TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

ISSUE NO. 188 | VOL NO. 18/2023 | MONTHLY ISSUE NO. 1 | PRIVATE CIRCULATION ONLY | FEBRUARY 2023

Energy Conservation Day Celebration

on 17th December 2022 at Hotel Fortune Pandian, Madurai

Dignitaries

Inauguration - Lighting of Traditional Lamp

Er. S. Umadevi,
Chief Engineer,
TANGEDCO

Mr. M. Prabhakaran,
IRSEE, Southern Railway,
Madurai

Er. A. Sahayaraj,
SE, Theni EDC,

Delivering Inaugural Speech by Chief Guest

TNEIEA, Office Bearers
Lighting the Kuthuvilakhu

Mr. J. John, Senior Member TNEIEA
honouring **Er. S. Umadevi,** Chief Engineer,
TANGEDCO, Madurai

Mr. S. Ponnambalam, Senior Member, TNEIEA
honouring **Mr. M. Prabhakaran,** IRSEE,
Southern Railway, Madurai

Mr. K. Chandran, Member, TNEIEA
honouring **Er. A. Sahayaraj,** SE, Theni EDC,

TNEIEA honouring
Mr. D. Muthukumar, M.E.
Eiectrical Inspector, Madurai

Mr. D. Chandran, & **Mr. K.R. Thangaraj** Member,
TNEIEA honouring **Mr. Joe,**
M/s. Genlite Engineering P. Ltd. Madurai

Mr. S. Sankaravel, & **Mr. Muruganandham** Member, TNEIEA honouring **Mr. Srini Sudarsanam,** M/s. 3Si Eco Power LLP, Chennai

Mr. A. Radhakrishnan & Mr. JRK Anandaramanna Member, TNEIEA honouring **Mr. N. Pandiyarajan,** M/s. RR Kabel Ltd.,Madurai

Mr. M. Arumugam, & **Mr. V.L. Radhakrishnan** Member, TNEIEA honouring **Mr. C. Rajangam ,** M/s Perfect Earthings, Coimbatore

Mr. T. Rajadurai, & **Mr. R. Shanmugananthan** Member, TNEIEA honouring **Mr.Pothiraju,** M/s Atandra Energy Pvt. Ltd. Chennai

TNEIEA honouring **Mr.A.A. Murali** **Vice President -Madurai**

Members Gatherings in Seminar

Winners of Lucky draw for Members

Energy Conservation Day Celebration
on 17th December 2022 at Hotel Fortune Pandian, Madurai

Mr. K. Vinoth Babu
M/s Vinoth Electricals, Chennai

Mr. K. Prakash
M/s Evergreen Engineering, Madurai

Mr. JRK Ananda Ramamanna
M/s Shastha Electricals, Chennai

Mr. G. Hariharan,
M/s Gajendraa Electric Company, Chennai

Mr. P. Selvanathan,
M/s Selva Engineering Enterprises, Chennai

End Session - Lunch

EDITORIAL

Dear Members, Fellow Professionals and Friends,

Greetings To All!

Best Wishes To All For A Bright 2023!!

The bright and busy Music and Dance Season in December - January in Chennai followed by a joyous Pongal Season this year, with all round prosperous business activities demonstrated that we have achieved complete normalcy in almost all fronts. This assures our marching forward in the growth path with full vigor to achieve a Good and Respectable position in the Global scenario. Our Democracy is vibrant and so is the vigor of political activities, which sometimes, underplays our growing strength and increasing influences all over the world. All analysis and the activities that are seen constantly, certainly makes us feel proud about our present growth and future prospects. Another matter of our pride is that in all spheres of activities of the Globe, be it Technology or Business or Politics, people of Indian origin are playing key roles.

Our 73rd Republic Day was celebrated on January 26th and we can certainly feel proud about our growth and achievements over the years, understanding that we are one of the most complex and diverse country of the world and are also one of the oldest civilizations, and have faced invasions and foreign and colonial rule for hundreds of years before achieving our independence. We are a growing economy with abundant human and other resources and with the direction of activities and the potentials, we are heading to enter the top league of the world.

It is Budget time and by the time this News Letter is in your hands, the Budget would have been presented and as predicted by many, focus on Energy and infrastructure, encouragements for Industries including MSMEs, and further push for Innovation and Technology and their fast adoption can all be found in the Budget. Taxation measures with eyes on ease of doing business and measures resulting in increase of purchasing power of the masses, particularly the growing middle class, would all be there.

Energy Conservation Amendment Bill 2022 was introduced in August/ December 2022 with amendments to the Energy Conservation Act, 2001 to empower the central government to specify a carbon credit trading scheme and to specify measures to achieve our commitments made at COP26. Important details are given separately in this News Letter.

Electricity Amendment Bill 2022 was also introduced in August 2022, mainly to streamline DISCOM operations and power purchases and their profitability and so on, but the bill is referred to Standing Committee and not yet passed.

With regard to investors and investments including foreign investments, the healthy situation of India being a favorable and preferred destination continues due to global developments and many states including Tamilnadu are actively working to attract large investments with good successes.

"World Water Day" 2023 will be celebrated on March 22 worldwide to increase awareness on crucial importance of water to all living things. On this day let us all come together and request people not to waste water. The global campaign, called *Be the change*, encourages people to take action in their own lives to change the way they use, consume and manage water.

We thank all those members who have helped us by participating in the advertisement appearing for the issue December 2022 – 3SI Eco Power LLP, E Power Engineering, Gravin Earthing & Lightning Protection System (P) Ltd., Global EPC India Pvt. Ltd., MV Power Consultants & Engineers (P) Ltd., Pentagon Switchgear (P) Ltd., Power Cable Corporation (Cable Network), Power Cable Corporation (Cable Solution), RBB Electricals, Sri Bhoomidurga Marketing (P) Ltd., Supreme Power Equipment (P) Ltd.

Editor

TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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CONTENTS

MAKING BEST USE OF ADDRESSABLE AND CONVENTIONAL FIRE ALARM SYSTEMS (PART – 2)

A RECAP!!

In the first Part of the above article in the Issue No. 187, Volume No. 17/2022 of Dec. 2022,we saw the following:

1. It is best to avoid unwanted fires in the first place by planning proper layouts, making proper selection of systems and processes, optimizing the storage and use of hazardous materials, providing proper training to personnel, segregation, separation, isolation, substitution of hazards etc.
2. We however also saw that we cannot preclude the possibility that fires will never happen as fires could also happen due to natural means.
3. Early detection of the fires are most important to activate control measures and reduce collateral damage. Fires can grow exponentially if the detection and suppression of the fires is slow.
4. Manual recognition of fires is very important, but in today's scenarios of industrial, commercial, residential buildings, fires can start in obscure areas and it may not be possible for human beings to be the first source of detection or it could not be safe enough to utilize human beings as 'early warning systems'.
5. Coming to automatic fire alarm systems, there are two popular types of detection systems technologies – the 'conventional' and the 'addressable' types. In today's age of automation, almost all the 'conventional' fire alarm technologies are incorporating the 'addressable' fire alarm technologies but still some distinction could be drawn in the method of operation.
6. The most important questions one should ask oneself in selecting the technology are:
    a. What technology does my occupancy need?
    b. Which technology can I afford?
    c. Which system do I have the resources to maintain? – There are some projects with extra ordinary electronics engineers working there, but in their busy schedules they do not have the time to spend on the programming / upkeep of the fire alarm systems.
    d. How reliable is the supplier and service partner?
    e. The manufacturers may advertise about 'Mean-time-between-failures'. How about the 'mean-time-between-repairs'? Both are essential.
    f. Would technology development make the current system obsolete?

FURTHER INTRICACIES!

In addition, there are peculiar differences between conventional and addressable fire alarm systems.

- A Bill of Quantity or design drawn out for an conventional fire alarm system will be lead to almost the same installation architecture by various conventional fire alarm system manufacturer.

Electrical safety leads to Fire Safety.

Ensure Fire Safety.

SAVE LIFE – SAVE PROPERTY

- However, in addressable fire alarm systems, the architecture could be very different from manufacturer to manufacturer and sometimes even between the different models of a manufacturer. For example –
  - Number of initiating devices per loop could be different. Some would allow 128, some 256 initiating devices etc.
  - Number of notification devices (hooters, hooters cum strobes) could be different.
  - Powering to the notification devices could be different.
  - Agent release modules availability could be different.

MAKING A SUCCESS OUT OF FIRE ALARM SYSTEMS:

A detailed planning and implementation will be required to make the fire alarm system a success. The same includes:

1. Collecting the detailed project information as mentioned in standards like NFPA-72, IS-2189.
2. Indicate the systems or service requirements – whether it is a new or existing system modification.
3. Plan the details of the control units, circuits and pathways, remote annunciators, initiating devices, notification devices, system control functions, interconnection systems, certification and approvals required etc.
4. Plan the 'CAUSE AND EFFECT' requirements and understand the 'LOOP LOADING CALCULATIONS', 'BATTERY LOADING CALCULATIONS', layout drawings, bill of quantities etc. proposed by the Contractor etc.

THE GREAT WAY FORWARD:

Hence it is now understood that much thought process and actions are required to make the fire alarm system a success and secure the life and properties.

To this extent, the standards help a lot to disseminate the knowledge. It addition, it could be prudent to appoint a specialist like a Fire Alarm System Consultant who will be able to understanding the implications of risk, installation ease, budget, technical differences between the products, maintenance capabilities of the client and suppliers, reliability, flexibility, scalability, operation convenience, vendor independence required etc. and provide a complete fire alarm system solution.

Let us all of us understand and implement proper fire alarm systems to improve Life and Property Safety. All the best to our readers.

Mr. Muthukrishnan Kalyanasundaram, M.E.
Proprietor – M/s HKM ENGINEERS AND CONSULTANTS
Services- Fire and Life Safety Consultancy
Email id - mr.k.muthukrishnan@hkmconsultants.com
Contact Number - 9930265069
(Son of Mr. H.Kalyanasundaram
Ex. Best and Crompton Engineering Limited)

Fire Destruction is One Man's Job.

Fire Prevention is Everybody's Job.

Fire Fighting is the one of the most essential services of an organised Society.

KNOW THY POWER NETWORK - 169

Generally, when any change occurs in our life, we call it as a lead to "New Life". In my view, we can treat it as "New Year". So in this New year "2023", I wish that "Many happy events / happenings may occur in the lives of all respectable readers". With this, let me start this write up.

"Dear Brutus, the fault lies not in our stars but in ours". This quote is taken from Shakespeare's JuliusCaesar drama. It holds good in our real life situations also when we deal with the efficient running of our "Man-made Machineries" (electrical equipment) i.e.the real problems in the Energy Consumption of machines lie not in the machines but in the way we handle, erect, operate, feed with inputs and loads, maintain, repair and finally dispose them. So the focus should be made on our ways to treat the equipment (There is a need to mend / correct our ways to the maximum possible extent). Hope the readers will agree / concur with these views. With this brief, let me continue my earlier (last) article further.

S. No	System / Equipment / Device	Important Energy Related Parameters	Energy Saving Measure Required
I	II	III	IV
8	Pumps and pumping system	Pump suction	Ensure adequate NPSH (Net positive suction head) at the time of installation
		Pump operation	It should be nearest to best efficiency point
			Throttling should be kept at minimum
			Depending upon the needs of the site conditions, adopt variable speed drives / sequenced control of multiple pumps
		Higher pressure	Install booster pumps for small loads that require higher pressures.
		Water losses	Make regular inspections and repair seals and packing to minimize water loss by dripping
			Balance the system to minimize flows and reduce pump power requirements.
			Avoid pumping head with a free fall returns (gravity)
			Use siphon effect to maximum advantage
			Conduct / perform water balance studies to minimize water consumption
		System resistance effect	Reduce this by pressure drop assessment and pump size optimization
		Old pumps that require frequent repairs	Replace them will higher energy efficient pumps
		Over designed pump	Provide variable speed drive or down size impeller / replace impeller. If need arises, replace the existing pump with the correct sized pump
9	Cooling Towers	Interferes with the air intake or exhaust	Adopt the clearances as advised by the manufacturer around cooling towers. If need arises relocate / modify structures

		Optimization of cooling tower fan blade	Do it or load basis
		Fan blade tip clearance	Correct excessive / or uneven blade tip clearances and poor fan balance.
		Nozzles condition in counter flow cooling towers	Replace old spray type nozzles with new square spray nozzles.
			Replace splash bars with self-extinguishing PVC cellular film fill.
			Install new nozzles to get a more uniform water pattern
		Plugged distributions nozzles	Periodically clean them
			Balance the flow to cooling tower hot water basins
		Fouling of hot water basins	Cover hot water basins to minimize algae growth
		Blow down flow sets	Optimize it
			Replace slat type drift eliminators with low pressure, self- extinguishing PVC cellular units
			Segregate high heat loads like furnaces, DG sets, air compressors and provide cooling towers for sensitive applications like AC plants condensers of captive power plants seperately.
		L/G Ratio, CW flow rates approach, effectiveness and cooling capacity	Monitor power parameters for continuous optimization efforts:
			Energy efficient FRP blade adoption may be considered for fan energy savings

With this, the write up is completed. Now it is time for me to go for next article. Viz. **"Lessons learnt from energy audits conducted in industries".** I am eager to share my experiences and the lessons I learnt from the Energy Audits conducted in various industries that mirrored the real life site conditions. Different lessons are learnt from different industries.

In this context, kindly note that to make no mistakes not in the power of man; but from their errors and mistakes, they can learn the lessons for the future. It is our responsibility to avoid / prevent such mistakes from happening again.

1. **Higher LT voltage level**

   LT voltage level was meticulously maintained at 440 volts in two industries I visited.The lighting loads (FT lamp) fittings at these premises required400 volts only for their efficient functioning. The excess voltage Viz. 40V over and above the required level leads to unnecessary energy wastage. Then we have to go for either lighting energy savers to keep the voltage level at the level of 400 volts or some other measures to avert the voltage level going beyond 400V.

2. **Avoidable iron losses of Transformers (over designed Transformers)**

   To avoid frequent visits to power provider's office (TANGEDCO) to get approval/sanction for additional loads, most of the industries get sanction for **"Higher Contracted Load"**(KVA Demand). This is also in line with their consultant's advice for meeting their future load growth. To certain extent, this meets the demand of harmonic loads and the consequential heating faced. As a result, the installed transformer capacity

is more than the actual requirement. Many a time, it gets scaled up to the level of 3-4 times the required level. The end result (the avoidable constant / fixed (iron losses) losses of transformers for 24 x 365 hours), is higher losses. (e.g) In one HT hospital near to my house, their demand is around **"200 KVA"**but the in service transformer capacity is **"800 KVA".**

Then imagine the unnecessary and avoidable fixed losses caused by this step. Don't think, it is prevalent in one or two industries. It is widely practiced in all HT industries, No doubt, it happens in most of the industries inspected by me.

3. **Low Load Factor**

In one industry, the contracted demand was around 12-13 MVA; the connected load was 23.5 MW. The equipments were connected in accordance with it.But their usage is scarce and the maximum demand reached was around 2.76 MVA during our inspection. As a result, the load factor of plant is around 0.4

There are several consequences of such low load running of the plant with the attendant low power factor. Among them are,

High cost electrical energy in wasted due to idle running / low loading of the machines. The energy losses due to the idle running / low load machines, if measured, would mirror the actual wastage of electrical energy occurred. The operation with the attendant P.F. also makes a drain on the performance of the machines. Proper assessment of loads and production levels would have averted such situations.

4. **Demand Controller**

Another factor is the stress generally made on the role of demand controllers by the consultants.Actually the contribution of these devices to energy savings is very much limited / negligible. But the demand side management measures lay stress on its installation as if they would lead to higher energy savings which is not a fact. To clarify this situation, following are stated

"There is a perception that by reducing the maximum demand incident on the plant by suitably sequencing the demands of the different shops / sectors functioning in the plant or splitting the bulk utilization of electrical power in the same section, adequate energy savings could be achieved. But in reality, it is not correct perception.

When the above said measures are put in place at best, it can help to regulate the maximum demand of the plant and thereby help to achieve certain monetary savings. But these measures do not help to reduce the KVA demand made by the plant nor reduce the energy usage. The reduction in KWH can only be achieved only by the efficient utilization of the electrical energy supplied and not by only other means. In other words, the energy supplied to all the load centres of the plant need to be monitored and controlled. It is possible only by the wide application of energy efficient equipment and systems; improvement in the productions process; regulating / conditioning the required inputs to the plant not by any the means.

5. **Specific Energy Consumption**

Specific energy consumption of the equipment is another valid factor. This needs our attention. This is one more lesson I got from my Energy Audits. This will be elaborated in my forth coming chapter.

With this. I sign off

(To be continued)

V. Sankaranarayanan, B.E., FIE,
Former Addl. Chief Engineer/TNEB
E-mail: vsn_4617@rediffmail.com
Mobile: 98402 07703

SUBSTATION DESIGN APPLICATION GUIDE – 8

4.11 TRANSFORMER BUSHING CT's

The 132kV Bushing CT's

132kV, 120MVA, SGTs FULL LOAD CURRENT = 530A			Continuous Current	Secondary Current Rating
CT1	1000 / 500 / 1A	Type A	800A	1A at 1000/1
CT2	1000 / 500 / 1A	Type B	800A	1A at 1000/1
CT3	1200 / 600 / 1A	Class 1 5P10/20 30VA	800A	1A at 1200/1
CT4	1200 / 600 / 1A	Type A	800A	1A at 1200/1
132kV, 180MVA, SGTs FULL LOAD CURRENT = 790A			Continuous Current	Secondary Current Rating
CT1	1000 / 500 / 1A	Type A	1200A	1.2A at 1000/1
CT2	1000 / 500 / 1A	Type B	1200A	1.2A at 1000/1
CT3	1200 / 600 / 1A	Class 1 5P10/20 30VA	1200A	1A at 1200/1
CT4	1200 / 600 / 1A	Type A	1200A	1A at 1200/1
132kV, 240MVA, SGTs FULL LOAD CURRENT = 1050A			Continuous Current	Secondary Current Rating
CT1	1000 / 500 / 1A	Type A	1600A	1.6A at 1000/1
CT2	1000 / 500 / 1A	Type B	1600A	1.6A at 1000/1
CT3	1200 / 600 / 1A	Class 1 5P10/20 30VA	1600A	1.35A at 1200/1
CT4	1200 / 600 / 1A	Type A	1600A	1.35A at 1200/1
The 275kV Bushing CT's				
275kV, 120MVA, SGTs FULL LOAD CURRENT = 250A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	450A	1A at 1200/1
CT2	1200 / 600 / 1A	Type A	450A	1A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	450A	1A at 1200/1
CT4	1200 / 600 / 1A	Type B	450A	1A at 1200/1
275kV, 120MVA, SGTs FULL LOAD CURRENT = 250A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	660A	1A at 1200/1
CT2	1200 / 600 / 1A	Type A	660A	1A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	660A	1A at 1200/1
CT4	1200 / 600 / 1A	Type B	660A	1A at 1200/1
275kV, 240MVA, SGTs FULL LOAD CURRENT = 500A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	870A	1A at 1200/1
CT2	1200 / 600 / 1A	Type A	870A	1A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	870A	1A at 1200/1
CT4	1200 / 600 / 1A	Type B	870A	1A at 1200/1
The 275kV Bushing CT's				
275kV, 500MVA, SGTs FULL LOAD CURRENT = 1050A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	1600A	1.35A at 1200/1
CT2	1200 / 600 / 1A	Type B	1600A	1.35A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	1600A	1.35A at 1200/1
CT4	1200 / 600 / 1A	Type B	1600A	1.35A at 1200/1
275kV, 750MVA, SGTs FULL LOAD CURRENT = 1580A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	2500A	2.1A at 1200/1
CT2	1200 / 600 / 1A	Type A	2500A	2.1A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	2500A	2.1A at 1200/1
CT4	1200 / 600 / 1A	Type B	2500A	2.1A at 1200/1

275kV, 1000MVA, SGTs FULL LOAD CURRENT = 2100A			Continuous Current	Secondary Current Rating
CT1	1200 / 600 / 1A	Type A	3200A	2.7A at 1200/1
CT2	1200 / 600 / 1A	Type A	3200A	2.7A at 1200/1
CT3	1200 / 600 / 1A	Class 1 5P20 30VA	3200A	2.7A at 1200/1
CT4	1200 / 600 / 1A	Type B	3200A	2.7A at 1200/1
The 400kV Bushing CT's				
400kV, 240MVA, SGTs FULL LOAD CURRENT = 350A			Continuous Current	Secondary Current Rating
CT1	2000 / 1000 / 1A	Type A	610A	1A at 2000/1
CT2	2000 / 1000 / 1A	Type A	610A	1A at 2000/1
CT3	2000 / 1000 / 1A	Class 1 5P10/20 30VA	610A	1A at 2000/1
CT4	1200 / 600 / 1A	Type B	610A	1A at 2000/1
400kV, 500MVA, SGTs FULL LOAD CURRENT = 720A			Continuous Current	Secondary Current Rating
CT1	2000 / 1000 / 1A	Type A	1100A	1A at 2000/1
CT2	2000 / 1000 / 1A	Type A	1100A	1A at 2000/1
CT3	2000 / 1000 / 1A	Class 1 5P10/20 30VA	1100A	1.1A at 1000/1A
CT4	1200 / 600 / 1A	Type B	1100A	1A at 2000/1
400kV, 1000MVA, SGTs FULL LOAD CURRENT = 1445A			Continuous Current	Secondary Current Rating
CT1	2000 / 1000 / 1A	Type A	2200A	1.1A at 2000/1
CT2	2000 / 1000 / 1A	Type A	2200A	1.1A at 2000/1
CT3	2000 / 1000 / 1A	Class 1 5P10/20 30VA	2200A	1.1A at 2000/1
CT4	1200 / 600 / 1A	Type B	2200A	1.9A at 1200/1

4.12 145kV, 45 MVA MSCDN's CT's

1. Main capacitor C1 – H – Type Configuration Unbalance Protection

   3 - Single phase, 20/5A, 30VA, Class 0.5, 50 Hz, 123kV, 550kVp BIL, rating 40A max, 5kA/1 sec S/C current

2. Auxiliary Capacitor C2 – H – Type Configuration Protection

   3 - Single phase, 20/5A, 30VA, Class 0.5, 50 Hz, 36kV, 170kVp BIL, rating 40A max, 5kA/1 sec S/C current

3. Reactor Thermal Overload

   3 - Single phase, 400/1A, 30VA, Class 5P10, 50 Hz, 24kV, 125kVp BIL, rating 480A max, 15kA/1 sec S/C current

4. Resistor Thermal Overload / Open Circuit

   6- Single phase, 20/1A, type B, Class X, Vkp $\geq$ 82 (RCT + 3.0) with RCT $\leq$ 2.4 Ω, i.e = 60mA at Vk/2, 10kA/1 sec S/C current

5. Circulating Current Protection

   a) HV Side CT's

   3 - Single phase, 600/300/1A, type B, Class X, Vkp $\geq$ 95(RCT + 2.5), RCT $\leq$ 2.5 Ω at 75°C, i.e. = 60mA at Vkp/2 at 600/1 ratio

   b) LV Side CT's

   3 - Single phase, 600/300/1A, type B, Class X, Vkp $\geq$ 95 (RCT + 2.5), RCT $\leq$ 2.5 Ω at 75°C, i.e. = 60mA at Vkp/2 at 600/1 ratio

4.13 145kV, 60 MVAr MSC CT's

1. Capacitor Split Phase "U" – Type Configuration Unbalanced Protection

   3 x 2 = Single phase, 150/A, 20VA, Class 0.5, 50 Hz, 40kA/3 secs S/C Current

2. Circulating Current Protection

a) HV Side CT's

3 - Single phase, 600/300/1A, Class X, Vk $\geq$ 95 (RCT + 2.5), i.e. = 60 mA at Vk/2, RCT $\leq$ 2.5 Ω at 75°C at 600/1A ratio

b) LV Side CT's

3 - Single phase, 600/300/1 A, Class X, Vk $\geq$ 95 (RCT + 2.5), i.e. = 60 mA at Vk/2, RCT $\leq$ 2.5 Ω at 75°C at 600/1A ratio

4.14 145kV, 60 MVAr MSCDN's CT's

1. Capacitor C1 Split Phase "U" – Type Configuration Unbalance Protection

3 x 2 = Single phase, 150/1A, 20VA, Class 0.5, 50 Hz, 15kA/3 secs S/C current

2. Auxiliary Capacitor C2 Split Phase "U" Type Configuration Unbalance Protection

3 x 2 = Single phase, 150/1A, 20VA, Class 0.5, 50 Hz, 15kA/3 secs S/C current

3. Reactor Thermal Overload

3 -Single phase, 400/1A, 30VA, Class 5P10, 50 Hz, 15kA /1 sec S/C current

4. Resistor Thermal Overload / Open Circuit

6 - Single phase, 20/1A, type Class X, Vk $\geq$ 82 (RCT + 3.0) with RCT $\leq$ 2.5 Ω at 75°C i.e. = 60mA at Vk/2, 10kA/1 sec S/C current

5. Circulating Current Protection

a) HV Side CT's

3 - Single phase, 600/300/1A, Class X, Vk $\geq$ 95 (RCT + 2.5) i.e. =60mA at Vk/2, at 600/1A ratio, 10kA/1 sec S/C current

4.15 400kV, 225 MVAr MSCDN's CT's

1. Main Capacitor C1 Split Phase "U" – Type Configuration Protection

3 x 2 = Single phase, 200/5A, 25VA, Class 0.5, 72.5kV, 325kVp, 240A maximum primary current, 50 Hz, 15kA/1 sec S/C current

2. Auxiliary Capacitor C2 Split Phase "U" – Type Configuration Protection

3 x 2 = Single phase, 200/5A, 25VA, Class 0.5, 72.5kV, 325kVp, 240A maximum primary current, 50 Hz, 15kA/1 sec S/C current

3. Main Capacitor C1 – "H" – Type Configuration Unbalance Protection

3 – Single phase, 20/5A, 30VA, Class 0.5, 50 Hz, 300kV, 1050kVp BIL, 40A maximum primary current, 5kA/1 sec S/C current

4. Reactor Thermal Overload Protection

CT's specifications are same as other 145kV, MSCDN's Reactor

5. Resistor Thermal Overload Protection

CT's specifications are same as other MSCDN's resistors

6. Circulating Current Protection

a) HV Side CT's

3 – 1200/600/1A, 50 Hz, Class X, Vk $\geq$ 82 (RCT + 3), with RCT $\leq$ 2.2 Ω at 75°C, 60mA at Vk/2, 10kA/1 sec S/C current

b) LV Side CT's

3 – 1200/600/1A, 50 Hz, Class X, Vk $\geq$ (RCT + 3), with RCT $\leq$ 2.2 Ω at 75°C, 60mA at Vk/2, 10kA/1 sec S/C current

4.16 DISTANCE PROTECTION CT KNEEPOINT VOLTAGE (VK) REQUIREMENT

$$Vk \geq if \left(1 + \frac{X}{R}\right)(ZR + RCT + 2RL)$$

ZR = Relay Burden

RCT = CT Secondary Resistance

RL = Cable lead Resistance

4.17 EARTH FAULT PROTECTION CT KNEEPOINT VOLTAGE (VK) REQUIREMENT

$$Vk \geq ife \left(1 + \frac{X}{R}\right)(ZRE + RCT + 2RL)$$

ZRE = Relay Burden

4.18 CALCULATION OF KNEEPOINT VOLTAGE OF 5P, 10P, CLASS CT's BASED ON BURDEN AND ALF

1) CT parameters are (say) 5P20, 40VA burden

CT ratio 2000/1 A

i.e. secondary CT rating 1A

Vk = $\frac{Rated\ Burden}{Rated\ Currect}$ x ALF + RCT x ALF x Rated Current (1)

Rated Current = 1 A

RCT = 2.0 Ω

ALF = 40VA

Therefore $Vk = \frac{40}{1} \text{ x } 20 + 2 \text{ x } 20\ 1$

= 800 + 40V

= 840V

OR

2) Vk = ALF x Rated Current x CT Impedance (2)

= 20 x 1 x 2 1 40 = 800V

3) Voltage Transformers

a) 400kV System

VT ratio = $\frac{396kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$

= 228630 / 63.5 / 63.5V, Class = 0.5/3P

Burden 50VA at both windings

b) 132kV System

VT ratio = $\frac{132kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$

= 76210 / 63.5V / 63.5V, Class = 0.5/3P

Burden 50VA at both windings

(To be Continued)

Courtesy: V. Ayadurai Bsc, C.Eng, FIEE

Engineering Expert

ELECTRICAL MAINTENANCE UNIT (QUESTION & ANSWERS) - 15

Turbine Generator Basics

1. Explain the principle of working of impulse steam turbine.

   When steam enters the turbine it suffers a change in direction and momentum, which gives rise to the rotation of the turbine. There will be no drop in pressure in impulse steam turbine.

2. Mention the four processes involved in Rankine cycle.

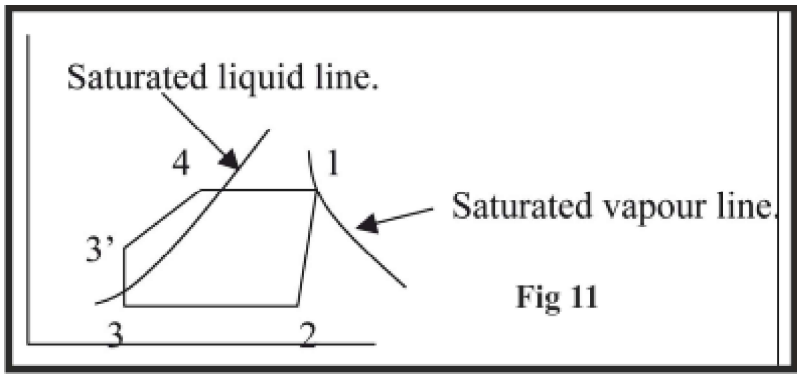


Fig 11

   1 – 2 ⟶ Expansion process.

   2 – 3 ⟶ Constant pressure heat rejection.

   3 – 3 ⟶ Reverse adiabatic expansion.

   3 – 4 and 4 – 1 ⟶ Constant pressure heating.

3. What are the methods of removing moisture from turbine?

   a. External method by moisture separator and reheater, which separates the moisture and reheates the steam.

   b. Internally by stainless steel mesh, which reduces moisture (water particles) to 1%.

   c. By main steam reheat.

4. Define capacity factor.

   Capacity factor can be defined as net power produced by the plant divided by perfect net power that can be produced in the plant.

   Capacity factor = Net power produced / Perfect net power produced.

5. What is the purpose of turbine governing system?

   Turbine governing system governs the speed of the turbine with the help of centrifugal governer. It reduces the steam inlet when turbine over speeds.

6. What are the benefits of feed water heating?

   a. It improves the plant efficiency.

   b. Feed water is heated nearer to saturation point thus thermal shock to boiler is avoided.

7. Mention parameters monitored by turbovisory instruments.

   a. Speed governing.

   b. Eccentricity monitoring.

c. Vibration monitoring.

d. Valve position monitoring.

e. Temperature monitoring.

f. Pressure monitoring.

g. Level monitoring.

h. Gas leak monitoring.

i. Conductivity monitoring.

j. Flow monitoring.

8. What are the purposes of turning gear?

Turning gear is used to run the turbine from rest to low speed and from normal running speed to low speed with the help of barring motor to eliminate the hogging and sagging of turbine because of the high temperature.

9. Explain the differences between the two types of feed water heaters.

a. *Open type*: In which bleed steam and condensed water are mixes directly and there is also dearation of steam.

b. *Closed type (shell type)*: It has tubes and shell. The water passes through the tubes and steam passes through shell. The heat exchange takes place through the metal tubes.

10. Why condenser back-pressure must be low? How it is achieved?

Condenser back- pressure must be low, because steam should be dumped into the condenser so as to recycle it to boiler through the recycle process. It improves efficiency of the turbine, as the heat rejection is less. It is achieved by the help of ejectors and also passing cold water in the condenser through the tubes of the condenser so that maximum vacuum can be obtained.

11. What are the materials used for TG rotor and blades?

TG rotor is made up of alloy steel and blades are made up of stainless steel.

12. Define the term *heat rate*?

Heat rate is defined as the heat supplied in to the plant in Btu by power generated or output by the plant in kWh.

Heat rate = Heat supplied in Btu / Power output in kWh.

13. What is the purpose of gland steam system?

Gland steam system is provided to arrest the steam leak from the turbine and to protect the air ingress into the turbine.

14. Explain the main difference between impulse and reaction turbine.

When the inlet pressure of steam to the turbine is equal to outlet pressure of steam from the turbine the turbine is called the impulse turbine. In this type the heat added is very less.

In reaction turbine the outlet pressure of steam is less than the inlet pressure of the steam. There is reduction in pressure with the increase in kinetic energy.

15. What is meant by hydrodynamic film lubrication?

In high-speed turbines the lubricating oil will be at the sides and there is metal to metal contact when turbine at rest. When the turbine speeds up there is pressure pushing the oil through the metal to metal contact. When turbine finally achieves its speed the oil film breaks the barrier and it takes the load on itself. This is hydrodynamic lubrication.

16. How does the hydrostatic lubrication differ from hydrodynamic type?

In hydrostatic lubrication which is used in slow speed turbines the lubricating oil is pressurised externally where as in hydrodynamic system it forms oil film by its speed which pushes the lubrication oil to form film.

17. What are the functions of dearator?

Dearator removes non-condensable gases (O2), which gets added in the steam and it, mixes steam with the condensed water for feed water heating. This is a contact type feed water heater.

18. Why non-return valves are provided in the steam extraction lines?

Non-return valves are provided because when the turbine trips there will be an instant drop in pressure inside the turbine. But there will be steam in feed water heaters, which is at high pressure. These will rush in to the turbine and over speed will be there in turbine. So non-return valves are provided in steam extraction lines to prevent over speeding of turbine.

19. What is the function of the steam traps?

During startup the steam traps will bypass turbine drains.

20. What do the term sensible heat and latent heat mean?

Sensible heat: We can measure the rise in temperature. When we add more heat to a substance. Example – heat that added to water from 0°C to 100°C. This added heat is measured as sensible heat.

Latent heat: Though there is addition of heat there will be no rise in temperature. This is latent heat. Example – when water boils at 100°C though we added more heat the temperature remains at 100°C till all water becomes steam.

21. How are the generator rotor and stator cooled?

Passing highly DM water through the hollow conductor of the generator cools generator stator and rotor is cooled by hydrogen.

22. What is the function of seal oil system?

Seal oil prevents the leakage of hydrogen from the generator casing to the atmosphere, where it can form explosive mixture. Seal oil is at higher pressure than hydrogen.

23. What are the base load and peak load power stations?

During certain periods the load demands are very high. Example the morning when all factories operate. During these time certain power plants like thermal plants gives this extra power required. These are the *Peak load* stations, which operates at certain periods.

But during the rest of period that is when there is no peak power demand there are some power stations, which cater to the *base load* always runs giving power to the grid. These stations are producing power at constant rate. These stations cannot be easily stopped or restarted. Nuclear power station comes under Base load power station category.

24. What are two types of governing system.

Throttle governing system: In this a valve (just like tap water controlling) which reduces the steam pressure controls the steam flow. This has very less efficiency.

Nozzle governing: In this the steam flow is reduced but the pressure remains the same. This is achieved by four valves in which when one is closed to 25% of steam is reduced. This is efficient way of governing.

(To be continued)

Courtesy:https://www.scribd.com/document/244623258/Question-and-Answers-Electrical-Maintenance-Unit

THE ENERGY CONSERVATION (AMENDMENT) BILL, 2022

HIGHLIGHTS OF THE BILL

- The Bill amends the Energy Conservation Act, 2001 to empower the central government to specify a carbon credit trading scheme.
- Designated consumers may be required to meet a proportion of their energy needs from non-fossil sources.
- The Energy Conservation Code for buildings will also apply to office and residential buildings with a connected load of 100 kilowatt or above.
- Energy consumption standards may be specified for vehicles and ships.

Context

The Energy Conservation Act, 2001 provides a framework for regulating energy consumption and promoting energy efficiency and energy conservation. [i] Energy efficiency means using less energy to perform the same task. The Act has set up the Bureau of Energy Efficiency to recommend regulations and standards for energy consumption. These apply to appliances, vehicles, industrial and commercial establishments and buildings. Efforts towards energy conservation and efficiency gains are among the key instruments envisaged for climate change mitigation. Efforts on these fronts lower the energy generation requirement, and thereby reduce greenhouse gas emissions. These also have positive implications for energy security in a country like India, which relies on imports to meet some of its energy needs. [ii] As per an estimate by the Bureau, programs for efficient energy use have helped India save about 28 million tonnes of oil equivalent energy in 2019-20 (this amount of energy could light about 185 crore 20W LED bulbs 24X7 for a year). [iii] During the COP-26 summit in 2021, India made the following commitments which may be relevant for energy efficiency efforts: (i) reducing total projected carbon emissions by one billion tonnes by 2030, and (ii) reducing the carbon intensity of the economy by 45% by 2030 over 2005 levels. [iv] Carbon intensity is defined as the volume of carbon emissions per unit of GDP. In addition, India aims to have 500 GW of non-fossil energy capacity and meet 50% of its energy requirements from renewable energy by 2030.3 Against this backdrop, the Energy Conservation (Amendment) Bill, 2022 was introduced in Lok Sabha in August 2022. [v] The Bill was passed by Lok Sabha and is currently pending before Rajya Sabha. The Bill seeks to amend the 2001 Act to: (i) facilitate the achievement of COP-26 goals, and (ii) introduce concepts such as mandated use of non-fossil sources and carbon credit trading to ensure faster decarbonisation of the Indian economy.

Key Features

- **Carbon credit trading:** The Bill empowers the central government to specify a carbon credit trading scheme. Carbon credit implies a tradeable permit to produce a specified amount of carbon dioxide or other greenhouse emissions. The central government or any authorised agency may issue carbon credit certificates to entities registered and compliant with the scheme. The entities will be entitled to trade the certificates. Any other person may also purchase a carbon credit certificate on a voluntary basis.
- **Obligation to use non-fossil sources of energy:** The Act empowers the central government to specify energy consumption standards. The Bill adds that the government may require designated consumers to meet a minimum share of energy consumption from non-fossil sources. Different consumption thresholds may be specified for different non-fossil sources and consumer categories. Designated consumers include: (i) industries such as mining, steel, cement, textile, chemicals, and petrochemicals, (ii) transport sector including Railways, and (iii) commercial buildings, as specified in the schedule. Failure to meet this obligation will be punishable with a penalty of up to Rs 10 lakh. It will also attract an additional penalty of up to twice the price of oil equivalent of energy consumed above the prescribed norm.
- **Energy conservation code for buildings:** The Act empowers the central government to specify Energy Conservation Code for buildings. The code prescribes energy consumption standards in terms of area. The Bill amends this to provide for an 'Energy Conservation and Sustainable Building Code'.

This new code will provide norms for energy efficiency and conservation, use of renewable energy, and other requirements for green buildings. Under the Act, the energy conservation code applies to commercial buildings: (i) erected after the notification of the Code, and (ii) having a minimum connected load of 100 kilowatt (kW) or contract load of 120 kilo volt ampere (kVA). Under the Bill, the new Energy Conservation and Sustainable Building Code will also apply to the office and residential buildings meeting the above criteria. The Bill empowers the state governments to lower the load thresholds.

- **Standards for vehicles and vessels:** Under the Act, the energy consumption standards may be specified for equipment and appliances which consume, generate, transmit, or supply energy. The Bill expands the scope to include vehicles (as defined under the Motor Vehicles Act, 1988), and vessels (includes ships and boats). The failure to comply with standards will be punishable with a penalty of up to Rs 10 lakh. Non-compliance in case of vessels will attract an additional penalty of up to twice the price of oil equivalent of energy consumed above the prescribed norm. Vehicle manufacturers in violation of fuel consumption norms will be liable to pay a penalty of up to Rs 50,000 per unit of vehicles sold.
- **Composition of the governing council of BEE**: The Act provides for the setting up of the Bureau of Energy Efficiency (BEE). The Bureau has a governing council with members between 20 and 26 in number. These include: (i) secretaries of six departments, (ii) representatives of regulatory authorities such as the Central Electricity Authority, and the Bureau of Indian Standards, and (iii) up to four members representing industries and consumers. The Bill amends this to provide that the number of members will be between 31 and 37. It increases the number of secretaries to 12. It also provides for up to seven members representing industries and consumers.

Key Issues and Analysis

- Carbon credit trading aims to reduce carbon emissions, and hence, address climate change. The question is whether the Ministry of Power is the appropriate Ministry to regulate this scheme. A further question is whether the market regulator for carbon credit trading should be specified in the Act.
- Same activity may be eligible for renewable energy, energy savings, and carbon credit certificates. The Bill does not specify whether these certificates will be interchangeable.
- Designated consumers must meet certain non-fossil energy use obligation. Given the limited competition among discoms in any area, consumers may not have a choice in the energy mix.

15 WAYS TO SAVE MONEY ON ELECTRICITY

THIS SUMMER

1. Check your air ducts for leaks
2. Replace your air filters regularly
3. Make sure your vents are *actually* open
4. Use the "Energy Saver" option on your AC
5. Instead of turning off your AC during the day, cut the temperature back 7-10% (Your AC won't have to work as hard to cool your house back down)
6. Consider investing in a programmable thermostat
7. Only run full loads when using your large appliances (washer, dryer, dishwasher)
8. Use appliances in off-peak hours if you can (usually after 8PM)
9. Do your laundry in cold water (it won't damage your clothes like you think it will)
10. Try sun drying your clothes instead of using the dryer
11. Skip the heated dry cycle on your dishwasher
12. Use power strips and shut them off when you aren't using what's plugged in
13. Keep your curtains closed (reduces incoming heat by up to 30%)
14. Install awnings on south and west facing windows
15. Consider installing window AC units in bedrooms so you only have to cool the bedrooms at night, instead of the whole house.

PEROVSKITE SOLARCELLS – THE FUTURE OF SOLAR POWER GENERATION - 3

How cells are made?

Solution method

Basically, perovskites can be made using two step "wet chemistry method" in which a saturated methanol solution of Pbl_2, is used as the precursor solution for the spin coating on the substrate. The mixture is deposited on a substrate like glass, metal oxide, flexible polymer, a silicon solar cell or even transparent wood. The deposition of the perovskite solution is usually done via spin-coating. The solution is dripped or sprayed onto the substrate, which is then spun at high speed to spread a thin layer of the solution across the surface. And then, the Pbl_2 - coated substrate is immersed in a propanol solution containing methylammonium iodide (MAI) for a suitable time. After drying at a suitable temperature, the $Pb1_2$ reacts with MAI and thin layers of perovskite crystals are formed that is ready to be wired into a solar cell. The dipping time and the MAI solution concentration are crucial to the morphology and electronic properties of the final $MAPbI_3$ film. Perovskite cells made by this method have high PCE of 15%.

Sequential Vapour deposition method

In this method, the synthesis is done in the laboratory under high vacuum conditions in which $pb1_2$ is first deposited by thermal evaporation followed by vapour deposition of MAI. This sequential deposition has been developed so that monitoring of MAI can be done with ease. Perovskite thin films prepared by this method exhibit a PCE of 15.4% and a perovskite / provskite tandem solar cell could deliver of PCE of 18%

Architecture and working principle of PSC

The PSC's structure basically consists of a light harvesting perovskite layer sandwiched between electrons selective contacts (TiO2) and holes selective contacts (spiro-OMeTAD) . On top of the fluorine- doped tin oxide (FTO) /glass substrate the TiO2 layer is grown. and then CH3NH3Pb13 perovskite followed by growth of spiro-OMeTAD. The metallic electrodes are often made of gold or silver in order to achieve better connections with load.

The transparent electrode made from fluorine-doped tin oxide (FT0), is coated with an electron transporting layer (ETL) made of compact Ti02. ETL is transparent to visible light, has low absorption and high refractive index. The layers of TiO2 can be grown by many low cost techniques like spin coating or spray pyrolysis obtaining crystalline films as well as nanostructured coatings. Sometimes an additional mesoporous TiO2 layer is used on top of ETL. This porous layer acts as a scaffold for the photoactive perovskite layer which is deposited (usually from solution) on top of it.

Mesoporous materials are widely applied because of their high porosity and large specific area upto 1000 m2 / gm. Use of mesoporous materials in PSCs allows the perovskite to adhere to the mesoporous metal oxide framework enabling to increase the light receiving area of the photosensitive material and improving the efficiency of the device. TiO2 is the most typical mesoporous framework material, which allows the perovskite nanocrystals to penetrate into the pores of mesoporous TiO2 and form an interconnecting absorbing layer. In this structure TiO2 not only plays a supporting role but also has significant functional roles, e.g transporting electrons. blocking holes and inhibiting the recombination of electron - whole pairs in the FTO conductive substrate that improves the photoelectric conversion efficiency. Besides Ti02. other commonly used frame materials are ZnO. Al203 and Zr02.

A whole transport layer (HTL) is deposited on top of the perovskite layer followed by metallic evaporation of top gold electrode. HTL material is the organic tetrakismethoxyphenylaminospirobifluorene (Spiro-OMeTAD) molecular glass. In 2014 conversion efficiency of PSC reached 19.3% under full sun in planer cell geometry without mesoporous TiO2 scaffold that incorporated Spiro-OMeTAD. The main advantage of this HTL is that

it possess large solubility and a reasonably large hole mobility and it does not require any post annealing treatment. Its suitable affinity with the perovskite layer. associated with a favourable energetic configuration reduces charge recombination that means reduction of potential losses. It is the most efficient HIM till date. Its main drawback is that unless the doping protocol is strictly followed and if there is any deviation from the recommended quantities. then it can drastically alter the performance. Furthermore, the presence of dopants might be responsible for poor stability of PSC. SpiroOMeTAD is also quite expensive.

Working principle of PSC

The working principle of perovskite solar (PVSK) cell is shown in Fig - 1. When incident photons reach the perovskite layer through transparent electrode, excitons are formed which are found to be easily dissociated into free charge carriers in ambient conditions. The exciton binding energy is dependent on the composition of the perovskite as well as the optical gap. In any case, free charge carriers are easily formed and are transported to the ETL and HTL interface due to high diffusion length for both electrons and holes.The HTL and ETL ensure selective charge collection at the electrode, while reducing recombination events.

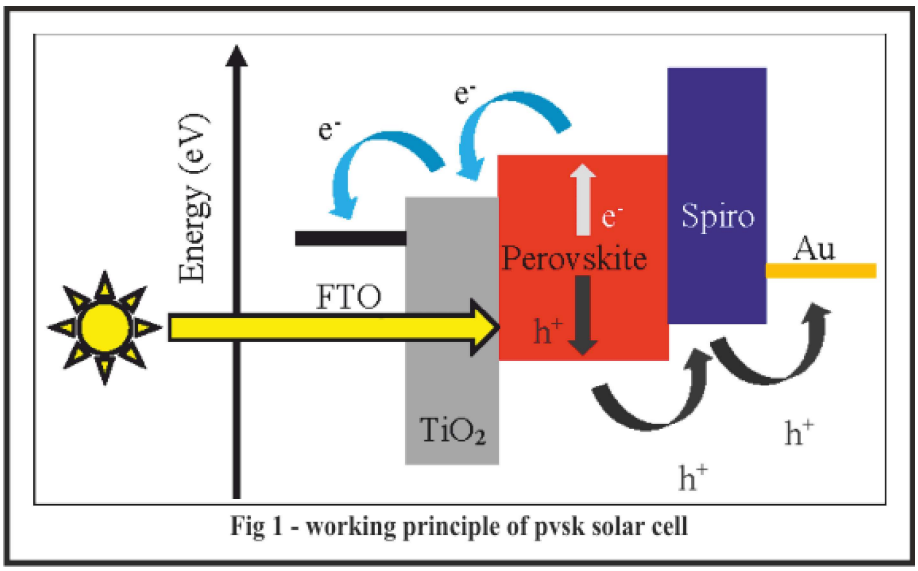


Fig 1 - working principle of pvsk solar cell

Types of perovskite solar cells

There are essentially two different types of perovskite solar cells: thin - film cells with perovskite as the only photovoltaic material and tandem cells, which have either multiple layers of perovskite or a thin perovskite layer on top of traditional crystalline silicon.

Thin - film cell with perovskite as the only PV material

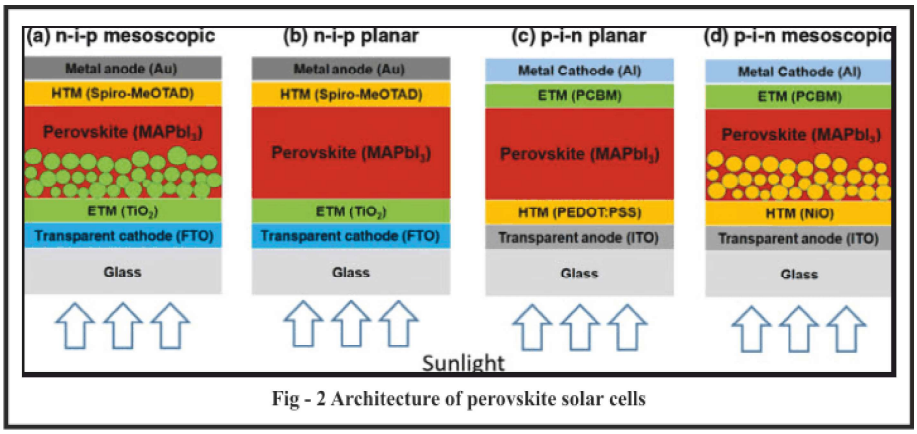
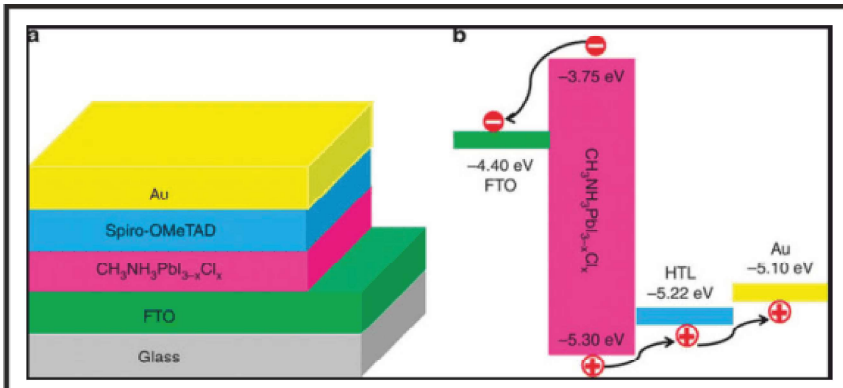


Fig - 2 Architecture of perovskite solar cells

The basic structure of perovskite solar cell consists of electron transporting layer/material (ETL / ETM), a hole transporting layer /material (HTL/HTM), an anode and a cathode . PSCs are classified as regular n-i-p and inverted p-i-n structures, depending on which transport layer on the exterior portion of the perovskites encounters sunlight first. In the n-i-p structure, the ETL is deposited first whereas in p-i-n structure HTL is deposited first. These two structures can be further subdivided into two categories: - mesoporic and planar structures as shown in Fig - 2.

"America is home to the best researchers, advanced manufactures, and entrepreneurs in the world. There is no reason we cannot lead the planet in manufacturing solar panels and wind turbines, engineering the smart energy grid and inspiring the next great companies that will be the titans of a new green energy economy." – BRAD SCHNEUDER

The mesoporic structure incorporates a mesoporous metal oxide layer sandwiched between ETL and HTL, whereas n-i-p planar configuration does not envisage a mesoporous metal oxide layer and makes the whole morphology simple. The cathode is a transparent glass and a metal layer acts as anode. In an n-i-p planar structure, the perovskite light harvesting layer is placed between ETL and HTL. The efficiency here can be increased by controlling the interfaces between the various layers of the structure. n-i-p PSCs show higher open circuit voltage and short circuit current density compared to the mesoporous n-i-p structure. The current density - voltage hysteresis is a major drawback of n-i-p planar PSCs.



(a) - Electron transport layer free planer PSC
(b) - Energy level diagram showing collection and separation of electrons and holes
Fig - 3 Arrangement of etl free perovskite solar cell

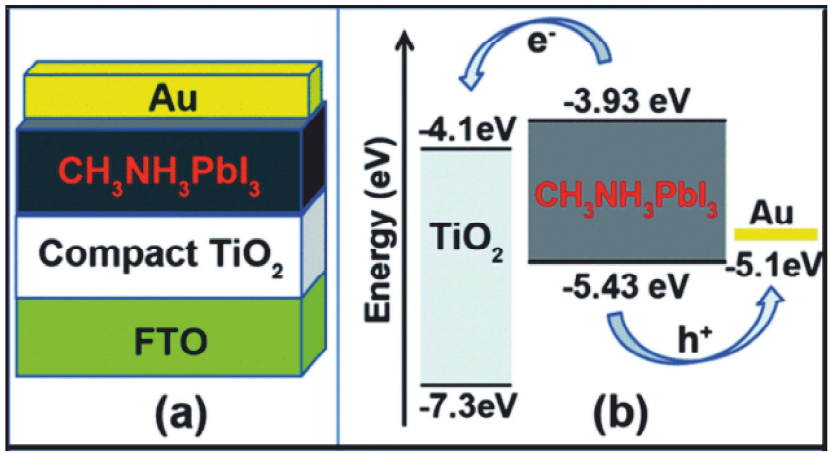


Fig - 4 Configuration and Energy Level Alignment of Hole Transport Layer Free Perovskite Solar

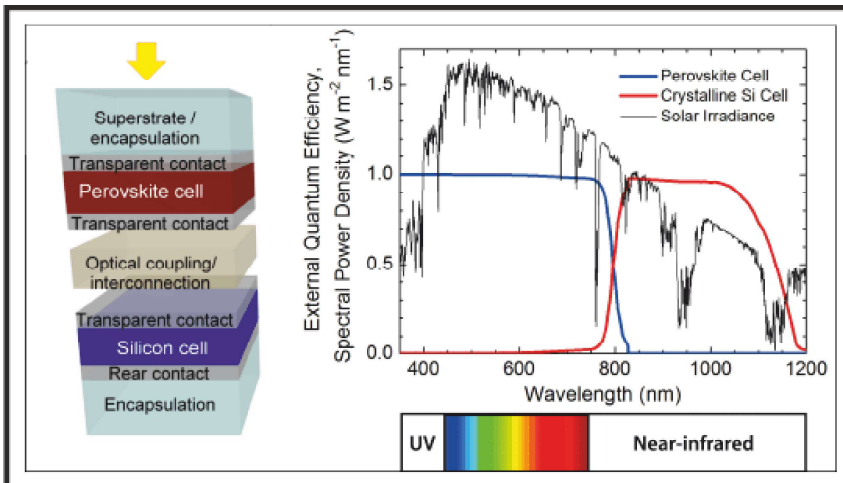


Fig - 5 Quantum efficiency of perovskite and silicon cell

Apart from the above configurations, there are other configurations that include:

ETL free configurations and HTL free configurations.

In the ETL free configuration (Refer Fig - 3) perovskite layer is directly deposited on the FTO (flourine doped tin oxide) surface via a one stop solution process without any hole blocking layers. This ETL free configuration exihibited a PCE of 14.4% and a V_{OC} of 1.06 V.

HTL-free PSC architectures are a simpler cell configuration that is garnering increased attention, because HTLs are very costly. As earlier said organo-lead halide perovskite materials show outstanding semiconducting properties like long charge transport lifetimes and an ambipolar nature which allows for the exclusion of the hole-transporting layer. MAPb13 itself can have the function of both a light harvester and hole conductor. A remarkable 12.8% certified efficiency with high stability has been obtained in HTL-free PSC using a double layer of mesoporous TiO2 and ZrO3 covered with porous carbon. The structure is shown in Fig - 4.

Hence researchers have now focusing on tandem solar cells, which feature a thin layer of perovskite cells - about one micrometer thick - on top of a layer of silicon based cells: a perfect pairing. The resulting combination recently reached a record efficiency of 29.52% manufactured by Oxford PV (Refer Fig - 6).

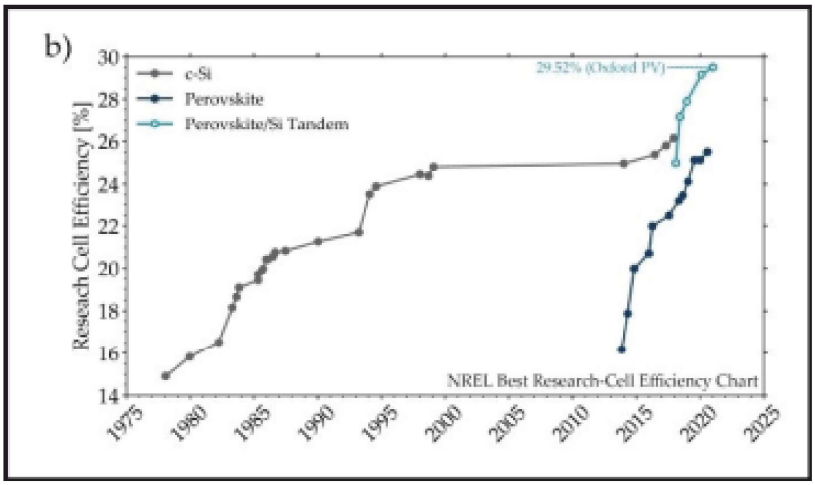


Fig - 6 Solar Cell Efficiency Chart

Whereas silicon is a weakly absorbing material that requires hundreds of micrometres of thickness to fully absorb sunlight due to its indirect bandgap, perovskitesare strongly absorbing, direct bandgap semiconductors that requires less than a micrometre of material thickness. Silicon is a covalently bonded material that requires energy intensive fabrication process to synthesize high purity single crystals necessary for making low defect wafers, whereas perovskites are ionic semiconductors that are inherently defect tolerant and can be processed at low temperatures into pollycrystalline forms. Due to these reasons the paired perovskite - silicon tandem cells are very economical to manufacture high efficiency solar cells. The sub-cells can either be uncoupled semitransparent devices that are mechanically stacked to form a four terminal (4T) or alternatively serially connected in a monolithically integrated two-terminal (2T) configuration. Traditional 4T designs require twice the number of inverters of 2T tandem modules and hence the cost of power electronics for 4T module is economically prohibitive. In contrast, 2T designs are fully compatible with the standard power electronics of mainstream single junction solar modules and therefore. represent the most cost effective tandem configuration. Schematic arrangement of 2T perovskite-silicon tandem cell is shown in Fig - 7.

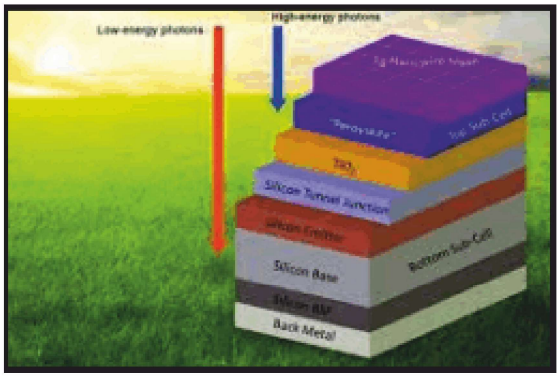


Fig - 7 Schematic Arrangement of Tandem Cell

In series connected 2T configuration, the generated carriers transport from one subcell to another subcell through the conductive layer. As the subcells are connected in series, they need to match the current and hence the material having suitable bandgap has to be used, which limits the choice of material. 2T connection imposes an important boundary condition - that the current in both subcells must remain equal.

(To be Continued)

Courtesy: Ieema Journal, February 2022

"We are like tenant farmers chopping down the fence around our house for fuel when we should be using Natures inexhaustible sources of energy - sun, wind and tide. ... I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that." – THOMAS EDISON

CENTRAL ELECTRICITY AUTHORITY REGULATION 2010 – CHAPTER III – REGULATIONS PART - 2

General Safety Requirements

12. General safety requirements pertaining to construction, installation, protection, operation and maintenance of electric supply lines and apparatus –

(1) All electric supply lines and apparatus shall be of sufficient rating for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty cycle which they may be required to perform under the environmental conditions of installation, and shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human beings, animals and property.

(2) Save as otherwise provided in these regulations, the relevant code of practice of the Bureau of Indian Standards or National Electrical Code, if any, may be followed to carry out the purposes of this regulation and in the event of any inconsistency, the provisions of these regulations shall prevail.

(3) The material and apparatus used shall conform to the relevant specifications of the Bureau of Indian Standards or International Electro-Technical Commission where such specifications have already been laid down.

(4) All electrical equipment shall be installed above the Mean Sea Level (MSL) as declared by local Municipal Authorities and where such equipment is to be installed in the basement, consumer shall ensure that the design of the basement should be such that there is no seepage or leakage or logging of water in the basement.

13. Service lines and apparatus on consumer's premises –

(1) The supplier shall ensure that all electric supply lines, wires, fittings and apparatus belonging to him or under his control, which are on a consumer's premises, are in a safe-condition and in all respects fit for supplying electricity and the supplier shall take precautions to avoid danger arising on such premises from such supply lines, wires, fittings and apparatus.

(2) Service lines placed by the supplier on the premises of a consumer which are underground or which are accessible shall be so insulated and protected by the supplier as to be secured under all ordinary conditions against Electrical, Mechanical, Chemical or Other injury to the insulation.

(3) The consumer shall, as far as circumstances permit, take precautions for the safe custody of the equipment on his premises belonging to the supplier.

(4) The consumer shall also ensure that the installation under his control is maintained in a safe condition.

14. Switchgear on consumer's premises –

(1) The supplier shall provide a suitable switchgear in each conductor of every service line other than an earthed or earthed neutral conductor or the earthed external conductor of a concentric cable within a consumer's premises, in an accessible position and such switchgear shall have contained within an adequately enclosed fireproof receptacle:

Provided that where more than one consumer is supplied through a common service line, each such consumer shall be provided with an independent switchgear at the point of rigid junction to the common service.

15. Identification of earthed neutral conductors and position of switches and switchgear therein –

Where the conductors include an earthed conductor of a two-wire system or an earthed neutral of a multi-wire system or a conductor which is to be connected thereto, the following conditions shall be complied with:

(i) An indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor, or the conductor which is to be connected thereto, to enable such conductor to be distinguished from any live conductor to be distinguished from any live conductor and such indication shall be provided-

(a) Where the earthed or earthed neutral conductor is the property of the supplier, at or near the point of commencement of supply;

(b) Where a conductor forming part of a consumer's system is to be connected to the supplier's earthed neutral conductor, at the point where such connection is to be made;

(c) In all other cases, at such other points as may be approved by an Electrical Inspector.

(ii) No cut-out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted or remain inserted in any earthed or earthed neutral conductor of a two wire-system or in any earthed or earthed neutral conductor of a multi-wire system or in any conductor connected thereto.

Provided that the above requirement shall not apply in case of –

(a) a link for testing purposes, or

(b) a switch for use in controlling a generator or transformer.

16. Earthed terminal on consumer's premises –

(1) The supplier shall provide and maintain on the consumer's premises for the consumer's premises for the consumer's use, a suitable earthed terminal in an accessible position at or near the point of commencement of supply.

Provided that in the case of installation of voltage exceeding 250V the consumer shall, in addition to the aforementioned earthing arrangement, provide his own earthing system with an independent electrode.

Provided further that the supplier may not provide any earthed terminal in the case of installations already connected to his system on or before the date to be specified by the State Government in this behalf if he is satisfied that the consumer's earthing arrangement is efficient.

(2) The consumer shall take all reasonable precautions to prevent mechanical damage to the earthed terminal and its lead belonging to the supplier.

(3) The supplier may recover from the consumer the cost of installation on the basis of schedule of charges published by him in advance and where such schedule of charges is not published, the procedure laid down, in regulation 63 shall apply.

Explanation – For the purposes of sub-regulation (1) the expression "point of commencement of supply of electricity" shall mean the point at the incoming terminal of the switchgear installed by the consumer.

17. Accessibility of bare conductors -

Where bare conductors are used in a building, the owner of such conductors shall. –

(a) ensure that they are inaccessible;

(b) provide in readily accessible position switches for rendering them dead whenever necessary; and

(c) take such other safety measures as are specified in the relevant Indian Standards.

18. Danger Notices -

The owner of every installation of voltage exceeding 250V shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the District, with a sign of skull and bones of a design as per IS – 2551 on –

(a) every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same;

(b) all supports of overhead lines of voltage exceeding 650V which can be easily climbed upon without the aid of ladder or special appliances;

(c) luminous tube sign requiring supply, X-ray and similar high frequency installations of voltage exceeding 650V but not exceeding 33kV;

Provided that where it is not possible to affix such notices on any generator, motor, transformer or other apparatus, they shall be affixed as near as possible thereto, or the word 'danger' and the voltage of the apparatus concerned shall be permanently painted on it:

Provided further that where the generator, motor, transformer or other apparatus is within an enclosure one notice affixed to the said enclosure shall be sufficient for the purposes of this regulation

Explanation – For the purpose of clause (b) rails, tubular poles, wooden supports, reinforced cement concrete poles without steps, I-sections and channels, shall be deemed as supports which cannot be easily climbed upon

19. Handling of electric supply lines and apparatus -

(1) Before any conductor or apparatus is handled, adequate precautions shall be taken, by earthing or other suitable means, to discharge electrically such conductor or apparatus, and any adjacent conductor or apparatus from being accidently or inadvertently electrically charged when persons are working thereon.

(2) Every person who is working on an electric supply line or apparatus or both shall be provided with tools and devices such as Gloves, Rubber Shoes, Safety Belts, Ladders, Earthing Devices, Helmets, Line Testers, Hand Lines and the like for protecting him from mechanical and electrical injury and such tools and devices shall always be maintained in sound and efficient working condition.

(3) No person shall work on any live electric supply line or apparatus and no person shall assist such person on such work, unless he is designated in that behalf and takes the safety precautions given in Schedule – III.

(4) All panels shall be painted with the description of its identification at front and at the rear.

20. Supply to vehicles and cranes -

Every person owning a vehicle, travelling crane, or the like to which electricity is supplied from an external source shall ensure that it is efficiently controlled by suitable switch enabling all voltage to be cut off in one operation and where such vehicle, travelling crane or the like runs on metal rails, the owner shall ensure that the rails are electrically continuous and earthed.

21. Cables for portable or transportable apparatus -

(1) Flexible cables shall not be used for portable or transportable motors, generators, transformers, rectifiers, electric drills, electric sprayers, welding sets or any other portable or transportable apparatus unless they are heavily insulated and adequately protected from mechanical injury.

(2) Where the protection is by means of metallic covering, the covering shall be in metallic connection with the frame of any such apparatus and earthed.

(3) The cables shall be three core type and four core type for portable and transportable apparatus working on single phase and three phase supply respectively and the wire meant to be used for ground connection shall be easily identifiable.

22. Cables protected by bituminous materials -

(1) Where the supplier or the owner has brought into use an electric supply line, other than an overhead line, which is not completely enclosed in a continuous metallic covering connected with earth and is insulated or protected in situ by composition or material of a bituminous character –

(i) any pipe, conduit, or the like into which such electric supply line may have been drawn or placed shall, unless other arrangements are approved by the Electrical Inspector in any particular case, be effectively sealed at its point of entry into any street box so as to prevent any flow of gas to or from the street box and;

(ii) Such electric supply line shall be periodically inspected and tested where accessible and the result of each such inspection and test shall be duly recorded by the supplier or the owner.

(2) The supplier or the owner after the coming into force of these regulations, shall not bring into use any further electric supply line as aforesaid which is insulated or protected in situ by any composition or material known to be liable to produce noxious or explosive gases on excessive heating.

23. Street boxes -

(1) Street boxes shall not contain gas pipe and precautions shall be taken to prevent as far as reasonably possible any influx to water or gas

(2) Where electric supply lines forming part of different systems pass through the same street box, they shall be readily distinguishable from one another and all electric supply lines of voltage exceeding 650V at or in street boxes shall be adequately supported and protected so as to prevent risk of damage to or danger from adjacent electric supply lines.

(3) All street boxes shall be regularly inspected for the purpose of detecting the presence of gas and if any influx or accumulation is discovered the owner shall give immediate notice to any authority or company who have gas mains in the neighbourhood of the street box and in cases where a street box is large enough to admit the entrance of a person after the electric supply lines or apparatus therein have been placed in position, ample provision shall be made –

(i) To ensure that any gas which may be accident have obtained access to the box shall escape before as person is allowed to enter; and

(ii) For the prevention of danger from sparking.

(4) The owners of all street boxes or pillars containing circuits or apparatus shall ensure that their covers and doors are kept closed and locked and are so provided that they can be opened only by means of a key or a special appliance.

24. Distinction of different circuits –

The owner of every generating station, sub-station, junction – box or pillar in which there are any circuits or apparatus, whether intended for operation at different voltages or at the same voltage, shall ensure by means of indication of a permanent nature that the respective circuits are readily distinguishable from one another.

25. Distinction of the installation having more than one feed –

The owner of every installation including sub-station, double pole structure, four pole structure or any other structure having more than one feed, shall ensure by means of indication of a permanent nature, that the installation is readily distinguishable from other installations.

26. Accidental Charging –

(1) The owners of all circuits and apparatus shall so arrange them that there shall be no danger of any part thereof becoming accidentally charged to any voltage beyond the limits of voltage for which they are intended.

(2) Where alternating current and direct current circuits are installed on the same box or support, they shall be so arranged and protected that they shall not come into contact with each other when live.

27. Provisions applicable to protective equipment -

(1) Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires, in addition to fire extinguishers suitable for dealing with fires, shall be conspicuously marked and kept in all generating stations, enclosed sub-stations and switching – stations in convenient location.

(2) The fire extinguishers shall be tested for satisfactory operation as per relevant Indian Standard at least once a year and record of such tests shall be maintained.

(3) First-aid boxes or cupboards conspicuously marked and equipped with such contents as the State Government may specify, shall be provided and maintained in every generating station, enclosed sub-station, enclosed switching station and in vehicles used for maintenance of lines so as to be readily accessible during all working hours and all such boxes and cupboards shall, except in the case of unattended sub-stations and switching stations, be kept in charge of responsible persons who are trained in first-aid treatment and one of such persons shall be available during working hours.

(4) Two or more gas masks shall be provided conspicuously and installed and maintained at accessible places in every generating station with capacity of 5 MW and above and enclosed sub-station with transformation capacity of 5 MVA and above for use in the event of fire or smoke;

Provided that where more than one generator with capacity of 5 MW and above is installed in a power station, each generator shall be provided with at least two separate gas masks in an accessible and conspicuous place.

Provided further that adequate number of gas masks shall be provided by the owner at every generating station and enclosed sub-station with capacity less than 5 MW and 5 MVA respectively.

28. Display of instructions for resuscitation of persons suffering from electric shock –

(1) Instructions, in English or Hindi and the local language of the District and where Hindi is the local language, in English and Hindi for the resuscitation of persons suffering from electric shock, shall be affixed by the owner in a conspicuous place in every generating station, enclosed sub-station, enclose switching station, mines and in every factory as defined in clause (m) of section 2 of the Factory Act 1948 (63 of 1948) in which electricity is used and in such other premises where electricity is used as the Electrical Inspector may, by notice in writing served on the owner, direct.

(2) The owner of every generating station, enclosed sub-station, enclosed switching station and every factory or other premises to which these regulations apply, shall ensure that all designated persons employed by him are acquainted with and are competent to apply the instructions referred to in sub-regulation (1).

(3) In every manned generating station, sub-station or switching station of voltage exceeding 650V, an artificial respirator shall be provided and kept in good working condition.

29. Precautions to be adopted by Consumers, Owners, Occupiers, Electrical Contractors, Electrical Workmen and Suppliers -

(1) No electrical installation work, including additions, alterations, repairs and adjustments to existing installations, except such replacement of lamps, fans, fuses, switches, domestic appliances of voltage not exceeding 250V and fittings as in no way alters its capacity or character, shall be carried out upon the premises of or on behalf of any consumer, supplier, owner or occupier for the purpose of supply to such consumer, supplier, owner or occupier except by an electrical contractor licensed in this behalf by the State Government and under the direct supervision of a person holding a certificate of competency and by a person holding a permit issued or recognised by the State Government.

Provided that in the case of works executed for or on behalf of the Central Government and in the case of installations in mines, oil fields and railways, the Central Government and in other cases the State Government mayby notification in the Official Gazette, exempt on such conditions as it may impose, any such work described therein either generally or in the case of any specified class of Consumers, Suppliers, Owners or Occupiers.

(2) No electrical installation work which has been carried out in contravention of sub-regulation (1) shall either be energised or connected to the works of any supplier.

30. Periodical inspection and testing of installations –

(1) Where an installation is already connected to the supply system of the supplier or trader, every such installation shall be periodically inspected and tested at intervals not exceeding five years either by the Electrical

Inspector or by the supplier as may be directed by the State Government in this behalf or in the case of installations belonging to, or under the control of the Central Government, and in the case of installation in mines, oil fields and railways by the Central Government.

(2) The periodical inspection and testing of installations of voltage above 650V belonging to the supplier, shall also be carried out at intervals not exceeding five years by the Electrical Inspector;

(3) Where the supplier is directed by the Central or the State Government, as the case may be, to inspect and test the installation, he shall report on the condition of the installation to the consumer concerned in the | Forms I, II and III as specified in Schedule – IV and shall submit a copy of such report to the electrical Inspector;

(4) The Electrical inspector may, on receipt of such report, accept the report submitted by the supplier or record variations as the circumstances of each case may require and may recommend that the defects may be rectified as per report;

(5) In the event of the failure of the owner of any installation to rectify the defects in his installation pointed out by the Electrical Inspector in his report and within the time indicated therein, such installation shall be liable to be disconnected under the directions of the Electrical Inspector after serving the owner of such installation with a notice for not less than forty eight hours.

Provided that the installation shall not be disconnected in case an appeal is made under sub-rule (1) of rule (8) of "Qualifications, Powers and Functions of Chief Electrical and Electrical Inspectors issued by Central Government vide GSR 481 (E) dated 17.08.2006 and the appellate authority has stayed the orders of disconnection.

31. Testing of consumer's installation –

(1) Upon receipt of an application for a new or additional supply of electricity and before connecting the supply or reconnecting the same after a period of six months, the supplier shall either test the installation himself or accept the test results submitted by the consumer when the same has been duly signed by the licensed Electrical Contractor.

(2) The supplier shall maintain a record of test results obtained at each supply point to a consumer in a Schedule – V.

(3) If as a result of such inspection and test, the supplier is satisfied that the installation is likely to be dangerous, he shall serve on the applicant a notice in writing requiring him to make such modifications as are necessary to render the installation safe and may refuse to connect or reconnect the supply until the required modifications have been completed.

32. Installation and testing of generating units –

Capacity above which generating units will be required to be inspected by the Electrical Inspector before commissioning shall be as per the notification to be issued by the Appropriate government, under clause (x) sub-section (2) of section 176 and sub-section (1) of section 162 of the Act.

(To be continued)

Courtesy: The Gazette of India: Extraordinary (Part III – Sec.4)

Entrepreneurship is the engine fuelling innovation, employment generation and economic growth. Only by creating an environment where entrepreneur-ship can prosper and where entrepreneurs can try new ideas and empower others can we ensure that many of the world's issues will not go unaddressed.

– KLAUS SCHWAB

ENERGY – GLOBAL MISSION AND INITIATIVES INDIA'S COMMITMENTS AND STRATEGIES – 9

Sustainable Growth, Sustainable Energy, Emission reduction and Renewable Energy.

Hydrogen and Green Hydrogen

Some more details on Hydrogen and Green Hydrogen, in addition to the coverage in the last issue will throw more light on this important development in our country with the launch of the National Hydrogen Mission 2021.

It must be clearly understood that Hydrogen, like electricity, is an energy carrier that must be produced from another substance.Hydrogen can be produced—separated—from a variety of sources including water, fossil fuels, or biomass and used as a source of energy or fuel.

Two News Items, both of January 2023, given below will throw light on current developments and priorities:

Green hydrogen economy

January 6, 2023

Green hydrogen is now seen all over the world as a pillar of most net-zero emission scenarios.

The national green hydrogen mission, a key project for ensuring energy transition, is also the cornerstone of India's climate action targets for 2030 as well as the 2070 'Net Zero' goal. In that context, the Union Cabinet's decision on Wednesday to approve an initial capital outlay of Rs 19,700crore for green hydrogen is a good beginning towards achieving the mission's 2030 investment target of `8 trillion, and a hydrogen production capacity of 5 million metric tonnes (MMT) that would create 600,000 jobs. Green hydrogen, which is produced through the electrolysis of water using renewable energy sources, has the potential to greatly reduce carbon emissions. It is also estimated to result in a cumulative reduction in fossil fuel imports of over `1 trillion and abatement of nearly 50 MMT of annual greenhouse gas emissions.

There is a reason for the government's enthusiasm. Green hydrogen is now seen all over the world as a pillar of most net-zero emission scenarios. It's a no-brainer that if hydrogen were adequately available, it would be something of a de carbonization wonder. It can make carbon-free fuels for transportation and heating, and power some energy-intensive industries that can't easily be electrified, such as the manufacture of steel or fertilizer. That explains why the government has already promised faster clearances for setting up renewable energy plants for hydrogen production. Any surplus electricity from such plants can be 'banked' with the local utility for up to 30 days. If a hydrogen producer wishes to buy electricity from a renewable energy company, 'open access' permission would be given within 15 days of application; and if the energy supplier is in another state, inter-state transmission system charges would be waived for a period of 25 years.

The problem is that green hydrogen is not commercially viable at present. The current cost in India is around '350-400 per kg; it is likely to become viable only at a production cost of under Rs 100/ kg. The technology used in the production and use of hydrogen is at a nascent stage in India, and is therefore expensive. This, in turn, increases the cost of hydrogen production and will require a lot of investment. In addition to the higher manufacturing cost, there is higher maintenance cost as well. So far, creating a hydrogen economy has been a chicken-and-egg problem as consumers seek lower costs which could be possible with scalability and large investments, but for those, producers seek assured demand. The good news, according to TERI estimates, is that by 2030 green hydrogen will become increasingly competitive, coinciding with a decline in electrolyser costs and the increasing load factors of solar plants. These are the factors why a host of public sector and private companies have already announced big plans for green hydrogen production.

The green hydrogen policy has addressed several critical challenges such as open access, waiver of inter-state transmission charges, banking, time-bound clearances, etc, but specific guidelines for implementation are yet to be announced. That is critical. For example, the issue of transportation and storage will require prerequisites such as clearances from the Petroleum and Explosives Safety Organization as well as various environmental safeguards and right of way across states. Water scarcity could also pose a challenge as production of 1 kg of hydrogen by electrolysis requires around nine litres of water. Therefore, hydrogen project planning should be holistic and targeted in areas that are not water-scarce.

NTPC starts India's first green hydrogen blending operation in PNG network

New Delhi, January 04, 2023:

Country's largest power generator, NTPC Ltd commissions India's first green hydrogen blending project. Green hydrogen blending has been started in the piped natural gas (PNG) network of NTPC Kawas township, Surat. The project is a joint effort of NTPC and Gujarat Gas Limited (GGL).

The first molecule of green hydrogen from the project was set in motion by Shri P Ram Prasad, head of project, Kawas in presence of other senior executives of NTPC Kawas and GGL.

After the start of the blending operation, NTPC Kawas held awareness workshops for township residents with help of GGL officials.

NTPC and GGL have worked relentlessly towards achieving this milestone in record time after the foundation stone laid by the Hon'ble Prime Minister of India on 30th July 2022. This set-up is geared up to supply H2-NG (natural gas) to households of Kawas township at Adityanagar, Surat. Green hydrogen in Kawas is made by electrolysis of water using power from an already installed 1 MW floating solar project.

(NTPC Kawas Green H2 Blending project having electrolyser, hydrogen storage and blending skid)

Petroleum and Natural Gas Regulatory Board (PNGRB), the regulatory body has given approval for 5% vol./vol. blending of green hydrogen with PNG to start with and the blending level would be scaled phase wise to reach 20%. Green hydrogen when blended with natural gas reduces CO_2 emissions keeping net heating content same.

(Kawas HoP P Ram Prasad starting the green hydrogen injection into PNG network of NTPC Kawas Township)

This feat is achieved only by a few select countries like the UK, Germany, and Australia etc. This would bring India at the centre stage of the global hydrogen economy. India would not only reduce its hydrocarbon import bill significantly but can also bring forex ashore by being a green hydrogen and green chemicals exporter to the world.

WHAT'S HAPPENING?

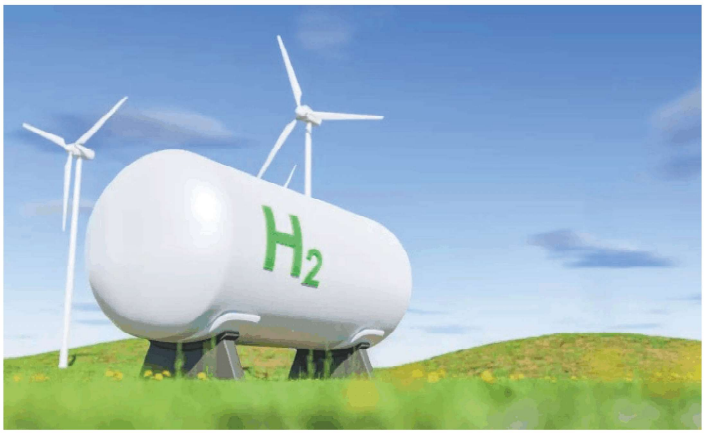
– More News

Green hydrogen, termed as the 'fuel of the future' - this colorless and odorless chemical element is giving much hope in the global fight against climate change.

Gujarat aims to become a global centre for green hydrogen in next 12 yrs: The state plans to create about 8 MTPA green hydrogen production capacity in another 10-12 years, according to state Industries Minister Balwantsinh Rajput. He said that by 2026-27, Gujarat aims to be a $500-billion economy and by 2030-32, a $1-trillion economy. The state will focus on farsighted policies and green production processes for the new generation in alignment with the global agenda.

Brazil's Unigel to invest up to $1.5 billion in green hydrogen production: Brazilian chemical maker Unigel will invest up to $1.5 billion in its complex in the state of Bahia to produce green hydrogen, the first in the country to do so on an industrial scale. The plant, located in the city of Camacari, will have the first of three phases inaugurated by the end of 2023, expanding capacity until it achieves production of 100,000 tonnes of hydrogen by 2027, or 600,000 tonnes of one of its derivatives, ammonia. The green hydrogen, obtained from the conversion of wind or solar energy, will use electrolysers to be supplied by Thyssenkrupp Nucera.

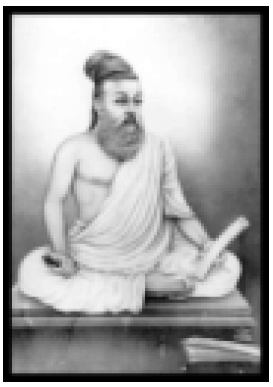
Spain says Germany to join hydrogen pipeline project: Spain has reached an agreement for Germany to join a hydrogen pipeline that will bring the 'green' gas from the Iberian Peninsula to the rest of Europe. Madrid, Paris and Lisbon agreed in December to build by 2030 a major undersea pipeline to transport hydrogen from Spain and Portugal to France and eventually the rest of Europe.



(To be continued)

S. Mahadevan, *B.E., F.I.E., M.B.A.,*
Consultant, Energy and Energy Efficiency,
Mobile: 98401 55209

TIRUKKURAL ON 'ACTION' & 'ACTIVITY' – 2



'Act', 'Action' and 'Activity' form the most important components of Life or Business or Management or anything we do to accomplish and excel.

The fundamental of Business Management is 'Act', taking into consideration relevant factors depending on the task or issue or problem on hand. On "Seyal" or action, the Kurals chosen for analysis below deal with business action and decision making taking into consideration internal aspects and external environment.

The first Kural deals with the essential internal factors to be considered before acting, say with regard to business or diversification or planning a new strategy.

Azhivadhooum Aavadhooum Aagi Vazhipayakkum
Oodhiyamum Soozhndhu Seyal Kural 461

அழிவதூஉம் ஆவதூஉம் ஆகி வழிபயக்கும்
ஊதியமும் சூழ்ந்து செயல் குறள் 461

"Take into consideration the output and the wastage and the profit that an undertaking will yield; and then put thy hand to it"

The second Kural deals with the analysis of factors around like the challenges, support that can be expected and the competition, before deciding to act.

Vinaivaliyum Thanvaliyum Maatraan Valiyum
Thunaivaliyum Thookkich Cheyal Kural 471

வினைவலியும் தன்வலியும் மாற்றான் வலியும்
துணைவலியும் தூக்கிச் செயல் குறள் 471

"Weigh justly the difficulty of the enterprise, thy own strength and the strength of thine enemy, and the strength also of your allies; and then enter thou upon it."

HUMOUR

Holy cow!

A pair of cows were talking in the field. One says, "Have you heard about the mad cow disease that's going around?"

"Yeah," the other cow says. "Makes me glad I'm a penguin."

A higher authority

One day the telephone in the office of the rector of President Roosevelt's Washington church rang, and an eager voice said, "Tell me, do you expect the President to be in church this Sunday?"

"That I cannot promise," the rector explained patiently. "But we expect God to be there, and we fancy that will be incentive enough for a reasonably large attendance."

With a vengeance

In Denver, the members of a Sunday--school class were asked to set down their favorite biblical truths. One youngster laboriously printed: "Do one to others as others do one to you."

Taking stock

One of the oddities of Wall Street is that it is the dealer and not the customer who is called broker.

Shrink rap

Two Hollywood stars ran into each other at the door of their psychiatrist's office.

"Hello, there," said one. "Are you coming or going?"

"If I knew that," said the other, "I wouldn't be here."

Just desserts

At a party, a young wife admonished her husband, "That's the fourth time you've gone back for ice cream and cake. Doesn't it embarrass you?"

"Why should it?" answered her spouse. "I keep telling them it's for you."

Running joke

Two hikers were walking through the woods when they suddenly confronted a giant bear. Immediately, one of the men took off his boots, pulled out a pair of track shoes, and began putting them on.

"What are you doing?" cried his companion. "We can't outrun that bear, even with jogging shoes."

"Who cares about the bear?" the first hiker replied. "All I have to worry about is out running you."

HOME FESTIVALS - 2

மாசி - Masi (February/March)

Above, this is the month of **Mahasivaratri**, *Siva's great night*. In the above painting four stories associated with the festival are told. At lower left a hunter has been cornered in a tree-top by wild beasts, where he must spend the night. To avoid sleep he plucks leaves from the bilva tree, sacred to Lord Siva, and drops them upon a sivalinga below-a traditional form of worship. Many undertake fasts and stay awake the whole night, praying to Lord Siva both at home and in temples (lower right).

The home observance of Karadainombu (upper right) derives from the story of Savitri and her husband, Satyavan. They enter a forest, where he dies. When Lord Yama, the God of Death, comes to take his life, Savithri persuades Yama to let him live. The intent of the observance is that wives not be separated from their husbands.

Another explanation of this festival (upper left) is that on this day Lord Siva tied a thread to parvati's right hand after their marriage as a sign of protection and fidelity.

(To be continued)

HOME FESTIVALS - 3

பங்குனி - Panguni (March/April)

This month brings the popular nine-day festival of Ram Navami, celebrating the birthday of Lord Rama, an incarnation of Lord Vishnu. When the full moon rises, Vishnu in the form of Satyanarayana is worshiped before a decorated kumbha pot with a branch of mango leaves placed in its mouth and a coconut on top. Rice is spread on banana leaves and the sacred vessel is completed with a tray of fruits, flowers, betel leaves and nuts. This month is also known for Sita's marriage to Rama. King Janaka, Dasaratha and priests surround the sacred fire, as Sita garlands Rama in Janaka's royal palace.

(To be continued)

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