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Ajah Maiden
Sunway Engineering Sdn Bhd
AEON Cash Voucher of RM 250

2nd Runner-Up

Jackson Wong
Schneider Electric Industries (Malaysia)
Sdn Bhd
AEON Cash Voucher of RM 200

4th Prize

Pan Kin Yew
Success Electronics & Transformer
Manufacturer Sdn Bhd
AEON Cash Voucher of RM 150

5th Prize

Koh Jui Seng
Active Hi-Tech Engineering Sdn Bhd
AEON Cash Voucher RM 120

6th Prize

Gallen Loh
Omron Electronics Sdn Bhd
AEON Cash Voucher RM 100

7th Prize

Amirul
Schneider Electric Industries (Malaysia)
Sdn Bhd
AEON Cash Voucher RM 80

8th Prize

Muzaiman Saari
EITA Resources Berhad
AEON Cash Voucher RM 80

9th Prize

Tang Kok Quan
Success Electronics & Transformer
Manufacturer Sdn Bhd
AEON Cash Voucher RM 60

10th Prize

Lee Kok Wei
Success Electronics & Transformer
Manufacturer Sdn Bhd
AEON Cash Voucher RM 60

11th Prize

C. V. Liew
EITA Resources Berhad
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12th Prize

Tunku Ariff Shah
Omron Electronics Sdn Bhd
AEON Cash Voucher RM 60

High Games

Norris Burhanuddin
Sunway Engineering Sdn Bhd
Bath Towel

High Series (Game 1, 2, 3)

Zubaidy Zabir
Active Hi-Tech Engineering Sdn Bhd
Bath Towel

High Series (Game 4, 5, 6)

Hishamuddin Othman
Success Electronics & Transformer
Manufacturer Sdn Bhd
Bath Towel

Ladies' Singles Event

Champion

Norashikin Alladdin
Sunway Engineering Sdn Bhd
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AEON Cash Voucher of RM 300*

1st Runner-Up

Yong Sim Min
Omron Electronics Sdn Bhd
AEON Cash Voucher of RM 250

2nd Runner-Up

Michelle Woo
Schneider Electric Industries (Malaysia)
Sdn Bhd
AEON Cash Voucher of RM 200

4th Prize

Janet Siew
Gruppe Lighting Solution Sdn Bhd
AEON Cash Voucher of RM 100

5th Prize

Hajarah Mohamed
Gruppe Lighting Solution Sdn Bhd
AEON Cash Voucher of RM 80

High Games

Norashikin Alladdin
Sunway Engineering Sdn Bhd
Bath Towel

High Series (1, 2)

Tan Kui Har
Active Hi-Tech Engineering Sdn Bhd
Bath Towel

High Series (3, 4)

Susilawati Mohd Noor
Success Electronics & Transformer
Manufacturer Sdn Bhd
Bath Towel

TEAM Event

Champion

Mohd Sofie Hassan, Norris Nurharnuddin,
Ajah Maiden, Norashikin Alladdin
Sunway Engineering Sdn Bhd
Trophy + AEON Cash Voucher of RM 320

1st Runner-Up

Gallen Loh, Tunku Ariff Shah, Shukri
Omar, Yong Sim Min
Omron Electronics Sdn Bhd
Trophy + Bath Towels + UMBERLLAS

2nd Runner-Up

Jackson Wong, Arrenvalagam, Amirul,
Michelle Woo
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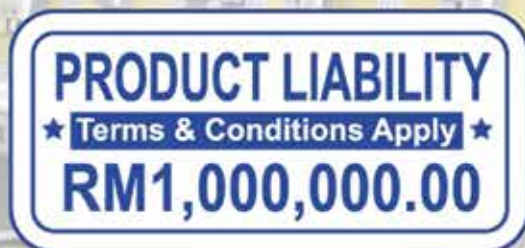
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Workshop on Lightning Protection System

A one day workshop on Lightning Protection System was organised on 6th October 2015 at TEEAM Conference Room. IEC62305 is one standard widely adopted or modelled upon due to its robust background. The workshop aimed to share with participants on various chapters of IEC62305, with specific highlights on risk assessment and practical implementation of lightning protection and surge protection solutions to meet IEC62305.

The speaker was Mr Hans Slagter of DEHN, Germany and the workshop was support by Wise Pro Sdn Bhd. It drew some 30 participants. This was a beneficial workshop to the participants as they demonstrated on the usage of software to perform risk assessment and calculation of separation distant. TEEAM wishes to thank Wise Pro Sdn Bhd for bringing in the expert to share his knowledge and expertise with TEEAM members.



Engrossed – The workshop was accredited with CIDB CCD points and BEM CPD/PDP hours.



TEEAM President – Ir Chew Shee Fuee KMN delivering his welcome speech.



Speaker – Mr Hans Slagter giving his presentation.



During workshop – Participants captivated by the surge protection device on display.



Golf Tournament 2016

Date : 28th July 2016 (Thursday)

Time : 12:30pm

Venue : Staffield Country Resort, Mantin, Negeri Sembilan

Registration : Contact TEEAM Secretariat

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TEEAM Specialised Group – Trading Supercapacitor, the Energy Storage Device of the Future

By the Committee Member, Ir Dr Ng Kok Chiang

Introduction

Given the daunting climate change phenomenon the world is currently facing, a sustainable supply of energy from renewable sources is desperately being sought. In addition, the depletion of fossil fuels due to extensive extractions to meet the sudden demand by growing economies such as China and India has also caused concerns about the preservation of such resources for future generations. Amidst all these worries, social responsibility prevails with the change in the direction of the energy industry towards the harvesting of renewable energy from sustainable and abundant sources such as the sun, ocean tides and wind.

Due to increased awareness through extensive environmental campaigns among the people, the automotive industry has also shifted their focus to the development of environmentally friendly cars. These cars, which are driven by hybrid engines or completely powered by electricity, are manufactured to substantially reduce CO₂ emissions.

However, energy yielded from renewable sources has its own disadvantage as the consistency of the amount generated is beyond our control. This is because these energy sources are heavily influenced by wind cycles (wind energy), the revolution of the earth and the moon (tidal energy), and the intensity or amount of sunlight received (solar power). For this reason, energy storage systems have become one of the most important initial parts in the chain of power distribution. Ensuring maximum and efficient utilisation of energy in electric vehicles requires strategic and specialised energy storage systems to deal with sudden power bursts during acceleration and braking. Batteries and supercapacitors occupy a large niche in the spectrum of specific power and energy among the various kinds of energy storage systems available to date in the market.

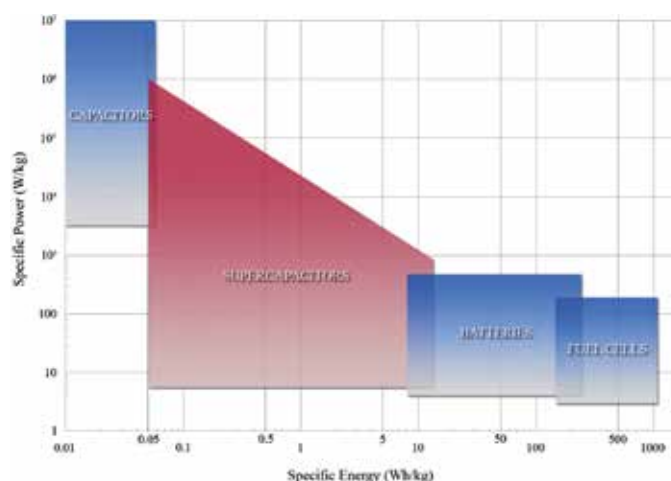


Figure 1. Ragone plot of specific power versus specific energy, indicating the relative capabilities of conventional capacitors, supercapacitors, batteries, and fuel cells.

However, due to the ever demanding consumer market with different specific applications ranging from portable electronics and electric vehicles to large scale storage systems for industrial purposes and power distributions, the performance of batteries and supercapacitors requires significant improvement. This improvement is also needed due to the increasingly complicated requirements of these future applications.

Thus, there is a need to develop and characterise new or improved materials to support the growing demand caused by innovations in consumer products and technology. A good understanding of these new materials is crucial, particularly with the recent advancement in nano-scale materials having brought with it a whole new chapter of novel discoveries in the area of interfacial chemistry and electrochemistry that have significantly impacted the performances of electrochemical devices.



Ir. Dr. Ng Kok Chiang
kokc.ng@gmail.com

Background

Ground-breaking work by Whittingham, Scrosati and Armand with lithium ion batteries brought about the introduction of lithium-ion batteries in 1990 by Sony. Huge energy densities can be obtained from the lithium type batteries, reportedly reaching as high as 180 Wh/kg. However, lithium ion batteries are costly and known to be environmentally unfriendly, thus they would need to be disposed off appropriately.

Whilst significant effort has been expended in the fabrication of advanced lithium ion batteries and other superior secondary batteries with new nano-structured materials, supercapacitors were not popularly researched until a few years ago. Supercapacitors are advantageous as they occupy a different niche in the specific energy and power position (faster and higher power energy storage) as compared to lithium-ion batteries, thereby compensating what is lacking in the current energy industry.

Applications of Supercapacitor and How it Works

The supercapacitor is a budding technology that is playing a significant role in the advancement of electronic devices and systems in both the present and future of energy storage. Unlike batteries, supercapacitors can be charged and discharged within seconds, giving straight-line potential-time plots and providing a high power density due to the rate of the charge-discharge. This characteristic ability allows the immediate delivery of power when required, which is a drawback associated with battery technology.

However, the cost of this property is that supercapacitors have lower specific energy than batteries. The interplay of these two factors is most aptly demonstrated in a Ragone plot Figure 1.

With such properties, supercapacitors have the potential to replace certain batteries whilst compensating for the inconsistency of electrical energy generated from renewable sources. Examples of such applications are photovoltaic devices or other renewable energy generators which are employed to meet the sudden surges of power demand or as back-up supplies to prevent sudden black-outs in power distributions.

Supercapacitors have found their place in many new technologies, from miniature devices such as iPod chargers to the emergency doors of a modern Airbus A380. These examples demonstrate the recognition accorded to this new energy device in terms of safety, functionality, and dependability, despite its short history. In addition, the US Department of Energy has stated supercapacitors as being as much of a priority and as important as batteries for future generations of power sources.



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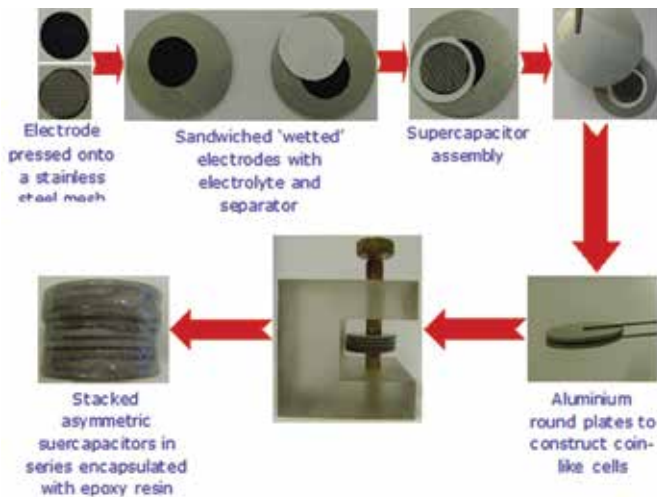


Figure 2. Lab Constructed Supercapacitors

Supercapacitors differ from conventional capacitors in the way in which they store charges. Depending on the storage mechanism, supercapacitors can be divided into two main categories. The most basic type of supercapacitor is called the electrochemical double-layer capacitor (EDLC) which, as the name suggests, stores the charge in the double-layer of the high surface area carbon electrode/electrolyte interface.

The other type of supercapacitor utilises the rapid and reversible redox properties of the electrode materials, such as transition metal oxides and conducting polymers, to effect charge storage. Such Faradic reactions occur in the bulk of the active material close to the surface and involve adsorbed species at the electrode/electrolyte interface of the active materials. These reactions are known as 'pseudo-capacitance'; and capacitance in the range of 10 to 100 times the double-layer capacitance per unit area is obtainable through pseudo-capacitance.

The limited use of historical supercapacitors lies in the low specific energy they command as compared to batteries, which confines them to a narrow range of applications. Unfortunately, most appliances and equipment require prolonged discharge times of more than a few seconds. When the supercapacitor was first built and patented in the 1950's, there was no real sense of the direction for the technology, and a consequent lack of strategic research aimed at increasing its specific energy. When coupled with a lack

of application in the real world, it is understandable that little technological progress in supercapacitors has taken place from the 1960's to the 1990's. In fact, it was only recently, when the demand for high power energy sources emerged, that supercapacitors were given a second lifeline.

Unfortunately, due to their deficiency in technological development as compared to batteries, supercapacitors now still have some way to go in order to overcome their disadvantages with respect to batteries to be competitive for a wider range of applications.

Electric/Hybrid Car: A Supercapacitor Case Study

The supercapacitor device can be used to successfully improve the performance of an electric or hybrid vehicle, or other device requiring bursts of power much larger than its steady-state requirement. If we assume the application requires steady-state power of 7.2 kW for 10 hours, with occasional peak power of 80 kW for a few seconds to tens of minutes at a time, we can use the data presented in Figure 1 to determine how this supercapacitor technology would be of benefit.

In a first case scenario, we assume that the vehicle is powered solely by Li-ion batteries, with energy density of 100 Wh/kg and power density of 0.1 kW/kg. Here, the total energy requirement of 72 kWh requires 720 kg of Li-ion batteries. These batteries can provide 72 kW of power at maximum, thus not meeting the burst requirement of 80 kW of the occasional peak power which may also cause the over-discharging of the Li-ion batteries if stretched. To achieve the required peak power, the Li-ion batteries would need to be sized-up with an extra 80 kg. By combining Li-ion batteries of 720 kg and 0.8 kg of supercapacitor however would allow this peak power requirement to be met, thus a savings of 79.2 kg of the total weight of the energy storage.

In a second case scenario, we assume that the electric vehicle is powered by Ni-Cd batteries, with energy density of 70 Wh/kg and power density of 0.06 kW/kg. Here, the total energy requirement of 72 kWh can be supplied by 1029 kg of batteries. These batteries are capable of providing 61.7 kW at maximum power, which is less than the maximum power requirement. To achieve maximum power of 80 kW, the vehicle would actually need to carry 1334 kg of Ni-Cd batteries, or an extra load of 305 kg. This extra power of 10.3 kW could alternately be supplied by a 2 kg supercapacitor, for burst times of a few seconds to tens of minutes. Similar performance benefits would be obtained when fuel cells replace batteries as the primary power source, as the energy density is higher and power density is lower for fuel cells. In this case, the supercapacitor could provide burst power with less mass than Li-ion batteries.

Conclusion

It is evident that in many application areas, supercapacitors are emerging strongly as either a new, complementary or alternative technology to existing energy storage devices, such as rechargeable batteries. The superior effectiveness of supercapacitors in terms of energy efficiency compared to rechargeable batteries will help lower the total energy consumption in many energy-driven processes and devices, offering a green solution to the ongoing energy crisis. Further research and development will undoubtedly extend their coverage of applications and bring the supercapacitors to a more advanced level to continuously satisfy the increasing civil and industrial demands for clean energy.



Figure 2. Commercial Supercapacitors of different sizes and built available in the market for different applications

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National Conference on Electrical Safety

A National Conference on Electrical Safety “Be Energy Smart – Safety Starts with You” was organised by Energy Commission (ST) on 9th November 2015 at Putra World Trade Centre in Kuala Lumpur. The objective of the conference was to provide a platform for policy makers, regulators, industry players and consumer group to discuss and share the latest information and experiences on electrical safety towards enhancing safety in the country.

Safety statistics for the power sector show an increasing trend in the number of electrical accidents happening in the country recently. Among the main causes identified were improper installation and maintenance as well as inadequate safety procedures. Hence there is an urgent need for us to make the country a safer and better place to live.

Experts and practitioners from government agencies, professional institutions, industry,

consumer associations and our national utility presented papers on safety topics at the conference. TEEAM had the opportunity to present a paper which was represented by Ir Looi Hip Peu during the conference. A booth was provided for TEEAM to promote

Self-Test Residual Current Circuit Breaker (RCCB) during the day. The conference was well attended by some 200 participants. Each received a certificate of attendance with approved CPD hours at the end of the conference.



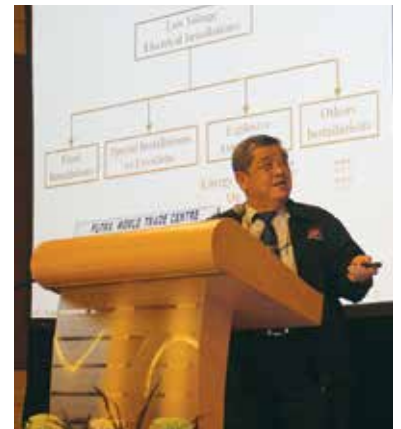
Speakers at the conference – (5th from left) Datuk Ir Ahmad Fauzi Hasan (ST CEO) with experts on the stage.



Networking – (2nd from left) TEEAM President, Ir Chew Shee Fuee KMN with guests and participants during tea break.



Ir Looi Hip Peu of TEEAM – “Ensuring Water Heater Safety – Challenges in Design and Installation”.



Ir Lim Kim Ten of IEM – “Enhancing Compliance to MS IEC 60364 – Standards for Residential Wiring”.

Snapshots of TEEAM Self-Test RCCB promotion during the Conference





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Badminton Tournament

Twenty pairs of men's doubles and eighteen men's singles participated in the TEEAM Badminton Tournament 2015. The tournament was held on two Sundays, 4th & 11th October 2015 at Sports Forum 19, Petaling Jaya, Selangor. The tournament was based on the International Badminton Federation (IBF) twenty-one point rally knockout system. Every player participated enthusiastically with very strong fighting spirit. A big thank you to the referees, umpires and linesmen who ensured a smooth tournament. The list of winners appear on page 87.



Congratulations! – A group photo of TEEAM officials and winners before the event capped off.



Men's doubles champion – (left) Mr Wong Choon Onn (Success Electronics) and Mr Chang Chong Seong (Power Solution) received the AEON cash vouchers and trophies from Ir Chew Shee Fuee KMN (TEEAM President).



Men's singles champion – (right) Mr Gallen Loh (Omron Electronics) received AEON cash voucher and trophy from Ir Chew Shee Fuee KMN (TEEAM President).



Semi-final, Men's doubles event – (from left) Mr Mohd Sofie Hassan and Mr Ahmad Khaizarul (Sunway Engineering) versus Mr Jackson Wong and Mr Yap Chun Wah (Schneider Electronic). Umpire was Mr Yap Swee Huat (centre).



Semi-final, Men's singles event – (from left) Mr Tan Kim Hoong (Genuine Electric) versus Mr Liew Chun Keat (Success Electronics). Umpire was Mr Callistus Tan.



Happy game – Enthusiastic players posing for the album.

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Badminton Tournament 2015 Results

Men's Singles Event

Champion

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AEON Cash Vouchers worth RM550 +
Trophy

1st Runner-Up

Liew Chun Keat

Success Electronics & Transformer
Manufacturer Sdn Bhd

AEON Cash Vouchers worth RM350 +
Trophy

2nd Runner-Up

Tan Kim Hoong

Genuine Electric Sdn Bhd

AEON Cash Vouchers worth RM250 +
Trophy

3rd Runner-Up

Tan Kian Huat

Individual Member

AEON Cash Vouchers worth RM150 +
Trophy

Men's Doubles Event

Champion

Chang Chong Seong & Wong Choon Onn

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Success Electronics & Transformer
Manufacturer Sdn Bhd

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Wiring Design Workshop in Ipoh

As its on-going programme, TEEAM conducted another session of Wiring Design Workshop on 19th November 2015 at Impiana Hotel Ipoh. Besides the main supporting organisations which include Energy Commission, the International Copper Association Ltd, Association of Consulting Engineers Malaysia and Institution of Engineers Malaysia, the session was also well supported by the local associations in Perak i.e., The Perak Electrical Chargeman & Wireman

Competence Association and The Perak Electrical Association.

The topics highlighted were:

- “Update on the Electricity Supply Act & Regulations” by Ir Hj Nur Ali Omar.
- “The Public Distribution Network, the TNB ESHB and Installation Approval Process” by Ir Francis Xavier.
- “The IEC 60364 Earthing Systems” & “Fundamentals of short circuit and system design” by Ir Lim Kim Ten.

- “Protection for LV, RCD (IEC 61008 & 61009)” by Mr Dahari Mat Siran.

- “Voltage drop studies” & “Wiring design for safety electrical systems” by Ir Looi Hip Peu.

The workshop attracted some 58 participants. The majority of the participants were electrical contractors, engineers, consultants, project managers as well as university students. Overall the workshop was beneficial to all participants.

Snapshots of Wiring Design Workshop @ Ipoh





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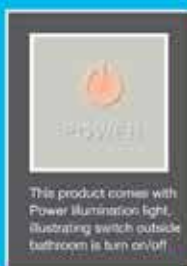
Splash Proof Water Heater Connector

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FOR WATER HEATER EXCEEDING 3.0KW



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Technical Specification

Description	Splash Proof Water Heater Connector
Model	WHC-1
Rated Voltage	250 V A.C.~
Rated Ampere	25 A
Rated Power	5.5 kW
Water Ingress Protection	IP25.
Tested and comply to	IEC 60998-1 & IEC 60670-22 Ed. 1.1 b: 2015.
Material	Fire-retardant Thermoplastic : Polycarbonate (PC)
Wire length	Recommended 1.0 Meter length. (Provided in this product).
Wire Type	Recommended 4.0mm ² wire / 3 core cable (SIRIM Approved)

- The whole idea of this splash proof junction box is to prevent installer from using 13A / 15A type of plug and socket & sub-standard terminal block in running the high current water heater which consumes more than 16Amp. It provides good electrical contact in the junction box, and also proper anchorage to the cable connection (permanently connected, instead of quick connect by using socket & plug).
- The 25 Ampere rated terminal block is mounted at the back of the socket cover and it is 850°C glow wire test compliant to IEC 60998, IEC 60670-22 & Water Ingress Protection Rating of IP25.
- The flexible 3 core cable that comes out from the bottom of the cover are to be fitted with a cable gland PG-11. Our design caters for both 2.5mm² and 4.0mm² for the gland. It is not required to change the gasket inside the cable gland to secure these 2 types of cables.
- The product is made by fire retardant plastic, and it is IP25 rated.



A safer way of electrical connection for Household Water Heater



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Risk of Electrocution by Running Instant Electric Water Heater with Plug and Socket

By Choo WS, ShowerTec Industries Sdn Bhd

Introduction

In Malaysia, Electric Instant Water Heater is always the best seller (half a million units per year) followed by Electric Storage Heater (80k units per year) and Solar Water Heater (20k units per year). Due to simplicity and affordability, Electric Instant Water Heater can be seen in almost every Malaysian household, including landed houses, high-rise condos, service apartments, chalets, budget hotels, service apartments or even some saloons.

Despite the popularity and increasing usage of Electric Instant Water Heater, we have noted that some aspects of the safety measure are being overlooked, and often neglected, or just simply being ignored (“tidak-apa” attitude), and that is where accidents start to happen. As shown in fig 1 and fig 2, we have noted that most of the Malaysian households are running this appliance with 13A/15A plug and socket, or via sub-standard connector (without approval). Are they safe?

Based on wiring guidelines published by ST, water heaters exceeding 3kW shall be

permanently connected to a 20A/30A rated 2 pole On/Off switch outside bathroom, but why is the socket and plug being put up in the bathroom, on top of the shower rose?

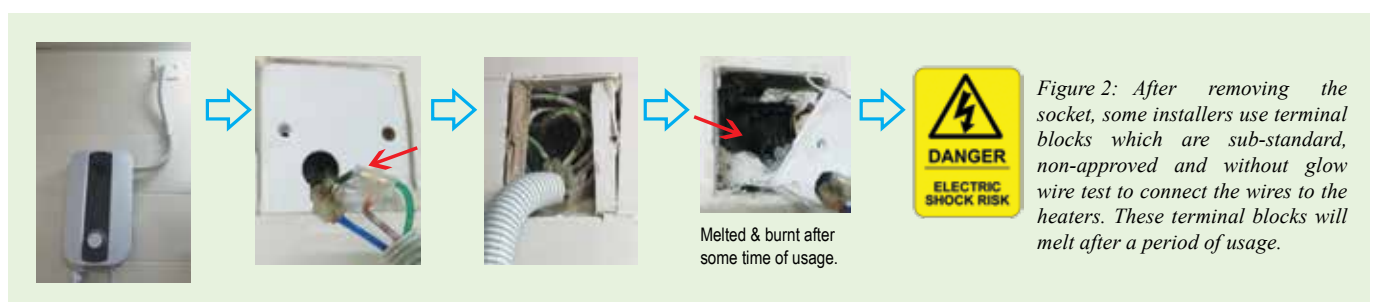
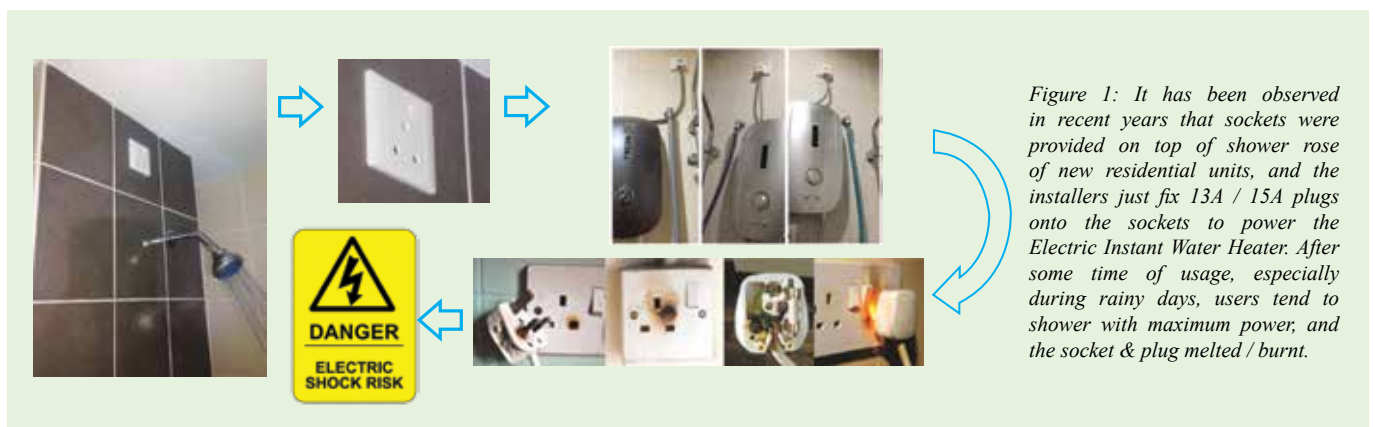
Summary

- 1) Water heaters shall only be wired permanently and directly from the 2 pole On/Off switch outside the bathroom using 4.0mm square wire.
- 2) Remove the socket and plug, and use the “SPLASH PROOF WATER HEATER CONNECTOR” to run Electric Instant Water Heater.
- 3) Use only water heaters that are approved by SIRIM and ST (Suruhanjaya Tenaga), *you may log on to www.malaysiancertified.com.my to check.
- 4) Test the RCCB in your house Distribution Box regularly to ensure its functionality, it should be tested 4 times annually in accordance to the requirement by manufacturer.
- 5) House wiring system is recommended to be inspected by qualified electrical contractors every 10 - 15 years for deteriorations.

Conclusion

The above actions are often being neglected due to unawareness of users, unscrupulous businesses / installers who are taking things for granted, weak enforcement on safety regulations, and many other factors which will make it impossible to install the water heating system in a risk-free environment. In fact, socket and plug cannot be used for water heater installation anymore as all water heaters in Malaysia are above 3.0kW and it consumes more than 15 Amps. Developers should be urged to stop providing socket on top of shower rose in new houses to enhance user's safety.

Mr Choo Wei Seng is the Factory Manager of ShowerTec Industries S/B, a manufacturer of Electric Water Heater. He is also an active committee member of SIRIM Working Group WG02 for Household Heating Appliances, and Working Group WG01 for Household Electric Motor Appliances. Over the years, he has helped suggesting ideas and changes in developing Code of Practices, Safety of Household and Electrical Appliances for MS and IEC standards.





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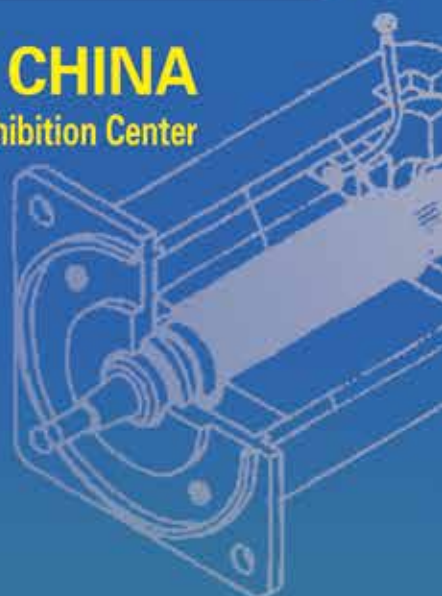
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Solar Technology Today

This paper is prepared by Wong Ying Qian

Abstract

The well-known renewable energy, solar energy, is a very promising, clean and sustainable alternative energy source. This paper discusses its conventional, interesting and future applications, types of solar cells available, their advantages and disadvantages, solar market growth in Malaysia and its most current development.

Keywords:

Solar energy, renewable energy, alternative energy, applications, development.

Introduction

Undoubtedly, solar energy is a well-known renewable energy. Solar energy, unlike fossil fuels, does not contribute to the degradation of our environment and it is unlimited, as the source of the energy is the Sun. It is a very promising, clean and sustainable alternative energy source. While solar energy first found its use in space application, the prominent 1958 Vanguard satellite, improvements for the next two decades were slow, due to its high cost. Many were unwilling to pay steeply for electricity. However, with the vision to use solar energy in terrestrial applications as well, research focusing on reducing the price of solar cell by using cheaper materials, using alternative processing steps and more began.

During mid-1970s, the cost was \$96/watt for a solar module and by 2016, it dropped to \$0.68/watt [1]. This significant decrement was contributed by process improvements and large boost in production. With cheaper price now, solar energy today has found its way into commercial and residential application. We will discuss more of its application in the next section. We will also be discussing the types of solar cells available, their advantages and disadvantages, solar market growth in Malaysia and the current development of solar cell.

Solar Cell Applications

Some conventional applications for solar cells include using the electricity produced to power up buildings, power orbiting satellites, roadside emergency telephones and more. It can also be used to heat water. In addition, there are several interesting applications using solar energy. One of them is solar cars. They are very stable and can come in different sizes. For now, they are mostly used for races as there is limitation in terms of total energy input into the car. Since they are an environmental-friendly transportation, hopefully this can develop into practical form of transportation.



Fig.1 Sunswift solar car eVe – The world's fastest electric car over 500 km [2]

Another interesting application is solar-powered trash and recycling compactors. They hold about five times more than average trash bin and can cut down on collections. This is a very thoughtful application. Currently, it is available in cities such as Philadelphia, New York and Chicago [3].



Fig.2 Solar-powered trash and recycling compactors [3]

Few other common usages of solar energy such as solar phone charger, solar street light and solar window are also available. On the other hand, few other unconventional yet promising solar applications are being explored currently. Solar cells are commonly being dissed for its space-inefficiencies. The space taken for solar panel installation is huge to produce high amount of power. Therefore, scientists are exploring ways to line highways and roads with solar panels. Another proposed application is to make use of the abundance of water to build solar plants [4]. Also, recently, a team of Chinese scientists reported on solar cell that is able to generate power from both the sun and raindrops [5]. This enhances the usage of solar cell even in bad weather.

Types of solar cells

The first generation of solar cell, also the most efficient solar cell, is made of monocrystalline silicon. They are mostly use in the semiconductor industry in integrated circuits and central processing units for computers. They are also heavily used in solar panels production. The reported commercial efficiency based on monocrystalline silicon is about 22% (as produced by US and Japanese solar manufacturers) and it has the highest efficiency compared to all other type of solar cells to-date. In addition to that, some manufacturers reported that their solar panels based on monocrystalline silicon can last up to 50 years, although typically the warranty is given for 25 years.

This type of solar cell is able to produce high efficiency because it is using extremely pure crystal of silicon. However, due to the demand for high purity silicon, this increases the costs of this type of solar cell. A typical cost estimation to build a solar plant based on monocrystalline silicon is USD 1M/MW [6]. The cost of the solar panels is around 60% of the cost of solar plant installation, meaning the installation itself costs a lot, too. This type of solar cell also tends to lose some of their efficiency when the temperature reaches around 50°C. However, if you look at long term investment instead of the initial cost, monocrystalline proves to be the most economical over the life of the installation. Therefore, depending on the application, the budget and the longevity expected, consumers can decide whether this monocrystalline solar cell is worth the initial high investment.

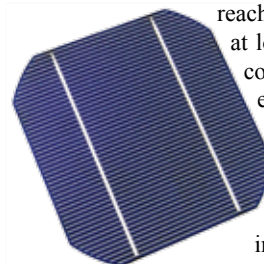


Fig. 3 Silicon solar cell [7]

For crystalline solar cell, a semiconductor junction is formed by diffusing n-type or p-type onto the top surface of the silicon water to

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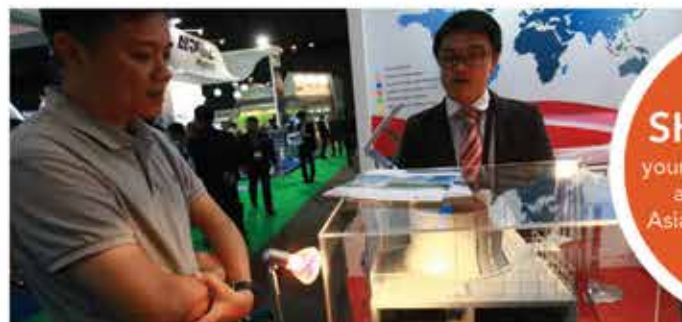
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form the p-n junction in a solar cell [8]. N-type material has excess of electrons while p-type material has excess of holes. When light incident on the cell, an interior electric field is built up, leading to separation of charge carriers at the p-n junction. These charge carriers are extracted by metal contacts at their respective sides and generation of electricity occurs, as illustrated in Fig. 4 [9].

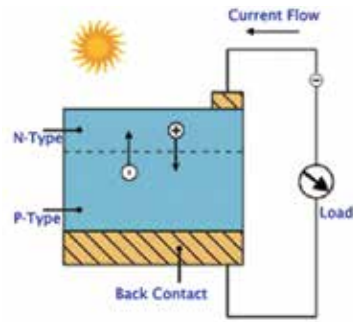


Fig. 4 Generation of electricity for crystalline solar cell [9]

The manufacturing of crystalline solar cell is shown in Fig. 5. The basic material used to obtain polysilicon is silica and silica comes from sand. After a series of carbothermic reduction process, refining process and casting scratch process, polysilicon material is obtained. Depending on whether monocrystalline or polycrystalline solar cell is being produced, the polysilicon material is subjected to different process. For monocrystalline silicon, the polysilicon is used for ingot growing then the ingot is sliced into wafers. As for polycrystalline silicon, the polysilicon material is melted and cast into bricks, and then the bricks are diced into bars and subsequently sliced into wafers.

After that, regardless of monocrystalline or polycrystalline cell, a p-n junction is formed by diffusing n-type or p-type onto the top surface of the silicon wafer. Next, they are wired together to form a circuit and contacts are applied to the front and back of the cell. These cells are then assembled together to form solar modules, and modules can be assembled together to form solar array, for larger output [8].

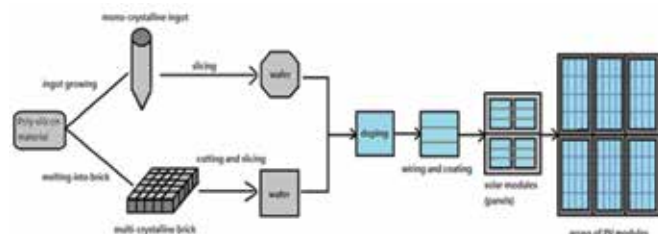


Fig. 5 Manufacturing process of crystalline solar cell [8]

Second generation of solar cell, named as thin film solar cell, applies amorphous, protocrystalline and nanocrystalline to a plastic or metal surface. This type of cell has relatively lower power conversion efficiency and thus, is less expensive compared to its predecessor. Generally, their efficiencies are below 20% [10]. However, some reported that the installation of amorphous solar cell actually costs more than monocrystalline solar cell as there are more mounting rails and take longer time to install. Also, some thin film contains cadmium telluride (CdTe), which is toxic. Although using the panel itself will not bring any harm to the environment, problems arise when the panel reaches its lifetime and disposal is required. Disposal of toxic waste is a large cost itself. On the other hand, due to their thin nature, they do have their own advantages over monocrystalline silicon cell. Amorphous thin film cell can be made flexible and thus, they can be installed in places other than rooftop. They can be installed on curved surfaces and can be rolled up to be used as portable solar cell [11].



Fig. 6 Amorphous thin film solar cell [12]

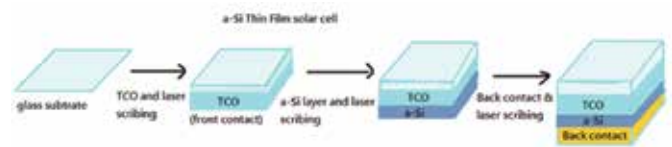


Fig. 7 Manufacturing process of amorphous silicon solar cell [8]

The manufacturing of thin film solar cell commonly consists of 6 steps, as illustrated in Fig. 7. Since thin film uses less or no silicon at all, an extremely thin film is commonly deposited onto a substrate such as glass, stainless steel or plastic. This serves as the front contact. After that, using laser scribing, a layer of amorphous silicon is deposited and next, a second time of laser scribing is applied. Subsequently, the back contact metal conductive layer is deposited and a final laser scribing is applied. Another type of thin film, namely CIGS/ CIS consists of copper, indium, selenium and/or gallium. Its manufacturing process is similar to that of amorphous-Silicon, with the exception that the glass substrate of CIGS/CIS cell is at the back, instead of the front. CdTe, consisting of cadmium and tellurium is also a type of thin film cell. The composition is similar to that of amorphous-silicon, but with an additional Cds layer for buffer.

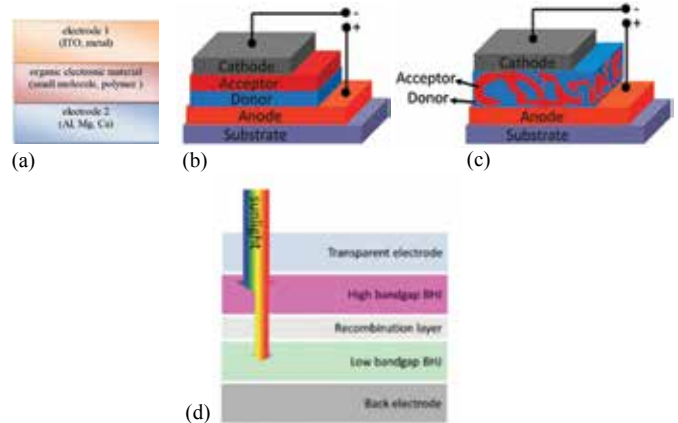
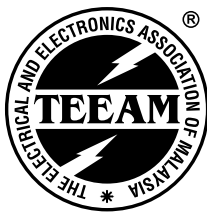


Fig. 8 Types of OSC (a) Single layer (b) Bilayer (c) BHJ (d) Tandem

Organic Solar Cell (OSC) is considered as the third generation of solar cell. It uses organic polymer of small molecule for light absorption and electrical charge transport. However, instead of directly producing free electron and hole like crystalline cell and thin film cell when light incident on them, exciton is produced and it has short diffusion length, only around 10 nm [13]. The built-in electric field is not sufficient to break the exciton apart. Therefore, OSC commonly consists of two different materials with different electron affinities and ionization potentials to break the exciton apart and be extracted by their respective electrodes before it recombines.

Currently, many researches are focusing on this type of solar cell as it promises to be low cost, solution processable (polymer solar cell), easily scalable to large area for manufacturing and can be made flexible. This type of solar cell is mainly still under research and development stages and there are many different structures and types of organic solar cell being proposed. The most basic structure is the single layer structure, where one organic layer such as magnesium phthalocyanine (MgPc) is being sandwiched between two metallic conductors as contacts. One metal should be of high work function e.g. Indium Tin Oxide (ITO) and another metal should be of low work function e.g. Aluminium (Al) in order to set up an electric field in the organic layer. However, as mentioned, the electric field is typically not sufficient to break the exciton apart therefore this type of OSC commonly has low power conversion efficiency of less than 1% [14].

Therefore, another type of OSC, known as bilayer cell, is proposed. It consists of two organic layers sandwiched between two metallic



64th Anniversary Dinner

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conductors. These organic layers have different electron affinities and ionization potential, sufficient to break the exciton apart for charge extraction. One organic layer serves as a donor (electron donor) and the other layer serves as an acceptor (electron acceptor). Since the exciton diffusion length is as low as 10 nm, the organic layers have to be made extremely thin, around the same length as the exciton diffusion length. Thin layer compromises the light absorption and thus the power conversion efficiency of this type of cell is limited as well. A few combinations of organic material such as C60/MEH-PPV [15], PPV/C60 [16], and perylene derivatives/copper phthalocyanine (CuPc) [17] also showed efficiency of around 1% or lesser.

The most common type of OSC is the bulk heterojunction (BHJ) type. It is a blend of the donor and acceptor materials and the domain sizes are on the order of nanometers. This caters to the short exciton diffusion length where excitons are able to reach the interface of the donor and acceptor quickly and dissociate into free charge carriers. These free charge carriers need to be extracted by the electrodes therefore the interpenetrating network of the bulk heterojunction needs to form a percolating network as well, allowing the donor to reach the hole transporting electrode and the acceptor to reach the electron transporting electrode. BHJ also can be made thicker for higher photon absorption since the short exciton diffusion length is no longer an issue for this type of solar cell. This type of OSC is the most heavily investigated type.

Another type of OSC available is tandem OSC. This type is the first type that reached the efficiency of 10%. The idea is to stack several layers of BHJ together to absorb different part of the solar spectrum. The individual BHJ can be connected in series or parallel. However, this type of OSC is complicated as it is difficult to have middle electrode that is both transparent and sufficiently conductive to allow extraction of charges without significant loss. On the other hand, recently, a group of researcher from the Hong Kong University of Science and Technology (HKUST) has developed new donor and acceptor materials using single-junction OSC structure, they have achieved high power conversion efficiency of 10.8% [18].

In order to commercialize, the solar cell has to exhibit power conversion of more than 10% and has a lifetime of 5 to 10 years. Since there is organic solar cell that has exceeded the 10% power conversion efficiency threshold, now the effort should be more on lifetime of OSC. Lifetime of more than 10 years is still under monitoring and development.



Fig. 4 Organic solar cell [16]

It is believed that these criteria will be fulfilled very soon! The goal of this generation of solar cell is to improve on commercially available solar cell by making it more efficient over a wider range on the solar spectrum, less expensive and to have more different applications.

Solar Market Development

The solar trend has begun some time ago and Malaysia is finally catching up to the industry. In just merely seven years, Malaysia has become the world's fourth-largest producer of solar cells, behind China, Taiwan and Japan. This is mainly attributed to the influx of multinational corporations, such as US First Solar, Japan's Panasonic Energy and Germany's Hanwa Q Cells. The government offers an attractive 100% income tax break for 10 years and 100% investment tax allowance for capital expenditures. In addition to that, Malaysia has a well-established semiconductor manufacturing industry and has readily available low-cost labor and skilled engineers as well [17]. All these contributed to the significant growth of solar market in Malaysia.

Conclusion

In short, we have discussed the benefits of using solar energy as alternative energy, its applications, types of solar cells available, their advantages and disadvantages, solar market growth in Malaysia and its most recent development. Hopefully this environmental-friendly solar cell can make its way into more and more applications, replacing finite energy resources.

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Ms Wong Ying Qian graduated from UCSI University with B. Eng (Hons) in Mechatronic Engineering in year 2010. She pursued her Ph.D in Multimedia University with research focusing on organic solar cell. Currently she is under a research exchange programme at the National Chiao Tung University, Taiwan, working on semitransparent organic solar cell. She can be reached at lana_1123@hotmail.com.

New Members

The following new members have been approved and accepted by the TEEAM Council (as at 29th March 2016).
A warm welcome to all the new members and special appreciation is extended to those who introduced these new members.
For those who are not yet members.....why wait? Join us and find out how our Association can offer our services to you.

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Challenges and Opportunities in Electrical Industry - Part 25

This paper is prepared by Ir Chew Shee Fuee KMN, TEEAM President.

A. Shock to death while talking on a charging phone

Sunday, 17 April 2016 | MYT 9:23 AM

KUALA LUMPUR: A woman was electrocuted to death while she was talking on her mobile phone as it was charging.

Suhana Mohamad, 30, was struck by the electrical currents at her home in Taman Desa Baiduri, Cheras at about 11.30pm Friday.

The above news was reported recently and the public is worried about the using of phone chargers which may cause these fatal accidents.

The reason for the accident could be caused by the following:

1. The charger was defective allowing the mains voltage to reach the DC circuits in the handphone.
2. The RCCB in the house was defective and did not interrupt the leakage current.

Charger failure can be caused by inferior product or failures due to mishandling. Genuine chargers are recommended. It is also strongly recommended not to use the handphone when it is connected to the charger.

RCCBs in the house need to be tested regularly so that protection can be assured.

30mA RCCBs are still not commonly used in residential homes. New houses are now mostly fitted with power outlets protected by 30mA RCCBs. 30mA RCCBs are more sensitive and could have protected someone from being electrocuted when a device or appliance fails.

B. Code of practice for installation and maintenance of water heaters

The above is being drafted by the Energy Commission (ST) and the following have been extracted for information.

5 Operation and maintenance of water heaters

5.1 Periodic maintenance

- 5.1.1 It is recommended that periodic maintenance shall be done at least once every six (6) months.

- 5.1.2 The water heating system shall be switched off using the maintenance disconnect prior to maintenance.

- 5.1.3 Periodic maintenance shall be carried out on the following aspects:

- 5.1.3.1 Inspect the disconnect for signs of over-temperature.

- 5.1.3.2 Inspect the parts from the disconnect to the water heater for signs of water ingress.

- 5.1.3.3 Inspect terminations and tighten if necessary.

- 5.1.3.4 Check the installation earth loop impedance to ensure that it is not more than the maximum permitted value.

- 5.1.3.4.1 If the installation earth loop impedance measured is 30 % more than the last reading, carry out a detailed investigation and perform necessary remedial works

- 5.1.3.5 Test the water heater's RCD to ensure that its tripping mechanism is functioning.

- 5.1.4 All remedial works shall be carried out by competent persons.

5.2 Periodic checking of operability of earth leakage protection systems

The residual current devices must be tested periodically, preferably once every three months, by pressing the test button and resetting the devices. The RCDs involved for this purpose include: -

- i. The RCD at the main switch board of the premise
- ii. The dedicated RCD usually installed on the outside wall of the room where the water heater is located
- iii. The inbuilt RCD in the water heater itself.

5.3 Periodic checking of drain valves and proper operation of temperature and pressure relief valves

- a. The water heater drain valve should be checked periodically for leaks.
- b. The pressure relief valves of storage and solar water heaters should be checked for evidence of corrosion, leaks, improper installation, etc.
- c. The temperature and pressure relief valve should be manually operated at least once

a year to make sure that it is working properly. To prevent water damage, the valve must be properly connected to a discharge line which terminates at an adequate drain. While standing clear of the outlet (discharged water may be hot), the lever handle on the temperature and pressure relief valve must be slowly lifted to allow the valve to operate freely and return to its closed position. If the valve fails to completely reset and continues to release water, immediately shut off the electrical power and the cold water inlet valve and call a qualified service technician.

- d. The water heating system should be checked periodically for blockages

5.4 Need to fill heater with water before turning it on

The water heater switch should not be turned on until before the water heater is filled with water.

5.5 Setting of thermostat temperature

For most water heaters, the thermostat temperature is factory set so as not to exceed 60oC. If control of the thermostat is possible, it should be set lower than a temperature to prevent scalding but higher than 55oC to prevent bacterial infection, especially Legionnaires Disease or Legeionellosis.

5.6 Draining, flushing and descaling

- a. It is recommended that the tank of storage water heaters be drained and flushed every 6 months to remove sediment which may build up during operation. To drain the tank: -

- i. Turn off the power to water heater.
- ii. Close the cold water inlet valve and open a nearby hot water faucet.
- iii. Connect a hose to the drain valve and terminate it to an adequate drain..

- b. The spray head of instantaneous) water heaters must be descaled regularly.

5.7 Energy efficiency guidelines

- a. Instantaneous water heaters are more efficient than storage type water heaters, since storage water heaters have higher standby losses because they keep tanks full of heated water at all times and are typically located away from points of use. Where hot water use is low (e.g., kitchenettes and office restrooms),

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..... Continue Challenges and Opportunities in Electrical Industry - Part 25

installing instantaneous water heaters can save energy. In addition, their compact size allows them to be located near the point of use, further reducing heat loss through piping.

- b. Water heaters must be sized properly. Oversized products cost more to buy and use more energy due to excessive cycling and higher standby power losses.
- c. Insulation blankets for storage water heaters and insulation wraps for the hot water pipes can bring down energy costs.
- d. Setting a lower temperature for the heated water can also save energy. However the temperature set must not be too low as *Legionella pneumophila*, the bacteria known to cause Legionnaires Disease, can grow in water heaters.
- e. Turning water heaters down or off during unoccupied periods also reduces energy use and costs, as do timers or other load control devices in buildings with time-of-use rates or demand charges.
- f. For storage water heaters, if it can be turned on for high-use periods and off during low-use periods, good savings can be realised.

5.8 Energy efficiency standards

Energy Factor (EF): A measure of water heater overall efficiency, is the ratio of useful energy output from the water heater to the total amount of energy delivered to the water heater.

Testing Standards

Storage water heaters

For capacity of up to and equal to 55 gallons

(208.2 liters): $EF > 2.00$ or $(0.960 - (0.0003 \times \text{rated storage volume in gallons}))$

For capacity of less than 55 gallons (208.2 liters): $EF > 2.20$ or $(2.057 - (0.00113 \times \text{rated storage volume in gallons}))$

Instantaneous water heaters

$0.93 - (0.00132 \times \text{rated storage volume in gallons})$

Ir Chew Shee Fuee KMN B Sc (Hons) (Strathclyde), PEng, CEng, FIEM, MIEE Member, IEEE Member, 1st Grade Electrical Engineer (Competent up to above 500 kV).

Ir Chew is the current President of The Electrical and Electronics Association of Malaysia (TEEAM). He was TEEAM President for 2001 - 2003 and 2003 - 2005. He is the Past President of the Asean Federation of Electrical Engineering Contractors (AFEEC).

Ir Chew is the Managing Director of G H Liew Engineering (1990) Sdn Bhd and QATM Engineering Services Sdn Bhd. He graduated from the University of Strathclyde, Glasgow with a B Sc (Hons) in Electrical & Electronics Engineering. He is a Professional Engineer and is also licensed by Energy Commission as a competent engineer (without voltage limits) and a service engineer to carry out electrical testing up to a voltage of 500 kV.

Ir Chew has more than 30 years experience in electrical control and relay protection. He is also specialised in electrical site tests on power equipment, electrical fault investigation, service and maintenance of electrical switchgear and relays. His work also includes electrical supervision of substations and electrical audit. He presents lectures on electrical apparatus and the protection system. He is at present a WG representative in the development of Green Technology Road Map Phase 1. He is also a member of the National Energy Efficiency Technical Working Group. He is the Immediate Past President of IET Malaysia (Institution of Engineering & Technology) and Board Member of IET's APRB (Asian Pacific Region Board). He can be reached at E-mail: sfchew@ghliew1990.com.



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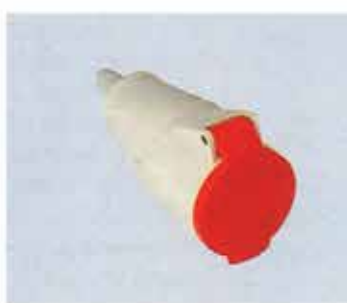


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