The 4th International Symposium on Engineering, Energy and Environment

Organizers

Faculty of Engineering, Thammasat University, Thailand
Nagaoka University of Technology, Japan
Saitama University, Japan
Tokyo Institute of Technology, Japan

Co-organizers

Hiroshima University, Japan
Toyohashi University, Japan
Sirindhorn Institute of Technology, Thailand
Faculty of Science and Technology, Thammasat University, Thailand

November 8 - 10, 2015
Learning Resort, Thammasat University, Pattaya Campus, Chonburi,

Symposium Background

The Fourth International Symposium on Engineering, Energy and Environment (4th ISEEE) is aimed at finding approaches and ideas toward an important question: "How can engineering research and practice help to create a sustainable society?" It serves as a forum for the presentation of technological advances and stimulating ideas to answer this challenging question. ISEEE 2015 is the fourth in the series which has been held since 2008. This year the symposium will be held in Pattaya, Thailand. The 2015 symposium will feature plenary talks by renowned speakers and parallel sessions which provide a platform for knowledge transfer and exchange.

COMMITTEE

GENERAL CHAIR

Associate Professor Prapat Wangskarn
Thammasat University, Thailand

INTERNATIONAL ORGANIZING COMMITTEE

Professor Hidetoshi Sekiguchi
Tokyo Institute of Technology, Japan
Professor Hiroshi Mutsuyoshi
Saitama University, Japan
Professor Phadungsak Rattanadecho
Thammasat University, Thailand
Professor Yoshiharu Mutoh
Nagaoka University of Technology, Japan

INTERNATIONAL ADVISORY COMMITTEE

Assistant Professor Ali Cheshmehzangi
The University of Nottingham Ningbo China, China
Professor Chongrak Polpraset
Thammasat University, Thailand
Professor Gethin Wyn Roberts
The University of Nottingham Ningbo China, China
Professor Hidetoshi Sekiguchi
Tokyo Institute of Technology, Japan
Professor Hiroshi Katsuchi
Yokohama National University, Japan
Professor Kambiz Vafai
University of California, Riverside USA
Professor Kikuo Kishimoto
Tokyo Institute of Technology, Japan
Professor Kunio Watanabe
Saitama University, Japan
Professor Lee Chew Ging
The University of Nottingham Malaysia Campus, Malaysia
Professor Masato Aketagawa
Nagaoka University of Technology, Japan
Associate Professor Krittiya Lertpocasombut
Thammasat University, Thailand
Associate Professor Montalee Sasananan
Thammasat University, Thailand
Associate Professor Thawatchai Onjun
Thammasat University, Thailand
Assistant Professor Dusit Athinuwat
Thammasat University, Thailand

PROGRAM COMMITTEE

Prof. Akinori Nishihara	Tokyo Institute of Technology, Japan
Prof. Atsuo Dawamura	Yokohama National University, Japan
Prof. Aya Kojima	Saitama University, Japan
Prof. Chih-Hsiang Liao	Chia Nan University of Pharmacy and Science,Taiwan
Prof. Finn Arve Aagesen	Norwegian University of Science and echnology, Norway
Prof. Hiroaki Furumai	University of Tokyo, Japan
Prof. Hiroshi Takami	Shibaura Institute of Technology, Japan
Prof. Hiroyuki Tominaga	Kagawa University, Japan
Prof. Hsiu-Ping Yueh	National Taiwan University, Taiwan
Prof. Jy Wu	University of North Carolina at Charlotte, USA
Prof. Kambiz Vafai	University of California, Riverside, USA
Prof. Kazushi Sano	Nagaoka University of Technology
Prof. Larry Cooperman	University of California, Irvine, USA
Assoc. Prof. Masanori Yamada	Kyushu University, Japan
Prof. Masao Murota	Tokyo Institute of Technology, Japan
Prof. Masato Aketagawa	Nagaoka University of Technology, Japan
Assoc. Prof. Masayuki Mukunoki	Kyoto University, Japan
Prof. Masato Saitoh	Saitama University, Japan
Assoc.Prof. Ryuichi Egashira	Tokyo Institute of Technology, Japan
Prof. Shankar Mahalingam	University of California, Riverside, USA
Prof. Shin Morishita	Yokohama National University, Japan
Assoc.Prof. Shinya Hanaoka	Tokyo Institute of Technology, Japan
Prof. Weijane Lin National	Taiwan University, Taiwan
Prof. Yusuke Morita	Waseda University, Japan
Asst.Prof. Bunyong Rungroungdouyboon	Thammasat University, Thailand
Assoc.Prof. Chanathip Namprempre	Thammasat University, Thailand
Asst.Prof. Apiwat Muttamara	Thammasat University, Thailand
Asst.Prof. Malee Santikunaporn	Thammasat University, Thailand
Assoc.Prof. Nakhorn Poovarodom	Thammasat University, Thailand
Assoc.Prof. Nurak Grisdanurak	Thammasat University, Thailand
Prof. Chongrak Polprasert	Thammasat University, Thailand
Dr. Nutthapong Tanthanuch	Thammasat University, Thailand
Dr. Patcharaporn Thitiwongsawet	Thammasat University, Thailand
Assoc.Prof. Perapong Tekasakul	Prince of Songkla University, Thailand
Asst.Prof. Phairat Usubharatana	Thammasat University, Thailand
Assoc.Prof. Pichai Aree	Thammasat University, Thailand
Prof. Somchai Wongwises	King Mongkut's University of Technology Thonburi, Thailand
Prof. Somchart Chantasiriwan	Thammasat University, Thailand
Prof. Somchart Soponronnarit	King Mongkut' s University of Technology Thonburi, Thailand
Asst. Prof. Somsak Vongpradubchai	Thammasat University, Thailand
Prof. Sumrerng Jugjai	King Mongkut' s University of Technology Thonburi, Thailand
Assoc.Prof. Supachai Surapunt	Thammasat University, Thailand
Prof. Tanongkiat Kiatsiriroat	Chiangmai University, Thailand
assoc.Prof. Thira Jearsiripongkul	Thammasat University, Thailand
Asst.Prof. Tippabust Eksangsri	Thammasat University, Thailand
Assoc.Prof. Tritos Laosirihongthong	Thammasat University, Thailand
Assoc.Prof. Virote Boonyapinyo	Thammasat University, Thailand
Assoc.Prof. Wanchai Pijitrojana	Thammasat University, Thailand
Asst.Prof. Wanwisa Skolpap	Thammasat University, Thailand
Asst.Prof. Watit Pakdee	Thammasat University, Thailand

Assoc.Prof. Wuthichai Wongthatsanekorn	Thammasat University, Thailand
Assoc.Prof. Wanchai Pijitrojana	Thammasat University, Thailand
Assoc.Prof. Jirarat Teeravaraprug	Thammasat University, Thailand
Asst.Prof. Harnpon Phungrassami	Thammasat University, Thailand
Assoc.Prof. Sanya Mitaim	Thammasat University, Thailand
Asst.Prof. Monchai Prukvilailert	Thammasat University, Thailand
Asst.Prof. Charnnarong Assavatesanuphap	Thammasat University, Thailand
Asst.Prof. Piya Techateerawat	Thammasat University, Thailand
Asst.Prof. Charnnarong Assavatesanuphap	Thammasat University, Thailand
Dr. Jiraprabha Kimsunthorn	Thammasat University, Thailand
Dr. Krit Jiamjiroch	Thammasat University, Thailand
Dr. Phisan Kaewprapha	Thammasat University, Thailand
Dr. Supamard Sujatanond	Thammasat University, Thailand
Asst.Prof. Supawat Supakwong	Thammasat University, Thailand
Dr. Supakit Prueksaaroon	Thammasat University, Thailand
Dr. Krisada Chaiyasarn	Thammasat University, Thailand
Sirisilp Kongsilp	Thammasat University, Thailand
Asst. Prof. Peerasak Paoprasert	Thammasat University, Thailand
Asst. Prof. Techn. Norasage Pattanadech	King Mongkut's Institute of Technology Ladkrabang , Thailand
Dr.Natthawut Phloymuk	King Mongkut's University of Technology North Bangkok, Thailand
Dr.Pakpum Somboon	Chulalongkorn University, Thailand
Dr.Ekasit Kijsipongse	National Electronics and Computer Technology Center, Thailand
Dr. Jackravut Dejvises	Thammasat University, Thailand
Dr. Komson Daroj	Chulalongkorn University, Thailand
Asst. Prof.Jirawan Kloypayan	Thammasat University, Thailand
Assoc.Prof. Pongchanun Luangpaiboon	Thammasat University, Thailand
Assoc.Prof. Busaba Phruksaphanrat	Thammasat University, Thailand
Dr. Siraprapa Brooks	Mae Fah Luang University, Thailand
Dr. Srimek Chowpongpang	Kasetsart University, Thailand
Assoc.Prof. Chavalit Chaleeraktrakoon	Thammasat University, Thailand
Assoc.Prof. Boonsap Witchyangkoon	Thammasat University, Thailand
Assoc.Prof. Uruya Weesakul	Thammasat University, Thailand
Asst. Prof.Panida saikhwan	Thammasat University, Thailand
Asst. Prof. Bunpot Sirinut	Thammasat University, Thailand
Assoc. Prof. Panu Danwanichakul	Thammasat University, Thailand
Assoc. Prof. Cattaleeya Pattamaprom	Thammasat University, Thailand
Asst. Prof. Woraratana Pattaraprakorn	Thammasat University, Thailand
Asst. Prof. Supitcha Rungrodnimitchai	Thammasat University, Thailand

CONFERENCE TOPICS

Agricultural and food engineering

Biomedical engineering and engineering in medicine

Chemical processing

Diagnostic and monitoring System

Digital technology

Engineering and educatio

Environmental technology and management

Manufacturing and design

Materials engineering

Productivity improvement

Renewable energy and energy management

Resilient engineering
(Natural disaster, Infrastructure, Transportation, etc.)

Transportation and logistics

Other

CONTENT

Agricultural and food engineering

Biomedical engineering and engineering in medicine

Chemical processing

Diagnostic and monitoring System

Digital technology

Engineering and education

Environmental technology and management

Manufacturing and design

Materials engineering

Productivity improvement

Renewable energy and energy management

Resilient engineering
(Natural disaster, Infrastructure, Transportation, etc.)

Transportation and logistics

Other

....

Analysis of Energy Consumption and Cooling Load for Improving Chiller Plant Management of Library: the Case Study of Puey Ungphakorn Library

Prakasit Kittasangka[a] and Chainarong Chaktranond[b*]

[a]*Department of Chemical Engineering, Faculty of Engineering,Thammasat University, Rangsit Center, Phathum thani, 12120, Thailand*
[*b]*Department of Mechanical Engineering, Faculty of Engineering,Thammasat University, Rangsit Center, Phathum thani, 12120, Thailand*

Abstract

This study aims to investigate and improve the chiller plant management of Puey Ungphakorn library, which is the fourth largest electricity consumption building in Thammasat University, Rangsit Center. In this plant, a primary-only chilled-water pumping system is used. Moreover, variable speed drives (VSD) are used for both chiller and condenser pumps. The flow rate of chilled water loop depends on differential pressure varying with working of air handling units (AHU). While the flow rate of condenser water loop is fixed.

It is found from data analysis that shut-off workings of chiller for long period causes the heat and moisture to much transfer and accumulate in the building, resulting in higher electrical energy consumption of chiller in the beginning operation. Moreover, by running two chilled-water pumps, the total flow rate is higher than estimation. This causes cooling estimation to be higher than the cooling capacity of chiller.

The study has proposed two measuring of energy saving. There are, for new chiller installation cause, the estimate of chiller capacity for Puey Library on weekday is equal to 330 tons. On weekends the estimate of chiller capacity is equal to 390 tons. For peak load period is operated chiller 2 set 390 tons 1 set and 330 tons 1 set this measuring will reduce the value of energy consumption is about 0.55-11% or 230 kWh per day. For existing chiller cause the suitable chiller operated on weekday should be run chiller No. 1 and control cooling load is equal to 267.6 ton and operated on weekend should be run chiller No. 2 or 3 and control cooling load is equal to 316.9 ton by variable speed drive of chilled water pump and increase set point of chilled water supply temperature for chiller operated on optimum point at percent load between 80%-90% the procedure of this measuring will reduce the value of energy consumption is equal about 190 kWh per days.

Keywords: Energy Consumption; Chiller Plant Management

1. Introduction

With growing up of energy consumption, all countries have paid much attention on efficient strategies of energy conservation, as well as, global warm problem. Normally in buildings, the most of energy consumption comes from electrical usage for air conditioning system. Due to constructing the new class rooms and large buildings for serving the increase of the large number of students in Thammasat University, Rangsit Centre, electrical cost increases in every year. The electrical costs are 178 and 274 million baht in 2013 and 2014 (1.4 Million kWh), respectively. Moreover, it is expected that the cost will be up to 330 million baht at the end of 2015. One of buildings, which consume a large amount of electrical consumption, is Puey library. In addition, the most of electrical usage comes from air conditioning system.

Yu and Chan (2013) examine the improvement of energy management of chiller systems with data envelopment analysis. This paper describes the energy management opportunities to maximize the coefficient of performance (COP). The system composes of seven sets of chillers with two different capacities, pumps and cooling towers. In the analysis, the improvement strategies involve find-tuning the temperature related controllable variables could achieve the highest possible COP with technical efficiency of one.

Xiaosong et al. (2006) study the improvement of the energy efficiency of air-cooled water chiller plant operating on part load conditions. The conventional multiple-chiller plant was proposed to be integrated into one refrigeration cycle, by connecting those separate compressors, condensers, and evaporators in parallel, respectively. The electronic expansion valve is used to control refrigerant flow of the system, achieving variable condensing temperature control. The system consists of four reciprocating compressors including one variable speed compressor, have total cooling capacity of 120 kW. It is found from both simulation and experimental results that the air-cooled chiller plant could get a significant performance improvement on various part load ratio (PLR) conditions. Moreover, when the PLR decreases from 100% to 50%, the COP increases about 16.2% from simulation and 9.5% from experiment. Furthermore, the refrigeration capacity of the system is 55% when the PLR condition is 50%.

Mak et al. (2013) explore and purpose the method to reduce the power consumption of chillers in a hotel. The parameters are air-conditioned floor area, guest floor area, gross floor area, number of employees, room occupancy, food cover, outdoor air temperature, wind velocity, service type, and relative humidity. From analysis, it indicates that number of hotel employees and outdoor temperature are a main parameter of consuming the electricity of chiller.

This research analyzes the chiller-plant data which influences the overall electrical power consumption of Puey library, and also purpose the strategies to saving the energy by considering the operation of chiller plant and the estimation of suitable chiller size.

2. Theory

In this study, the heat load estimation is computed by Eq. (1). New electrical power of pumps varying with water flow rate is calculated by affinity law, as shown in Eq. (2). In addition, efficiency of the chiller is presented in term of electric power using for a unit of cooling capacity, as shown in Eq. (3),

$$\dot{Q} \quad \frac{m\left(T_{CHS} - T_{CHR}\right)}{12,000} \qquad (1),$$

where $\dot{Q}$ = Cooling Capacity (Ton of refrigeration),
gpm = gallon per minute,
T_{CHR} = Chilled-water-return temperature (ºF),
T_{CHS} = Chilled-water-supply temperature (ºF),

$$\left(\frac{rpm_1}{rpm_2}\right)^3 = \left(\frac{gpm_1}{gpm_2}\right)^3 = \left(\frac{Power_1}{Power_2}\right) \qquad (2),$$

where rpm = rotation per minute,

$$Eff. = \frac{Power}{Cooling\ capacity} \qquad (3),$$

where $Eff.$ = efficiency of chiller (kW/Ton).

3. Results

Study courses of Thammasat University are divided into three semesters: (1) first semester (Aug – Dec), (2) second semester (Jan – May) and (3) summer (May – July). Information of main equipment of Puey Library is shown in Table 1. In regular course period, service hours are from 08:00 to 24:00 on weekdays and from 09:00 to 18:00 on weekends. In summer course, the library opens from 08:00 to 21:00 on weekdays and from 09:00 to 18:00 on weekends. Normally, one chiller, two chilled-water pumps, two condenser-water pumps and a cooling tower are used for air conditioning system on every day. In addition, chiller No.1 works on weekends. As shown in Fig.1, a primary-only chilled-water pumping system is used. Moreover, variable speed drives (VSD) with frequency control are used for both chilled and condenser water pumps. The flow rate of chilled water sides depends on differential pressure varying with working of air handling units (AHU). Due to the limitation of minimum water flow rate requirements of chillers, the frequencies to control chilled-water pump is in the range of 37 – 50 Hz. While the flow rate of condenser water pump is fixed at 900 gpm. In addition, the set point temperature of chilled-water supply (CHS) is at 48^{O}F

Table 1 Specification of equipments

Item	Description	Quantity [set]	Capacity	Power [kW]
1	Chiller No.1	1	280 Ton	165.3
2	Chiller No.2	1	316 Ton	221
3	Chiller No.3	1	316 Ton	221
4	Chilled water pump	3	900 gpm	30
5	Condenser water pump	3	950 gpm	15

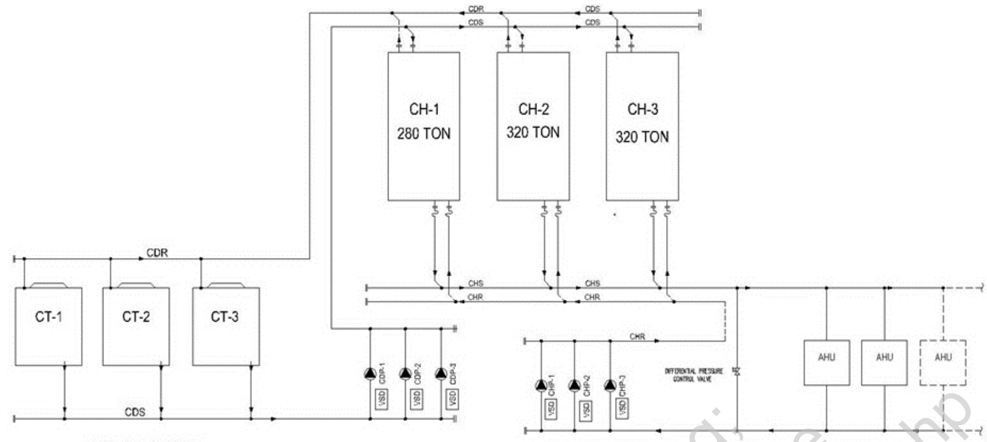

Fig. 1. Chiller plant diagram of Puey Library

3.1. Energy consumption of chiller plant

From data and, the total electrical energy consumption is around 59,000 kWh/month in regular courses and 43,000 kWh/month in summer course. Energy utilization indices (EUI) in regular and summer courses are 2.3 kWh/sq.m and 3.2 kWh/sq.m, respectively. By considering the occupancy, it is found that specific energy consumption (SEC) in regular and summer periods are 0.54 and 4.5 kWh/person, respectively.

Figure 2 shows that the number of users in regular and summer courses is quite different. However, it is found that overall electrical power consumption is not much different. Therefore, the number of users does not much influence the overall electrical power consumption, as shown in Fig. 3 and 4.

Figure 3 and 4 also indicate that the electrical power consumption of chiller rapidly increases in the beginning periods of chiller operation, and then trends to be constant in afternoon. Due to effects of high chilled-water temperature and high room temperature, chiller must run with full load in the beginning period. These figures also show that on weekends the power is higher than that on weekdays. Moreover, the power consumption on Monday is higher than that on the other weekdays. But Fig. 5 is shown that temperatures of air and fluid are approximately same. This is because air conditioning system is not used for long periods. Therefore, heat and moisture much more flow into and accumulate in the building. As mentioned before, operating hours of chiller on weekend is only 9 hours but on weekdays it is 16 hours. Therefore, chiller must operate at full load and consume the large amount of electrical power in order to remove these effects in the beginning. Consequently, electric power consumption of chiller mainly comes from heat and moisture accumulation in the building.

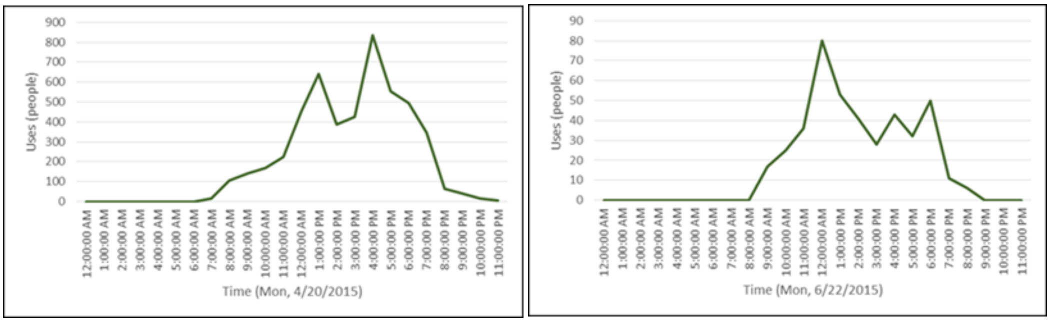

Fig.2 Number of occupancy in various times: (a) on April 20, 2015, and (b) on July 22, 2015.

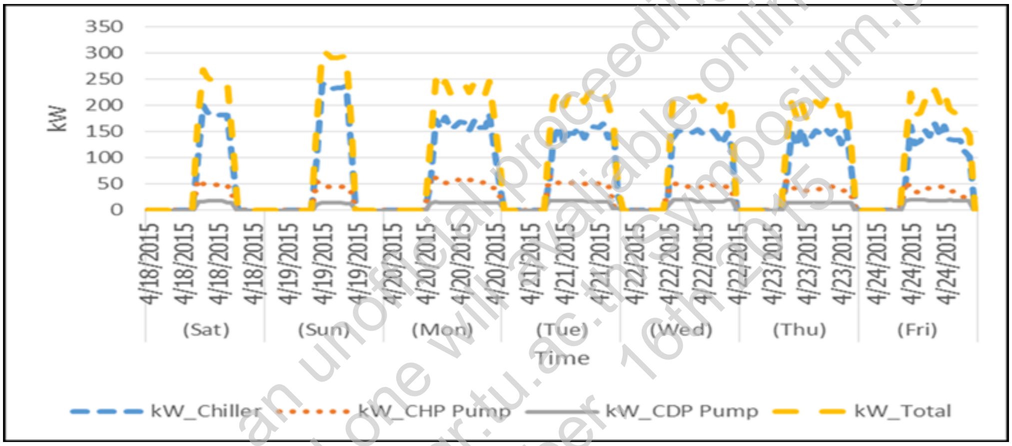

Fig.3 Total energy consumption of equipment in regular course in April 2015 (18th to 24th)

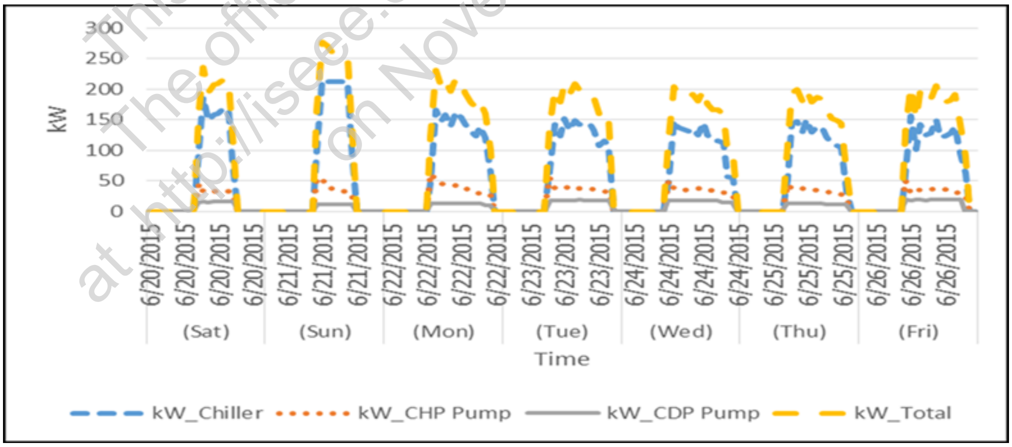

Fig.4 Total energy consumption of equipment in summer course in July 2015 (20th to 26th)

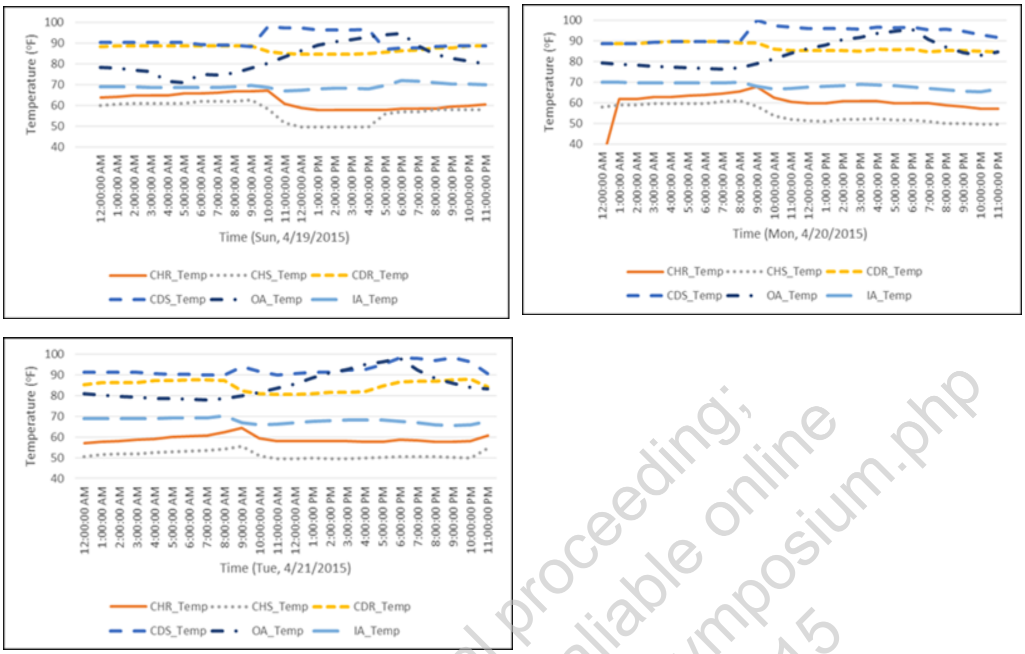

Fig.5 Comparison on temperature of fluids and air in April 2015 (19th to 21st)

Figure 6 shows that cooling load estimated by Eq. (1) rapidly increases in the beginning period, and then rapidly decrease again after 10:00. Afterwards, it is approximately constant in afternoon. In normal operation, two chilled-water pumps are run since library opens. When all AHUs are used, pressure drop in chilled-water pipe is high. Therefore, the signal from differential pressure sensor is sent to controller unit for requiring high flow rate of chilled water. Then chilled-water pump will rotate with high speed. In fact, the maximum cooling capacity of chillers is only 316 Tons, but cooling load estimated increases up to approximately 700 Tons. This implies that this plant is operated with over flow rate in the beginning. In other words, this chiller plant management may not be good in the beginning period. Moreover, it leads to misunderstand of evaluating the COP of system as well. As shown in Fig. 7, cooling load in beginning operation period is higher than the maximum cooling capacity of chiller. When a chiller is started, suitable flow rate of chilled-water pump should be around 758.4 gpm. But in practice, since two-way valves of all AHUs are fully opened, two chilled-water pumps are run with the total average flow rate of 870 gpm approximately, which is higher than the suitable flow rate. This conduct cooling load to be overestimated by Eq.(1). Even though cooling load in afternoon is nearby the capacity of chiller, flow rate is still high (~850 gpm). Therefore, it is possible to reduce power consumption by running only one chilled-water pump.

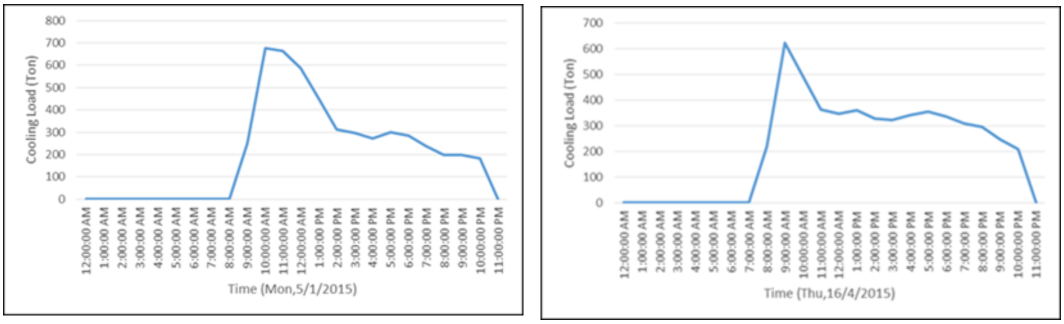

Fig. 6 Cooling load in various times: (a) on April 21, 2015, and (b) on May 23, 2015.

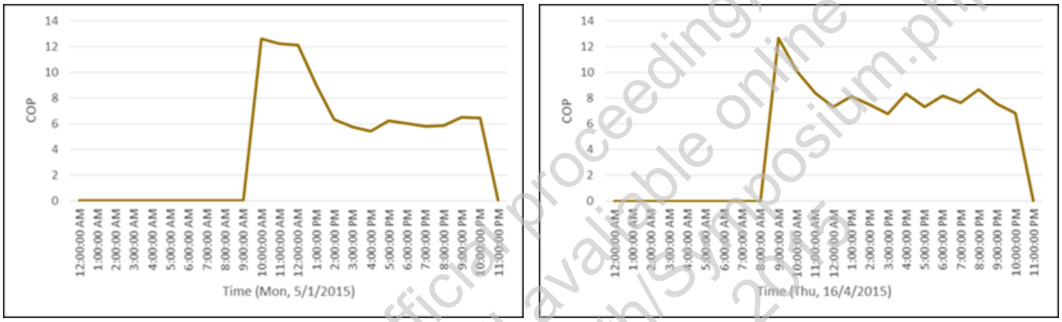

Fig. 7 COP in various times: (a) on 16/4/2015, and (b) on 5/1/2015

3.2 Optimal operating conditions

Table 2 and 3 show the chiller performance based on chilled-water supply (CHS) temperature at 48^{O}C and provided by supplier. It is shown that higher efficiency of chiller and chilled-water pump can be obtained when the temperature difference between CHR and CHS is larger.

Table 2 shows operate on optimum point for chiller No. 1 chilled water return temperature is 56-57 ºF, percent load 80-90% so as minimum total efficiency is equal 0.635 kW/ton and Fig. 13 shows optimum point for Chiller No. 2 and 3 chilled water return temperature is 56 ºF, percent load 90% so as minimum total efficiency is equal 0.619 kW/ton. Now chiller is not operated on optimum point by chilled water return is vary between 57.81 – 60 ºF because cooling capacity of chiller is not enough to compare with cooling load of building.

Table 2 Part Load Performance Chiller No. 1.

%Load	Cap. (Ton)	LWT Evap	EWT Evap	Flow Evap	EWT Cond	LWT Cond	Flow Cond	Kw.	Eff.
100	297.3	48.0	58.0	712.2	85.0	100	541.2	165.4	0.556
90	267.6	48.0	57.0	712.2	85.0	98.5	541.2	147.9	0.553
80	237.8	48.0	56.0	712.2	85.0	97.0	541.2	131.6	0.553
70	208.1	48.0	55.0	712.2	85.0	95.5	541.2	116.4	0.559
60	178.4	48.0	54.0	712.2	85.0	94.1	541.2	101.5	0.569
50	148.6	48.0	53.0	712.2	85.0	92.6	541.2	86.3	0.581
40	118.9	48.0	52.0	712.2	85.0	91.1	541.2	72.4	0.609
30	89.2	48.0	51.0	712.2	85.0	89.7	541.2	62.9	0.705
20	59.5	48.0	50.0	712.2	85.0	88.4	541.2	55.0	0.926

Table 3 Part Load Performance Chiller No. 2., 3.

%Load	Cap. (Ton)	LWT Evap	EWT Evap	Flow Evap	EWT Cond	LWT Cond	Flow Cond	Kw.	Eff.
100	352.1	48.0	58.0	843.6	85.0	100	652.5	222.0	0.630
90	316.9	48.0	57.0	843.6	85.0	98.5	652.5	197.4	0.623
80	281.7	48.0	56.0	843.6	85.0	97.0	652.5	174.4	0.619
70	246.5	48.0	55.0	843.6	85.0	95.5	652.5	153.0	0.621
60	211.3	48.0	54.0	843.6	85.0	94.1	652.5	133.6	0.633
50	176.0	48.0	53.0	843.6	85.0	92.6	652.5	115.3	0.655
40	140.8	48.0	52.0	843.6	85.0	91.1	652.5	102.7	0.729
30	105.6	48.0	51.0	843.6	85.0	89.7	652.5	95.1	0.900
20	70.4	48.0	50.0	843.6	85.0	88.4	652.5	88.6	1.258

3.3 Estimation of chiller capacity

The measuring to use the chiller at the point of highest efficiency, operate on optimum point for chiller is operated on chilled water return temperature is 56-57°F at percent load between 80%-90%. Form Fig. 6 cooling load in various time each day, it is found that the maximum peak load is equal to 670 tons on January 5th 2015. During the Monday to Friday, it is found that the average part load each day is equal to 250-300 tons. During Saturday to Sunday, it is found that the average part load each day is equal to 300-350 tons. During 09:00 to 12:00 is peak load period is operated about three hours and 12:00 to 22:00 is part load period is operated about ten hours.

The estimate of new chiller capacity for Puey Library on Monday to Friday is equal to 330 tons so that percent load of chiller is value between 75.8% - 90.9% during 12:00 to 22:00 part load period. On Saturday-Sunday the estimate of chiller capacity is equal to 390 tons so that percent load of chiller is value between 76.9% - 89.7% during 12:00 to 22:00 part load period. During 09:00 to 12.00 peak load period is operated chiller 2 set 390 tons 1 set and 330 tons 1 set so that chiller is operated between 69.4% - 93%. From Fig. 8 the procedure of this measuring will reduce the value of energy consumption is about 0.55-11% or 230 kWh per day.

For existing chiller cause, the suitable chiller operated on Monday-Friday should be run chiller No. 1 and control cooling load is equal to 267.6 ton and operated on Saturday-Sunday should be run chiller No. 2 or 3 and control cooling load is equal to 316.9 ton by variable speed drive of chilled pump and increase set point of chilled water supply temperature for chiller operated on optimum point at percent load between 80%-90%. The procedure of this measuring will reduce the value kw/ton to 0.04-0.07 kw/ton about 190 kWh per days.

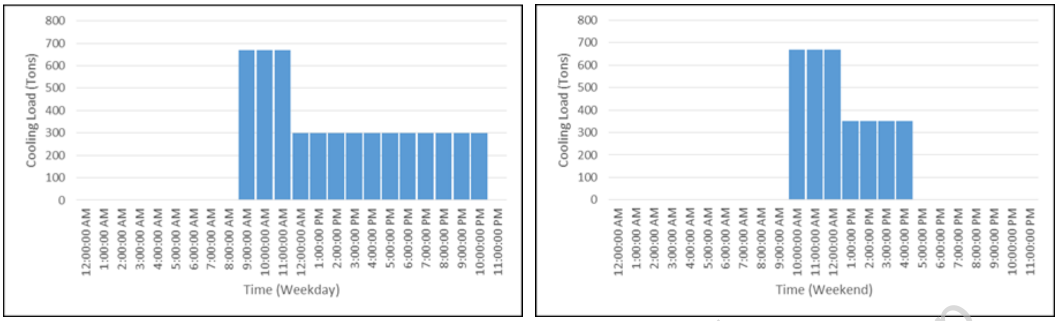

Fig. 8. Estimate Cooling load in various times: (a) on weekday, and (b) on weekend

4. Conclusions

This case study the total electrical energy consumption in regular courses is higher than summer course. Energy utilization indices (EUI) and specific energy consumption (SEC) in summer courses is higher than regular courses. The electrical power consumption of chiller rapidly increases in the beginning periods of chiller operation, and then trends to be constant in afternoon. Due to effects of high chilled-water temperature and high room temperature, chiller must run with full load in the beginning period. The power on weekends is higher than that on weekdays. Moreover, the power consumption on Monday is higher than that on the other weekdays.

The study has proposed two measuring of energy saving. There are, for new chiller installation cause, the estimate of chiller capacity for Puey Library on weekday is equal to 330 tons. On weekends the estimate of chiller capacity is equal to 390 tons. For peak load period is operated chiller 2 set 390 tons 1 set and 330 tons 1 set this measuring will reduce the value of energy consumption is about 0.55-11% or 230 kWh per day. For existing chiller cause the suitable chiller operated on weekday should be run chiller No. 1 and control cooling load is equal to 267.6 ton and operated on weekend should be run chiller No. 2 or 3 and control cooling load is equal to 316.9 ton by variable speed drive of chilled water pump and increase set point of chilled water supply temperature for chiller operated on optimum point at percent load between 80%-90% the procedure of this measuring will reduce the value of energy consumption is equal about 190 kWh per days.

References

Yu, F.W., and Chan, K.T. (2013). Improved energy management of chiller systems with data envelopment analysis, Applied Thermal Engineering, 50, pp. 309-317.

Xiaosong, Z., Guoying, X., Chan, K.T., and Yi, X. (2006). A novel energy-saving method for air-cooled chiller plant by parallel connection, Applied Thermal Engineering, 26, pp. 2012-2019.

Mak, B.L., Chan, W.W., Li, D., Liu, L., and Wong, K.F. (2013). Power consumption modeling and energy saving practices of hotel chillers, . International Journal of Hospitality Management, 33, pp. 1-5.