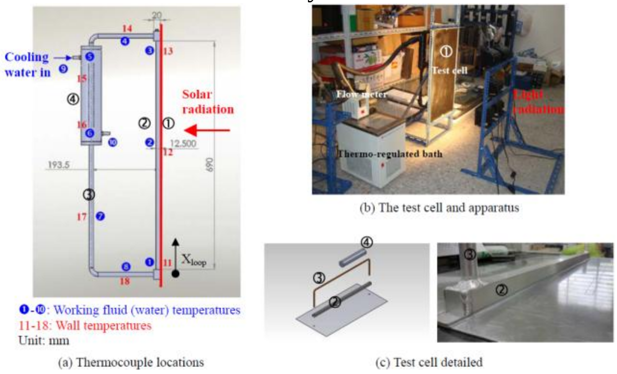

Figure 2. The loop model and the thermocouple positions in this study

The cooling section is installed ④ opposite the heated section. This structure is a cylindrical cooling sleeve, made of aluminum. Additionally, the cooled section uses the cooling water from a thermo-regulated bath to extract the heat from the circulation loop, generating an isothermal cooling boundary. The cooling sleeve measures 61×300 mm with an actual internal size of 40×280 mm. Cotton was wrapped around the cooled section and loop exterior to reduce heat loss by establishing thermal isolation of the system. To obtain temperature measurements, we installed type T thermoelectric couples, which measure the water and wall temperatures in the heated and cooled sections, in a path following the loop; additionally, we installed RTD at the entrance/exit of the circulation water for the cooling sleeve.

RESULTS AND DISCUSSION

Because the solar heat gain can change daily or hourly, the temperature of the water source that awaits solar heating changes accordingly, in a manner that follows the seasons. Therefore, we must have a general understanding of the thermal performance of the proposed test cell. Fig. 3 shows the heat transfer characteristics for different water extraction modes (the entering water flow volume) with either natural convection or forced convection. The single natural convection loop used for the study has an average Nusselt number $\overline{Nu_h}$ between 5.2-7.7 for the heated section and an average Nusselt number $\overline{Nu_c}$ between 9.2-16.6 for the cooled section; further, the average Nusselt number of the cooled section is higher than that of the heated section.

Because different water flow rates can impact the heat transfer temperature of the cooled end, when the water flow increases, the average Nusselt number of the cooled section decreases. The exterior wall area of the proposed test cell measures 0.32 m^2 (80 cm high x 40 cm wide) and can harvest the solar thermal power of 60-205.7 W with the incident solar radiation of 400 W/m^2-1000 W/m^2. The energy harvest ratio Q_f is 0.52-0.91. The highest value of Q_f (0.91) occurs at a flow rate of 20 mL/s with Tc=10 ℃ and approximately 600 W/m^2, while the lowest value (0.52) occurs at a flow rate of 20 mL/s with Tc=30 ℃ and approximately 400 W/m^2. Overall, the average Nusselt number $\overline{Nu_h}$ and extractable solar radiation heat $\dot{Q}_c$ of the test cell are insignificantly impacted by the entering water volume. As the volume of the entering water flow decreases, the average Nusselt number $\overline{Nu_c}$ of the cooled section increases, although the energy harvest ratio Q_f decreases minimally at Tc=10 ℃.

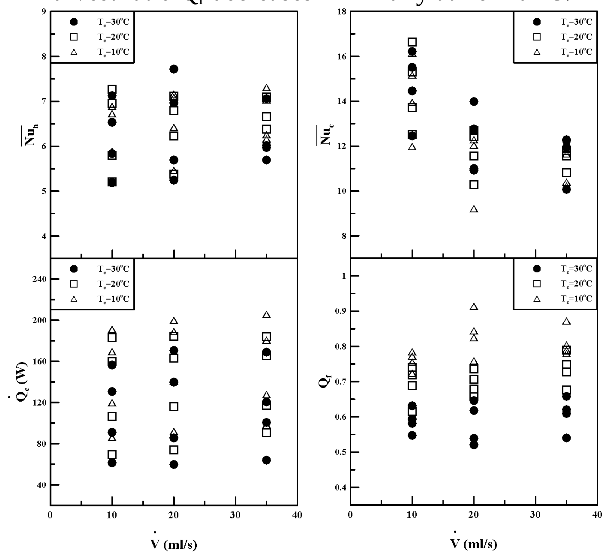

Figure 3. The impact of the water extraction models (the entering water flow rates) on the thermal characteristic of the test cell

REFERENCES

[1] C.M. Lai et al., "Development and thermal performance of a wall heat collection prototype", *Building and Environment* 57, 2012, pp.156-164.

ACKNOWLEDGMENT

Support from the National Science Council of ROC through grant No. NSC 100-2221-E-006-240-MY2 in this study is gratefully acknowledged.

附錄四:展示會註冊

> As following, we have received Pre registration of Grand Renewable Energy
> 2014 International Exhibition(July 30 - August 1), TOKYO BIG SIGHT.
> The organizer cannot provide overseas visitors with an invitation letter
> for visa.
> Please print this e-mail and bring it to the registration counter at the
> venue.
>
> [NO:99]
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> Grand Renewable Energy 2014 International Exhibition Show Office
> CNT Inc.
> FORECAST., 1-24-3 Kanda Suda－cho,
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