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Failure rate of distribution transformers in our public sector utilities is in the range of 8 to 16%...

Repeated replacement of online distribution transformers has been a common thing in our country. However, besides the direct cost factor that is borne by the distribution companies, there are other economic impacts that are shared by the users. So, it is a loss for both sides: supply and demand, and ultimately it is a national loss.

During 2014-15, against the target of 20,882 ckm (Circuit-Kilometre) of transmission lines and 47,871MVA of transmission capacity, we achieved a 22,100ckm and 65,554 MVA respectively, which is the highest achievement ever in a year. Also, the government is committed to provide affordable, 24 x 7 power to all households by 2019. In India, private utilities prefer copper-wound distribution transformers while public sector utilities prefer aluminium wound distribution transformers. Average rate of failure of the al-wound transformers is more than that of the cu-wound transformers.

Thus, failure rate of distribution transformers in the private sector utilities is in the range of 1 to 2% whereas that in public sector utilities is in the range of 8 to 16%. Now the question is – with such a weak distribution system, will we be able to sustain the plan just by increasing our generation capacity?

Power transformers and the distribution transformers are the main components of any Transmission & Distribution (T&D) system. Their failure leads to power outage, which hinders productivity of the country. There lies the value or importance of these devices. Thus, it is high time that our decision makers from utilities seek solutions to reduce the transformer failure rate.

Do send in your comments at miyer@charypublications.in

Mahadevan

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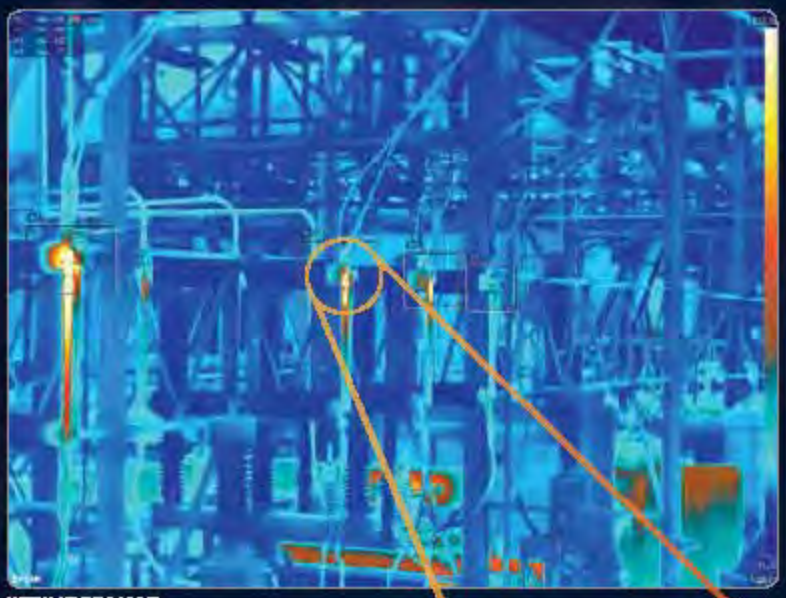

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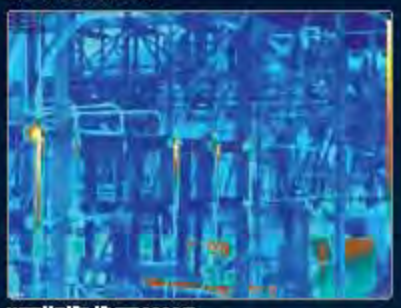

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Appointments

Tom King joins the Board of Directors of Energy Savvy

NR Mohanty takes over as CMD of NALCO

Praburaman R takes over as quality manager MMI

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"Focus of our power distribution companies is shifting from benefits of replacement contracts – towards buying better quality transformers..."

P K Chatterjee (PK)

More than rushing for more power generation with the traditional methods, it is important for us to plug the holes of power waste. In this context, we should remember that in developed countries the loss of energy expected in electric grids is generally less than 15%, whereas in India, the figure goes beyond 30%.

While talking about the overall energy loss, there are several components of this. It is not only the technical loss, power theft and metering challenges are also there. Most of our power generation plants are away from the main cities, thus, our transmission and distribution systems have to be very robust – as long as we remain dependent on the centralised power supply.

However, there are some almost unavoidable challenges due to our age-old plans of the cities, for example: small lanes or access points to large slums; where fixing, maintaining and repairing distribution transformers is a challenging task. Also, it increases the risk factor, especially the oil-cooled transformers, which lack regular monitoring and maintenance, often lead to devastating fire.

Parts of old cities like Delhi, Mumbai, Chennai or Kolkata cannot be changed overnight. Also, in a democratic country, public opinion (objection) often decelerates the development plans. Thus, at this moment, we have no alternative but to depend on the latest technologies. DRY type transformers are slowly making their ways in the Indian T&D sector. Also, focus of our distribution companies is shifting from benefits of replacement contracts – towards buying better quality transformers that will last longer with complete efficiency.

Although erection of the traditional fossil fuel based power plants is still cheaper, and its demand is growing globally, too much addition of such utilities in our country at this moment is not a prudent decision – as we have to eventually take the route of distributive generation.

Please e-mail me your views at pkchatterjee@charypublications.in

P. K. Chatterjee

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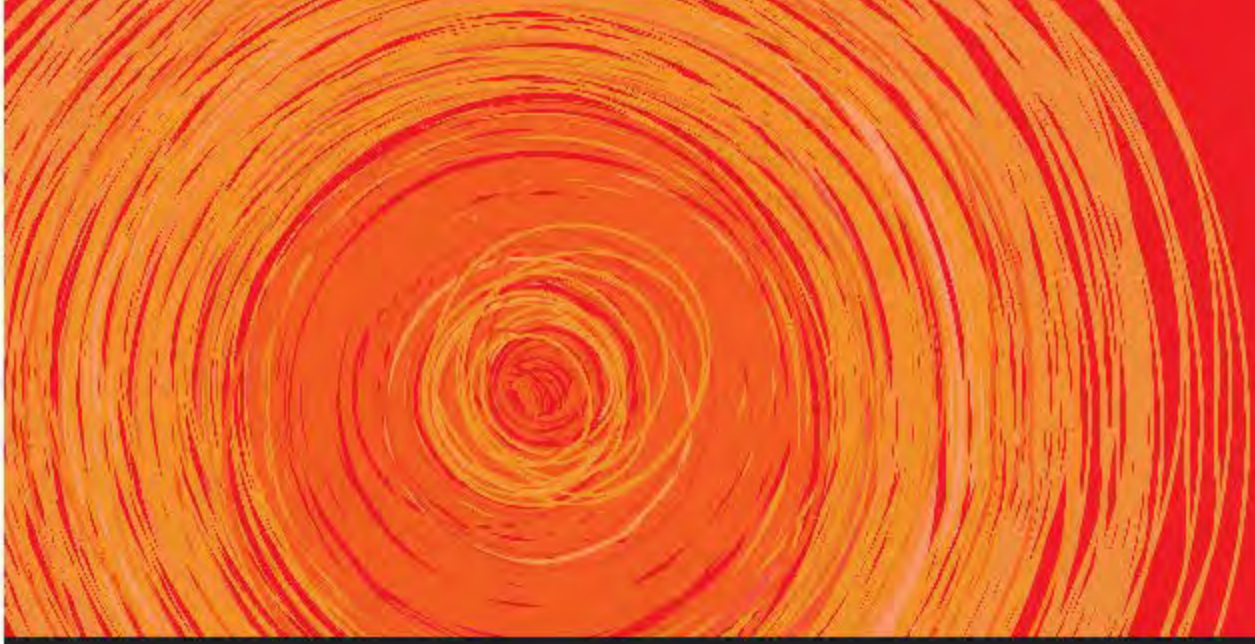

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MSEs need to be more quality conscious

S C Gupta, AGM (C&MM) is delivering the welcome speech...

Recently at Kakrapar, Nuclear Power Corporation of India Limited (NPCIL) organized its Vendor Meet-2015 for Micro & Small Enterprises(MSEs) in association with the Southern Gujarat Chamber of Commerce & Industries [SGCCI]-Surat, Surat Engineering Vikas Association [SEVA]- Surat and MSME-Development Institute-Ahmedabad.

In his inaugural welcome address, S. C. Gupta, AGM (C&MM) emphasised the achievement made by Kakrapar Gujarat Site. He highlighted that more than 20% business originating from the site has been provided to MSEs during the year 2014-15 against the set target of Government of India. The same was appreciated by the MSME as well as SEVA branch of Surat.

LK Jain (Site Director, Kakrapar Gujarat Site), during his keynote address, explicitly expressed that quality is the foremost factor for procurement of material by NPCIL from MSEs. He urged all the participants to develop the suitable quality testing facility in nearby Surat area that shall be helpful for NPCIL.

In the programme, V. K. Jain, Station Director, KAPS-1&2 expressed that MSEs would fulfill NPCIL's requirement, and informed that KAPS-1&2 has bagged the 'Gold Shield' award in the category of 'Performance of Nuclear Power Stations' for the year 2013-14, conferred by Central Electricity Authority (CEA), Ministry of Power, Government of India.

Subject: "Can't we act on our own?"– Article on ELECTRICAL INDIA June 2015 Edition (issue)

Hello Sir,
First of all it was a great article and in fact a topic where we should actually focus in today's energy scenario. I was just hovering over the magazines in my office pigeon hole post and found this interesting magazine "ELECTRICAL INDIA."

I stay in Pune, and the way I have seen the apartment culture of residents growing, this idea when implemented by default (as in many societies compulsory maintenance fee includes PARK, SWIMMING POOL, WI-FI etc. and many other amenities), initially in small amounts, will make people acquainted to investing in small amounts towards a world-changing initiative. I would love to have (see) more of your articles.

Thanks & Regards,
Sagarika Dash, Accounts Specialist - TELECOM
Power Generation Business Unit
Cummins India Limited, Cummins India Office Campus
Tower-A , 6th Floor, S. No. 21, Balewadi, Pune - 411 045 (India)

Editor's reply:

Madam,
Thanks for your attention on the issue. When everyone talks about power shortage and blames the government, I feel, it's high time that we start taking small initiatives at individual or (housing) society level. With Advanced Metering technology that will be implemented throughout the country in a few years, every consumer or group of consumers will benefit from such efforts. Everybody has to think seriously then only the change will come.

Regards,
PK - Editor, ELECTRICAL INDIA

New PV power plant is coming up in Southern India

Recently, juwi India Renewable Energies Pvt. Ltd., a subsidiary of juwi group, has started constructing a ground-mounted utility-scale PV power plant with 39 Megawatts capacity. The project is located in Tamil Nadu. Grid connection is scheduled for the end of this year.

"Around the globe the demand for cost-effective solar energy is increasing. This is especially true for Asia and India," says Amiram Roth-Deblon, juwi's Regional Director for Asia Pacific. By 2022, India is committed to install 100 gigawatts of PV

Image courtesy: juwi Group

power generating capacity. With its Indian branch, established in 2010 in the high-tech-mecca Bangalore, juwi is ideally positioned on the subcontinent. 'In addition to our impressive track record, we also have a well-filled project pipeline for the upcoming years,' Roth-Deblon continued. Covering an area of around 250,000 square metres in the vicinity of the village Samudram, powerful poly-crystalline solar modules are mounted on fixed racks. 'Because of the quality of the modules and the strong irradiation at this location, we expect an annual electricity production of almost 64 million kilowatt-hours. Carbon-free PV power can already compete in terms of cost with climate-damaging electricity from coal or other fossil fuels,' says Rajesh Bhat, Managing Director of juwi India.

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India has immense potential in the LED industry

The LED market has emerged as one of the fastest growing industries in India. This industry has been majorly driven by factors such as falling prices of LED lights, increasing initiatives taken by the government and rising concerns with respect to energy conservation. Research and Markets has recently released a research report titled, India LED Lighting Market Outlook to 2019 - Next Wave of Growth Driven by Government Initiatives.

A number of facilities for manufacturing and assembling LED lights have sprung up in India over the past few years. Also, a number of LED exhibitions have been held in the country ever since the advent of LED lights.

The government is also playing an important role in increasing LED penetration in the country with new initiatives such as Domestic Efficient Lighting Programme (DELP).

As per the report, the LED market is at a nascent stage in India, primarily due to low awareness regarding benefits of LED lights in the country. India has immense potential in the LED industry, which is evident from the fact that the market has displayed a CAGR of 56.1% in the last 5 years.

J&K to get centre's help to improve power scenario

Image courtesy: PIB India

Piyush Goyal

In a review meeting on the power sector of J&K, in presence of Dy. Chief Minister, J&K, Dr. Nirmal Singh; Finance Minister, J&K, Dr. Haseeb A. Drabu; Sajjad Gani Lone, Minister for S&T & Animal Husbandry, J&K; and MoS (Power), Mohammad Ashraf Mir at Sher-E-Kashmir International Convention Centre (SKICC), at Srinagar on 15 06 2015 – Union Minister of State (IC) for Power, Coal and Renewable Energy, Piyush Goyal has assured all help from Central Govt. for expeditious development of conventional and nonconventional energy sources of J&K State.

The meeting was also attended by the Chief Secretary, J&K, and senior officers from Ministry of Power, J&K government and Central PSUs. During the meeting , a presentation was given by the Principal Secretary P.D.D. J&K Govt., on power scenario of J&K state – and discussions were held on various issues pertaining to transmission, distribution generation and renewable energy-solar.

During the meeting, a Joint Venture (JV) agreement between NTPC – JKSPC was signed for development of thermal power for J&K State – and an MOU between J&K State and JKPDD- BEE (Govt. of India) was signed to bring out energy efficiency in power transmission and distribution in J&K state.

WindStream to help MNRE in defining SWES standards

In February 2015, the Ministry of New and Renewable Energy (MNRE) solicited for proposals to help define the Small Wind Energy and Hybrid Systems (SWES) – the new and growing sector in India – and to assist it with developing a specification that will be the benchmark for all companies going forward. WindStream Energy Technologies Pvt. Ltd., the Indian subsidiary of WindStream Technologies, Inc., has been shortlisted by the ministry to participate in the R&D project (SWES) to help define the standards that will be adopted by the MNRE for all manufacturers of hybrid energy solutions.

WindStream India's proposal was selected for the small wind sector using vertical axis turbines and solar panels. Seventeen respondents were chosen out of the many submissions and WindStream was one of two commercial companies chosen, with the remainder being academic institutions and government research programs. The MNRE has developed standards and has a process in place for approving solar and large wind, utility scale, products but not small scale distributed energy solutions. The MNRE is attempting to find technologies that address its energy challenges in rural and remote areas and has adopted the use of hybrid technologies. This project, when concluded, is expected to certify a variety of technologies that are deemed viable for use in off-grid areas.

There are greater than 400 million people in India who are without a grid connection, and this MNRE initiative is an attempt to address the problem. "When we first heard that this programme was being launched by MNRE, we believed we had the most viable solution and had to become a part of it. I could not be happier that WindStream India has been chosen and that the SolarMill will be officially evaluated and tested by this esteemed organisation," said Venkat Kumar Tangirala, President of WindStream India. "Should the project be successful, it would open up a vast sales channel for our products, not only for rural use but across the entire Indian electrical spectrum," he continued.

WindStream India's response to the RFP was to provide a technology that was a fully integrated, hybrid solution, which produces the greatest amount of energy in the smallest footprint possible, what the company calls, 'Energy Density.' "We are confident that our SolarMill technology will be found suitable by the MNRE for the SWES – and become a benchmark for hybrid products," said Timmaraju Venu Gopal, Head of Production and Engineering, WindStream India.

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L&T bags huge order in Transmission & Distribution segment

The Power Transmission and Distribution (T&D) Business, under Larsen & Toubro (L&T) Construction, has won orders worth ₹ 1,258 crores in the international markets recently.

Overall, the construction arm of L&T has won orders worth ₹ 2278 crores across various business segments in May and June 2015. Larsen & Toubro Saudi Arabia LLC, a fully owned subsidiary of L&T, has bagged a contract from National Grid Saudi Arabia (a subsidiary of Saudi Electricity Company) for Engineering, Procurement and Construction (EPC) of 132 kV cabling work in Hail city and a 132 kV double circuit transmission line in Turaif, Qaseem and Hail areas of Saudi Arabia against stiff competition.

A major order has come from a govt agency to design and build 66 kV sub-stations with associated cabling works in the GCC market. Further, L&T Oman LLC, a subsidiary of L&T, has received an order from Oman Electricity Transmission Company for engineering, procurement and construction of a new 132/33 kV Salalah Free Zone-2 grid station.

Philips India to focus on LED market

A sample LED tubelight made by Philips in China...

Philips India is demerging its biggest business, lighting, to focus on the fast-growing LED lighting market in the country in line with its global strategy to drive value in its core business areas.

Accordingly, 40,000-odd public shareholders in Philips India, who hold about 3% stake, will get shares in the new demerged lighting business on 1:1 basis. The Dutch parent Royal Philips holds the balance 97% in the Indian entity, which was delisted 11 years ago from Indian bourses with minority public shareholding. The diversified technology company has also set up an independent company - Philips Lighting India Ltd. It has appointed Harsh Chitale, former managing director of HCL Infosystems, as its MD. Philips India, which will continue with healthcare and consumer lifestyle, will continue to be led by its existing CEO Krishna Kumar.

'The estimated 8,000 employees in India will get split equally between the two companies and there will be no job losses. The demerger process is underway and we soon expect to receive court approval. India figures among the top five markets for lighting business of Philips and we expect to grow further under the new arrangement with dedicated focus on LED lighting,' said Chitale.

The company is going to launch intelligent LED lighting solutions. 'We have started local manufacturing of LED tube lights and luminaires. Once we are able to meet local demand, we will export LED lamps. Philips will also expand its LED manufacturing capacity at its two plants at Vadodara and Mohali' said Chitale.

Intertek to help in testing LEDs, batteries

André Lacroix, Chief Executive Officer, Intertek Group plc., is inaugurating Intertek's first LED and batteries lab...

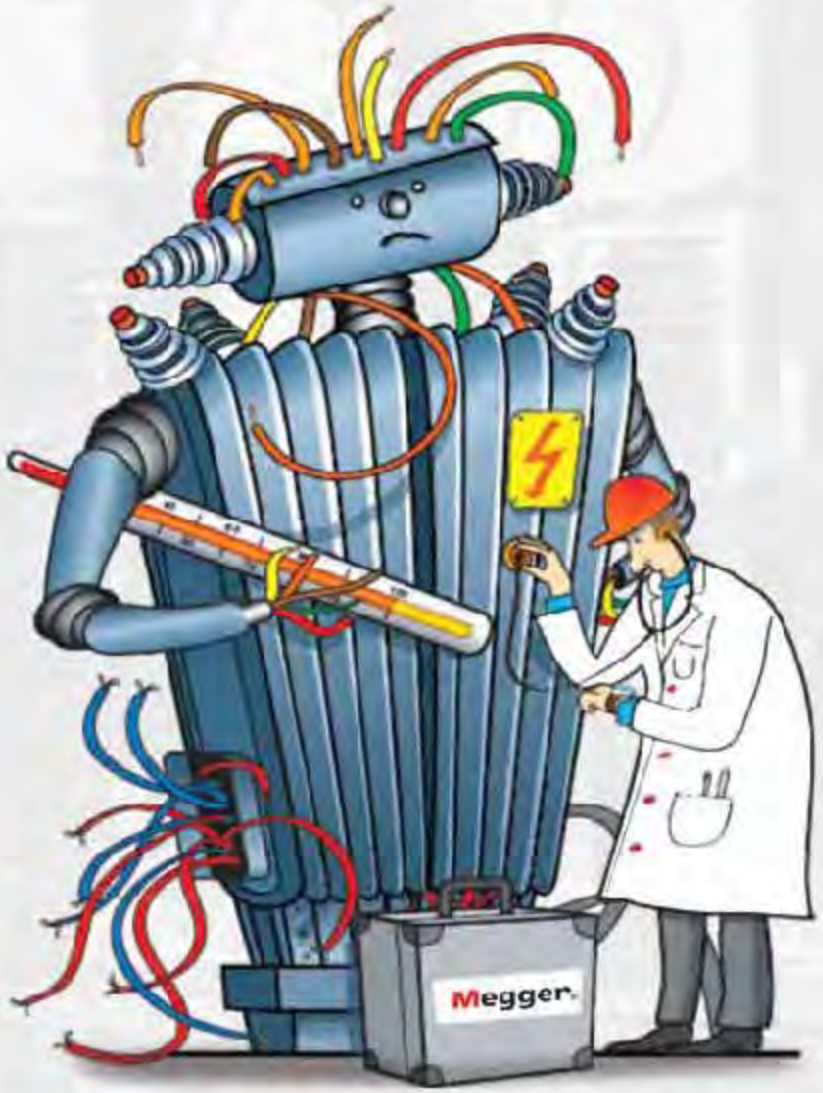
Quality solutions provider, Intertek has launched its first Electrical Centre of Excellence laboratory for LEDs and Batteries in, Delhi. The new laboratory was inaugurated by André Lacroix, CEO, Intertek Group plc., along with senior officials from Bureau of Indian Standards (BIS), Department of Electronics & Information Technology (DeitY), National Accreditation Board for Testing and Calibration Laboratories (NABL) and Bureau of Energy Efficiency (BEE) and important stakeholders from regulatory bodies and industry.

Considering the initiative by BIS and DeitY – requirement for 'Compulsory Registration Order,' which underlined 30 categories of electronics items to be tested on Indian soil for compliance to Indian safety standards, Intertek sees a huge potential to add value and strength to the government's plans.

Speaking on the future prospects of Intertek, Rajesh Saigal, Regional MD, South Asia, Intertek, said, "Intertek has always been a partner to the Indian govt; 10 years ago we've fast tracked the country's standards and labeling programme by putting up the 1st laboratory for HVAC. In the same way, we're glad to support the govt's regulations that are coming up in LED and battery with the necessary capacity and capability for testing these products. The well-equipped laboratory planned is aligned to the 'Make in India' initiative launched by the Prime Minister Narendra Modi."

André Lacroix, CEO, Intertek Group plc. added, "Intertek's commitment to the electrical sector has a very strong legacy associated with Thomas Alva Edison, the father of the electric bulb. Considering the growth of the lighting industry backed by the govt's focus, with the launch of the new laboratory Intertek will play a vital role in verifying the products being used."

The doctor is in...



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Tata Power receives Central Electricity Authority's award

Tata Power has been honoured by the Central Electricity Authority (CEA) in two categories under its 'Comprehensive Award Scheme'. The company has received a Silver Shield in the category of 'Performance of Distribution Companies' and Consolation Award in the category of 'Performance of Thermal Power Stations' for Trombay Thermal Power Station (750 MW).

The award was handed over by Piyush Goyal, Hon'ble Union Minister of State for Power, Coal & Renewable Energy. On behalf of Tata Power, Ramchandran Pillai, Sharad Baijal, Pradeep Manjrekar and Vishwas Shrikhande received the award. CEA under Ministry of Power recognises

Tata Power is receiving the award...

meritorious performances in the Indian power sector and felicitates various power utilities in the sector with the prestigious and commendable projects undertaken in the year.

Speaking on the occasion, Anil Sardana, Managing Director and CEO, Tata Power, said, "Tata Power has always strived towards achieving world class standards in the industry. We are honoured and proud to be recognised as one of the leading companies in the space of Generation and Distribution and very thankful that our efforts are fruitful to the community. As a company, we have committed to provide our customers reliable and uninterrupted power supply at competitive prices in years to come."

He further added, "Tata Power has won the National Award in areas of Generation & Distribution consecutively in the last three years. These awards make the team more committed and enthusiastic about working relentlessly and striving for excellence in our business."

BHEL receives India Pride Award 2014-15

Atul Sobti, Director (Power), BHEL (L) is receiving the award from Union Minister, Arun Jaitley (R)...

Bharat Heavy Electricals Limited (BHEL) – the integrated power plant equipment manufacturer – and one of the largest engineering and manufacturing companies of its kind in India engaged in the design, engineering, manufacture, construction, testing, commissioning and servicing of a wide range of products and services for the core sectors of the economy, viz. power, transmission, industry, transportation (railway), renewable energy, oil & gas and defence with over 180 products offerings to meet the needs of these sectors – has once again been recognised for its engineering efficiency.

For the sixth consecutive time, BHEL has been conferred the India Pride Award 2014-15 for Excellence in Heavy Industries. Significantly, BHEL has been winning this award every year since the award was instituted.

In addition, Atul Sobti, Director (Power), BHEL, was awarded the India Pride Award 2014-15 for Excellence as 'Head of Department' among Central PSUs.

The awards were received by Sobti from Arun Jaitley, Hon'ble Union Minister of Finance, Corporate Affairs and Information and Broadcasting.

Waaree Energies completes solar power project before schedule

Mumbai-based Waaree Energies has commissioned a 10 MW solar power plant for Sharda Construction and Corporation Pvt Ltd (SCCPL), a construction company based in Nanded, Maharashtra. The project located at Latur, Maharashtra was allotted to SCCPL under the Domestic Content Requirement (DCR) category of Jawaharlal Nehru National Solar Mission's (JNNSM) Phase 2, Batch 1. The EPC contract was awarded to Waaree Energies to design and execute the project by SCCPL. The project was completed by Waaree Energies in less than 90 days even in the face of challenging conditions.

Speaking at the occasion, Hitesh Doshi, CMD, Waaree Energies Ltd, said, "We had to face few challenges like undulated land and an extreme slope with a catchment area at the bottom, which added to the design complexity. We are proud to share that the plant performance till date is as expected and it is a proof of Waaree's design and engineering capability. This project is a hallmark of our growing capability in the field of solar."

CORRIGENDUM

Referring to the May 2015 issue of Electrical India

In the article titled "Switch To Switchgears, And Circuit Breakers With Relays," (Page 60, 2nd paragraph), by typographical error, we printed, "Electricity was invented about two decades back." Kindly read it as: "Electricity was invented about two centuries back." - **Editor, Electrical India**

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Nuclear energy prevented release of ~56 Gt of CO_2 since 1971

Photo: C.Brady/IAEA

Yukiya Amano, Director General, IAEA (R) with French Nuclear Safety Authority (ASN) President Pierre-Franck Chevet

A comparison of median values of gCO_2eq/kWh for different sources of power generation shows that the lifecycle CO_2 equivalent (including albedo effect) from coal and nuclear sources stands at 205: 3. Thus was echoed recently when IAEA Director General Yukiya Amano told in Paris that nuclear power is one of the lowest-carbon technologies available to generate electricity, and it can play a significant role in mitigating climate change. During his recent two-day-long visit to France, Amano met with the Minister of Foreign Affairs and International Development Laurent Fabius, Minister of Ecology, Sustainable Development and Energy Ségolène Royal and other government officials and representatives of the nuclear industry.

Amano said to the ministers, "Climate change is the biggest environmental challenge of our time. As governments around the world prepare to negotiate a legally bound, universal agreement on climate at the United Nations Climate Change Conference in Paris at the end of the year, it is important that the contributions that nuclear science and technology can make to combating climate change are recognised.

The use of nuclear power has already prevented the release of around 56 Gt of carbon dioxide since 1971, equivalent to two years of global emissions at current rates, according to World Energy Outlook statistics, published by the Paris-based International Energy Agency.

Amano and French officials discussed changes in nuclear energy policy throughout the world following the accident at the Fukushima Daiichi Nuclear Power Plant in Japan in 2011. "It is the sovereign decision of each country whether or not to add nuclear power to its energy mix. For countries that choose nuclear power, our job is to help them in using nuclear technology in a safe, secure and environmentally friendly manner," he added. He and his French hosts also discussed the status of the negotiations between Iran and the P5+1 group of countries, and the implementation of IAEA safeguards in Iran.

EPRI receives grant for power plant cooling research

The team will research a novel micro emulsion absorption system for supplemental power plant cooling...

The U.S. Department of Energy has granted a $3 million award to the Electric Power Research Institute (EPRI) to develop a novel dry cooling technology for thermoelectric power plants. This new cooling technology has the potential to significantly reduce fan power consumption and steam condensation temperatures – compared to current dry cooling systems, and produce a more cost-effective option for reducing water use at thermoelectric plants.

EPRI is teaming with Drexel University, University of Memphis, Evapco, WorleyParsons, Maulbetsch Consulting, and its utility advisors to develop, manufacture and demonstrate a cost-effective, 50 kW indirect dry cooling system that would use advanced phase change materials to improve heat transfer. The proposed design is anticipated to be compact, optimised for various geographic and weather conditions and would have the potential for integration into existing power plants.

"Successful scale-up and demonstration of this technology will help determine if it could be a competitive water conserving option for the next generation in power plant cooling," said Sean Bushart, Director, Generation Environmental Sciences, EPRI.

DOE's Advanced Research Projects Agency-Energy (ARPA-E) is funding the project under its Advanced Research In Dry cooling (ARID) programme. The EPRI project is one of 14 totalling $30 million to support development of transformative new power plant cooling technologies that can cost-effectively and efficiently reject waste heat with minimal water evaporation. ARPA-E project teams will work to design kilowatt-scale testing prototypes to help ensure the technologies can be scaled up to megawatt-cooling capacity without significant performance loss.

Yingli expands its partnership with Vivint Solar

Yingli Green Energy Americas (Yingli Americas) – a wholly owned subsidiary of Yingli Green Energy Holding Company Limited (Yingli), which markets its solar panels under the brand name "Yingli Solar," has been chosen again as a preferred supplier to Vivint Solar (VSLR) in 2015.

"We, as Vivint Solar, are excited to continue our relationship with Yingli. Yingli provides great products and has been a beneficial supplier to Vivint Solar this past year – and we are glad to continue working with them moving forward," said Jan Newman, Vice President, Business Development, Vivint Solar.

"With the U.S. residential solar market poised to reach nearly 3 gigawatts by the end of 2016, we are thrilled to expand our partnership with Vivint Solar, one of the nation's (America's) top home solar companies. We value our true partnership with Vivint and their dedicated team. Through this renewed supply agreement, we are helping in driving job creation in the flourishing American solar marketplace, as well as solidifying Yingli's position as a leading PV supplier," commented Robert Petrina, Managing Director, Yingli Americas.

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PV modules from JA Solar Holdings get certified

The PV modules of JA Solar Holdings Co. Ltd., one of the world's largest manufacturers of high-performance solar power products, have passed the high-grade Class 4 Hail Test conducted by RETC in May at its facility located at Fremont, California. This success of the company is followed by its successful pass of the similar test conducted by TÜV Rheinland in early March this year.

The Class 4 hail test uses solid ice balls frozen at -17 degrees Celsius with a diameter of two inches (50.8 millimetres) to strike different locations of the glass surface of a PV module that include centre, one corner, and one edge along the metal frame, as well as some random places, at various impact velocities with the maximum reaching 76 metres per second (274 kilometers per hour). The kinetic impact energy of this Class 4 Hail Test carried out by RETC this time on JA's PV modules is more than eight times higher compared to the energy registered in the previous hail test conducted by TÜV Rheinland Lab in March when 45-mm hailstones with a striking speed of 30.7 m/sec were used.

Wei Shan, Chief Technology Officer of JA Solar, said, "In order for our products to withstand harsher weather conditions, it is a necessity that our modules pass the hail impact test under more stringent conditions. Passing the Class 4 Hail Test at RETC is a testament that further demonstrates the high quality and reliability of JA Solar's PV modules, as well as our tirelessly devoted efforts to meet the needs of our customers through continuous performance improvement, product innovation, and vigorous quality control."

Egypt to have world's largest CC power plants soon

Joe Kaeser, CEO and President, Siemens AG

Two state-of-the-art Combined Cycle (CC) power plants are coming up in Egypt soon. Once completed, each power plant will be the largest in the world and the most efficient in Egypt. One of them will be located on the Mediterranean coast, north of Borolos Lake in Kafr El Sheikh Governorate, and the other in the new capital city development. Both will operate on natural gas with light fuel as a backup.

Orascom Construction (OC) will build them. Each plant will have a power generation capacity of 4,800 MW, and has a contract value of EUR 2 billion. They will be constructed in a consortium with Siemens. OC's combined share of the contracts totals EUR 1.6 billion. Siemens and OC previously collaborated on a 1,000 MW natural gas-fired power plant in Baiji, Iraq, where OC installed Siemens equipment and received technical support on the EPC scope. OC arranged a competitive 15-year financing package for its portion of the contracts on behalf of the Egyptian Electricity Holding Company.

Joe Kaeser, CEO and President of Siemens AG, commented, "With these unprecedented contracts, Siemens and its partner are supporting the Egypt's economic development by using efficient natural gas and renewable technologies to build an affordable, reliable and sustainable energy mix for Egypt's future."

Osama Bishai, CEO, OC, said, "This is another milestone that reflects our leadership in the power sector in Egypt and the region. Not only did our people achieve a world record in the construction of a GF dual fuel power plant last week, but we also signed contracts for two of the largest power plants in the world as an EPC partner with Siemens. We are looking forward to establishing a solid long term strategic relationship with Siemens that will go beyond Egypt."

Eighty six MW solar park is coming up in South Africa

Diggers are rolling, access roads are being established, posts rammed and fences erected. There is a lot of activity going on at juwi's biggest construction site at the moment. No wonder, close to the city of Prieska in South Africa's Northern Cape Province the utility-scale Mulilo Sonnedix Prieska PV solar park is scheduled to be completed by late summer 2016.

The mega project will then have a size of more than 200 football pitches and an installed capacity of 86 megawatt. For juwi the solar park is the largest individual project in the company history. It is managed and executed by juwi Renewable Energies Pty Ltd., the South African branch of the juwi Group.

Image courtesy: juwi

"We are delighted to finally realize this milestone project after a long an intensive planning period. With the construction of the solar park we are again playing a key role in adding substantial amounts of clean energy to the South African electricity grid", says Greg Austin, juwi South Africa's Managing Director. Over the past years, juwi Renewable Energies has realized four utility-scale PV projects in South Africa and built up a great reputation as a leading specialist for green energies in the country.

The Prieska project was selected by the Department of Energy of South Africa under the third bidding window of the national Renewable Energy Procurement Programme in October 2013.

"We are also proud that our efforts in designing the economic development aspects of the project brought the desired outcome," continues Austin.

Of all six projects in bidding round three, the Mulilo Sonnedix Prieska PV solar park had the highest economic development score. juwi will also provide Operations and Maintenance (O&M) services for the plant.

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Tom King joins the Board of Directors of Energy Savvy

Tom King

"Tom King's leadership and insights will help enable us to continue to provide breakthrough and increasingly valuable solutions to our rapidly changing industry," said Aaron Goldfeder, CEO Energy Savvy...

Tom King has joined the Board of Directors of Energy Savvy, a utility and industry partner for energy efficiency (cloud software). With more than two decades of utility senior management experience in roles including CEO of Pacific Gas and Electric Company – and more recently National Grid U.S., Tom brings invaluable expertise and a unique perspective to Energy Savvy.

Energy Savvy continues to scale its demand-side management software and solutions for utilities, powered by modern customer engagement, analytics and automation.

"Tom has run two of the world's leading utilities that operate in the #1, #2, #3 and #7 ranked states for energy efficiency. His experience is only matched by his passion for industry progress. His leadership and insights will help enable Energy Savvy to continue to provide breakthrough and increasingly valuable solutions to our rapidly changing industry. We're honoured to have him join us," said Aaron Goldfeder, CEO and Co-founder of EnergySavvy.

NR Mohanty takes over as CMD of NALCO

NR Mohanty

Mohanty has rich and varied experiences of more than 33 years in aluminium industry. He has worked in various capacities in NALCO's smelter plant and corporate office...

National Aluminium Company Limited (NALCO) is a Navratna CPSE under Ministry of Mines, Government of India. The company is a group 'A' CPSE having integrated and diversified operations in mining, metal and power. Government of India holds 80.93% equity of NALCO.

N R Mohanty, Director (Projects & Technical) of NALCO, has been given additional charge of the Chairman-cum-Managing Director of the company.

Mohanty graduated in B.Sc Engg (Hons) in Mechanical Engineering from NIT Rourkela in 1980, and was honoured as the best graduate of Sambalpur University. He started his career from Larsen & Toubro and worked in BALCO before joining Nalco in 1986.

He has rich and varied experiences of more than 33 years in aluminium industry. He has worked in various capacities in NALCO's smelter plant and corporate office. He has been instrumental in creating new vision and mission plan for the company.

Besides, he has also initiated various growth-oriented greenfield and brownfield projects – and has successfully steered NALCO into 'green energy' with the commissioning of wind power projects at Gandikota, AP and Jaisalmer, Rajasthan.

Praburaman R takes over as quality manager MMI

Praburaman R

"My ultimate goal is to satisfy 100% of MMI customers. This can be achieved through managing the company's quality systems effectively," said Praburaman Rengaramanujam...

Praburaman Rengaramanujam has been recently named Global Quality Manager for Michigan Manufacturing International. In this role, he will be responsible for quality systems at all MMI locations.

He has 14 years of experience in the quality assurance industry. He specialises in quality management systems, measurement system analysis and statistical process control.

Previously Praburaman was the Quality Manager at Modine Thermal Systems. He holds a Master of Science in Quality Management, and is a qualified internal auditor for ISO 9001:2008.

Commenting on his vision as the Global Quality Manager, Praburaman said, "My ultimate goal is to satisfy 100% of MMI customers. This can be achieved through managing the company's quality systems effectively."

MMI's CEO, Jacob Prak said, "I am very pleased to have Praburaman join our firm. He brings a wealth of quality and management experience, which will significantly enhance our knowledge base and enable our quality systems to reach the highest level."

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- Current and Potential Transformers (type tests upto 5000A/0.1 accuracy class for CTs and 66 kV/0.1accuracy class for PTs) as per IS:2705, IEC: 61867-1&2; IS:3156, IEC: 61869-1 & 3
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Witnessing Growing Demand

The demand for coal fired power generation is mainly driven by high demand for electricity for an array of industrial, commercial and residential applications...

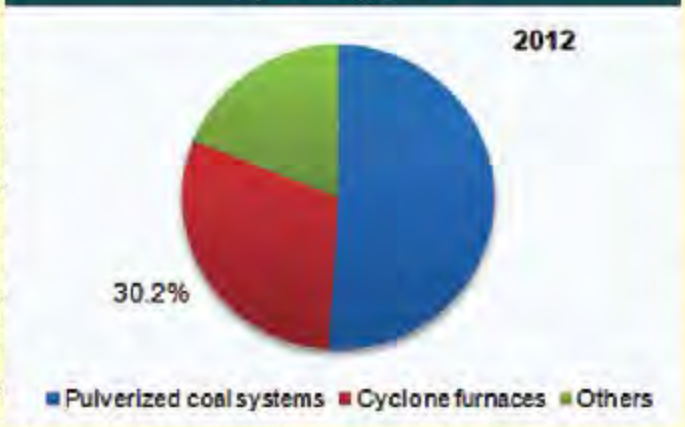
According to a recent report by Transparency Market Research – a global market intelligence company providing business information reports and service, the coal fired power generation market is projected to grow at a positive 3.1% CAGR between 2013 and 2019. The report, titled "Coal Fired Power Generation Market – Global Industry Analysis, Size, Share, Growth, Trends and Forecast, 2013 – 2019," also informs that the global coal fired power generation market exhibited an installed capacity of 1,673.1 GW in 2012. The demand for coal fired power generation is mainly drivenby high demand for electricity for an array of industrial, commercial and residential applications. Such factors are likely to boost the overall capacity of coal fired power generation to 2,057.6 GW by the end of 2019. In terms of technology, the global market for coal fired power generation is categorised into pulverised coal systems, cyclone furnaces and others (fluidised bed combustion and coal gasification). Geographically, the market can be segmented into North America, Europe, Asia Pacific and Rest of the World. Of the key geographic segments, Asia Pacific dominated the market for coal fired power generation in 2012, accounting for a significant 56% share of the overall installed capacity registered by the market.

The construction of new plants for coal fired power generation across the Asia Pacific region will pave the way for further expansion of the market...

According to the report, the market for coal fired power generation in Asia Pacific is expected to grow exponentially during the forecast period. The construction of new plants for coal fired power generation across the region will pave the way for further expansion of the market. North America dominated the global coal fired power market in 2012 on the basis of revenue, accounting for 21% of the total market.

On the basis of application, the commercial sector dominated the market with a 56% share of the global industry. The residential sector will register tremendous growth in the demand for solar and hydro power, thereby adversely affecting the demand for power generated from coal from the sector. Pulverised coal systems led the market in 2012, accounting for more than half of the total market. High availability of raw materials together with increasing demand for power – drove the demand for pulverised coal systems in coal fired power generation market.

Global coal fired power generation market shares, by technology, 2012



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Source: Primary Interviews, Transparency Market Research

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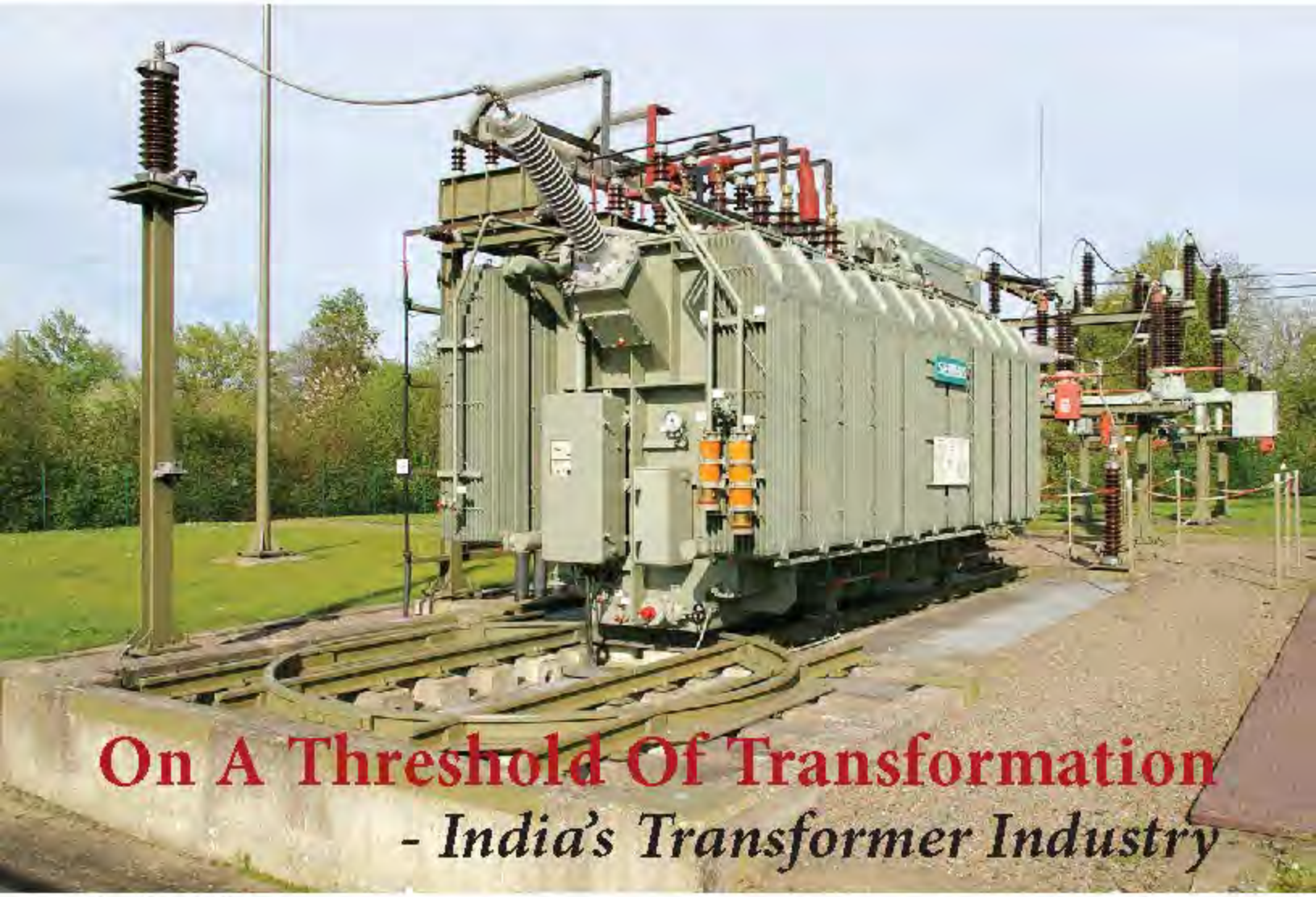


On A Threshold Of Transformation
- India's Transformer Industry

Image Courtesy: Siemens

The Transformer market in India can be pegged at more than INR 12,000 Crores. Power Transformers contribute 45 percent of the total market and distribution transformers, 55 percent. Over the last two years, the market has grown at a very moderate rate at less than 4 percent...

India is on the verge of becoming an emerging power nation among developing economies. The availability of electricity is directly linked to the Gross Domestic Product (GDP) growth of developing economies, India being no exception. Growth of the Indian electrical industry and its investment appeal primarily depends on government policies. Timely capacity additions to electricity generation, transmission & distribution (T&D) are necessary to improve and sustain GDP growth and reduce the electricity demand-supply gap.

The Indian Power Sector

India's power generation of installed capacity at the end of FY2014-15 stood at 271.7 Giga Watt (GW). Acute fuel shortage (both coal and natural gas), project clearances and delay in commissioning of new units, affected capacity addition plans.

Although India has the 5th largest power generation capacity, globally (trailing behind China, US, Japan and Russia), a power deficit scenario has been plaguing the sector for more than a decade. India's per capita power consumption of around 1010 kilowatt hour (kWH) per annum (as at the end of FY2014-15) is significantly below the world average of 2,600 kWH and developed countries' average of 8,000 kWH. India needs to rapidly increase its generation capacity, in order to achieve the goal set by the Ministry of Power – 'Power for All' by 2019.

Power deficit at the end of the 11th five year plan reached 3.6 percent, whereas peak deficit was to the tune of 4.7 percent. Key reasons (apart from missing out on power generation capacity addition targets) for the continued power deficit scenario in the country are:

- Dismal conditions and inappropriate maintenance of existing T&D equipment / infrastructure
- Rampant power theft, leading to high T&D losses (at the end of FY2014-15, T&D losses were to the tune of 20.8 percent) impacting financial condition of Power T&D utilities (DISCOMs & TRANSCOs).

A robust and efficient power T&D infrastructure is imperative for effective transfer of power from generation source to the consumption points / demand centres. Thus, expanding the T&D infrastructure to transmit the power generated to consumer points across the length and breadth of the country becomes imperative.

Transformers are critical components of the Power T&D network that are used to change voltage in the power transmission and distribution process, and hence play a key role.

Transformers can be broadly classified, based on the output rating as:

- Distribution Transformers (31.5 to 5,000 KVA)
- Power Transformers (5.1 to 500 MVA)
- Special Transformers (depending on the type of application like welding, traction, furnace, etc.).

Transformer Industry in India

The Indian transformer industry is more than five decades old, hence mature. Domestic manufacturers have developed capabilities to manufacture all types of equipment to meet the country's demand for transformers up to 800 Kilovolts (kV) and going up to 1,200 kV. The industry enjoys a good reputation in terms of quality, price, and delivery in the domestic as well as overseas markets.

India's transformer market is predominantly unorganized with many small participants catering to the smaller distribution transformer markets. However, many are slowly graduating to the medium-sized category, thus expanding the organized participants' base.

India's transformer market is predominantly unorganized with many small participants catering to the smaller distribution transformer markets...

There are approximately 300+ transformer companies in India, with an overall installed capacity of over 370,000 Megavolt Amperes, (MVA) per annum. The market is fragmented with 20 organized players including Bharat Heavy Electricals Limited (BHEL), ABB Ltd, Crompton Greaves Ltd (CGL), Areva T&D, EMCO Ltd, Bharat Bijlee Ltd (BBL), Vijai Electricals, Transformers and Rectifiers India Limited (TRIL), Voltamp Transformers Ltd, among others.

In the power transformers category, companies in the high-end segment (400 kV and above) mainly include international players such as ABB Ltd, Alstom T&D (erstwhile Areva T&D India), and Siemens; and Indian manufacturers such as BHEL, CGL, TRIL, and Toshiba Transmission & Distribution Systems India (Entity formed by acquisition of Vijai Electricals by Toshiba Corporation, Japan). Majority of other companies in this sector are present in the 220 kV segment in power and distribution transformers. Leading players have significant presence in both power and distribution transformer market.

Apart from catering to domestic demand, India exports transformers to over 100 nations including the US, Europe, Malaysia, Singapore, Bangladesh, African countries, and Gulf countries. India is also an importer of transformers; the major source countries include China, Germany, USA, Korea, and Japan.

Indian Transformer Market Size

The Transformer market in India can be pegged at more than INR 12,000 Crores. Power Transformers contribute 45 percent of the total market and distribution transformers, 55 percent. Over the last two years, the market has grown at a very moderate rate at less than 4 percent, due to the slowdown of power generation capacity addition and T&D infrastructure expansion.

Anticipating the huge domestic (due to a power deficit scenario, requirement of power sector expansion) and overseas demand, the transformer industry in India has more than doubled its manufacturing capacity over the last five years. Transformer manufacturing capacity in India stands at ~370 GVA with capacity utilization rates hovering around 60-70 percent on an average over the last 5 years. Transformer over-capacity in the Indian market has led to immense pricing pressure scenario severely impacting the profitability of the market players.

New Entrants

India's huge power shortage, need to ramp up power T&D infrastructure, economic slowdown of developed markets like Europe and North America and excess transformer manufacturing capacity in China has resulted in India being an attractive destination for transformer companies globally to tap the Indian market opportunity. Anticipating this, many foreign players are already in the process of setting up base in India. Over the last 18-30 months, new players have entered the market either through acquisitions or through setting up of facilities within India. A few notable examples are:

- Canadian company, Hammond Power Solutions Inc. had acquired 70 percent equity stake in the Hyderabad based transformer supplier Pan-Electro Technic Enterprises Pvt. Ltd in Feb' 2012
- Chinese manufacturer, TBEA has set up transformer manufacturing unit in Gujarat in order to qualify for the bids from PGCIL.

Market Drivers

- Power Generation Capacity augmentation and Power T&D infrastructure expansion to be in-line with Power generation capacity addition. According to the 12th plan, INR 1200K-1300K Crores likely to

be invested in the power sector. This spending on the power sector is expected to be equally distributed between generation and T&D. Spending on Power T&D infrastructure is expected to boost demand for transformers

- Rajiv Gandhi Grameen Vidyutikaran Yojna (RGGVY) scheme to improve rural electricity infrastructure and rural household electrification. The electrification drive is expected to provide impetus to demand for distribution transformers
- Increasing focus on Rural Electrification Accelerated Power Development and Reform Program (APDRP 1-2) in order to minimize Aggregate Technical and Commercial (AT&C) losses at the distribution level and improve the financial health of the State Electricity Boards (SEBs)
- Industrial sector growth
- Replacement of ageing equipment

These reforms are expected to significantly affect demand for transformers over the next 4 to 5 years.

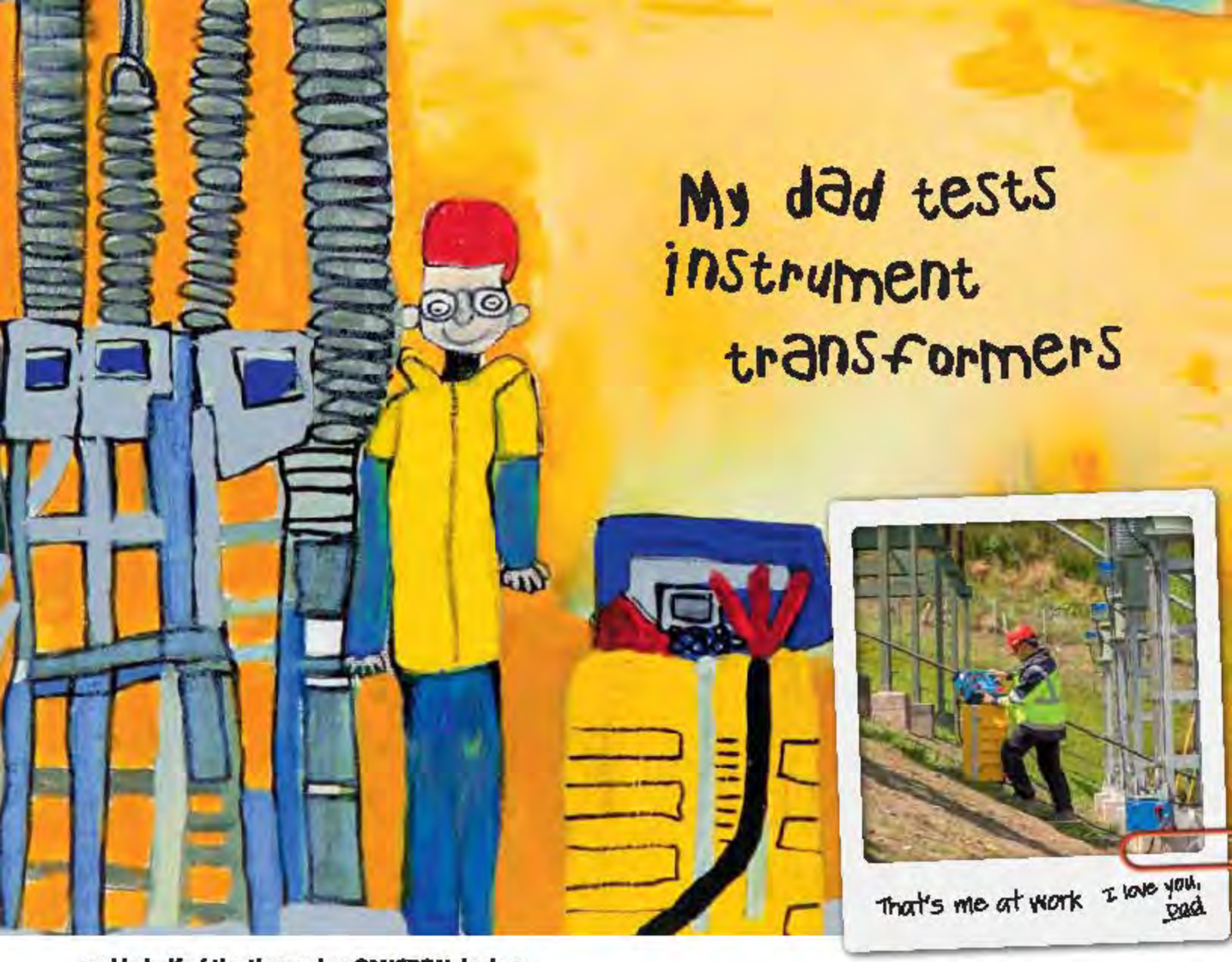
Market Challenges

- Inadequate supply of prime quality Cold Rolled Grain Oriented (CRGO) steel is the biggest challenge faced by transformer manufacturers in the country. CRGO requirement is completely met through imports; it is in fact challenging to assess the true quality of the material that is used by the transformer manufacturers in India. India needs 2.5 lakh tons of CRGO every year and an appalling 70 percent of this is scrap grade material
- Failure rate of Transformers – High failure rate of distribution transformers, is a big concern for the transformer industry in India. The average operational life of a transformer is between 25 to 30 years; however, transformers are known to be recalled for repair in as early as three years. The failure rate of distribution transformers in India is estimated at 10-15 percent (in stark contrast to the less than 2 percent failure rate in developing countries). This is due to the low entry barriers in the distribution transformer market leading to unorganized players entering the market, and competing on the price factor. SEBs historically follow a L1 vendor selection criteria, which has led to proliferation of many small players, that compromise on the quality of transformers manufactured
- Financial Condition of SEBs - SEBs have been facing losses due to the supply of subsidized power to agricultural farmers, theft of power, and inefficient T&D infrastructure. This has restricted private investment in the power T&D sector, thereby reducing the quality of service from SEBs. This, in turn, is affecting the capacity building program and transmission of power
- Lack of testing facilities – The growth in testing infrastructure has not kept pace with that of production, both, quantitatively and qualitatively. Testing infrastructure available at India's premier agency, the Central Power Research Institute (CPRI) is proving short of demand. Manufacturers of large power transformers at times need to send their equipment for testing to overseas facilities like Korea Electrotechnology Research Institute (KERI) and KEMA which is expensive. Apart from this, huge logistical costs and lead times are also involved.

Way Forward

The Indian power and distribution transformer markets are highly dependent on investments planned by the Government of India for the T&D segment and reform programmes like the Revised Accelerated Power Development and Reform Program and Rajiv Gandhi Grameen Vidyutikaran Yojna. These programmes, when fully implemented as scheduled, are expected to drive the demand for both power and distribution transformers. The Government of India currently plans to strengthen transmission lines and create a National Grid interconnecting the five regions (northern, southern, eastern, western and north-eastern) through the creation of 'Transmission Super Highways;' this is expected to drive the demand for higher-rated power transformers. With T&D companies actively striving to reduce Aggregate Technical and Commercial (AT&C) losses, the demand for energy-efficient transformers would get a boost.

With huge investments proposed across sectors such as power, infrastructure, etc., the transformers market in India is slated for strong growth. The excess capacity in the Transformer industry in India, and entry of new players is further expected to increase market competitiveness. Market consolidation over the next few years is inevitable.



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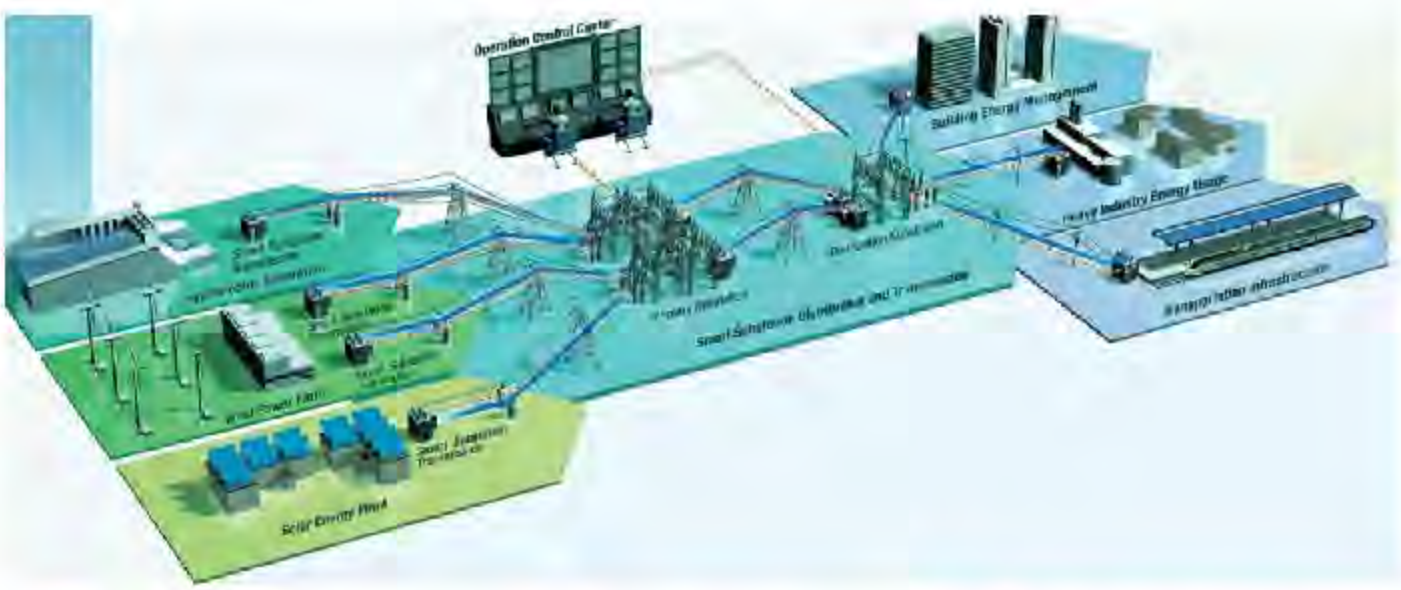

SMART TRANSFORMER
FOR DISTRIBUTION SYSTEM

Smart transformers work independently to constantly regulate voltage and maintain contact with the smart grid in order to allow remote administration (if needed), and to provide information and feedback about the power supply and the transformer...

A smart transformer (ST) provides the exact amount of power that is needed, and responds instantly to fluctuations within the power grid, acting as a voltage regulator to ensure that the optimized voltage is undisturbed. STs are programmed to, as a default, provide an voltage optimized power supply that directly addresses their facility's energy needs. ST can help large commercial facilities use power more efficiently to save money, power and go greener.

A solid state transformer (SST) with managerial role in the electric distribution grid is generally called Smart Transformer (ST). Smart transformers work independently to constantly regulate voltage and maintain contact with the smart grid in order to allow remote administration (if needed) and to provide information and feedback about the power supply and the transformer. Moreover this type of transformers are used in Point of Common Coupling (PCC) in a microgrid for voltage control – and it acts as a protecting device for electrical equipments during power fluctuations.

The ST has to have some intelligence to meet the requirement of future power systems. A possible idea of ST, based on power electronics and communication technology is depicted in Fig.1. The main aim of this article is to show the role of ST in distribution grid system with its hardware control and communication topology with its role in distribution system.

Some important characteristics of ST are:

- They give exact amount of power that's needed and respond instantly to fluctuations within the grid
- ST act as a voltage regulator and it ensures that the optimised voltage is undisturbed, because they directly reduce energy consumption & green house gas emissions
- ST immediately reduce power consumption by providing a stable, optimal power supply that supplies electrical equipment with its ideal voltage
- They also protect electrical equipments with its ideal voltage
- ST as a default, provide a voltage optimised power supply that directly addresses their energy needs.

Power converter cells for ST

Once chosen the ST, the next step is choosing, which should be the basic block of the ST, the power converter cell.

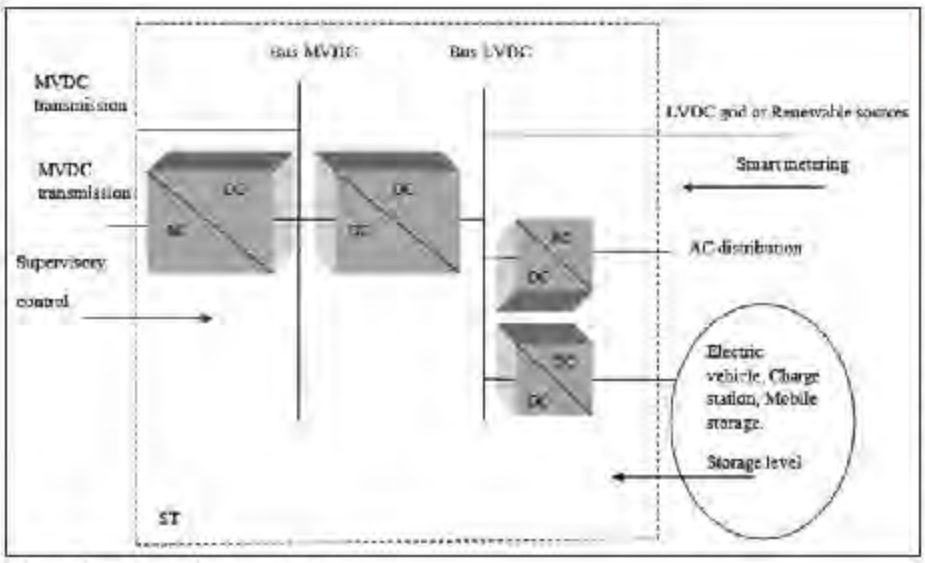

Fig. 1: Smart transformer concept...

The following goals are achieved using power converter cells with ST:

- Isolation for the different voltage level
- Reduced core size
- Minimal loss.

ST hardware control system

The set of hardware control blocks include ST, instrumentation, control gate drives, electronic On Load Tap Changer (OLTC), transformer builds the voltage regulation block, which is also responsible for the secondary voltage regulation.

The interface module blocks are data converters, which convert variables and events of the control system – and send them to the master module. In the master module the data of all the interface modules are packed and sent to the Programmable Logic Control (PLC) interface which converts the data to be sent through the medium voltage line. The data coming from a set of transformers are received by the gateway block, which concentrates and sends them to the wireless interface. From this block, the data are sent to the power utility where it is received and processed as in Fig. 2.

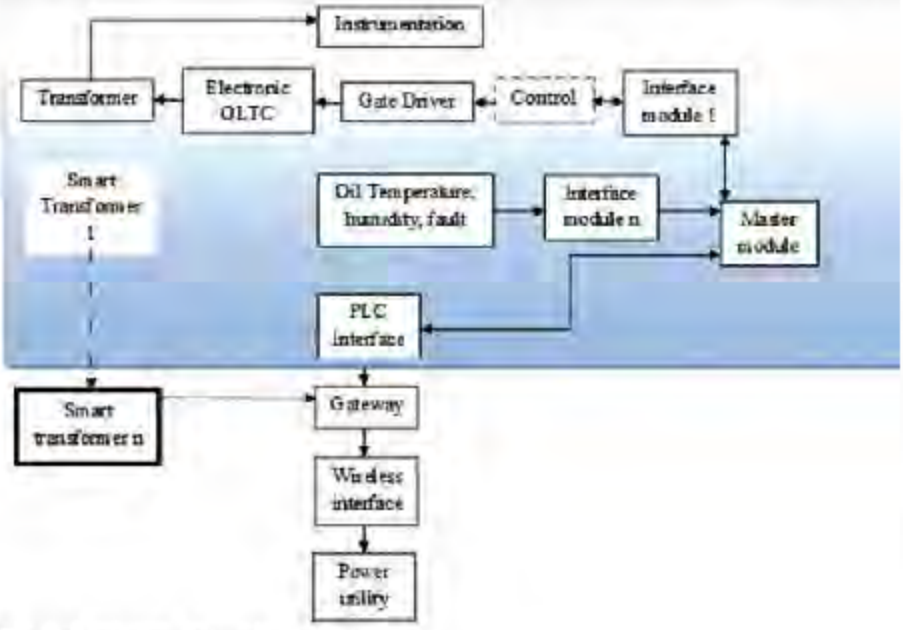

Fig. 2: Smart transformer hardware control ...

Communication topology for ST in distribution system

This system is designed for applications in rural distribution networks. This system consist of a distribution transformer equipped with an electronic OLTC for automatic voltage regulation and a communication system.

The PLC channel is used to establish a path between the distant locations, where the transformer is installed, and the gateway that concentrates the data from other smart transformer installed in that region. The gateway also converts the data into a wireless communication channel.

The amount of data transferred and received by the smart transformer makes the PLC suitable for this application, since it does not need a high data transmission rate. on the other hand, the wireless channel needs a higher data transmission rate, since it concentrates the data from a set of smart transformers, which prompts cell phone and internet topologies a good choice. A communication topology for employment in smart transformer in distribution system in shown in Fig. 3.

Area of applicability

These days, controlling the power transfer through the PCC has become a major issue.

- Smart transformers when used at the PCC, it controls the active power exchange between a microgrid and the utility grid dependent on the state of both networks and other information communicated to the ST
- To control the active power, the ST uses its taps that change the microgrid side voltage at the PCC. This voltage based control of the ST is compatible with the voltage based droop control of the units in the microgrid
- ST is a more powerful component providing faster and superior voltage regulation, as it can regulate the voltage, the frequency and the harmonic behaviour of each feeder
- A smart transformer enables to control the power exchange between a microgrid and the utility network by controlling the voltage at the microgrid side within certain limits.

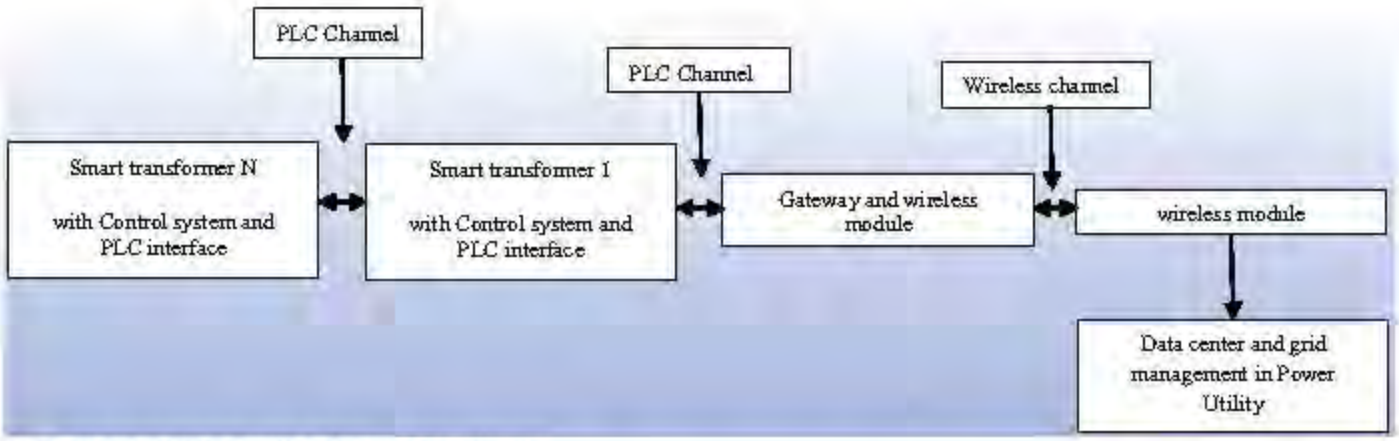

Fig. 3: Communication topology for smart transformer...

- The distributed generation units in the microgrid are equipped with a voltage based droop control strategy. This controller reacts on the voltage change making the smart transformer an element that controls power exchange without the need for communication to other elements in the microgrid.

Role of ST in the distribution system

In grid connectivity:

- ST are controlled dynamically allowing facilities to monitor and manage the transformers directly during the period of power fluctuations – and helping them ensure that their power supply remains voltage optimised even when new demands are being placed upon it
- The power transfer between a microgrid and the utility grid is actively controlled without the need for communication to all microgrid elements
- Protect the power system from load disturbances by isolating source and load harmonics, transients and voltage sags
- Enhance the power quality by summarizing the loads to the mains with identical phase current even for unbalanced loads
- Providing unity power factor with sinusoidal currents under non-linear loads
- Coordinate fault re-closing over sub-grids zones when connecting to other STs
- Accept direct connection to future medium voltage DC power transmission, low voltage DC grid, storage systems and renewable energy systems.

Issues solved through ST in distribution system

The ST can also help in overcoming several issues associated with distribution network, which are difficult to deal with conventional off-load and on-load tap changer transformers, some of the attributes of smart transformers are listed below,

- Reduction in grid losses
- Improved power quality & supply reliability

Merits of smart transformer

Smart transformer receives attention by researchers due to the following advantages:

- ST controls the bidirectional power transfer between utility grid and microgrid
- ST is able to aggregate information to determine its set point of power exchange
- ST enables to exploit the microgrid as a controllable entity, because the utility network only needs to communicate to the ST instead of all microgrid elements
- Sustainable, Reliable, Reduced overall weight & volume.

Profile

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High Efficiency Distribution Transformers

Due to use of better grade materials and optimum design, sudden failures are reduced along with lower cost of maintenance, leading to increased life expectancy. These benefits add up and balance against the inevitable increase in purchase cost – as additional copper in the windings and better materials in the core will be used in the manufacture of high efficiency transformers...

The cost of energy losses (iron, copper and stray) can be reduced by improving the efficiency of the transformer. This in turn reduces the life cycle cost...

Transformers convert electrical power from one circuit to another in the same frequency. In this process, they can raise or lower the voltage in one of the circuits with corresponding decrease or increase in current. Transformers achieve the above thorough mutual induction between the two circuits that are linked by a common magnetic flux in its core.

The invention of transformer

Transformers range in size from radio frequency transformers less than a few grams in weight to industrial transformers interconnecting the power grid, weighing hundreds of tons. A wide range of transformer designs is encountered in electronic and electric power applications. Since their invention in 1886, transformers have become the back bone of AC transmission, distribution, and utilisation of electrical energy.

Importance of transformers

Transformers play an indispensable role in the power distribution network. After transmission lines, transformers are the second large loss making equipment in electricity networks. Failure of a transformer causes sudden outage in the power supply, leading to loss in industrial production. High efficiency transformers create economic benefits in terms of lower operating costs besides reduced greenhouse gas emissions, improved reliability and potentially longer service life. In view of these important benefits, many countries including India have taken policy initiatives – to establish mandatory and voluntary programmes to conserve energy and help domestic markets be competitive by adopting high efficiency transformers. Moreover, it is relatively easy to replace the inefficient transformers with the efficient ones – when compared with laborious / time consuming efforts needed for change in lines or cables.

High efficiency vs life cycle cost

Life cycle cost of a transformer is calculated by adding the purchase cost (investment cost including bank interest), the cost of energy losses, cost of failure / repairs, cost of maintenance and de-commissioning cost after providing for resale price (residual value) of the transformer at the time of its replacement. The cost of energy losses (iron, copper and stray) can be reduced by improving the efficiency of the transformer. This in turn reduces the life cycle cost.

Also, due to use of better grade materials and optimum design, sudden failures are reduced along with lower cost of maintenance, leading to increased life expectancy. These benefits add up and balance against the inevitable increase in purchase cost as additional copper in the windings and better materials in the core will be used in the manufacture of high efficiency transformers.

Urgent need to increase efficiency

The demand for distribution transformers has been increasing at a rapid pace due to rising population and migration of people from rural areas to urban cities. This has further led to increased demand for reliable power supply systems within the country.

Reduction in transmission and distribution losses and providing reliable uninterrupted power supply have gained top most attention in our government's thinking. The emission of green house gas is reduced with decrease in energy loss. Also, every unit of energy saved is equivalent to about two units of energy generated. It is well known that the electrical energy tariffs are subsidised in certain segments in our country. The distribution transformers are special and critical as they are the final equipment – through which each unit of electricity consumed by the end user has to be delivered. Hence, it is essential that every unit of electricity reaches the consumer in a reliable and efficient way for ensuring a viable distribution.

The role of BIS

Bureau of Indian Standards (BIS) has brought out the revised standard IS 1180:2014, 'Outdoor Type Oil Immersed Distribution Transformers up to and including 2500 kVA, 33kV - Specification Part 1 Mineral Oil Immersed.' This standard extends the scope of coverage beyond 200 kVA and up to and including 2500 kVA and 33 kilovolts. This extension of the scope would bring India's norms on efficiency more at par with other major countries such as USA, China and Australia. The above BIS standard (for the first time) stipulates standard total loss (no-load + load losses) levels against specific rating of transformers both at 50% loading and at 100% loading.

BEE's star rated transformers

Bureau of Energy Efficiency (BEE), Government of India, has brought out 'star rating plan,' through which the distribution transformers (for the first time) are classified into '1star' to '5star' classifications. The transformers under '5Star' grade are the most efficient. Total loss figures are stipulated both at 50% loading and at 100% loading for each star classification.

Electricity networks

Power is generated at generating stations at voltage level ranging from 10 to 30kV. This power is converted to typically 230kV* to 400kV* by step-up transformers for transmission to the consumers' distribution networks, which are located at urban areas far away. At the distribution substations, the transformers step down the power to more usable levels of 110kV* for industries. For shorter distances, power flows at 110kV* level and at urban substations, voltage is again reduced to 11kV. Further along the streets/roads distribution is carried out at 11kV and distribution transformers are used to step down from 11kV to user voltage levels of 415/240V at the street level, very close to the consumers. Thus on an average, electrical power is transformed approximately 4 times from the generating station down to the consumer. [* Note: The voltage levels indicated in this paragraph are typical values. The exact levels are determined by the quantum of power to be transmitted and the distance between the two sub-stations (based on economics)]

Network losses

Technical losses are present in all electrical equipments as all equipments offer some resistance to the flow of current causing, I^2R losses. Integrated over a period of time, 't', this constitutes energy loss, namely, I^2Rt. Technical

losses are categorized and discussed in paragraphs below.

Line loss comprises energy loss in conductors and cables (due to selection of lower size), unbalanced loading (more than designed value of current flowing in one of the phase conductors), neutral conductor loading due to pre-dominant single phase loads, loosening of strands in ACSR conductors etc

Losses at joints and terminations including mid-span joints caused due to improper choice of materials and fasteners.

Losses in transformers (apply more to distribution transformers) such as:

- Loose connection at the bushings
- Bend in jumpers at the connectors where the strands are not tightly held
- High no-load losses due to the type of core used and/or improperly tightened cores in the case of repaired units
- High copper losses due to sub-optimal loading.

Losses in service cables and connections are caused due to under sizing of service cables, losses in joints in the poles and in junction boxes due to use of inappropriate fasteners, missing spring washers and non-use of torque spanners.

Loss due to high impedance faults occur due to the overhead wires touching trees, growth of creepers over the pole / the wires and bird nesting, broken insulators and tracking. Losses in rewired fuses and joints due to poor connections and inadequate sizing of the fuse wires leading to development of hot spot. As explained before, losses contributed by the transformers can be controlled through better design and installation practices besides proper evaluation of the load demand and choosing the right kVA rating to suit the demand requirement.

Industrial vs public distribution networks

Even though a large number of distribution transformers are used both in industrial and distribution networks, the quality of design, maintenance and application are considered superior in an industrial environment. The population of transformers in public networks is very high compared to the industrial networks.

At the same time, their working atmosphere is harsh both in the physical sense and in the electrical circuit point of view. Some of these factors may be seen as per the representative list given below:

- Industrial distribution transformers have a higher capacity range of 630 to 4000kVA. The public distribution transformers are rated from 15kVA to about 1000kVA
- The average load on an industrial transformer is higher when compared to the average load on an public distribution transformers, due to constant load monitoring practice adapted in the industry
- There is a huge tendency to go in for dry type transformers in the industrial network, which reduces the maintenance time and servicing cost when compared with oil cooled transformers till now almost exclusively used in public networks
- Even though the loads have a high harmonic content (caused by non-linear loads) in an industrial transformer, suitable harmonic reduction circuits are employed to bring down the harmonic content. The public distribution networks also suffer due to loads like UPS, computer power supplies and various other electronic gadgets used in households. However, harmonic reduction circuits are almost absent in public distribution networks, even though schemes are on the anvil to monitor and penalise polluting loads
- Load fluctuations are lower in an industrial network
- Public network transformers suffer from large unchecked unbalanced loads
- In industrial networks, the transformers are serviced or maintained better
- Accessibility for servicing / monitoring the transformers is poor in public networks
- Smaller rating transformers are predominantly used in the public distribution networks. When compared with higher ratings, these small transformers have a higher no-load and load losses
- Thus, we find that transformers in public distribution network needs more attention.

Losses in distribution transformers

No-load losses

It includes both hysteresis loss and eddy current loss. The core flux in a transformer is practically constant for all loads - about 1 to 3% variation from no-load to full load conditions. Due to this the core loss is assumed practically constant for a given transformer.

Load loss

Also called as copper loss or short circuit loss, this loss is due to resistive losses in the windings/leads and stray losses that are due to flow of eddy currents in the structural steel work and windings. This loss is proportional to the square of current.

Cooling fan loss

This is caused by the power consumed by the fans that cool the radiator bank / body of the transformer. Higher the transformer losses, larger will be size of the fan. This will result in increased losses in the cooling units.

Improving efficiency

The losses are to be reduced in order to improve the efficiency. The major areas are (a) Core and (b) Windings. However, it will not be easy to work exclusively on core and windings ignoring the other considerations. Transformer design is complex – and let us look into some of the important requirements besides the losses, which are also to be optimised by the design engineer.

- Leakage field
- Short circuit impedance
- In rush current
- Stresses and dynamic behaviour under short circuits
- Noise
- Insulation
- Cooling
- Transformer DC Bias
- Monitoring and diagnostics
- Incorporation of latest software (numerical methods) for design optimisation
- Weight and cost minimisation

Reduction in no-load losses

Better selection of the core material will minimise the core losses. The use modern Cold Rolled Grain Oriented (CRGO) Silicon Steel laminations have reduced core loss. More recently the emergence of amorphous metal has demonstrated significant reduction in no-load losses and capacity to tackle non-linear (harmonic) loads.

Apart from the type of core material, the method employed in the design, cutting, fabrication and assembly of the core materials also play an important role.

Increasing the size of the core will reduce the flux density, which will reduce the losses, as hysteresis loss is proportional to $Bmax^{1.6}$ max and eddy current loss is proportional to $Bmax^2$. But this method has to be optimised with respect to the attendant increase the weight of the transformer and the increase in transport and installation costs.

Reduction in load losses

Load losses are proportional to the square of the load current. Hence, the load current has to be monitored continuously and a fairly accurate estimation of the loads are needed to select the proper size of the transformer – as a fully loaded transformer achieves higher efficiency.

The size of the conductor can be increased thereby reducing the current density – and hence the losses, with attendant higher manufacturing cost. Increased quality control on the making of the windings through automated machines and their insertion into the cores also favour reduction in load losses. Superconducting windings with nitrogen cooling have been developed for special applications as their cost is high for normal applications or installations.

Points of concern

The high efficiency transformer apart from being an expensive purchase, also comes with a few other issues listed below, which are to be taken care by the designer or end user for extracting the advantages of the reduces losses. The higher initial cost of the transformer as such can be recovered over a period of time – as the lower losses will result in lower operating costs. Increase in size and weight occurs due to enlargement of the core as well as increase in conductor size. For amorphous iron transformers, the core size increases by about 50% over the conventional design. Hot spots developed due to non-linear loads (such as variable speed drives, computer power supplies, uninterruptible power supplies etc) can bring down the life expectancy of all the transformers.

As the financial burden is more in the case of high efficiency distribution transformers, the problem of hot spot is to be tackled vigorously. Non-linear loads cause harmonics, which increase the losses many fold, leading to the requirement of a higher sized transformer. Analysis of the loads prior to selection of the transformer is a prudent way to avoid failures. Mere installation of high efficiency distribution transformers alone is not sufficient. The following check list suggests some of the efforts to be taken at the distribution level to improve the voltage profile, reduce the single phase loads, balancing of loads, reduce the line losses etc., for ensuring the correct and optimum functioning of the high efficiency transformers.

Check list:

- Construction of more high voltage distribution lines, which will improve the HT-LT ratio as well as reduce the distribution loss
- Strengthening of the sub-transmission network by upgrading voltage levels of distribution feeders from 11 to 33kV
- Replacement of conductors in the old LT lines
- Use of higher sized conductors at the substation end of 11kV feeders
- Power factor compensation through installation of shunt and/or series capacitors
- Introduction of auto voltage boosters in areas of recurrent low voltage
- Re-arrangement of LT feeders to avoid overloading as well as under loading of distribution transformers
- Reducing length of LT lines by suitable relocation of the distribution transformers
- Balancing of loads on distribution feeders through regular monitoring
- Frequency energy audits at the transformer level.

Conclusion

High efficiency distribution transformers are the need of the day, as we have seen in this article. However, the transformers alone cannot reduce the losses. They must be provided with a sound environment including a network devoid of overloads, under voltage, single phasing, unbalance, harmonics, etc., as discussed. Supervision with monitoring the transformers' health on a continuous basis including periodic checks on the loads and load pattern will enhance their life and ensure continuous performance near to designed parameters.

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Profile

Comparison Of Supercapacitors Based On Carbon Derived From Leaves Of Tree

Supercapacitor also known as electric double layer capacitor is emerging as a new energy storage device. Due to its high power density, wide thermal operating range, low cost, and long cycle life, it bridges the gap between battery and conventional capacitor. However, it has lower energy density than batteries. Electrode material plays a key role for improving the capacitance, and hence energy density of supercapacitor. In leading research and development organisations in the world, research works are going on in search of new electrode materials for improving the capacitance of the supercapacitors. This article presents a new approach to synthesise activated carbon from leaves of trees as an electrode material for supercapacitors. Activated carbon obtained by such process can be cost effective and also environmental friendly...

Storage of energy has a major problem in recent years. Battery, fuel cells and capacitor are some of the examples of energy storage devices in which electrical energy is stored. In the last decade, the supercapacitor has come up as a new energy storage device. In battery and fuel cells, chemical energy is transformed into electrical energy – while in supercapacitor charge storage mainly takes place by electrostatic principle. Every energy storage device has its own advantage and disadvantage – and so is true for the supercapacitor. As compared to capacitor and battery, supercapacitor has moderately high power density and energy density.

Supercapacitors are made up of two electrodes of highly porous material, which are immersed in an electrolytic solution and separated by a separator. Electrolytes provide conducting medium while separator prevents internal short circuit between the electrodes. Voltage rating and internal resistance of supercapacitor are determined by electrolytes. Electrolytes of any energy storage device are basically of two types: i) aqueous electrolyte and ii) non-aqueous electrolyte. Aqueous electrolytes such as potassium sulphate, potassium hydroxide are non-toxic, highly conductive, and they have efficient charge transfer mechanism. So,they are gaining more popularity for the electrolyte of supercapacitor. On the other hand, non-aqueous electrolyte such as acetonitrile is flammable, toxic in nature. Moreover, they are costly and hence they are not preferred. Based on electrode design, supercapacitors are divided into three types (i) electric double layer, (ii) hybrid capacitor and (iii) pseudocapacitor. Electric double layer and pseudocapacitor are symmetric in nature i.e., both electrodes have same material. For hybrid capacitor, one electrode is made up of carbon material and the other of composite material consisting of carbon and other metal oxides. Carbon with high specific surface area, low impurity and high porosity is suitable for electrodes of supercapacitor. Carbon materials like activated carbon, carbon nano-tubes, graphene, carbon aerogels etc., are used as materials for the electrodes of supercapacitor and hybrid capacitor. By mixing graphene or metal oxide with activated carbon, composite materials are formed, which are also suitable for

Supercapacitors are made up of two electrodes of highly porous material, which are immersed in an electrolytic solution and separated by a separator...

electrodes of supercapacitors. Electrode material determines the capacitance of supercapacitor and hybrid capacitor. Scientists have tried several methods to synthesise high quality carbon, which includes vapour deposition, carbonisation of organic precursors, arc discharge synthesis etc. High capacitance supercapacitors are also developed from multi-walled carbon nano-tubes,synthesised from petroleum based precursor. Activated carbon obtained by petroleum precursor is very expensive and also it will not be available after few decades. Therefore, it is not commercially viable. A recent method of synthesising activated carbon is by burning dead leaves of trees at high temperature, which can be used as an electrode material for the supercapacitor.

Waste management is a major problem faced by big cities. Several environmental communities are taking initiatives for separating out waste material. Carbon content in such waste material is comparatively high. By burning these waste materials, harmful gases are produced along with ash. Dead leaves of trees, which are also a waste material, can be used for obtaining activated carbon. Activated carbon obtained by burning dead leaves at high temperature can be cost-effective and environmental friendly. To synthesise activated carbon, dead leaves are burnt at high temperature in absence of oxygen. After heating, it is washed with sulphuric acid and the solution is then filtered. This article presents a new methodology of synthesising activated carbon from neem tree leaves and coconut shell. The activated carbon derived from neem tree leaves and coconut shell at various temperatures is compared along with commercially available Vulcun XC-72R activated carbon. Area based capacitance is important when volume and shape are design parameters. Specific capacitance is important when weight of the electrode material is significant. Pulse current, energy density and power density of supercapacitor are most significant factors for automobiles applications. Therefore, comparison of various derived activated carbon is made on the parameters of area based capacitance, specific capacitance, pulse current, energy density and power density.

Experimentation with leaves of tree

For the development of supercapacitor, activated carbon plays an important role. It is used as main electrode material in supercapacitors. There are several processes of obtaining activated carbon. A recent method of obtaining activated carbon is from dead leaves of trees. For this purpose, composition of various leaves of trees were studied – and it was found that neem tree leaves and coconut shell have relatively high carbon content as compared to others. So, for obtaining activated carbon, neem tree leaves are collected, and those are thoroughly washed. After washing, it is kept in sunlight for drying purpose and then it is crushed with the help of a grinder. To synthesise activated carbon, neem tree leaves powder is heated in a furnace at 300^{O}C and 500^{O}C respectively in presence of nitrogen. Initially temperature is increased at a rate of 10^{O}C/min from room temperature. After attaining 300^{O}C, it is heated continuously for 5 hours. After heating for 5 hours, colour of neem tree leaves powder changes from light green to black colour carbon. After cooling the sample, it is washed with 3 molar strength sulphuric acid solution – so that ash content gets dissolved in acid and the samples are then filtered with the help of filter paper. After filtering, these samples are kept in oven at 100^{O}C for half an hour for drying purpose. These samples are then crushed into fine powder with the help of mortar pestle. Similar type of procedure is repeated for heating neem tree leaves at 500^{O}C for 2 hours. The obtained activated carbon is ready for use in electrodes of supercapacitor. A flow chart shown in Fig. 1 gives the detail process of obtaining activated carbon from neem tree leaves. This process of obtaining activated carbon is generic and can also be applicable to other dead leaves with minor changes.

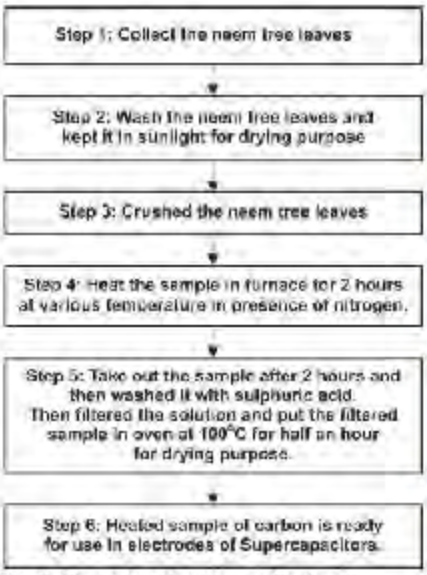

Fig. 1: Flow chart for the synthesis of activated carbon from neem tree leaves...

For obtaining activated carbon from coconut shell, it is crushed in to small pieces and then phosphoric acid is mixed in it in the ratio of 1:2. The sample is then kept in a rotary kiln at a temperature of 1000^{O}C for 1 hour in the absence of air. After 1 hour, sample is then taken out and is washed with demineralized water. Another commercially available activated carbon i.e., Vulcun XC-72R is used in experimentation. It is generally obtained by pyrolysis process in which carbonaceous material is heated at a very high temperature in absence of air. Vulcun XC-72R is used along with coconut shell derived carbon and neem tree leaves derived carbon for trails. The derived activated carbon by various methods is used for making electrodes of supercapacitor.

For development of prototype, wiremesh SS316 is used as current collector. Loading on the wire mesh is done by mixing 20% Vulcun XC-72R with 80% derived carbon and a paste of two are formed by using iso-propyl alcohol. Then the wire mesh loaded with carbon material is sandwich in between three separators. After developing the prototype of various activated carbons, they are put in an electrolyte solution.

Results

Various prototypes of supecapacitor are made with the activated carbon. Comparison of activated carbon derived from neem tree leaves at various temperatures, coconut shell and commercially available Vulcun XC-72R are made on the basis of specific capacitance, energy density, area based capacitance, pulse current, internal resistance, and power density.

Parameters	Vulcun XC-72R	Neem tree leaves derived carbon heated		Coconut shell derived carbon heated at 1000^{O}C for 1hr
		at 500^{O}C for 2hrs	at 300^{O}C for 5hrs	
Pulse current (mA)	32.11	39.35	28.8	16.89
Area based capacitance (F/cm^2)	0.039	0.086	0.025	0.08
Specific capacitance (F/gm.)	0.48	1.08	0.305	1.0
Energy density (Wh/gm.)	1.18	2.62	0.74	2.42
Internal resistance (Ω.)	42.73	38.61	57.53	79.16
Power density (Kw/gm.)	0.118	0.13	0.087	0.063

Table 1: Comparison of supercapacitor of various carbon materials...

On comparing supercapacitor of various activated carbons, it was found that neem tree leaves derived activated carbon heated at 500^{O}C for two hours gives much better performance. However, specific capacitance and energy density of coconut shell derived carbon heated at 1000^{O}C is equivalent to that of neem tree leaves derived carbon heated at 500^{O}C. From these, it can be concluded that functional properties such as specific surface area and porosity of neem tree leaves derived carbon heated at 500^{O}C for 2 hours sample is similar to that of coconut shell derived carbon.

Discharge current

A discharge current characteristic of various activated carbons is shown in Fig. 2. Area under the curve gives the charge stored by the supercapacitor, which determines the capacitance. Neem tree leaves derived carbon heated at 500^{O}C has more area under the curve as compared to others. So, it has high capacitance. Also, it has high pulse current and low internal resistance, which results in high power density. Coconut shell derived carbon heated at 1000^{O}C has low pulse current as it has high internal resistance, & hence low power density compared to other activated carbon. But it has almost same capacitance as that of neem tree leaves derived carbon heated at 500^{O}C as its discharge current characteristics after first few seconds almost matches with neem tree leaves derived carbon heated at 500^{O}C. Discharge rate of neem tree leaves derived carbon heated at 300^{O}C is faster as compared to other activated carbon. So, it has less area under curve, which results in lowest capacitance.

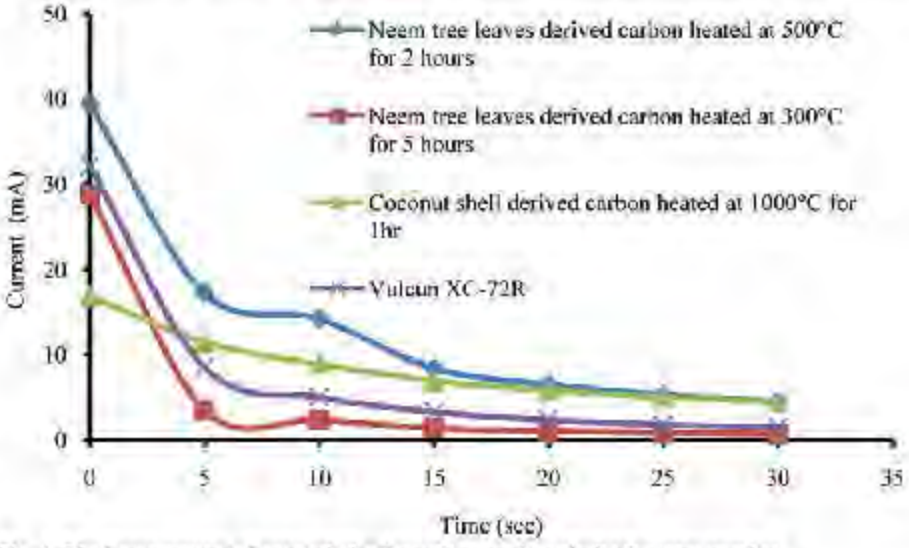

Fig. 2: Discharge current characteristics for various carbon derived supercapacitor...

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Area based capacitance & power density

Fig. 3 shows area based capacitance and power density of various activated carbons. As per parameters shown in Table 1, neem tree leaves derived carbon heated at 500^{O}C and coconut shell derived carbon heated at 1000^{O}C has almost same area based capacitance. But due to low pulse current,coconut shell derived carbon has high internal resistance, which results in poor power density among all activated carbon. However, discharge characteristic of Vulcun XC-72R is above the neem tree leaves derived carbon at 300^{O}C. Therefore, it has high capacitance and power density than neem tree leaves derived carbon heated at 300^{O}C.

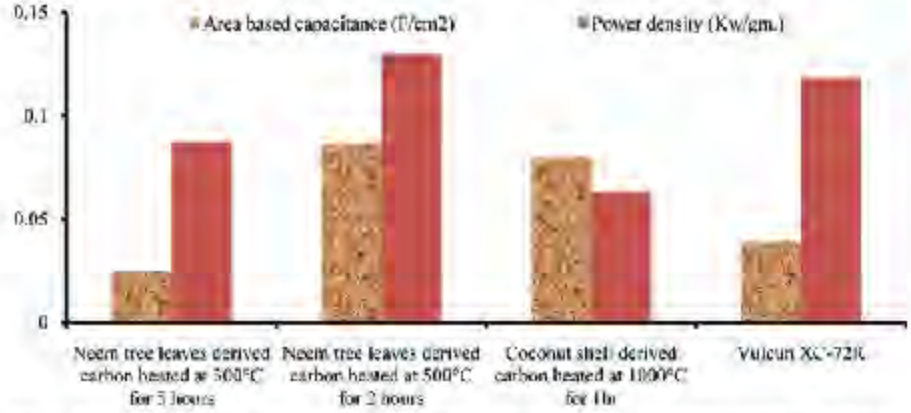

Fig. 3: Area based capacitance (F/cm^2) and power density (kW/gm) for various carbon derived supercapacitor...

Specific capacitance and energy density

Specific capacitance and energy density of various activated carbons are shown in Fig.4. As per parameter in Table 1,Vulcun XC-72R and neem tree leaves derived carbon heated at 300^{O}C has low specific capacitance & energy density compared to coconut shell derived carbon and neem tree leaves derived carbon heated at 500^{O}C.

However, coconut shell derived carbon heated at 1000^{O}C has almost same specific capacitance and energy density as that of neem tree leaves derived carbon heated at 500^{O}C. But the process of synthesizing activated carbon from neem tree leaves is much easier than coconut shell derived carbon. So, it will be preferred for making electrodes of supercapacitor. Thus, in future neem tree leaves derived carbon can be a better option than coconut shell based carbon.

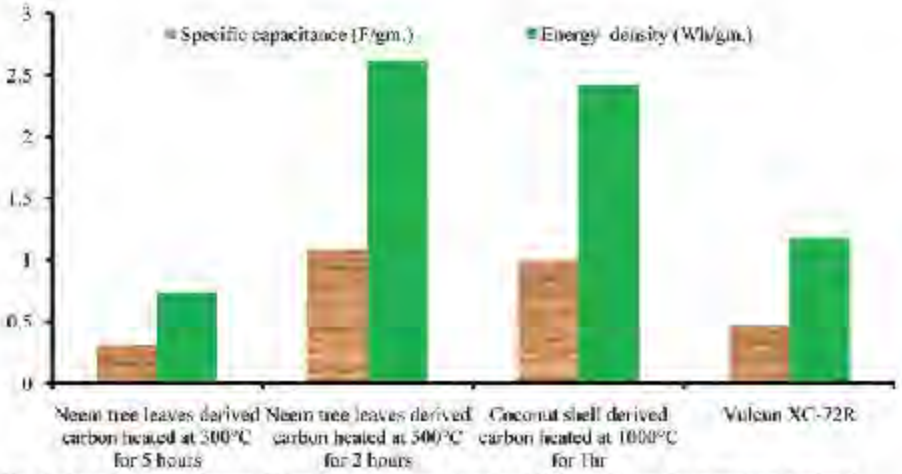

Fig. 4: Specific capacitance (F/gm.) and energy density (Wh/gm) for various carbon derived supercapacitors...

Pulse current and internal resistance

Pulse current and internal resistance of various activated carbons are shown in Fig.5. Internal resistance depend on the electrode and electrolyte materials. On comparing pulse current and internal resistance of various activated carbons, it was found that coconut shell derived carbon has low pulse current and high internal resistance which is undesirable. Vulcun XC-72R has high pulse current and low internal resistance than coconut shell and neem tree leaves derived carbon heated at 300^{O}C. Neem tree leaves derived carbon heated at 500^{O}C has high pulse current and low internal resistance compared to other activated carbons.

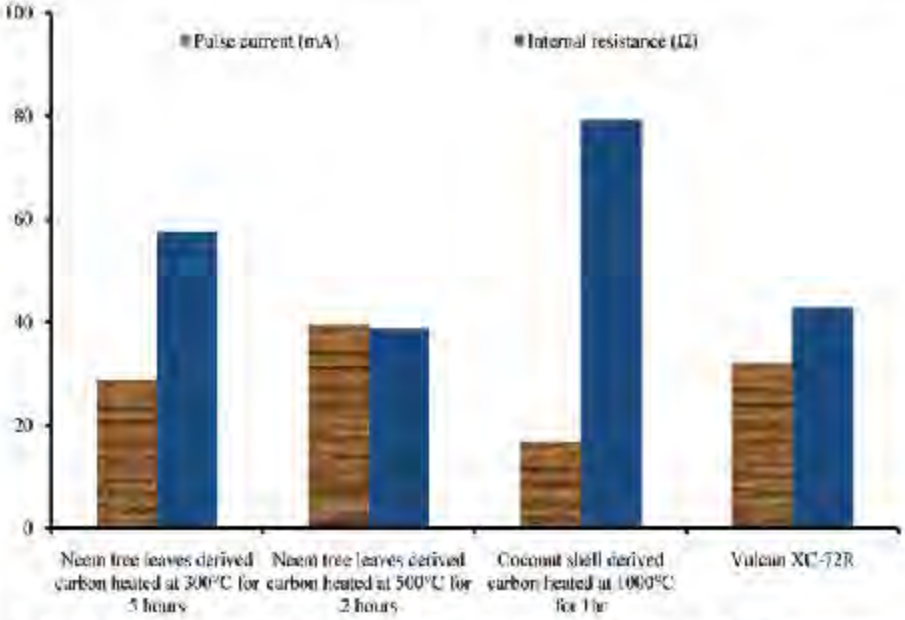

Fig. 5: Pulse current (mA) & internal resistance (Ω) for various carbon derived supercapacitor...

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The process of obtaining activated carbon from neem tree leaves is much easier compared to Vulcun XC-72R. Moreover, it can be cost effective and enviornmental friendly. So, it will be the preferred more.

Conclusion

Activated carbon synthesised from leaves of neem tree and coconut shell along with commercially available activated carbon i.e. , Vulcun XC-72R is studied for supercapacitor applications. On comparing these carbons materials at various temperatures, it was found that neem tree leaves derived carbon heated at 500^{O}C for two hours gives better specific capacitance, energy density, power density and pulse current as compared to other activated carbons. However, coconut shell derived carbon heated at 1000^{O}C has almost same energy density and capacitance as that of neem tree leaves derived activated carbon heated at 500^{O}C. But the process of synthesising carbon from neem tree leaves is much easier as compared to coconut derived carbon. Activated carbon obtained from neem tree leaves involve heating at low temperature, which is cost effective and environmentally friendly. Specific capacitance and energy density can be further increased by mixing metal oxide in proper proportion along with the derived activated carbon.

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Case Studies Of The

Transformers Failure Analyses

Collection of failure data is the first major task. In free repair service or in repair contract, very little effort is made by utilities to find out the root cause of failure, which could be one of the reasons why a damaged transformer is replaced by a new one without removing the cause of damage, leading to failure immediately or within a very short period...

India's manufacturing sector, heavy industries, various global service centres are all dependent on reliable power supply. This underlines the principle that 'No Power-No Business'. This makes it utmost important that 'Transformers', the heart of substation, must function reliably. Failures of critical transformer-assets not only impact industries but other consumer categories also affect the economy of the country and have social and political ramifications.

We'll study the transformers, which come for repairs after failure in the industry and analyse the various causes of failure of power transformer and distribution transformer in detail. By knowing the causes of failure, we can take steps to overcome it and thus reduce the fault occurrence in transformers and make the power supply more reliable.

A transformer is a vital equipment that connects the generation to various types of loads. The right kind of design, manufacture, test, operation and protection increase normal life of transformer.

All power utilities are much worried these days due to high rate of failure of distribution transformers and service. The failure rate of transformers in India is in the order of 12 to15% as against less than 1% in developed countries. No one wants to share responsibility of failure. Manufacturers often blame the users for running the transformers in overload for single phasing or unbalancing. Users are of the opinion that the cause of failure is due to faulty design or bad materials or poor workmanship. But the fact is – responsibility should be shared equally by both.

The manufacturer should accept the feedback from the utilities without any prejudice – and take remedial measures, while the users, on their part, should ensure that the equipment is not abused, and correct feedback on the product's performance is passed to the manufacturer.

Collection of failure data is the first major task. In free repair service or in repair contract, very little effort is made by utilities to find out the root cause of failure, which could be one of the reasons why a damaged transformer is replaced by a new one without removing the cause of damage, leading to failure immediately or within a very short period.

Right kind of design, manufacture, test, operation and protection increase normal life of a transformer...

Company details

The projects has been done at Royal Electricals Pvt. Ltd. plot no 1405, phase 5, GIDC Estate,Vithal Udhyognagar 388121, Dist. Anand, Under the IDP Scheme Gujarat Technological University.

Classification of failures of a transformer

For the purpose of discussion, we have divided faults into three classes:

Failure attributed by users

- Prolonged over loading
- Single phase loading
- Un-balanced loading
- Faulty terminations
- Power theft by hooking
- Faulty earth connection to tank body as well as LV terminal
- Failures due to external short-circuit
- Less maintenance
- Improper installation

Failure causes at the manufacturer's end

- Faulty design
- Poor quality of material
- Bad workmanship
- Improper transportation
- Sharp edges of conductor
- Incomplete drying
- Bad insulation covering on conductor
- Improper joints or connection

Failure during working condition

- Deterioration of oil
- Faults in magnetic circuit
- Inadequate pre shrinkage of the winding
- Inter turn faults

Major failures in power transformers

- Oil leakage
- Deterioration of oil
- Ventilation failure
- Loose clamping
- Bushing flashover
- Fault in OLTC
- Inter-turn fault

Case studies

Failure due to bad insulation of conductor

Various types of insulation are used as coverings of conductors. The type of covering depends upon the type of use and basic insulation of the transformer. It is very common to see a conductor with lost wrapping. Also, the conductors have single covering instead of double covering. The quality of paper is also one of the causes of failure.

The workmen should be properly trained for proper insulation of winding – and identity bad material of insulation during the process of coil making.

Fig. 1: Winding insulating process...

Improper joints or connections

The local heating generated by improper joints or connections may slowly lead to a deterioration of the oil – if the joints are oil immersed. The oil temperature indicator and/or winding temperature indicator (both with alarm contacts) can be used to insulate such problems. Gas operated relay, can also be used to sound an alarm – and actuate the trip circuit if the condition calls for it.

Case study: (improper joints or connections)

11kV/415V, distribution transformer: in distribution transformer, the linemen sometimes make improper terminal connection. This results in to overheating of transformer near the joints, resulting in to failure.

Fig. 2: Improper joint...

Deterioration of the insulating oil

The insulating oil deteriorates gradually with use. The main cause is the absorption of the moisture in the oil. Each time the moisture is doubled in a transformer, the life of the insulation is cut by one-half. Failures due to moisture are the most common causes of transformer failures.

Reasons for moisture influx

- Moisture can be in the insulation when it is delivered from the factory. If the transformer is opened for inspection, the insulation can absorb moisture from the atmosphere
- If there is a leak, moisture can enter in the form of water or humidity in air. Small oil leaks, especially in the oil cooling piping, will also allow moisture ingress
- Moisture is also formed by the degradation of insulation as the transformer ages
- Most water penetration is flow of wet air through poor gasket seals due to pressure difference caused by transformer cooling. The most common moisture ingress points are gaskets between bushing bottoms and the transformer top and the pressure relief device gasket
- If in breather the moist silica is not replaced by dry silica gel. Then moisture can enter from atmosphere.

Effect of moisture

Paper insulation has a much greater affinity for water than does the oil. The water will distribute itself unequally, with much more water being in the paper than in the oil. The paper will partially dry the oil by absorbing water out of the oil. Moisture and oxygen cause the paper insulation to decay much faster than normal.

Due to moisture oxidation takes place. Oxidation results in the formation of acids in the insulating oil, which in turn, contributes to the formation of sludge.

The rate of oxidation also depends on the temperature of the oil; the higher the temperature, faster is the oxidative breakdown. Sludge settles on windings and inside the structure, causing transformer cooling to be less efficient, and slowly over time temperature rises.

Acids cause an increase in the rate of decay, which forms more acid, sludge, and moisture at a faster rate. This is a vicious cycle of increasing speed forming more acid and causing more decay.

Case study : (Deterioration of the insulating oil)

Moisture content in the oil increases, and when the transformer is energized, water begins to migrate to the coolest part of the transformer and the site of the greatest electrical stress. This location is normally the insulation in the lower one-third of the winding. Paper insulation has a much greater affinity for water than does the oil. The water will distribute itself unequally, with much more water being in the paper than in the oil. The paper will partially dry the oil by absorbing water out of the oil. Temperature is also a big factor in how the water distributes itself between the oil and paper.

There is almost twice the moisture near bottom as there is at the top. So, this transformer failed in the lower one-third of the windings due to paper insulation breakdown.

Fig. 3: Failure due to moisture content in oil...

Case study : (Inter turn fault)

50 KVA, 11kV/440 V

Cause of failure

Failure of transformer took place due to shorting of few turns of winding of the same phase. This was due to overloading of transformer, which results into insulation failure due to overheating.

Fig. 4: Interturn faults...

Case study: (Fault in magnetic circuit)

Rating: 11kV/440V, 30 KVA

Cause of failure

Insulation between lamination got damaged, which resulted into local overheating and due to which many laminations got short circuited. Thus, winding temperature got increases and its insulation failed.

Fig. 5: Core insulation failure...

Inadequate pre shrinkage of the winding

Insulating paper blocks used for horizontal and vertical supports of coil are bound to shrink during service due to generation of heat. This shrinkage is more in case of disk coil. Shrinkage may cause looseness in coil assembly, which may result in failure due to short circuit forces.

To overcome such failure, it is recommended that good quality of insulating bolt must be used. After heating coils to the required level, coils are compressed judiciously by a skilled workman till it reaches the required shrunk height.

Case study :(Inadequate pre shrinkage of the winding)

Rating:11KV/440V,40 KVA

Cause of failure

As shown in the figurer (below), due to shrinkage of paper blocks, the coil got loose. During external short circuit fault, failure of the transformer occurred due to movement of discs.

Fig.6: Failure due to paper block shrinkage...

The curious case of the shrinking, but more cost efficient transformer.

Considering the total cost perspective: Truth be told, if only comparing the initial fluid cost of Envirotemp™ FR3™ fluid and mineral oil, FR3 fluid cost is higher. Yet consider the revolutionary advantages in optimized transformer design, extended insulation and asset life, and reduced maintenance that FR3 fluid brings, and a more accurate view of the total cost of ownership of the dielectric fluid and its exponential value for your organization emerges.

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CONSIDERING THE TOTAL COST OF OWNERSHIP

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Oil leakage

Oil in addition to serving as insulating means serves to transfer the heat generated in the windings and the core toward the walls of the tank and the radiators. Due to this it has:

- High dielectric breakdown
- Low viscosity

If the oil leaks from the transformer tank due to some reason, the oil level in the tank will drop. In the worst case, the connections to bushings and parts of the winding will get exposed to air. This will increase the temperature of the windings. This in turn, would damage the insulation of the winding. Apart from this moisture can get in through the leak, and degrade the transformer oil – leading to an overheated transformer.

In power transformer, the conservator tank is provided with an oil level indicator having an alarm facility. If the oil level drops below a predetermined level, the alarm will ring. It allows the operator to initiate necessary actions.

But in distribution transformer, oil level indicator with alarm facility is not provided. Only a small transparent window (gauge) placed conservator tank to see the oil level is provided. It shows the level of the oil directly, being able to see from the outside. When the crystal is dirty, you can wipe it off with a rag. Periodic checking of this window is not done in India. So, many of small transformers fail due to decrease in oil level.

Fig. 7: Oil level window...

Causes of oil leakage

Oil leaks can occur from many parts of transformer tank:

Radiator fins, Bad welds, Cracked voltage bushings, Gaskets, Butterfly valves controlling the flow of oil between the radiator and main oil tank.

Oil leaks in gaskets

Oil leaks from transformer gasket, if it has aged, lost elasticity and cracked as it cooled much further than its normal operating range. This is often a slow weeping rather than a catastrophic failure; however, over a time, the weeping can cause a serious amount of oil loss.

It is better to use the gasket without a joint, but it is not possible as the gasket is too large. There are round, square, rectangular and oval-shaped gaskets, but in any case try to join the gaskets by using a flat portion of the gasket. If this is not done, then there are more chances of gasket failure. If the element (or a component to seal that) adopted for the gasket, is not of thin layer or not dried with air – than the oil can leak through the gasket.

Many times even after correct adjustment, the gasket oil leak is not stopped, then the gasket will have to be replaced with a new one. A gasket with low elasticity such as lead type must always be changed with a new. Do not use the old one again.

Fig. 8: Gaskets...

Oil leakage from radiator

Radiator fins are a common area for oil leaks. Fins are made from thin metal to aid heat transfer. The downside of that thinness is that internal corrosion due to water ingress and separation or external environmental corrosion can quickly penetrate and spill the oil.

This leakage must be repaired by welding, to make sure that the heat from the welding is not going to produce an explosive gas mixture.

Fig. 9: Oil leakage from radiator...

Conclusion

From case studies of Royal Transformers Pvt. Ltd. on transformers, we conclude that major failures that occur are mainly on distribution transformer of rating 11kV/433V. The major causes of failure on this range of transformers are unbalanced loading, single phasing, overloading and some user attributed reasons. The major failures on power transformers are due to insulation damage, deterioration of oil, leakage of oil and also due to bushing failures.

(There is no need to take any cautionary steps in the case of nonflammable oil).

Profile

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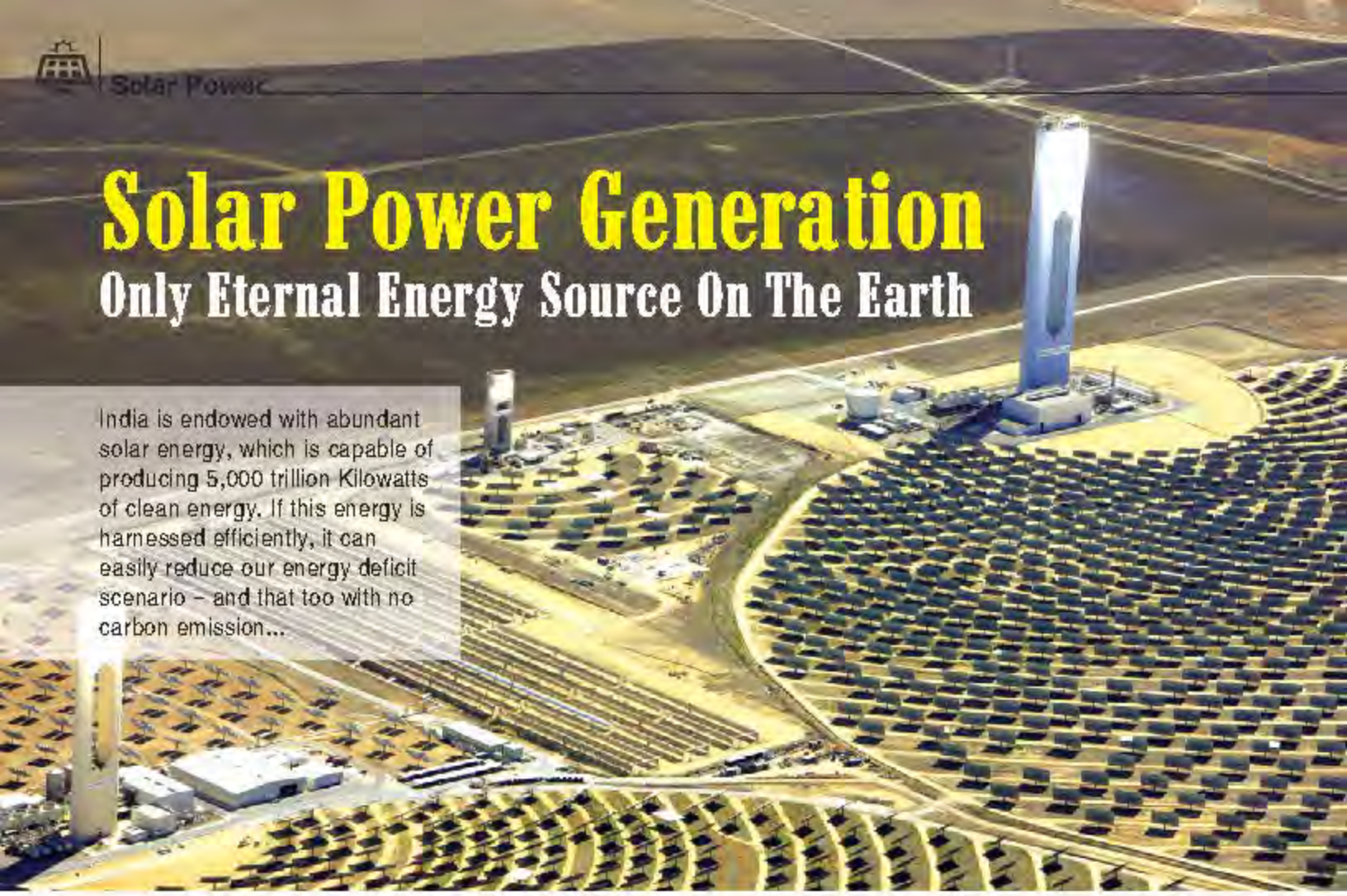
Solar Power Generation

Only Eternal Energy Source On The Earth



India is endowed with abundant solar energy, which is capable of producing 5,000 trillion Kilowatts of clean energy. If this energy is harnessed efficiently, it can easily reduce our energy deficit scenario – and that too with no carbon emission...

India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as a future source of energy. It also has the advantage of permitting the decentralised distribution of energy, thereby empowering people at the grassroots level.

India is endowed with abundant solar energy, which is capable of producing 5,000 trillion Kilowatts of clean energy. The country is blessed with around 300 sunny days in a year and solar isolation of 4 to 7 kWh per day. If this energy is harnessed efficiently, it can easily reduce our energy deficit scenario – and that too with no carbon emission.

Many states in India have already recognised and indentified solar energy potential. Others are lined up to meet their growing energy needs with clean and everlasting solar energy. In near future solar energy will have a huge role to play in meeting India's energy demand. Based on this vision Jawaharlal Nehru National Solar Mission was launched under the brand name 'Solar India.'

Jawaharlal Nehru National Solar Mission is a major initiative of the Government of India with active participation from states to promote ecologically sustainable growth while addressing India's energy security challenge. It plays a major role in India's contribution to fight against the issues of climate change, which is a big concern across the globe.

Launching India's National Action Plan on Climate Change on June 30, 2008, the then Prime Minister of India Dr. Manmohan Singh stated, "Our Vision it to make India's economic development energy-efficient. Over a period of time, we must pioneer a graduated shift from economic activity based on fossil fuels to one based on non-fossil fuels and from reliance on non-renewable and depleting sources of energy to renewable sources of energy. In this strategy, the sun occupies centre-stage, as it should, being literally the original source of all energy. We will pool our scientific, technical and managerial talents, with sufficient financial resources, to develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people. Our success in this endeavour will change the face of India. It would also enable India to help change the destinies of people around the world."

In the last three years the cost of generation from solar has drastically come down – and MNRE anticipates solar power achieving grid parity by 2017-18 – and parity with coal-based thermal power by 2020, but this recognises that cost trajectory will depend upon the scale of global deployment and technology development and transfer. There are a number of off-grid solar applications particularly for meeting rural energy needs, which are already cost-effective and provides for their rapid expansion.

- **Scalability:** India is endowed with vast solar energy potential. About 5,000 trillion

kWh per year energy is incident over India's land area with most parts receiving 4 to 7 kWh per sq. m. per day. Hence, both technology routes for conversion of solar radiation into heat and electricity, namely, solar thermal and solar photovoltaic, can effectively be harnessed providing huge scalability for solar in India

- **Environmental impact:** Solar energy is environmentally friendly as it has zero emissions while generating electricity or heat
- **Security of source:** From energy security perspective, solar is the most secure of all sources, since it is abundantly available. Theoretically, a small fraction of the total incident solar energy (if captured effectively) can meet the entire country's power requirements. It is also clear that given the large proportion of poor and energy un-served population in the country, every effort needs to be made to exploit the relatively abundant sources of energy available to the country.

Solar-based electric power generation:

- Off-Grid Solar Power for Rural India
- On-Grid Solar Power for Urban India

Off-grid solar power generation: 75% of Indians stay in rural areas, is an old saying. Off-grid solar-power generation in rural India shall definitely strengthen our economic health of grass root-level people. The poorest of poor, can have light in his/her hut in less than ₹ 1000. Only 100 Watts of Roof-top Solar in rural/ village house is enough to provide round the clock power for all the needs including LED-bulbs, small DC TV, Mobile charger & cooking at a very economical tag of ₹ 24,000/- only (one time expenditure) Solar-panel life is typically 25 years. In addition to this Solar-Powered agricultural pumps can be provided up to 10Hp through soft bank-loans by respective state government. The economically healthy rural India shall fulfill superpower dream of India.

A vision 2020 / future solar rural India

By 2020 conventional electrical lines shall be out of site. All rural houses shall be powered by off-grid solar panels for their total domestic lighting needs including lighting, TV, fridge, water-pumps etc. Latest battery technology like LiFePO4 or Capacitor batteries shall play the major role, wherein abundant solar-energy shall be stored for efficient, interruptable energy supply. Most of the daily cooking needs shall be taken care of by latest battery-powered cooking, eliminating cooking-gas & conventional fuel.

Solar home...

All petrol/ diesel pumps shall be converted to solar-charging stations, fuelling latest battery – operated efficient transport vehicles, like scooters, motorcycles, cars etc. Renewable-energy shall be the base of future rural – village. Conventionally manufactured electricity shall be fed only to urban areas and industries, reducing transmission-loss and leakages. This shall make India a better place to live in.

On-grid / Grid-tied solar power generation for urban India: Cost of solar-panels is the lowest today and on the contrary electrical tariff has shot up due to reasons well known to all of us. This has helped in achieving solar-power generation projects to reach breakeven point at 5 to 6 years. Very soon Renewable Energy Certificate (REC) shall be mandatory to all business houses, wherein 2% of their energy requirement has to be produced by renewable energy. Hence, major industrial houses have to start generating minimum 2% of their needs by renewable energy. On top of it, groups having surplus funds can avail depreciation benefit of 80% on Green-Technology Investment, recovering their cost in 2 years – and having their own power-generation units of 25 years life.

A typical 1 MW good-quality power – generation plant needs approx. 5 to 6 acres of land for solar-panels and shall cost approx. ₹ 6 to 7 Corers. The breakeven point is guaranteed for 5 to 6 years. Approx. 18 lacks units are produced per year by 1MW solar-plant. Rest calculation shall reduce power-needs still further.

Thus, we can be one of the future great-powers in the world – if we properly harness the solar energy incident on our land.

Profile

Bandal S D

E&TC Graduate Engineer
COEP, Pune

UCLA professor receives 2015 Pan Wen Yuan Outstanding Research Award

Dr. Kang L. Wang is a visionary, and is one of the leaders in nanoelectronics in the world. His leadership and fundamental contributions in semiconductor/nanoelectronics research have profoundly impacted both academia and industry...

Professor Kang L. Wang, from the Electrical Engineering Department of UCLA, has been presented the 2015 Pan Wen Yuan Outstanding Research Award. Dr. Wang's broad spectrum of contributions in semiconductor materials and devices has had an enormous impact in the semiconductor industry.

His contributions extended to new directions of nanoarchitectures for information processing. The Pan Wen Yuan Foundation Outstanding Research Award aims to commemorate outstanding local and foreign researchers of Chinese descent – who have not only made theoretical innovations, experimental technique developments, production process enhancement or instrument production with international standards, but also led large-scale or integrative projects with excellent performance in the areas of electronics, information technology (IT), telecommunication and many others.

Inventor of Insulated-Gate Bipolar Transistor (IGBT) honoured again

Dr. Baliga is famous for his invention of the Insulated-Gate Bipolar Transistor or IGBT, a power semiconductor device primarily used as an electronic switch in modern appliances...

Electrical engineer Jay Baliga, Director of NC State's Power Semiconductor Research Center, is renowned for his invention of the Insulated-Gate Bipolar Transistor or IGBT, a power semiconductor device primarily used as an electronic switch in modern appliances, from electric cars to air conditioners.

Baliga, lauded by Scientific American as one of the heroes of the semiconductor revolution, has scored another scientific honour. He shares the honour with Shuji Nakamura, a professor of UC Santa Barbara – who won the Nobel Prize in physics last year for inventing the blue LED. The award comes with a cash prize of 33 million rubles, equivalent to about $645,000. The IGBT is used in every sector of the economy to improve the quality of life for billions of people around the world. The improved efficiency gained by using the IGBT has resulted in saving over 1 trillion gallons of gasoline and reducing electrical energy consumption by more than 50,000 terra-watt-hours (equivalent to not having to build 600 one-gigawatt coal-fired power plants). This has saved consumers $15 trillion, while reducing carbon dioxide emission by more than 75 trillion pounds.

Electric Power Research Institute's scientist receives recognition

Wilmshurst oversees more than $170 million in annual collaborative research for the benefit of the public, targeting the safe, reliable, cost-effective operation of nuclear plants around the world...

Neil Wilmshurst, Chief Nuclear Officer at The Electric Power Research Institute (USA), has recently received an Energy Leadership Award at the Energy Inc. Summit (held in Charlotte, North Carolina) – for his significant contributions to the Carolinas' growing energy sector. The summit focusing on industry trends and business opportunities was sponsored by Charlotte Business Journal and E4 Carolinas. Wilmshurst oversees more than $170 million in annual collaborative research for the benefit of the public, targeting the safe, reliable, cost-effective operation of nuclear plants around the world. Notable accomplishments under his leadership include:

- Growing international funding of EPRI nuclear research to 45% today from 20% five years ago
- Increasing participation in EPRI's nuclear research programmes to 75% of the world's nuclear reactors. Participants include all the U.S. utilities and nuclear plant owners and operators from Japan, China, Korea, Taiwan, Brazil, Argentina, Mexico, Hungary, Spain etc.

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Trends In The Standards For
Dry Type Transformers

With the increasing use of Dry type transformers, it is important for the utilities and the regulators to have norms for losses for Dry type transformers – as we have norms for oil immersed transformers in form of star labelling programme...

Today the urban metropolitan cities, industries, power plants, high population density areas with sky scrapers, malls, and airports, metro rails have become a necessity. The spiral growth in the civic, business and industrial development has forced the system designers to look for safe and reliable solutions.

The public utilities have a big challenge to cater to the exponentially growing demand – and simultaneously maintaining the distribution system healthy and reduce the outage of the transformers.

The utilities with high population densities like CESC Kolkata; BEST Mumbai and Reliance Mumbai, Orissa and Assam have converted their distribution transformers from oil to dry – depending on the safety and maintenance needs, as these utilities have identified that working with the traditional oil immersed distribution transformers may not help them solve the concerns around safety and reliability. Considering the changing trends and the growth in the Dry type transformer markets, the need of the hour is to establish the right kind of standards that define the safety and reliability of these transformers.

What is the present state of the utilities?

The utilities in the country face difficult challenges on safety of oil immersed transformers, almost all the cities in the country are old and congested – where we can find oil filled transformers in very close vicinity to the houses buildings etc. The examples are the narrow by-lanes of cities like Delhi, Jaipur, Gwalior and Indore.

With the increase in population leading to the increase in load, the transformers in these locations inside the crowded cities have become susceptible to fire hazards (with oil immersed transformers).

India is a vast country and have a variety of climatic conditions – ranging from extreme hot nearing 50 Dec C in the hot deserts of Thar to a vast coast line with a high humid environment – and also high mountain ranges having sub-zero temperatures in places like Kargil. We need transformers that can work in all environments, pollution levels, and provide utmost safety to the establishments and people around them.

With increasing use of Dry type transformers, it is important for the utilities and the regulators to have norms for losses for them...

The most common technologies prevalent in the dry type transformer space are Open ventilated Dry type and Cast Resin technologies, while driving the specifications for Dry type transformers – all concerns are related to the fire safety, environmental and climatic conditions.

If we see the newspaper headlines related to the oil immersed distribution transformers, we often find pictures of the recent fire on 25th August 2014 in the narrow by lanes of Chandani Chawk in Delhi. Shown below:

FIRE IN CHANDANI CHAWK
Fire breaks out in Chandni Chowk area of New Delhi
25 Aug 2014, 1645 hrs IST, AGENCIES
A fire broke out in the narrow bylanes of Chandni Chowk area in New Delhi on Monday afternoon (August 25) leaving several shops gutted although no casualty has been reported so far, Delhi Fire Service officials said. Around 25 fire tenders and at least 50 fire fighters were pressed into service to douse the flames. **"We got a call around 2:30 PM regarding fire in a transformer for shops, the fire was upgraded to the level of medium fire.**

The impact of the incident was: 25 shops were destroyed and put to flames although no human causality was reported. Some incidents turn very severe, and cause incidents like UPHAR CINEMA – where 59 people lost their lives as an oil immersed transformers caught fire in the basement.

The Indian Electricity Rules 1956 were amended on 25th Nov 2000, and mandated the use of Dry type transformers in all indoor applications. However, the rule says 'Dry type' – but it is now the responsibility of the standards to define 'HOW FIRE SAFE?'

The IS 11171:1985 is the present standard for the Dry type transformers in India. This standard is derived from the IEC 726 1982, subsequently the ICE was called the IEC 60076-11 the 60076 series.

The second most important aspect for the use of Dry type transformers is the energy efficiency. With the increasing use of Dry type transformers it is equally important for the utilities and the regulators to have norms for losses for Dry type transformers – as we have norms for oil immersed transformers in form of star labelling program.

Standards bodies provide an important platform for the cumulative experience of the users and manufacturers, and leading in the education and introduction of practices for the improvement on the quality, reliability and safety of products and services.

The standards document developed are thus 'living' documents and are constantly evolving as the society demands change.

To address the changing needs of the country and increasing demand for the Dry type transformers, BIS (Bureau of Indian Standards) is looking to revise the IS 11171:1985 as per IEC standards 60076-11.

How do the standards stand today?

IS11171:1985 titled 'Dry-type transformer' is the primary reference and application standard for Dry type transformers in India.

IS11171:1985 is primarily based on IEC 726 (1982) 'Dry type power transformers' issued by the International Electro-technical Commission.

IEC 726 (1982) has been replaced by IEC60076-11 (2004-05) with the same title, and now forms a part of the IEC60076 series of standards on power transformers.

Based on the experiences and issues of users and manufacturers, there are some major additions in the IEC60076-11 standard focusing on improving the dry type transformer reliability and safety.

What are the major differences in the IEC 60076-11 and the present Dry type standards IS 11171:1985? Learning from the cumulative experience of the users and manufacturers, the new draft document for IS 11171 (subject to revision) includes some additional tests to

define the fire safety standard of the transformer, the climatic conditions standard for the transformer and the environmental standard for a dry type transformer. We will now have a closer look at the new draft standards – and what it would mean to the transformer manufacturers users and the specifies.

Additions proposed in the IS 11171 draft

Three distinct additions in the IS 11171 standards draft are:

- Environmental classification
- Fire behaviour classification
- Climatic classification.

These three classifications are added because of concerns expressed by users including:

- How does the Dry type transformer product perform under high humidity or pollution?
- How safe is Dry type transformer under fire?

The classifications intend to offer more clarity on the performance of the Dry type transformers under different operation conditions.

Environmental classification

Intent

Defining the environmental conditions in which the Dry type transformers can operate reliably in terms of humidity, condensation, pollution and ambient temperature.

Three operation conditions for considerations

- No condensation and pollution (class E0)
- Occasional condensation and limited pollution (class E1)
- Frequent condensation and heavy pollution (class E2)

Rationale

The insulation system resistance level to moisture and pollution varies with the insulation material used and processes applied. The classifications are based on the different pollution conditions impacting the transformer, the worst condition are described E 2 as under.

Brief test description (most severe condition)

- Transformer is placed in test chamber with
  A. Humidity greater than 93%
  B. Atomised water conductivity 0.5-1.5 S/m period of 6 hrs
- Within 5 min after removing from the test chamber, the transformer is injected with 1.1 times rated voltage for 15 min

PIC showing the environmental test E2 on a Dry transformer in the test chamber...

Fire behaviour classification

Intent

Defining the risks of fire on the dry type transformers. Expected safety performance of the dry type transformer in terms of flammability, opaque smoke and toxic substances emitted.

Two operation conditions for consideration:

- No fire risk to consider(class F0)
- Fire hazard (class F1)

Rationale

Though the transformer may not be the cause of fire, but under an external fire, there should be minimal contribution of thermal energy, emission of opaque smoke and toxic gases.

Test measurements

- Temperature variation over time (heat contribution by object)
- Optical transmission of light (smoke opacity)
- Gases emitted (toxicity)

The test conducted for the fire behaviour is a destructive one. The coil is placed in the chamber and put to fire to see the behaviour of the coil under fire.

PIC showing the fire behaviour F1 class: the transformer coil is placed in the test setup...

Brief test description

Test facilities

- Dimensions and construction of fire chamber
- Monitoring devices (temperature, optical, gas detection)

Ignition source

Ethyl alcohol placed directly below 40mm away from the test object – and fire to last for approximately 20 min

Heat source

Heating panel 800mm (h) by 500mm (w) with expected temperature of 750degC for 40 min

Climatic classification

Intent

Defining the temperature in which the dry type transformers can

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PIC showing the coil of an OVDT transformer after the test...

operate reliably in. Two operation conditions for consideration

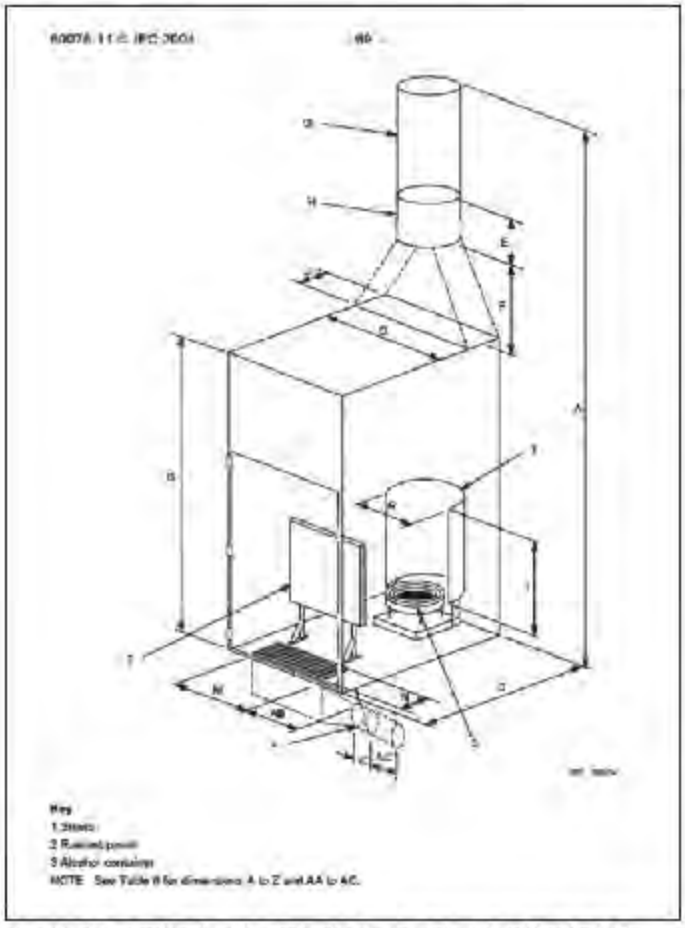
- Ambient Temperature of -5 deg C (Class C1)
- Ambient Temperature of -25 deg C(Class C2).

Rationale

The difference in the thermal expansion between the solid insulation and conductor may induce mechanical stresses (thermal shock) causing the insulation system to fail.

Test description (most severe condition)

Transformer is placed in test chamber controlled at -25degC for 12 hrs. Current at two times the rated current is injected into the transformer until rated temperature of the transformer is reached.



A typical setup for the Fire behavior test as described in the IEC 60076-11...

Transformer returned to normal ambient for 12 hrs and subjected to separate source and induced voltage test.

What makes Dry type transformers safer and reliable?

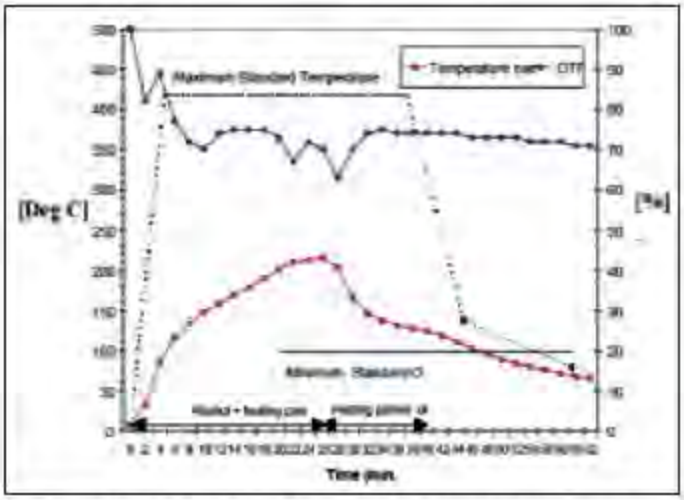
Nomex paper

For the new trends on the standards, Nomex paper will provide superior performances. It provides a unique combination of properties found in no other insulating materials.

- Long term stability for continuous exposure to 220 Deg C
- Will not melt, flow or support combustion below 250 Dec C
- Strong resistance to acids and alkalis
- Compatible with all varnishes, resins, adhesives, and fluorocarbons
- Stable properties over a wide range of temperature and moisture conditions
- Inherently flame retardant; self-extinguishing

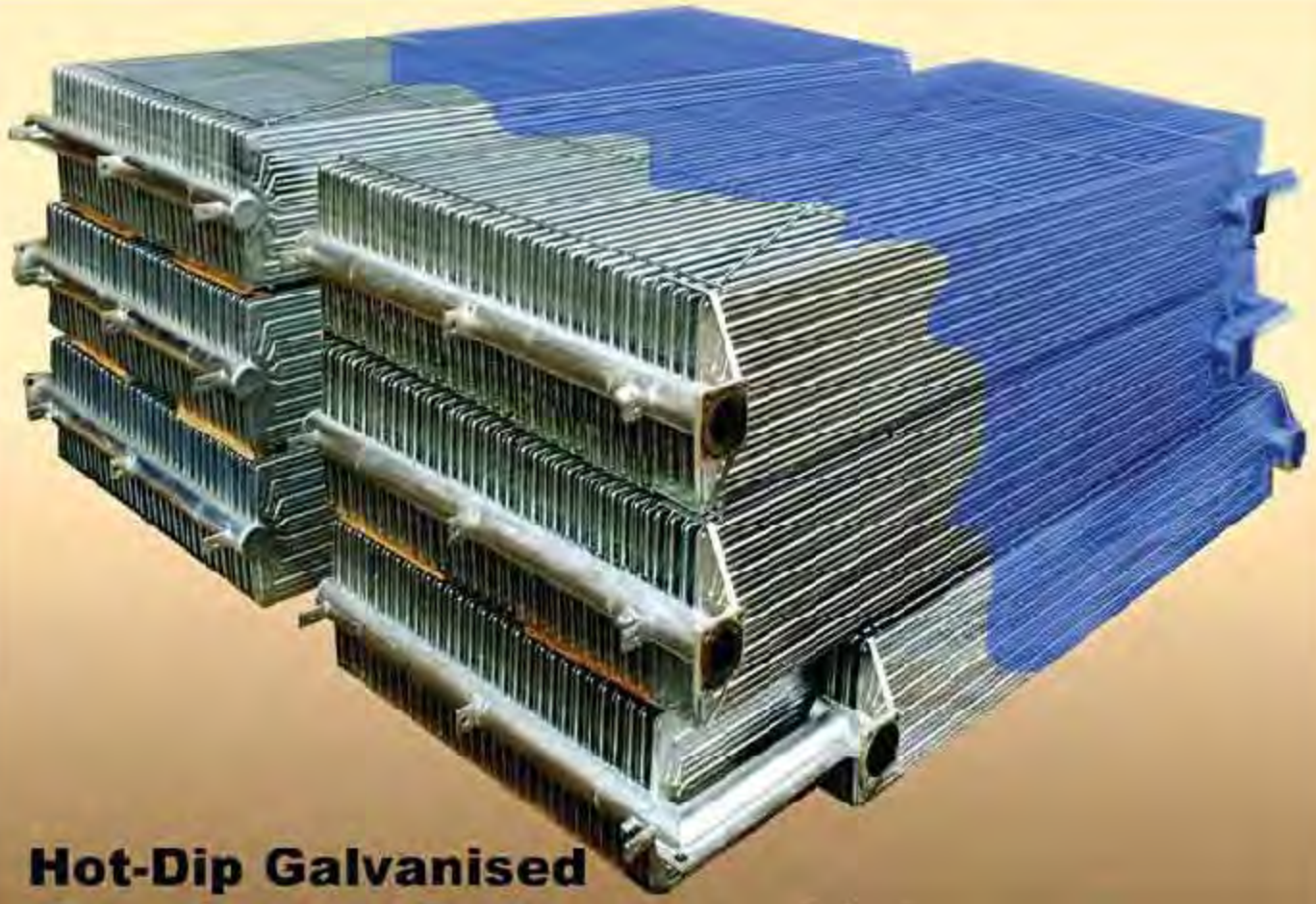
Nomex is a class C insulation material, which performs at 220 Deg C. The insulation used on the conductors for Relitran co-branded transformers is 2Mil Nomex paper and all other solid insulation material used for manufacturing of these transformers is class H.

When the fire behaviour test is performed on dry type transformers (IEC 60076-11) using Nomex has a better Optical Transmission Factor (OTF) during burning. The graph below indicates OTF (Visibility) of about 60% to 75% for a time period ranging from 5 minutes to 45 minutes (Max standard temperature range) of burning. The graph below translates into better visibility as the smoke is not dense or black. In case of fire, people do not die of fire but the damage is due to the suffocation in toxic smoke. The injuries to people trapped in the fire are due to stampede because of poor visibility.



Fire test behaviour according to IEC60076-11 temperature rise and Optical Transmission Factor (OTF)...

The graph in the fig. below compares the flame resistance behaviour of Nomex with other materials used in the dry type transformers, It is found that the Limiting Oxygen Index of Nomex is very high, which means that it requires more oxygen to burn – and when this insulation is burnt, it does not support combustion so it does not spread fire.



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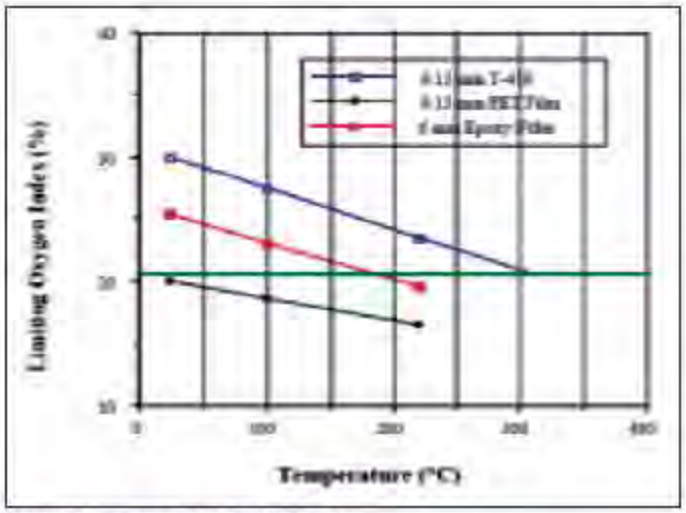

Limiting oxygen index vs temperature...

Environmental and climatic conditions performance of Nomex based OVDT transformers

VDT Transformers are well protected from invasion of water high quality vacuum impregnation technology using the most modern equipment. Nomex is not adversely affected by water, even if it does become exposed to 95% RH

- It retains 80% of dielectric strength
- It retains low dielectric constant and dissipation factor
- It retains superior volume resistivity.

The VPI (Vacuum Pressure Impregnated) Varnishes used with UL approval for usage at 180 deg C and higher for continuous operation in the hottest areas. Nomex insulation is fully coated with varnish makes the encapsulation of the transformer.

Temperature limits for various insulations classes

The insulation system of transformers represent the highest temperature the electrical winding can accept while operating at the highest load condition (Hot Spot) and should have insulating materials which at least match this rating.

Relative Humidity (%)	Dielectric Constant (60 Hz)	Dissipation Factor (60 Hz)	Volume Resistivity (ohm- cm)
Dry	2.5	0.006	10^{16}
50	2.7	0.006	10^{16}
95	3.2	0.011	10^{14}

Insulation Class	Temp Rise	Temp Class	Ambient Temp.	Hot spot Allowance	Hottest Temp.
Class B	80	130	40	10	130
Class F	100	155	40	15	155
Class H	125	185	40	20	185
Class C	150	220	40	30	220

Highest Temperature = Average Winding Rise (K) + Max. Ambient + Hot Spot Allowance

Conclusion

Every B class city in India has a part called the old city where the population density is very high. The government needs to think of redefining the need for installation of dry type transformers in the distribution utilities not only in the indoor application – but also in outdoors where the population density is very high, especially in these old city areas.

The OVDT Nomex based designs are safer, reliable and help in reducing the environmental foot print. With the increasing load demand and the load density of individual household, these transformers with inherent overload capacities are the best option for the builders, utilities and the industry.

The OVDT transformers made out of Nomex insulation will tend to resist to the fire – as the material does not support fire, and in unfortunate case of fire these transformers will help save the human lives and reduce the loss due to fire. The inherent properties of the insulating material used and the VPI technology make the transformers resistant to environmental effects. The higher temperature endurance of the Nomex helps the OVDT transformers bear short-term overload without damage to the insulation.

Profile

Sailesh Purohit
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Radoslaw Szewczyk
Application Development Leader – Transformers, EMEA; DuPont Protection Technologies Nomex Energy Solutions

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Water Flow Measurement in Progress Console of Ultrasonic Fluid...

Motorized fluid handling machinery such as air compressors and pumps consume nearly 40 to 60% electric power used by the industry. A large number of such systems installed in our process and power plants, either operate under degraded efficiency conditions due to service induced deterioration of the equipment – or operate far from the optimal operating point on the characteristic curve due to over design or mismatch with the demand or process requirements...

Energy conservation is an optimal operational practice, which improves the efficiency of the equipment associated with both supply side and demand side i.e., at the user end. Since the industries account for a greater share of power consumption, energy conservation programmes will benefit them by reducing their Specific Power Consumption and making them more competitive in the market. 'Negawatt' (a negative 'Megawatt'), a term coined by the renowned energy analyst Amory Lovins, highlights the fact that a Negawatt produced by reducing energy need saves more than a Megawatt generated. Energy audits lead to the generation of 'NEGAWATTS' and thus result in virtual augmentations to the installed power generation capacity of the Nation! Energy Audit is the basic tool of energy conservation, and is defined as a systematic exercise to identify the practices & processes that consume a significant amount of energy, estimate the efficiency in each of these practices & processes – and based on these estimates devise methods of improving efficiency and curbing loss of energy.

Motorized equipment such as air compressors and pumps are the workhorses of power & process plants. Nearly 60% of total power consumption in the process industry happens to be related to pumping systems. Typically, for such motorized process equipment, about 2% of total life cycle cost is the initial cost, about 8 to10% is spent on repairs and maintenance and the balance 90% is the energy cost for driving the system.

Consequently, a huge potential exists for energy savings related to air compressors and pumping systems. Systematic surveys conducted by the energy management group at ERDA indicate a savings potential of nearly 25% of the present day energy consumption. This translates into the equivalent saving of nearly 178 MW (approximately ₹ 6 million). In the present paper, we present five singular case studies pertaining to audit of air compressors and pumping systems, where significant energy savings were realised.

Air Compressors

During audit of compressors, the current drawn by motor, pressure reducing valve opening position, discharge and user end pressure, controlling mechanism and load - unload time can give ideas for energy savings. Compressor motor's loading depends on pressure developed and flow delivered. Proper mechanism for controlling the output of compressor always gives efficient operation. Pressure drop across valves, more unloading time than the loading time, motor over loading, under utilisation of design capacity etc., are indicators of energy loss.

Case Study 1 (Nuclear Power Plant)

Two Generating Units have three Air Compressors for each Unit to supply compressed air for Instrument Air, Service Air and Mask Air requirements. Two Air Compressors for each Unit are kept in operation to meet the air requirement. Load-unload time duration data for each compressor is given below:

Air Compressor	Load Time (min:sec)	Unload Time (min:sec)
(Unit-1) 1	1:58	1:30
(Unit-1) 2	1:57	1:30
(Unit-2) 1	1:23	2:05
(Unit-2) 2	1:25	2:25

It can be seen that compressors are remaining in unloading condition for around 50% time, which indicates that air requirement is much lower than the present capacity of compressors. Hence, the energy savings solution found is to open the interconnection valve between two units, and feed the complete requirement of both generating units with only three compressors – instead of running all four compressors – so that reliability of air supply will be maintained and energy can also be saved.

After switching off one compressor, load on other compressors will get somewhat increased. At least No load power consumption of one compressor is clearly saved on a conservative basis. Energy saving potential is computed below:

Motor Rating = 140 kW

Average Power Consumption:

Flow Measuring Unit...

Ultrasonic Probes installed on Piping for Velocity Measurement...

At 50% load = 84.8 kW

At No load = 27.0 kW

Power Saving Potential = 27.0 kW

Energy Saved/Year = 1,06,920 kWh

(Considering 12 hrs/day & 330 Days/Year No load operation)

Amount Saved/Year@Rs.2.0/kWh = Rs. 2.13 Lakhs

Investment Required = Nil

Pumps

During audit of pumps, the current drawn by motor, throttling of discharge, recirculation and user end valves, discharge pressure and controlling mechanism can give an idea for energy savings. One major reason observed for decrease in efficiency of motor driven auxiliaries is the deviations in the operating conditions from design parameters.

Normally at design stage, selection of motors is done such that they operate at 80 to 85% loading even if driven equipment is operating at full rated condition. Following case studies present energy conservation opportunities for pumps with motor operating at full load condition.

Case Study 2 (Thermal Power Plant)

Motor of Cooling Water Pump of rating 1550 kW in Thermal power plant was operating at almost full load condition – while the pump was operating at lower loading condition. Hence the pump was taken under maintenance and overhauling was done.

Specifically, bearings were checked and repaired. Complete overhauling work of replacement of stainless steel liner, muff coupling of runner shaft and shaft sleeve were undertaken. Maintenance of the above pump improved its performance. Energy saving calculations are presented below:

Parameters	Before Improvement	After Improvement
Voltage (kV)	6.78	6.75
Load current (A)	166	146
Power factor	0.80	0.82
Input power (kW)	1558	1400
Load (%)	94	85
Flow (m^3/hr)	15,100	15,680
Suction/ Discharge pressure (kg/cm^2,g)	-0.6/1.8	-0.6/1.8
Calculated overall pumping efficiency (%)	63.7	73.2
Assumed motor efficiency (%)	94	94
Calculated pumping efficiency (%)	67.7	77.9
Improvement in efficiency (%)		10.2
Power saved (kW)		158
Units saved/year (For 24 hrs/day, 220 days/annum)		8,34,240
Amount saved/year @ ₹ 2.0/kWh (Lakh)		16.7
Investment required (₹ Lakh)		8.48
Payback period (months)		6.0

Preparation in Progress for Water Flow Rate Measurement...

Case Study 3 (Hydro Power Plant)

Cooling water pumps are provided for generator cooling in Hydro power plant. Design capacity of the pumps is given below:

1	Motor Rating	150 kW
2	Rated Head	60 m
3	Rated Flow	600 m^3/hr

Measurements were taken as mentioned below:

1	Motors Input Power	107 kW
2	Measured Flow	360 m^3/hr
3	Measured Head	68 m
4	Computed Pump Efficiency	62.3%

Valves were throttled at user end and flow was found 40% lower than the design capacity. Hence, it was clear that pumps were of oversized design. Therefore, it was recommended to replace the existing pumps with lower sized pumps as per the actual requirement having specification given below:

Flow : 360 m^3/hr
Head : 60 m
Pump Efficiency : 70%
Motor Rating : 110 kW

Energy Efficiency calculations are given below:

Power consumption for new pump = 84.0 kW

Actual power consumption of pump = 107 kW

Difference in power (107MW – 84MW) = 23.0 kW

Units saved per year = 1,82,160 kWh

(For 24 hrs/day and 330 days/year operation)

Amount Saved/Year@Rs.2/kWh = Rs. 3.64 Lakhs

Investment Required = 4.0 Lakhs

Payback period = 13.1 months

Case Study 4 (Thermal Power Plant)

Two Boiler Feed Pumps rated 3500 kW each are kept in operation to meet feed water requirement of 210 MW thermal power plant. The boiler drum level is controlled by controlling feed water flow by maintaining Differential Pressure across Feed Control Valve (FCV) and scoop control is being done by maintaining fixed differential pressure of 5 to 7 kg/cm^2 across Feed Control Valve. After analysing the system, initiative was taken to change the operating system to make zero pressure drop across FCV.

Keeping the FCV fully open, flow was controlled by adjusting the scoop position (scoop control). The scoop position was reduced from 79 to 72% keeping the FCV fully open (DP across FCV zero). Efficiency was observed to increase from 61.8% to 66.5%. Details are presented below:

Parameters	Before Improvement	After Improvement
Voltage (kV)	6.66	6.65
Load current (A)	276	244
Power factor	0.94	0.93
Input power (kW)	2,993	2,613
Load (%)	81	70
Flow (T/hr)	360	335
Suction/ Discharge pressure (kg/cm^2, g)	7.0/170	7.1/170
Scoop position (%)	79%	72%
Feed water density (kg/m^3)	0.909	0.90
Calculated head	1793	1810
Feed water flow (TPH)	360	335
Pump output (kW)	1,758	1,651
Input power to the motor (kW)	2,993	2,613
Calculated overall pumping efficiency (%)	58.7	63.2
Assumed motor efficiency (%)	95	95
Calculated pumping efficiency (%)	61.8	66.5
Improvement in efficiency (%)		4.7
Power saved (kW)		380
Units saved/year (24 hrs/day and 220 days/year)		20,06,400
Amount saved/year @ ₹ 2.0/kWh (₹ Lakh)		40.12
Investment required		Nil

Case Study 5 (Fertilizer Plant)

Boiler house of a fertilizer plant has 12 bowl mills. Depending on requirements, 9 or 10 mills are kept in operation. The plant has two crushers and normally one is kept in operation. Parameters measured for crushers are tabulated below:

Drive	Motor Rating (kW)	SEC (kWh/T)
Crusher-1	225	1.0
Crusher-2	225	0.26

Power consumption and coal crushed by each crusher were measured to evaluate the

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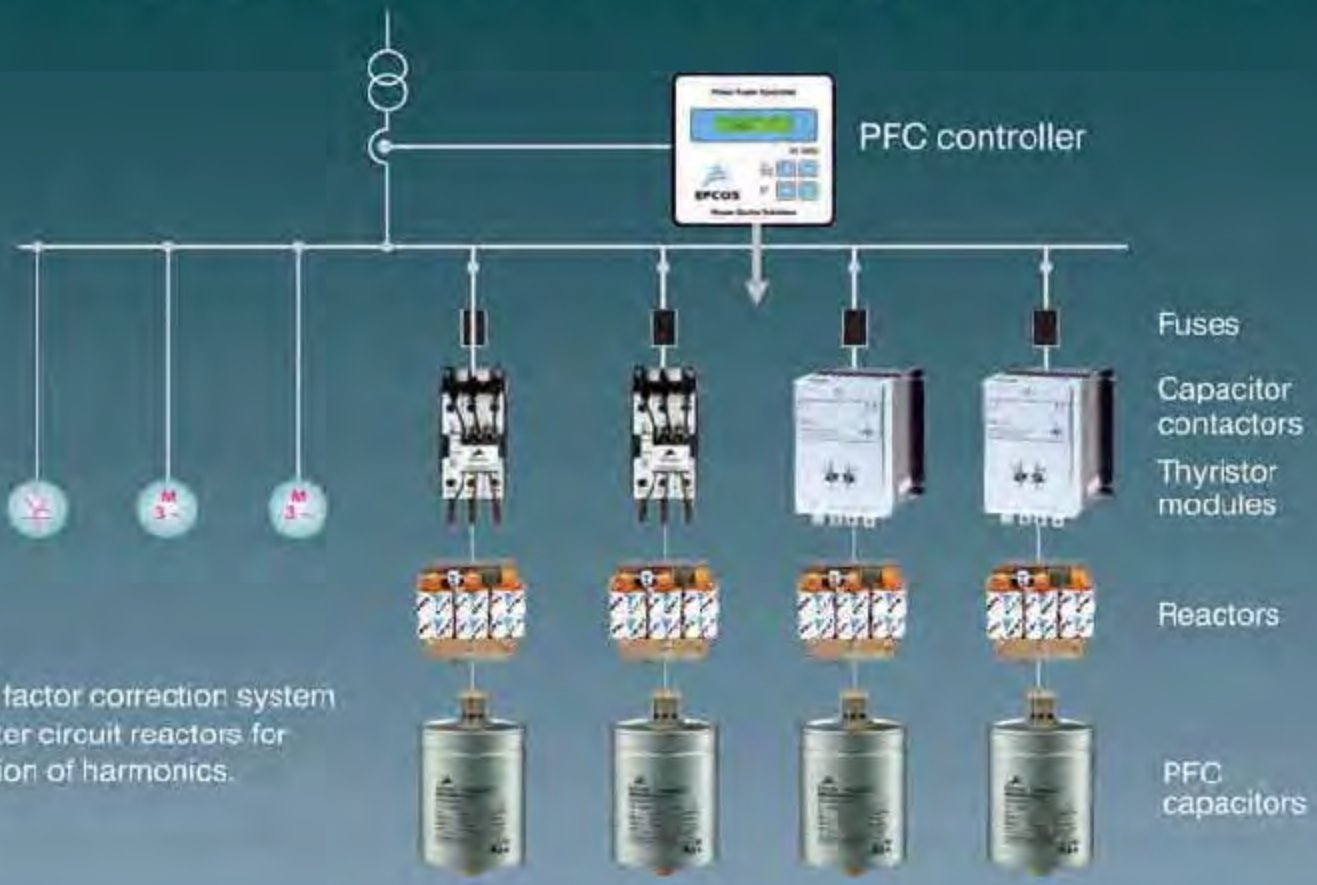

Power factor correction system with filter circuit reactors for reduction of harmonics.

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specific power consumption. Observation made are:

- Specific energy consumption of Crusher-2 was found very low
- Huge amount of coal rejection observed at mill end.

Hence, the whole system was analysed to identify the problem. Larger size coal at mill inlet was observed. This suggested non-optimal functioning of the coal crusher and/or damage to its outlet screen. Hence, checking of Crusher-2 and its outlet screen was suggested. Damage was found on the outlet screen, as a consequence of which large sized lumps of coal were being passed through to the coal mill instead of being recirculated back into the crusher. Repairs to the outlet screen were suggested. Further, the practice of checking coal fineness at outlet of both the crushers before supplying into mills was suggested. This exercise will reduce the power consumption by mills, reduce mill rejection and also mills will require less maintenance.

Considering at least 5% reduction in power consumption of mills, the energy saving potential is computed below:

Average power consumption of mill	= 169 kW
Power saving potential @ 5%	= 8.45 kW
Power saving potential for 9 mills	= 76.0 kW
Units saved	= 2,09,760 kWh
(24 hrs/day, 115 days/year crusher-2 operation)	
Saving potential @ Rs.3.00/kWh	= Rs. 6.29 Lakh
Approx. investment required	= Rs. 2.00 Lakh
Pay back period	= 3.8 months

Conclusions

The audit of five process flow equipment, presented in this paper, have resulted in identification of saving potential of nearly 3450 MWh per year at a cumulative investment of only about 30 lakhs.

In other words, the specific 'per unit' cost for saving electrical energy is only about Rs. 0.85 per unit against per unit electricity price of nearly Rs. 5. This study thus clearly highlights the significant electrical energy savings potential existing in the country for motorized fluid handling equipment such as pumps and air compressors.

Profile

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Discrete Wavelet Transform Based Differential Protection for Power Transformers

Transformers are a critical and expensive equipment in the power system network. They function as a node to connect two different voltage levels. Hence, the availability of their service is vital in maintaining the continuous power supply to consumers. Since many decades, differential protection provides the best overall protection for a power transformer to protect against faults...

In this article a wavelet transform based differential protection scheme for three phase power transformers has been presented. The proposed technique uses wavelet transforms for characterization of different transients, which will aid in the development of a novel differential protection scheme for power transformers.

The results of wavelet based differential protection reveal for identification of inrush currents and distinguish from other type of faults – such as internal and external short circuit faults.

The functioning of power transformer is crucial to maintain uninterrupted supply to the consumers. Hence proper detection of fault helps in isolation of the defective transformer, and thereby avoiding unnecessary outages and instability of the power system – and ensures good power quality. To accomplish these objectives, an efficient fault detection method will help the electric utilities enhance the availability of generation and T&D.

Differential Protection

Traditionally, differential protection for power transformers has been used for decades. The principle of differential protection scheme is one simple technique. The differential relay compares the primary current

and secondary current of power transformer, the differential current due to disbalance found in primary and secondary currents will actuate the relay to trip the breaker, thereby isolate the faulty system. The schematic diagram of differential protection for power transformer is shown in Fig. 1.

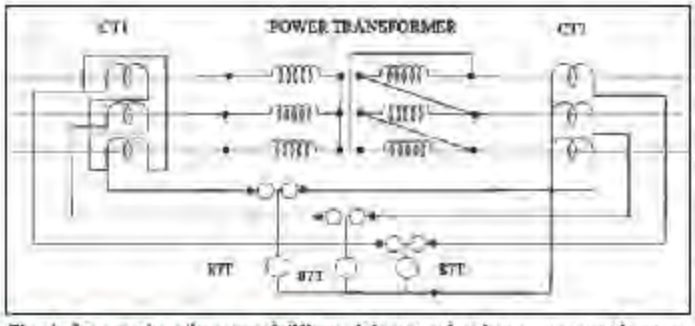

Fig. 1: Connection diagram of differential protection for power transformer..

Discrete Wavelet transform (DWT)

The Wavelet Transform has been introduced in place of Fourier analysis and received considerable interest in fields such as acoustics, voice communications and seismic etc. – and this technique is a powerful mathematical tool for signal analysis and can be used for wide range of applications such as signal processing, data compression, speech recognition, wave propagation and pattern recognition. In recent study, wavelet transform has been implemented for fault detection in power system equipment that use wavelet transforms – and this technique is efficient in fault detection of power system components. Wavelet transform has a special feature, which translates the time-amplitude representation of a signal to time-frequency representation – that is encapsulated as a set of wavelet coefficients. The wavelet transforms can be analysed using Continuous Wavelet Transforms (CWT) and Discrete Wavelet Transforms (DWT).

In this article a discrete wavelet transform is used for fault detection – because of improved resolution, less computational time and memory required to calculate the wavelet coefficients. The DWT is defined as follows:

$$DWT(f,m,n) = \frac{1}{\sqrt{a_0^m}} \sum_{k=-\infty}^{\infty} f(k)\,\overline{\Psi}[(k - na_0^m b_0)/a_0^m] \quad (2)$$

Where a_0 and b_0 are fixed constants with $a_0 > 1$, $b_0 > 1$ and m, n are positive integer variables. The values of a_0 and b_0 are selected such that mother wavelets form an orthonormal basis. The orthonormal basis satisfies if $a_0 = 2$ and $b_0 = 1$.

The implementation of the DWT with a filter bank is effective for analysing the information of the signals. The DWT is computed by analysing the signal at different frequency bands with different resolutions by decomposing the signal into coarse approxi- mation and detailed information. Using this technique any wavelet such as Haar, Daubechies, Symlets Coiflets and Bior 4.4 etc., can be implemented.

The selection of mother wavelet is an important role as it enhances the performance of fault detection scheme, and the process leads to an accurate fault classification thereby protecting transformer from faults. In order to select the most capable mother wavelet, different mother wavelets such as Haar, Daubechies, Symlets, Coiflets and Bior 4.4 wavelet have been considered and compared. Bior 4.4 is simply chosen since it gives a more accurate result in detecting low amplitude, short duration, fast decaying transients and minimum error during the magnetizing inrush condition.

Proposed diff.protection scheme using DWT

The DWT technique has been proposed for differential protection of power transformers. The wavelet decomposition technique analyses the transient signal which characterises the condition of the component. The primary current and secondary currents of power transformer are measured through Current Transformers (CTs) are used for signal analysis such as normal operation, magnetising inrush and short circuit faults. Wavelet technique, a time-scale domain approach is applied to detect the magnetizing inrush and short circuit faults by comparing with normal operation of power transformer. The signal obtained from the CTs of power transformer is passed through a low pass and a high pass filter to obtain approximate coefficients and detail coefficients respectively. The structure of the proposed DWT based differential protection scheme used for detecting faults and classifying different transients is shown in Fig. 2. The fault detection is summarised as below step by step

- **Step 1:** Obtain the primary current and secondary current signals from the terminals of Current Transformers (CTs)
- **Step 2:** Apply DWT for the current signals obtained in step 1 and calculation of differential current
- **Step 3:** Identify the fault through interpretation of detailed wavelet coefficients of differential current
- **Step 4:** Distinguish between a magnetising current, internal short circuit current, external short circuit current and normal operation current.

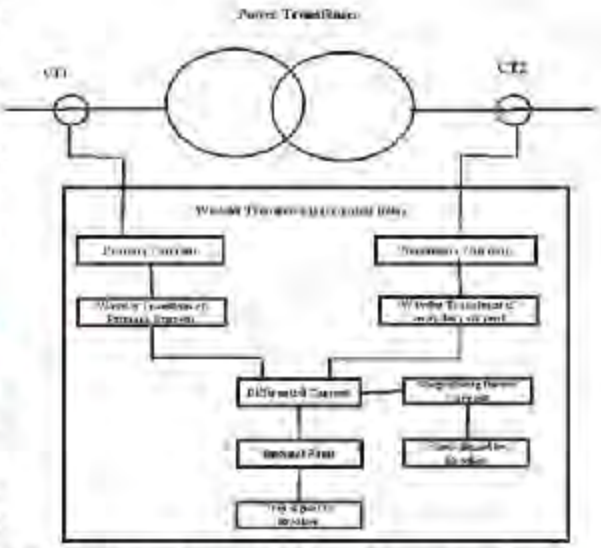

Fig. 2: Structure of proposed differential protection scheme..

Simulation, Results and Discussions

A power system network, with a three phase transformer and a load, is shown in Figure 3. is simulated using MATLAB/ SIMULINK software. Table 1 presents the parameters associated with the power transformer.

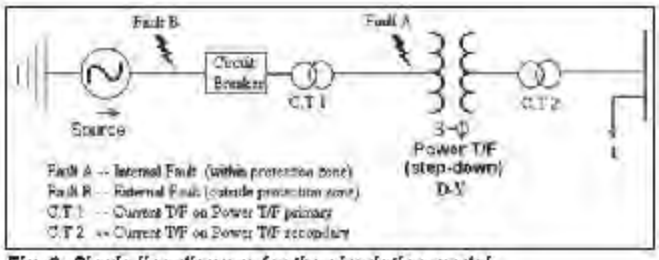

Fig. 3: Single line diagram for the simulation model...

The power transformer is simulated for various types of transients. The primary and secondary currents are measured and the discrete wavelet analysis is performed on signals obtained. The simulation is carried out for 0.2 sec and the data is captured for 10-cycles.

S.No.	Parameter	Rated Value
1	Rated Power	250MVA
2	Primary Voltage	735KV
3	Secondary Voltage	315KV
4	Rated Frequency	50Hz
5	Magnetization Resistance (Rm)	500pu
6	Magnetization Reactance (Lm)	500pu

Table 1: Transformer Parameters...

Normal Operation

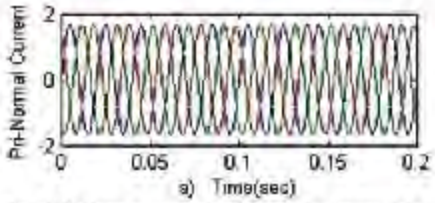

Fig. 4(a): Normal current entering at primary side...

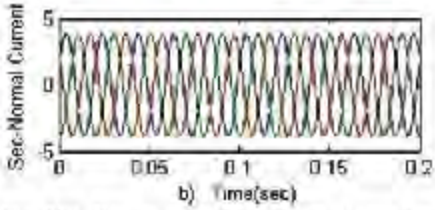

Fig. 4(b): Normal current leaving the secondary side...

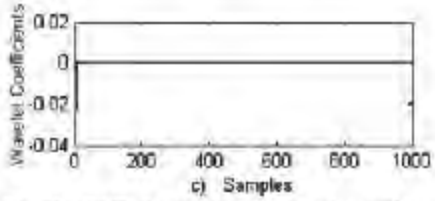

Fig. 4(c): DWT of normal current at primary side ...

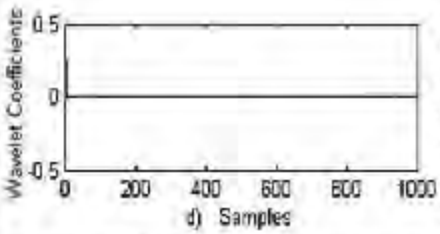

Fig. 4(d): DWT of normal current at secondary side...

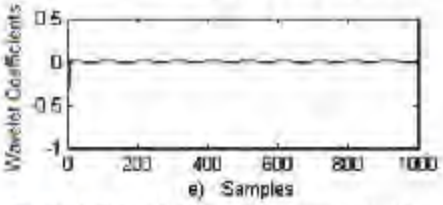

Fig. 4 (e): DWT of differential normal current...

The output currents from both primary and secondary side CTs are analysed for comparison with other conditions like internal and external faults in the system. During normal operation, there is no malfunctioning of the transformer – and hence the wavelet decomposed output signal is a straight line. The current signal obtained from the CTs of power transformer and DWT analysis for normal operating condition are as shown in Fig. 4 (a) to 4 (e).

Magnetising Inrush

When a power transformer is energised, it generates inrush current, the magnitude of this current will be 1 to 2 % of rated current. This type of transient may cause unnecessary tripping of transformer. In time domain signal analysis, it can be observed spikes during the entire in rush transient period whereas in DWT localsation can be observed in 600th sample which corresponds to 0.12 sec, which is the time of enerziation of power transformer. The current signal obtained from the CTs of power transformer and

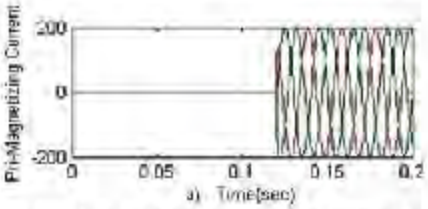

Fig. 5(a): Inrush current entering at primary side...

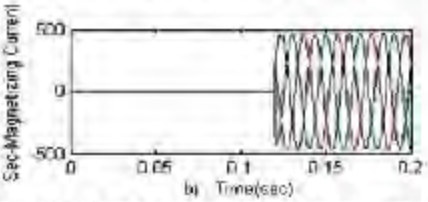

Fig. 5(b): Inrush current leaving the secondary side...

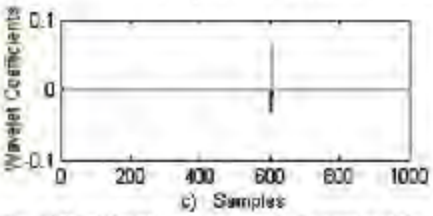

Fig. 5(c): DWT of inrush current at primary side...

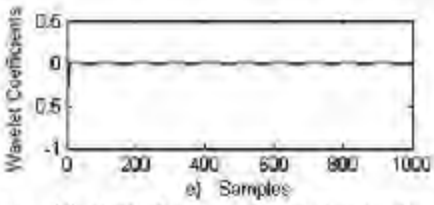

Fig. 5(d): DWT of inrush current at secondary side...

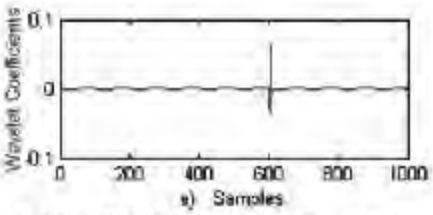

Fig. 5(e): DWT of differential inrush currents...

DWT analysis for magnetising inrush condition are as shown in Fig 5 (a) to 5 (e). The DWT coefficients are lower compared to other transients such as magnetising inrush current and external fault which enables the restrain relay to operate.

Internal Fault

Short circuits in transformers results in currents of high magnitude. The detection of short circuit fault is essential – and requires fast action by protective relay to de-energize transformer, otherwise this leads to extreme mechanical stress of core and coil assembly. The simulation was carried out for 0.2 sec. The short circuit fault is set to occur at instants 0.12 sec and cleared at 0.14 sec that is the total fault time is 0.02 sec. The peak primary current is measured for an internal short circuit

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fault is 1000 A. The spikes can be observed at the short circuit time and there is a differential current and DWT coefficients are high compared to other transients such as magnetising inrush current and external fault, which enable the relay to operate. The current signal obtained from the CTs of power transformer and DWT analysis for internal fault are as shown in Fig. 6 (a) to 6 (e).

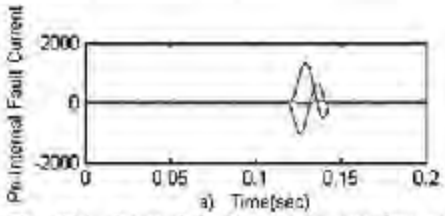

Fig. 6(a): Internal fault current entering at primary side...

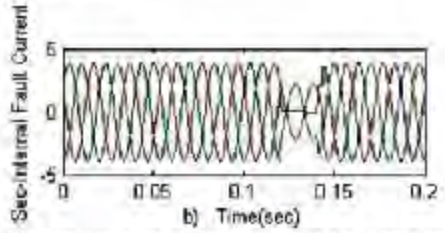

Fig. 6(b): Internal fault current leaving the secondary side...

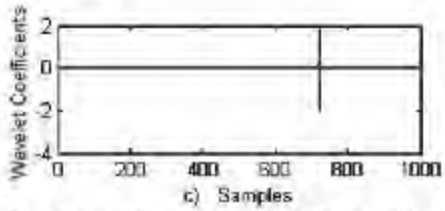

Fig. 6(c): DWT of internal fault current at Primary side...

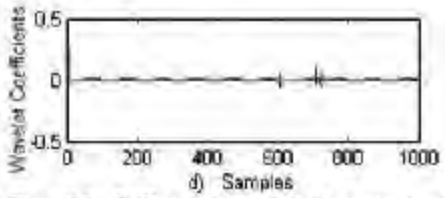

Fig. 6(d): DWT of internal fault current at secondary side...

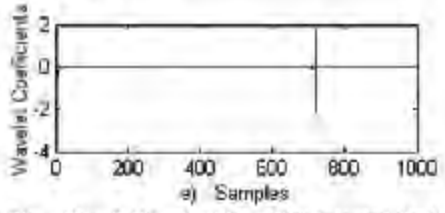

Fig. 6(e): DWT of differential internal fault current...

External Fault

External faults are system faults that occur outside the transformer differential protection zone. The external fault event also appears to be localised and DWT coefficients at fault time are higher than their values beyond or before this time. The fault existence timing is 0.12 sec to 0.14 sec. The fault selected for analysis is LL-G fault. The current

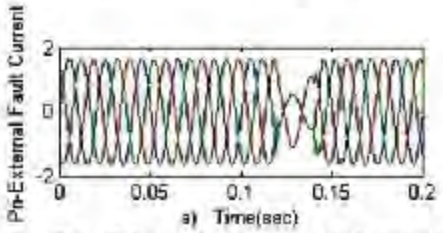

Fig. 7(a): External fault current entering at primary side...

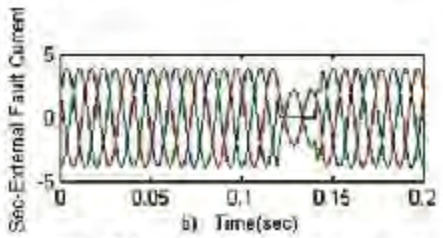

Fig. 7(b): External fault current leaving the secondary side...

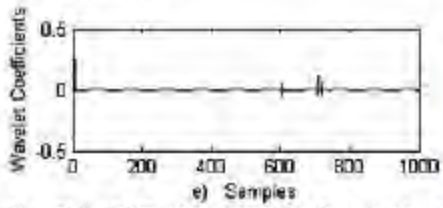

Fig. 7(c): DWT of external fault current at Primary side...

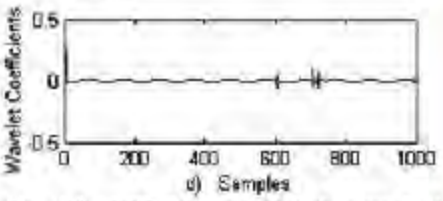

Fig. 7(d): DWT of external fault current at secondary side...

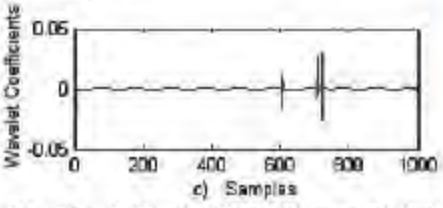

Fig. 7(e): DWT of differential external fault current...

signal obtained from the CTs of power transformer and DWT analysis for external fault are as shown in Fig 7 (a) to 7 (e). The DWT coefficients are lower compared to internal fault, hence DWT based relay performs correctly and remains stable as the conventional scheme does.

Conclusions

This article presented a new scheme based on discrete wavelet transform differential protection of power transformer. The wavelet decomposition breaks up signal into both time and frequency, allowing for a complete and efficient description of signal. This information is very important in detecting the fault. It is observed from the coefficients that fault is seen to be localised.

The wavelet transform is applied to normal operation, magnetising inrush currents, internal fault condition and external fault condition. It is also concluded from the obtained results that this technique is better in characterisation and discrimination of faults.

Application of wavelet transforms for differential protection scheme of transformer protection enhances the drawbacks arising in conventional differential protection method as fault localisation and characterisation is very precise.

Profile

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Nagireddy Ravi

Assistant Divisional Engineer, Telangana State Power Generation Corporation Ltd, Telangana

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7th ELASIA Concluded Forging Technology Partnerships

The exhibition focused on bringing awareness on latest developments in power generation, distribution and utilisation – and technological developments in the electrical industry...

This time ELASIA 2015 essayed a unique "Think about Electricity – Think about Future" value proposition during the course of the 4-day event followed by 1-day technical conference on the subject "Empowering India's Energy Innovation and Investments."

The event, 7th ELASIA 2015 Exhibition, organised by Triune Exhibitors Pvt. Ltd., a well known organiser of exhibitions, was held at Bombay Exhibition Centre (BEC) in Mumbai from 29th May to 1st June 2015.

The four-day expo turned out to be one of the India's largest gathering of professionals from the fields of power transmission & distribution, electricity and lighting.

V Thakur and others during inauguration of ELASIA 2015...

The exhibition was inaugurated by VIDYA THAKUR, Hon. Minister for Consumer Grievances, Govt. of Maharashtra in the presence of a host of sponsors and EMA representatives from Maharashtra. It was held on an area of 82,000 Sq. Ft., and hosted 270 stalls. With around 13500 visitors, the exhibition is expected to guarantee INR 220 crores worth of business. It received a good support through partnership from different firms, namely: Co-partner ABB India Ltd., Associate Partners Eaton Power Quality Pvt. Ltd. / Mitsubishi Electric India Pvt. Ltd. / Exide Industries Ltd. / IIGM Pvt. Ltd. – EAE Elektrik / Greaves Cotton Ltd.

ELASIA-2015 was also supported by NSIC (National Small Industries Corporation), COSMA (Control Switchgear and Manufacturing Association), EMA (Electrical Merchant Association of Maharashtra) & Poona Electric & Electronics Association – Pune.

The exhibition focused on bringing awareness on latest developments in power generation, distribution and utilisation and technological development in the electrical industry to the doorstep of the practicing technocrats as well as the common man.

ELASIA-2015 provided opportunities for visitors to forge technology partnerships, close business deals and assess vendors' capabilities. ELASIA-2015 concluded on a positive note with the valedictory and award distribution function on 1st June 2015. The award winners were: Best stall: M/s. ABB India Ltd., 2nd Best stall: M/s. IIGM Pvt. Ltd. EAE- Elektrik, 3rd Best stall: M/s. Socomec Innovative Power Solutions, Consolation – (1) Kohler India Corporation Pvt. Ltd., (2) HPL Electric & Power Pvt. Ltd.

Electrical India's stall in the event ready for the show...

Visitors are collecting information at Electrical India's stall...

Curious visitors are gathering ideas through interaction...

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CWST-Expo 2015 Built An Organised Avenue For Stakeholders

The 13th edition of TRAFOSEM-2015 conference, organised jointly by ITMA and CPRI in association with BRANDSCOPE EXHIBITIONS, was held along with the show...

Between fourth to sixth June 2015, Hall 2 of Bombay Exhibition and Convention Centre buzzed with the latest innovation, technology and novelty – as the first edition of Coil Winding, Stamping & Transformer Manufacturing Exhibition was concluded there amidst great fervour and aplomb.

Entrance to the venue of CWST 2015...

The event consisted of three days of exhibition and one-day conference. The synchronous events ensured effective cross-pollination of ideas owing to the mutual synergies.

It had more than 50 exhibitors and a remarkably more than 1900 quality visitors from across the globe. The CWST-Expo2015 was exceptional, since it offered an organised avenue for all the industry stakeholders to come together for networking, business expansion and idea exchanges.

It also provided a niche platform to learn and gain knowledge about the industry for the naïve audience. For the advanced audience, it provided sophisticated- technical information on the products and services that the exhibitors had to offer. The expo is one of its kinds – and remains unparalleled. The exhibition served as a platform and an important gateway to the companies to access the Indian market.

A view of Electrical India's stall in CWST 2015...

Inauguration of the 13th edition of TRAFOSEM-2015...

CWST-Expo was aimed specifically at Coil Winding Machines, Coils, Carbon Brushes, Winding Wires, Tapes and Electrical Insulation, Software Testing, Magnetic Core, Commutators, Testing Equipments,Power Transformers, Distribution Transformers, Auto Transformers, Furnace Transformers and allied products. The show focused towards a quality audience, which included people from Electrical industry, Consumer electronics manufacturers, Industrial and Infrastructure sector, Lighting industry, Motor manufacturers, Industrial automation, Trade associations, State power distribution companies, Government officials from Power Industry and many more.

The 13th edition of TRAFOSEM-2015 conference, organised jointly by ITMA & CPRI and in association with BRANDSCOPE EXHIBITIONS, was held alongside with the show on June 05, 2015 in Hall-2C. The conference was inaugurated by PiyushGoyal- Hon'ble Minister of State with Independent Charge for Power, Coal and New & Renewable Energy, Govt. of India. The theme of the conference 'Modernisation of Global Transformer Technology For Use in Indian Power Scenario,' provided an appropriate platform for the Transformer Manufacturers to interact directly with the government officials – and to solve their long awaited issues. The synergy between the Exhibition and the Conference ensured perfect platform for all connected with the subject of power.

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ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS

(As on 31.05.2015)
(UTILITIES)

Region	Ownership/ Sector	Modewise breakup							Grand Total
		Thermal				Nuclear	Hydro	RES* (MNRE)	
		Coal	Gas	Diesel	Total				
Northern Region	State	15438.00	2879.20	0.00	18317.20	0.00	7052.55	651.06	26020.81
	Private	12405.00	108.00	0.00	12513.00	0.00	2313.00	6505.80	21331.80
	Central	12000.50	2344.06	0.00	14344.56	1620.00	8066.23	0.00	24030.79
	Sub Total	39843.50	5331.26	0.00	45174.76	1620.00	17431.78	7156.86	71383.40
Western Region	State	21380.00	2993.82	0.00	24373.82	0.00	5480.50	311.19	30165.51
	Private	33311.00	4388.00	0.00	37699.00	0.00	447.00	12483.85	50629.85
	Central	11738.01	3533.59	0.00	15271.60	1840.00	1520.00	0.00	18631.60
	Sub Total	66429.01	10915.41	0.00	77344.42	1840.00	7447.50	12795.04	99426.96
Southern Region	State	14182.50	555.70	362.52	15100.72	0.00	11398.03	473.45	26972.20
	Private	4770.00	4047.50	554.96	9372.46	0.00	0.00	14643.75	24016.21
	Central	11390.00	359.58	0.00	11749.58	2320.00	0.00	0.00	14069.58
	Sub Total	30342.50	4962.78	917.48	36222.76	2320.00	11398.03	15117.20	65057.99
Eastern Region	State	7040.00	100.00	0.00	7140.00	0.00	3168.92	225.11	10534.03
	Private	8541.38	0.00	0.00	8541.38	0.00	99.00	209.27	8849.65
	Central	13001.49	90.00	0.00	13091.49	0.00	845.20	0.00	13936.69
	Sub Total	28582.87	190.00	0.00	28772.87	0.00	4113.12	434.38	33320.37
North Eastern Region	State	60.00	445.70	36.00	541.70	0.00	382.00	253.25	1176.95
	Private	0.00	24.50	0.00	24.50	0.00	0.00	9.13	33.63
	Central	0.00	1192.50	0.00	1192.50	0.00	860.00	0.00	2052.50
	Sub Total	60.00	1662.70	36.00	1758.70	0.00	1242.00	262.38	3263.08
Islands	State	0.00	0.00	40.05	40.05	0.00	0.00	5.25	45.30
	Private	0.00	0.00	0.00	0.00	0.00	0.00	5.85	5.85
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub Total	0.00	0.00	40.05	40.05	0.00	0.00	11.10	51.15
ALL INDIA	State	58100.50	6974.42	438.57	65513.49	0.00	27482.00	1919.31	94914.80
	Private	59027.38	8568.00	554.96	68150.34	0.00	2859.00	33857.65	104866.99
	Central	48130.00	7519.73	0.00	55649.73	5780.00	11291.43	0.00	72721.16
	Total	165257.88	23062.15	993.53	189313.56	5780.00	41632.43	35776.96	272502.95

Figures at decimal may not tally due to rounding off

Abbreviation:- SHP=Small Hydro Project (≤ 25 MW), BP=Biomass Power, U&I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

Note : - 1.RES include SHP, BP, U&I, Solar and Wind Energy. Installed capacity in respect of RES (MNER) as on 31.03.2015 (As per latest information available with MNRE)

*Break up of RES all India as on 31.03.2015 is given below (in MW) :

Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total Capacity
		BM Power/Cogen.	Waste to Energy		
4055.36	**23444.00**	**4418.55**	**115.08**	**3743.97**	**35776.96**

Source: Central Electricity Authority, Ministry of Power, Govt. Of India

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FLIR Systems offers flexible coil clamp meters

FLIR Systems has rolled out CM55/57 Flexible Clamp Meters and the TA72/74 Universal Flex Current Probe Accessories designed for electrical applications. Made with narrow, flexible coil clamps, these new tools allow electricians to take accurate measurements in tight, awkward spots that are difficult to access with a traditional hard-jaw clamp meters.

The CM55/57 Flexible Clamp Metres and TA72/74 Universal Flex Current Probe Accessories can easily snake around obstacles to achieve the most accurate measurements and readings, adding up to 3000A AC current for multiple conductor measurements. Both products are available in 10" flexible coil lengths for easy maneuverability and compact convenience, or 18" flexible coil lengths for larger and multiple conductor measurements, double-wrap requirements, and deeper access.

Portable, lightweight, and ruggedly built to withstand a 3 metre drop, the CM55/57 and TA72/74 also provide bright, dual LED work lights for illumination when taking readings in poorly lit locations and in deep, crowded cabinets.

"FLIR's new flexible clamp meters were designed to add safety and convenience to electrical inspections, making it easier to take measurements around multiple conductors, crowded panels, tight switch gears, large bus bars, and wire bundles," said Rickard Lindvall, Vice President and General Manager of FLIR's Instruments segment. "Those who already own a clamp meter but want the same flexibility of the CM55 or CM57 can pair most DMMs and clamp meters with a TA72 or TA74 probe accessory for easy inspection & navigation."

Website:
www.flir.com.hk/flex

igus presents new ideas in energy supply

In machinery and equipment construction, as well as in medical and automotive industries, corrugated hoses are an integral part of the energy supply system. Cologne-based igus GmbH presents an entirely new idea: the e-skin. This easy-to-open hose can be self-supporting contrast to comparable products, and can even be used in the clean room for short unsupported lengths. Existing corrugated hose systems can obtain a more defined movement with the new snap-on e-shell. The e-skin is a hose consisting of an upper and lower shell, which when clipped together is completely enclosed. Due to the simple and reusable opening mechanism, a trouble-free maintenance and inspection of cables is possible. igus also provides an additional tool with which the hose can be opened and closed quickly.

By virtue of the construction method and the high flexibility, the e-skin can be used in a variety of industries - from machine tools and medical technology through to sophisticated electronics manufacturing.

Website:
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Power Factor Correction or Reactive Power Compenation forms a small but very important part of Electrical scheme of any Electrical network, which source its supply from electrical utility company. Its inadequacy in any form can result in power losses, voltage drop, increase in peak demand, unutilized transformer and cable capacity. Moreover, with most of the electricity companies billing in KVAH units, there are direct losses in terms of higher units if power factor of installation is maintained below unity.

Most common methods of improving power factor is to install Power Capacitor

Banks at load sides or mains. Thus, the Power Factor shall be improved, but depending on the type and characteristics of load of the system, if it is not designed properly, it can interact with network to generate resonance condition and other negative impacts. Therefore, it is imperative to follow certain guidelines for design of Power Factor Correction System to prevent resonance condition in order to avoid operational problems and damage to capacitors.

Neptune offers high quality Power Quality Studies for short durations, 24 hours to many days by high end waveform and PQ recorders so that to comprehensively understand harmonics, voltage flicker, Voltage fluctuation (Sags & Spikes), power factor issues during various load cycles of plant / office and their impact. Based on these inputs, the company offers Intelligent PFC Systems with appropriate Detuning / Tuning Reactors switched through Contactors or Real Time Thyristor-based switching. Possibility of Hybrid System is also worked out, which is combination of Contactor based and Real Time TSM based. Balanced or Unbalanced (Phase to Phase) Compensation Systems are offered as per type of loads.

Addition to PFC if harmonic mitigation is required combination of P.F. Correction plus Active Filter is offered again in hybrid model. The systems are intelligent with GSM modem, data logging and various communication options for reporting and analysis.

Website:
www.neptuneindia.com

AFL offers Al Coil Bracket

AFL has introduced an aluminium coil bracket for splice enclosures including its Opti-Guard and SB01 products. The aluminium coil bracket is much lighter, making it easier to ship and install. The new bracket consists of three-pieces. It is easy to assemble and ships in a box preventing damage to the unit. Furthermore, the bracket now includes banding slots added to the vertical body extrusion portion of the unit for more versatility in the attachment schemes to the structures. The aluminium coil bracket supports AFL's SB01 and Opti-Guard splice enclosures – and stores extra lengths of ADSS or OPGW. The Opti-Guard splice enclosure accommodates up to 504 single fusion splices. Easy to maintain and re-enter, the enclosure is light-weight and mounts to many types of structures. The SB01 enclosure can store up to 25 feet of buffer tubes with 144 fibre splice capacity. Manufactured of iron and steel, this enclosure is weather and bullet-resistant.

Website:
www.AFLglobal.com

CBS Arcsafe rolls out a new HPC switch

CBS ArcSafe, a manufacturer of remote racking and switching solutions for low- and medium-voltage switchgear, introduces its remote switch actuator for General Electric Type HPC (High Pressure Contact) Switches. The new CBS ArcSafe RSA-73A actuator allows technicians to remotely charge, close, and/or trip the switches from a safe distance while remaining stationed outside the arc-flash boundary.

Installation and operation of the CBS ArcSafe RSA-73A is quick, simple, and does not require any modifications to the existing electrical equipment. It is compatible with all styles of General Electric Type HPCs. Typical applications of these switches include main service, feeder and branch circuit disconnects, as well as both transformer and large motor disconnects.

Website:
www.CBSArcSafe.com

REDUCTION IN FAILURE RATE OF ELECTRICAL EQUIPMENTS & ENERGY SAVING
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Voltage Variation is a common phenomenon.
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- Uniform quality of end product
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Model:- R-2070A / R-2070B

Features:-
Voltage DC, Voltage AC, Ampere AC, Resistance, Diode Testing, Continuity Buzzer, Data Hold, Back light
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2) Frequency (R-2025Hz)

Model:- R-2025 / R-2025C / R-2025Hz

R-9A
(Auto Ranging)

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Voltage DC, Voltage AC, Ampere DC, Ampere AC, Resistance, Battery Test, Diode Testing, Temperature, Continuity Buzzer, Transistor Test, Diode Test, Data Hold.
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Features:-
Voltage DC, Voltage AC, Ampere DC, Ampere AC, Resistance, Battery Test, Diode Testing, Continuity Buzzer, Back Light Function, Data Hold.
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Model:- R-36B / R-36C

Features:-
Voltage DC, Voltage AC, Ampere DC, Ampere AC, Resistance, Capacitance, Diode Testing, Continuity Buzzer, Data Hold.
Additional feature:- (R-603C) Temperature, Frequency

Model:- R-603A / R-603B

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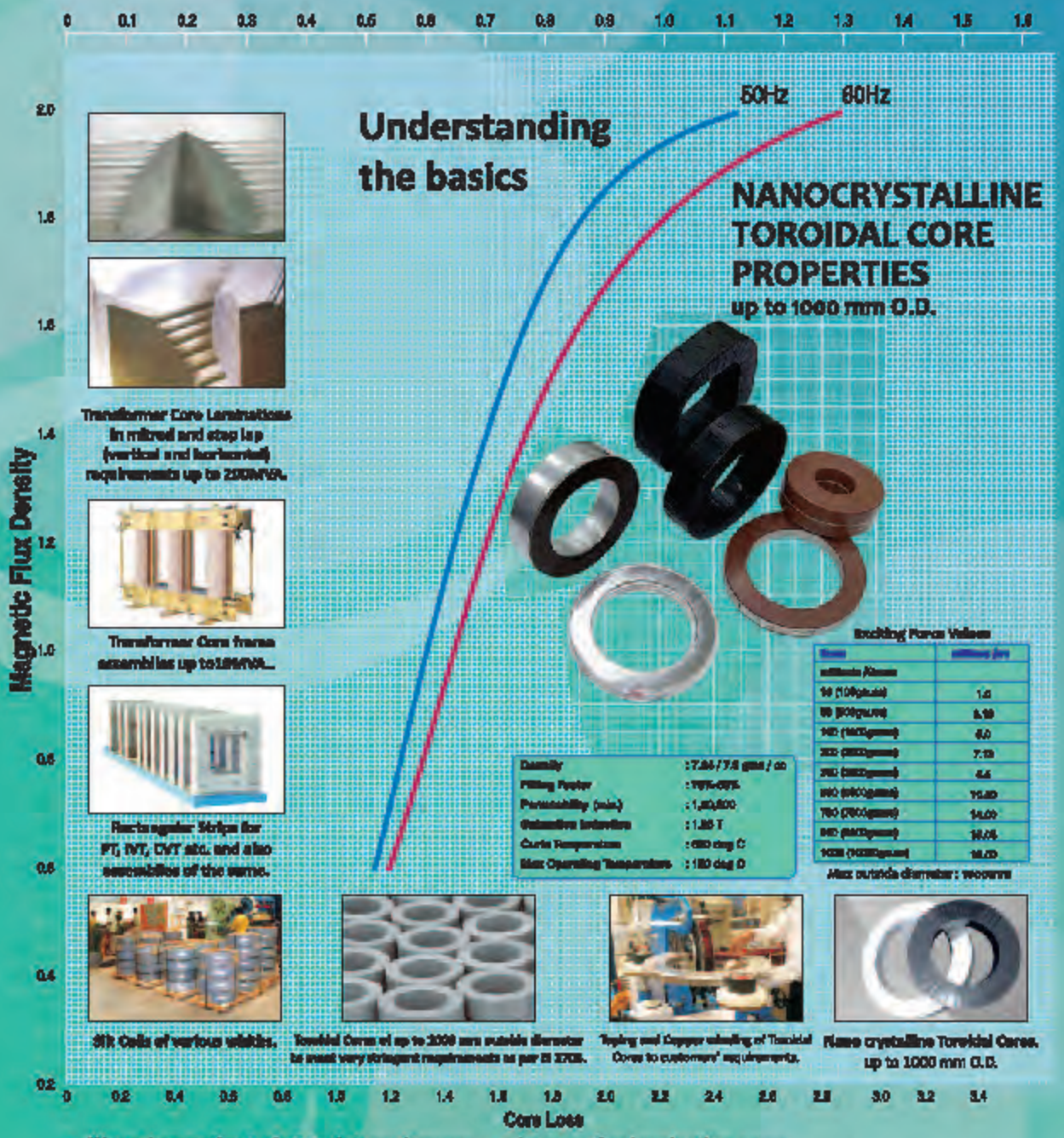

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