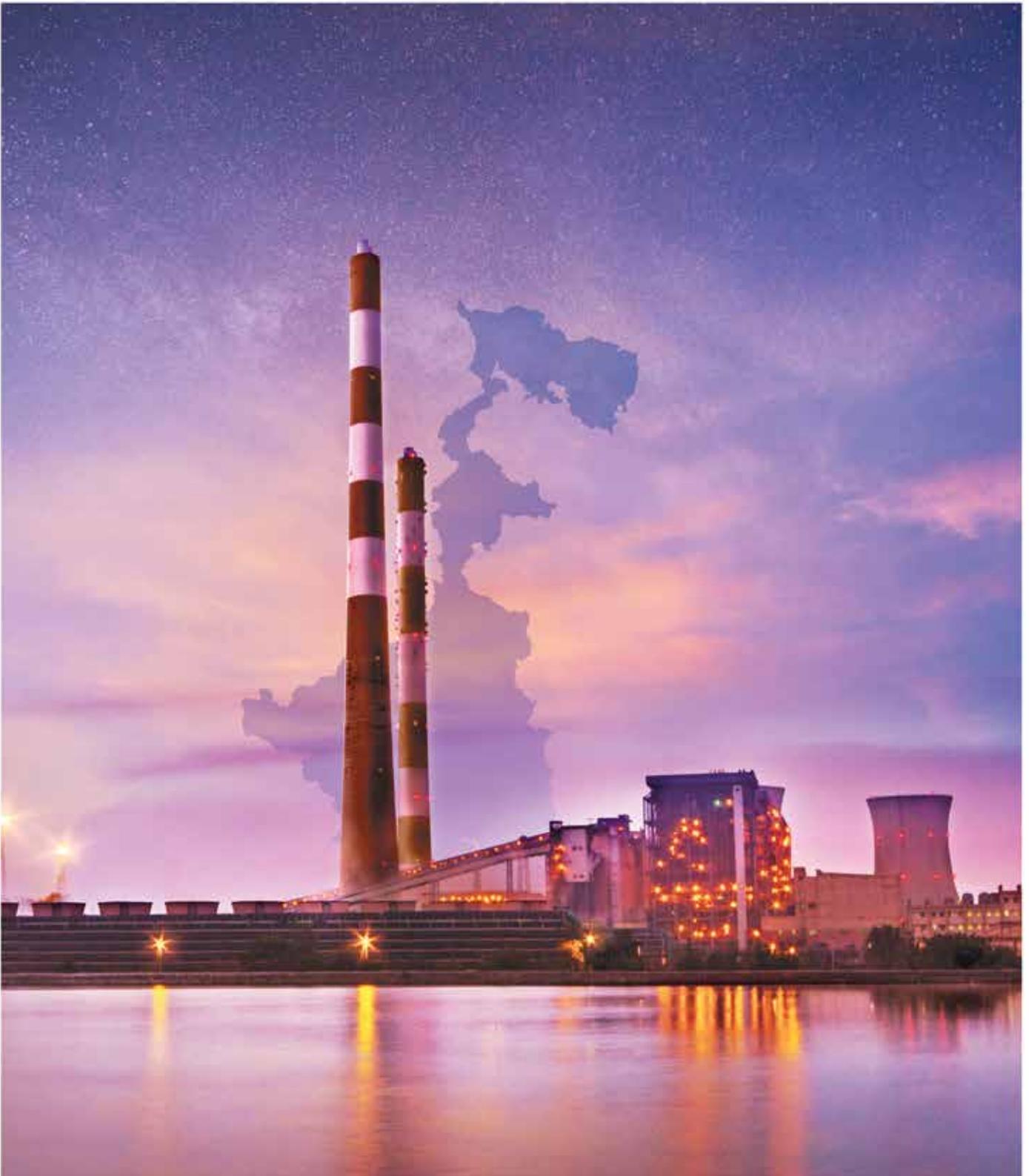


paradigm

THE PROFESSIONAL JOURNAL OF WBPDC

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WBPDC

The West Bengal Power Development Corporation Limited
(A Government of West Bengal Enterprise)

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Message from Hon'ble Power Minister



Aroop Biswas

Minister-in-Charge
Department of Power, Youth Services & Sports
Government of West Bengal

WBPDC is dedicated to generate quality power for the people of the nation particularly for the State of West Bengal. The organization has touched many prestigious land marks of all India power scenario, received many significant awards and continuing its excellence through the brilliant effort by its team of officers and staffs.

Now, they are going to publish a quarterly professional journal, "**Paradigm**", which shall provide a platform for exchange of knowledge and documentation of the valuable experience of the organization with others.

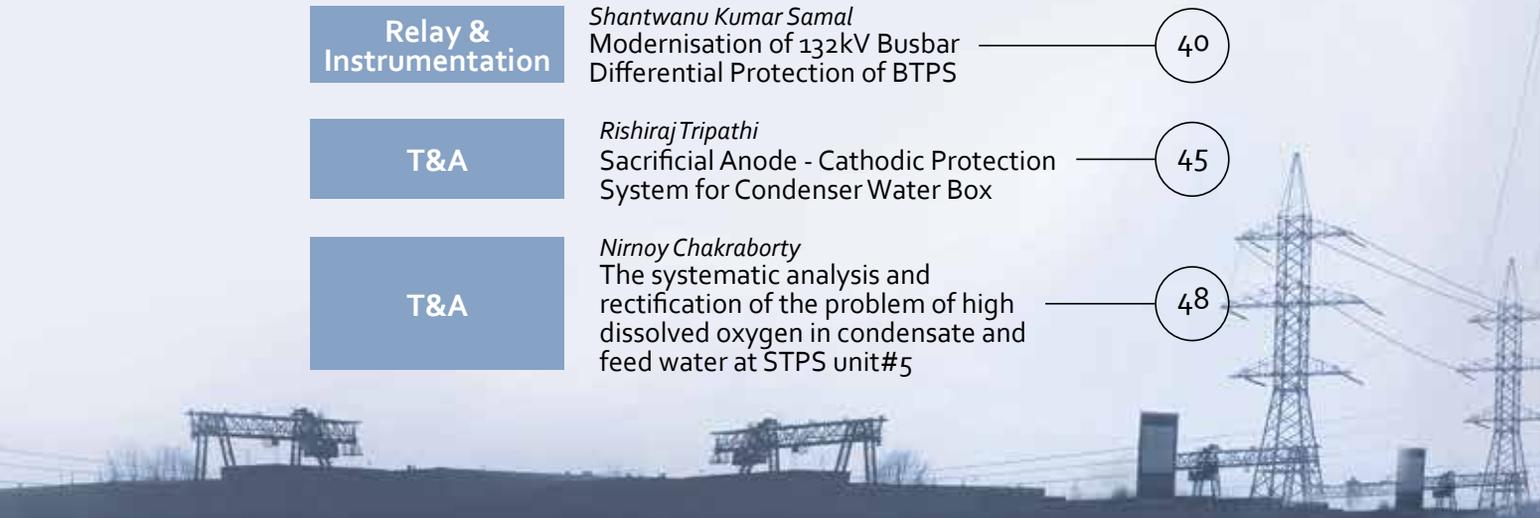
I wish the journal a successful journey through the years to come.

A handwritten signature in black ink, appearing to be 'Aroop Biswas'.

(Aroop Biswas)

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Editorial Team

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Associate Editor	<i>Sri Sanjay Sinha</i> <i>General Manager (R&M), WBPDCCL</i>
Published by	<i>Sri Ashim Ray Chowdhury</i> <i>Deputy General Manager (Corp Comm), WBPDCCL</i>

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info@abcadvertising.in

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Editorial

In Satyajit Ray's film *Aparajito*, teenager Apu was excited to find an electric lamp in his Kolkata room. It was 1956. After almost 65 years nobody points out such presence of electricity, rather we notice its absence during power failure, as it has now become an inevitable part of our existence. WBPDC is proud to play its behind the curtain role by generating power for the people.

The system of power generation is not confined within the boundary walls of our power plants; it flows through so many aspects of our livelihood – optimal use of natural resources; balancing the sensitive issues of environment; motivating & safe guarding the power plant personnel & all related people for the challenging, high risk and round the clock job of power generation; keeping abreast with the world wide developing technologies and so on. The area is vast and there is need to compile knowledge, experience and related information on this area for sharing and mutual benefit.

The management of WBPDC has decided to launch a quarterly professional journal, "Paradigm." This journal shall try to document the important experiences of the organization; to compile the new directions of the emerging systems & technology; to open dialogues with the academicians in future issues to bridge the gap between academic world and the person in the field. From next issue onwards, Reader's Response shall be added.

The editorial team is grateful to our hon'ble CMD, as the very concept of this journal was conceived through his initiative and he is the guide and the guardian of this journal. The advisory board has taken the pain to shape up the journal despite their busy schedule. We are overwhelmed with the response of the WBPDC family as they have contributed a huge number of articles, a small part of which is accommodated in this first issue and the rest shall be the life line for forthcoming issues.

The journey has just started and we have miles to go ...

Managing a fair transition away from coal

Abstract:

Power industry is sensing a shift from coal based energy to alternate renewable energy systems. The impact of this transition is multi-faceted – advent of localised renewable power may retune the balance of existing economy and politics of power industry; whereas phasing out of coal may bring adverse implications on public finance, business of railway and other elements of coal dependent economy.



S. Suresh Kumar, IAS
Additional Chief Secretary, Dept. of
Power, GoWB

Coal has been the mainstay of energy in general and electricity in particular. Its use has led to problems of environmental pollution, adverse health impacts, climate change etc. Driven largely by economics and climate considerations, we are seeing a shift towards renewable energy supported by Government policies both operationally and financially. Other than the installed 100 MW of solar renewable energy, overwhelmingly the power produced in our State is thro' coal fired power plants. This is because of the natural advantage of having good quality coal mines at close proximity to our power plants which has reduced the rail haulage costs. In the Glasgow Conference of 2022, India had committed to a carbon-neutral economy by 2070 and by the year 2030 to the following targets: to a fossil fuel free generation of 500 GW by 2030; reduce its 'emissions intensity', or emissions per unit of GDP, by 45 per cent from 2005 levels; ensure that at least 50 per cent of its installed capacity of electricity generation would come through non fossil-fuel based energy sources and ensure that it reduces 1 billion tonnes of emissions from its projected emissions between now and 2030.



Coal is no more the cheapest source of energy for electricity generation while variable renewable energy sources are already cost competitive and probably emerging technologies and solutions are likely to mitigate its challenges of variability and make it more dependable and dispatchable in the coming years. Moreover, the modularity of clean energy will accelerate the migration from centralized supply to a decentralized/local supply. Hence in the near future, even if coal remains a significant source of energy in India for a long time due to the lock-ins that have been created which would take time to remove but its importance will diminish over time. This transition will disrupt the existing political and economic patterns in India's energy system.



The phase-out of coal in the electricity sector would be the fastest unfortunately due to the cheaper alternatives available, the environmental regulations and the economics adopted by the electricity regulator and consumers. Future investments in coal-fired electricity generation, if any, run the risk of becoming stranded assets and need to be evaluated carefully. Coal as a source of energy is an important driver of economic growth. Out of the 931 MT of coal consumed in India in 2020, 705 MT (75.7%) went to electricity generation and 170 MT for non-power applications. During the 2021 coal-based power generation was 74% due to the economic rebound post-covid that saw severe coal

shortages from Coal India Ltd which kept everyone on the tenterhooks. International Energy Agency (IEA) expects that with the continued expansion of Indian economy through 2024, it expected that the demand would rise to 1185 MT by 2024 at a growth rate of 3.9%.

The actual pace of the phase-out will be driven by prevailing political economy, economic considerations, environmental regulation and international commitments. Coal has been an important source of public finance for several States and the Centre. Mention may be made that 40% of the revenues of Indian Rail accrue from transportation of coal and the phase-out of coal has implications on railway fares all around. Similarly, a reduction in coal share has direct implications for public finance and therefore on infrastructure and welfare spending by Governments at various levels while clean energy may not compensate for this loss in public finance or in jobs.

We are at the cusp of an interesting phase in energy transition and managing the transition is very critical for the economic well-being of the vast populations dependent on coal as well as that of the country.



Fossil fuels and us

Abstract:

Fossil fuels are the backbone of the modern society. On the other hand, it destroys the environmental balances. Sustainable development is the key to our survival.



Dr. P. B. Salim, IAS
Chairman & Managing Director, WBPDC

Energy is the essence of life. Since origin our ancestors have been trying to harness all available sources of energy. Starting with the discovery of fire, which was by far the most significant discovery in our journey so far in this world, we have cared very little about our nature.

In the pre-industrial age, solar energy met all of humanity's energy needs. Plants convert solar energy into biomass through the process of photosynthesis. People burned this biomass for heat and light. Plants provided food for people and animals, which, in turn, used their muscle power to do work. Even as humans learned to smelt metals and make glass, they fuelled the process with charcoal made from wood. Apart from photosynthesis, humans made some use of wind and water power, also ultimately fuelled by the sun. Temperature differences in the atmosphere brought about by sunlight drive the wind, and the cycle of rainfall and flowing water also gets its energy from sunlight. But the sun is at the centre of this system, and people could only use the energy that the sun provided in real time, mostly from plants.



Then, fossil fuels opened new doors for humanity. They formed from the transformation of ancient plants through pressure, temperature, and tens to hundreds of millions of years, essentially storing the sun's energy over time. The resulting fuels freed humanity from its reliance on photosynthesis and current biomass production as its primary energy source. Instead, fossil fuels allowed the use of more energy than today's photosynthesis could provide, since they represent a stored form of solar energy.

First coal, then oil and natural gas allowed rapid growth in industrial processes, agriculture, and transportation. The world today is unrecognizable from that of the early 19th century, before fossil fuels came into wide use. Human health and welfare have improved markedly, and the global population has increased from around 1 billion in 1800 to around

8 billion today. The fossil fuel energy system is the lifeblood of the modern economy. Fossil fuels powered the industrial revolution, pulled millions out of poverty, and shaped the modern world.



But over the decades, through mindless exploitation to satiate our greed we are fast forwarding our own destruction, along with destruction of all other living things (and non-living things too) on earth. An impending disaster is lurking our planet that is threatening the very existence of our earth due to anthropogenic activities especially by releasing the green house gas emissions of which the most predominant is carbon dioxide due to burning of fossil fuels while the other contributors are Methane gas predominantly due to agriculture especially growing paddy and ruminant animals especially cattle and nitrous oxide due to industries.

But the lessons learnt from Chernobyl and other

such catastrophic sites, where though humans perished along with the entire ecosystem, due to manmade causes, the earth there is slowly but steadily coming back to normalcy except for human habitation. It shows that we need the earth much more than the earth needs us.

In the existing world scenario, the underdeveloped and developing countries doesn't have much options available which are cost effective and affordable as compared to fossil fuels for its energy needs.

But at the same time, we can't afford to burn fossil fuel which threatens our very own existence. In our country, more than 80% of the energy needs are met through thermal power plants (around 150 of them), operating on fossil fuels. Now, the alternatives available, the renewable energy sources be it solar, wind, wave energy etc. The resources required are so prohibitive that it doesn't come very handy. The other alternative, i.e. hydro power by constructing huge dams has its own perils.

The new technology of Carbon Capture and Storage (CCS) is in its nascent stage with only around two dozen such projects mostly in North America.

While I completely agree that we have no option but to move away from fossil fuels and that too as fast as we can, we need to enable the not so developed countries around the world with technologies which are affordable and sustainable.



Turn around of WBPDCCL

Abstract:

The experience of WBPDCCL during its journey towards excellence through the small sustained steps over the years and the guideline for future is the essence of this article.



Subhasis Ghosh

Director (O&M), WBPDCCL

An Electrical Engineer of JU 1981 batch.

Joined NTPC Ltd in 1981 and worked in different capacities in Project, Operation & Maintenance, Human Resource etc. at Farakka, Ramagundam, Kahalgaon, Delhi and Mumbai units. Retired from NTPC Ltd in 2017 as Regional Executive Director (Western Region -1).

Joined WBPDCCL as Director (O&M) since September 2017 and continuing till date.

Introduction:

For the first time WBPDCCL is going to publish their First Professional Journal - PARADIGM.

Hope we will continue with this initiative in coming days so that we can share our professional knowledge amongst our employees. Our mission and goal for this technical journal is to be trustworthy source of various Information. Hope our Journal will reflect celebration of achievements of past and will also focus on changes and challenges of future.

My best wishes to all members and authors of the articles.

I thought to share with you the topic of "Turn Around of WBPDCCL" which is a dream for all family members of WBPDCCL.

Thermal power of WBPDCCL:

Total Capacity – 4745 MW, Operating Capacity – 4325 MW with five thermal plants at

Sagardighi

(2X300+2X500) =1600 MW

Kolaghat

(6X210), Unit#1 & #2 under Demolition, Available Capacity -840 MW

Bakreswar

(5X210) =1050 MW

Santaldih

(2x250) =500 MW

Bandel

(1X215 + 2X60) =335 MW. Unit#1 under demolition

At present we have 18 units on the bar.

Renewable Solar Energy of WBPDCCL:

Ground Mounted-10 MW at Sagardighi, Floating-5MW at Sagardighi, Rooftop at all 5 stations- 10.54 MW = Total 25.54 MW.

Under Construction:

660 MW Supercritical Unit at Sagardighi.
10 MW Floating Solar at Sagardighi.

Coal Mines in Operation:

660 MW Supercritical Unit at Sagardighi.
10 MW Floating Solar at Sagardighi.

Coal Mines in Operation:

- 01 Pachhwara (North)
- 02 Barjora (North)
- 03 Barjore
- 04 Gangaramchak

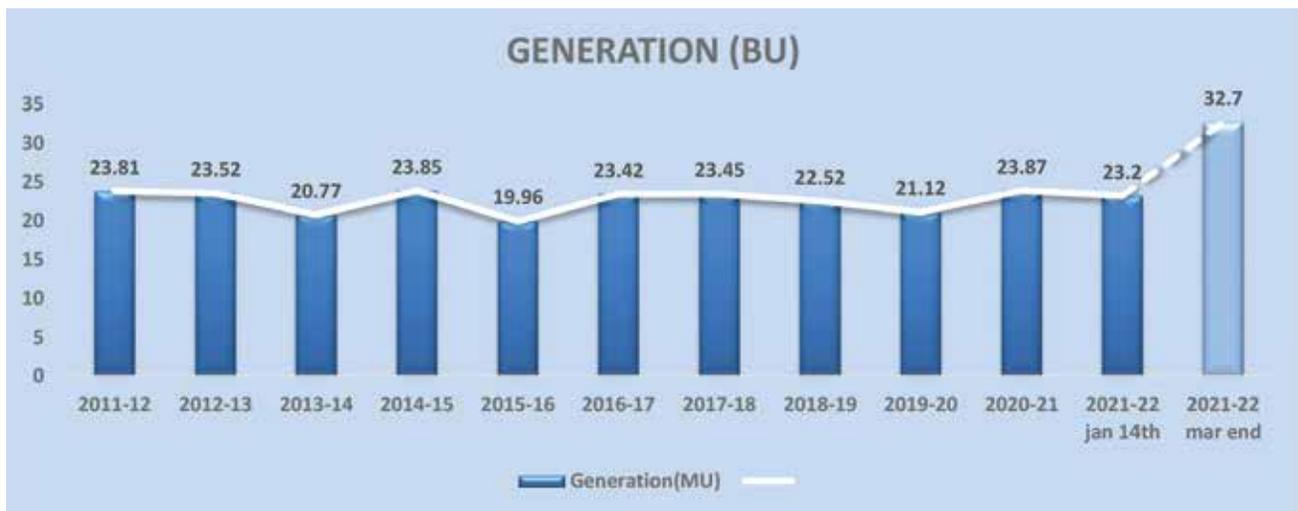
Coal Mines in hand:

- 1 Tara - Finalization of MDO in process.
- 2 Deocha-pachami – land acquisition in progress

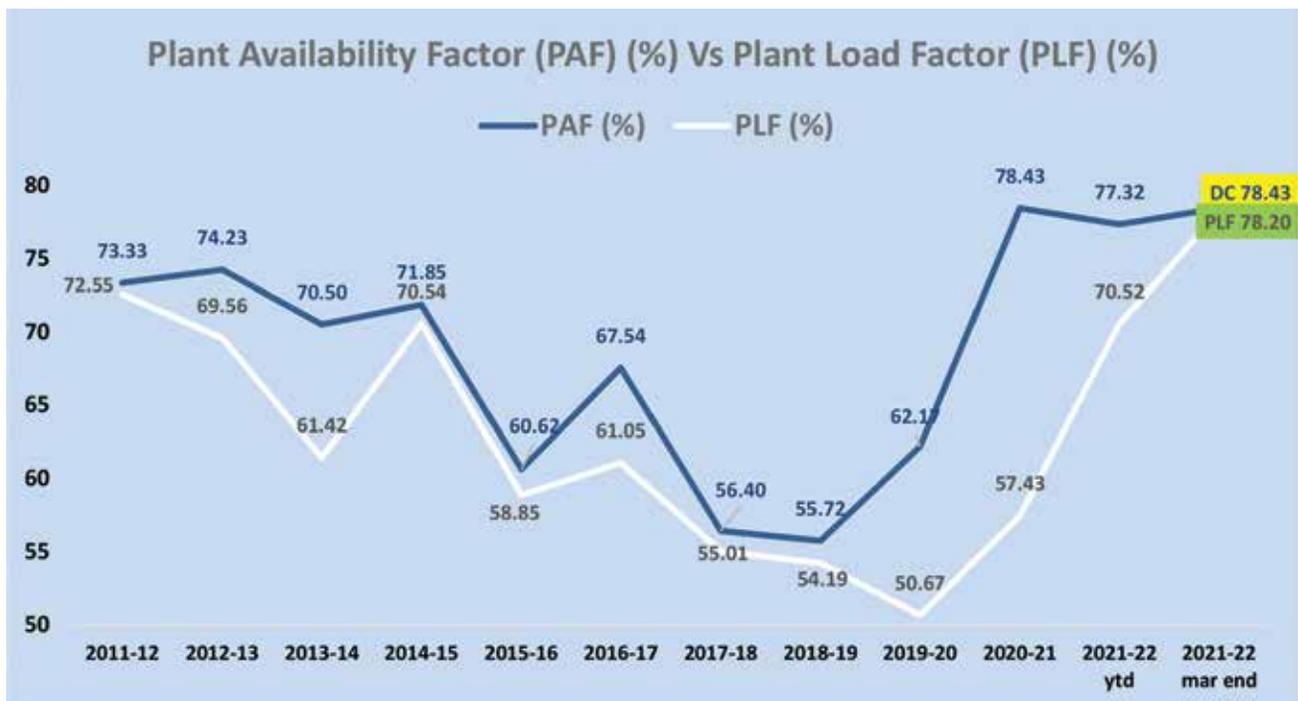
Units are as old as from 1963 (Bandel-1 & 2) and new from 2016 (Sagardighi 3 & 4). We have already demolished Bandel 3 & 4 during April '19

If we look at the Generation since 2011-12: 23.81 BU, 2020-21- 23.87 BU (ever highest) and this FY (till 14th Jan '22) is 23.2 BU which is already – 5600MU more than last FY on YTD basis

WBPDCL – Last 10 Years Performance



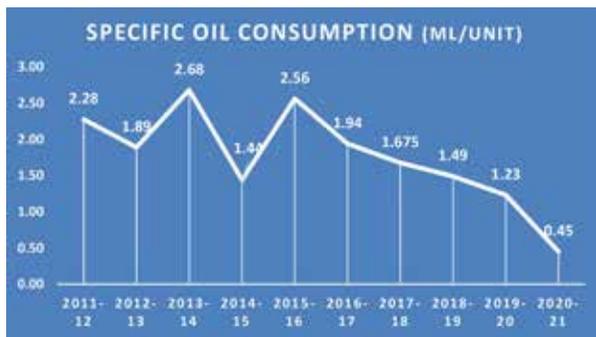
Availability in the year 2018-19 was 55.72%, 2019-20 was 62.17% and 2020-21 was 78.43%



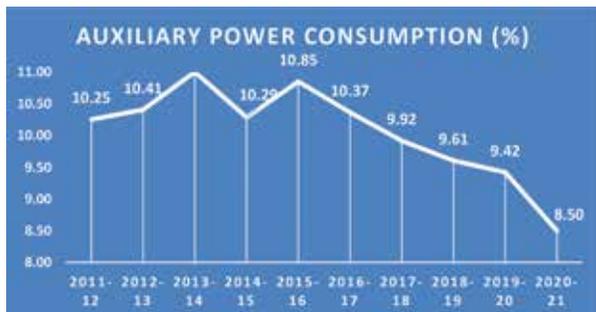
As a result the under recovery has reduced from Rs. 951.36 Cr. to Rs. 764.74 Cr. to 119.74 Cr. (2020-21) in respective FY and thereby improvement in saving of Rs. 645.00 Cr.



If we look at the reduction in SOC from 2.28 ml/kwh (2011-12) to 1.23 (2019-20) to 0.45 (2020-21). Savings was Rs. 76.37 Cr. over Financial last year.



If we look at APC reduction, from 10.25% (2011-12) to 11.00% (2013-14) 9.42% (2019-20) to 8.5% in (2020-21), savings Rs. 54 Cr. over last financial year.



Boiler tube leakage reduced from 30 to 22 to 13 during last 3 FY resulted in savings of Rs. 23 Cr. over last financial year. There were no Boiler tube leakages in 6 units in 2018-19, 10 units in 2019-20, 7 units in 2020-21 out of 18 operating units.

Tripping has been reduced from 95 to 86 to 35 during last 3 FY resulted in savings of Rs. 37 Cr. over last financial year.

The major Improvement came after our captive mines have started production.

We are getting coal for M/s. CIL (ECL, MCL, BCCL & CCL) as per FSA.

The ratio of coal from Captive was 21.85% (2019-20), 45.81% (2020-21) and YTD it is 63.62%. This year it is expected to be more than 65% by FY. Projected Production is 13.6 MMT in 2021-22.

This has resulted in reduction of Rs. 0.70 per Unit in last FY. This year further improvement in performance is expected in all areas.

Since last 4 years our Santaldih & Bakreswar Plant are figuring in First 25 top station of India as per CEA ranking on PLF basis.

This year till April to August 2021 Santaldih was No.1, YTD it is holding No.2 place. We expect Santaldih will achieve its everbest plant load factor at the end of financial year.

For the period April-21 to Dec-21, Bakreswar plant with 87.18% PLF is at No.4 and Plant load factor and Auxiliary power consumption both have crossed the station's best ever figures since inception. Sagardighi Plant with PLF 79.92% is at No.21 among all thermal power plants in India.

Our Bandel Station has also started making Profit since last Two years after Unit -5 is Running steadily.

All the stations are expected to improve their position further by FY end.

If we compare our overall performance at National level, this FY till Dec.'21,

All India Coal PLF is 57.02 %

Private Sector- IPP (Coal) is 52.09 %

Private Sector- UTL (Coal) is 68.08 %

Central Sector (Coal) is 67.90 %

SEBs (Coal) is 51.50 %

and WBPDC is at 70.49%, highest amongst all

As a result the profit after tax soar upto Rs. 252.0 Cr. from 15.48 Cr. (2019-20). This year it is expected to cross Rs. 500 Cr.



This is mainly due to efficient, dedicated operation and maintenance by our team members and regular going through the best practices of other stations and Generating Units like NTPC, CESC etc.

Also the following practices and tools are used:

01

Regular holding of ORM (Operation Review Meeting) every month.

02

OPR (Operation Performance Review) 4 monthly.

03

Formation Cross functional team in Boiler, Turbine, Electrical, C&I and Fuel area.

04

Technical audit.

05

Safety & Environmental audit by cross functional team.

06

Award & Reward Policy is in place for individuals upto DGMs.

07

Safety & Environmental award for performing stations.

08

Award for NIL demurrage.

These are the awards in place to motivate our people.

Further to strengthen the O & M areas.

- Each and every trippings are analyzed at stations and at Corporate, to avoid such happenings in future and recommendations are implemented.
- Each BTL is analyzed through a Committee and recommendations are implemented to avoid future occurrences.
- All major failures of equipment are analyzed to avoid future occurrences.
- Overhauling of Units are carried out on schedule time with an 8 years rolling plan. No Boilers are operated after expiry of its license.
- OPI is practice with Engineering declarations.
- A 3rd party is engaged to supervise the Boiler overhauling jobs including quality.
- Overhauling of turbines are carried out without

support of OEM (For Foreign Vendors).

- Water Chemistry is under strict monitoring at Plant and Corporate level.
- CBM is followed across the plant.
- Regular interaction with plants at CMD and Directors level to address their issues.
- Regular visit of senior people at plants.
- Initiative like "Marching Towards Excellence" at plant and Township has given very good results and ambience.
- As Plants are quite old, regular improvement through CAPEX in the areas of obsolesce, Safety, Efficiency improvement, change in Law and Infrastructure are carried out which is giving good results. This is being done in a structured way.

There are some issues in the cases of Environment and ash utilization.

NGT case at Kolaghat is addressed by Renovation of new ESP at Unit#3, and carrying out R&M of ESP at Unit#4, 5 & 6 and demolition of Kolaghat Unit-1 & 2.

Issues of SOx are addressed by installation of Wet FGD at Sagardighi and Santaldih and installation of DSI systems at Bakreswar, Kolaghat and Bandel shortly.

NOx issue at Bandel is addressed during this overhauling and for other stations it will be done through OEM.

Last year 3 of our stations Bandel, Kolaghat and Santaldih had achieved more than 100 % ash utilization, Sagardighi was less due to Stage-II dry ash commissioning delay and Covid situation. Bakreswar was less due to less ash takers and Covid situation.

All-out efforts and initiatives are taken to ensure 100% ash utilization at all stations.

Specific water consumptions are well within limit and regular checks are made.

It is expected that WBPDCCL will reach a newer height in the coming days.

This turnaround could be achieved through the dedicated team efforts by our employees and guidance from our leaders. We are hopeful to make 1st time best achieved WBPDCCL Plant load factor in this year with enhancement of ratio of captive coal. Growth in production of Pachwara mines in this fiscal has boosted output of Sagardighi TPP after capacity addition of 1000 MW. Under 'Marching Towards Excellence', factory and township ambience have improved significantly across WBPDCCL plants. Each and every plant is marching in full throttle to improve the overall panorama. We are hopeful that WBPDCCL will live up to the expectation of fulfilling the power requirements for the state.

Preparedness for the unexpected

Abstract:

It is very important to envisage the collateral effects of a forthcoming event and all untoward incidents leave us a lesson for improvement of the system. This article explains the matter based on a real time experience.



Utpal Bhadra

CVO & Ex-officio Director, WBPDCCL

M.Sc. in Genetics & Plant Breeding from Banaras Hindu University in 1990.

Joined State Civil Service as 1992 batch WBCS(Exe) and worked in various capacities in district and sub-district level like BDO; Deputy Magistrate; Sub-Divisional Magistrate; Additional District Magistrate. Worked in Industry, Commerce & Enterprise Department having charges of various sections like mines & minerals; petroleum & natural gas; plantation Industries; and Financial Advisor of the Department.

Joined WBPDCCL in 2019. Looking after vigilance; legal; land; mining etc.

Introduction:

Very recently the WBPDCCL corporate office witnessed a sudden agitation by the job seekers. A walk-in interview advertisement triggered an unprecedented response than the usual such advertisements. The unmanageable collection of job seekers including their friends and relatives suddenly turned into an unruly mob. The office securities were outnumbered by the deluge of mob that scaled up the entry gates; destroyed the flower pots at the stairs and lashed out at the reception. The mob did maintain no social distancing during the pandemic situation though the interview was for nursing staff. The HR officials rushed to the reception desks but could not control the situation initially due to huge noise and chaos. The crowd consisted of lady candidates in majority and there was no lady among the security. A small contingent of police force arrived but they also became helpless. A loudspeaker was the need of the hour and to our misfortune the police jeep was not also loudspeaker mounted. A reinforcement to police forces then arrived and by that time the HR officials regrouped themselves and very efficiently handled the situation. A senior HR official stood up on the desk; and by elevating his stance he could overpower the crowd through intense negotiation. Ultimately the crowd could be dispersed by issuing tokens from two places in queue.



The above incident pointed out the loopholes in our preparedness in handling unexpected situations. Now, it's high time that we make a post mortem of the incident; identify our shortcomings; re-orient ourselves and keep ourselves prepared to face any unexpected situations. In case of the above incident it's crystal clear that the WBPDCCL officials were stunned by sudden violent behaviour of the mob. As a result, the chaotic situation could initiate and persist for a while before the officials could take control over the situation. Once the situation became under control then everything was smooth and that reflected the professionalism of the organization. But initial hiccups and nervousness in handling the

unexpected situation gives us the opportunity to grow ourselves stronger to handle any situation without being unnerved any more.

In case of organized mob, negotiations can be done. But in this particular case, the mob was not an organized one. So addressing the public in general through loudspeaker was the only way left with. Though there are loudspeakers in the office but the concerned official didn't bring it out or he had no idea that it was the most needed item in such situation. Even others didn't know with whom loudspeaker was available. Besides, there is good number of security staff in the entire building deployed at different floors; but only the securities at entry gate and reception were battling the situation. Had the securities from other floors also interrupted, the situation could have been handled more easily.

When an unwanted situation occurs, concerned officials generally become disoriented. Hardly a few play proactive roles while others watch it from a distance thinking that somebody else would take the lead. Hence, in all practical purposes, it is always better to keep in mind that we might face

any unexpected situation and keep ourselves ready with mitigating articles, responsive manpower, safety measures, safe houses, medical team, command & communications and public address system. The security staff should be briefed in advance including drills as to how to inform all concerned through phone or walky-talky; quickly regrouping and reinforcement at strategic locations and division of responsibility. Similarly, there should be division of responsibility in case of the officials who should respond quickly to any unwanted situations. The senior officials should read the situation, inform police, seal the entry points to prevent spreading out the problem, alert the safe house and medical team, take control over the public address system, divide and diffuse the unruly assembly and negotiate with the leaders of mob. There should be published SoP for handling such unexpected situations with necessary phone numbers, availability of mitigating items, maps etc. There should be variants of SoP based on type of unwanted situation; be it mob violence, fire hazard, earthquake, accidents and other types. So, let's learn from the experience and act upon early.



It has never been this expensive to finance a new coal fired power plant

Abstract:

The article explores the challenges of financing new fossil fuel based industrial endeavours.



Indranath Chatterjee

Executive Director (F&A)

Joined WBPDCCL in 2012 as GM F&A.

He has served Humboldt Wedag, Phillips Carbon and PWC during his 34 years of experience.

- The cost of loans related to coal fired Power Plants are on the rise.
- This means that the cost to finance a Coal Fired Power Plant is the highest that it has ever been.
- The “Loan Spread” for financing coal mines and coal fired Power Plants rose 38% and 54% respectively between 2010 & 2020 as the global economies looked for more sustainable investments.
- “Loan Spread” is the difference between the interest rate that a bank charges a borrower and the interest rate a bank pays a depositor.

For many decades, the infrastructure for coal, oil and gas was seen as a relatively safe investment delivering good methods to investors.

The renewable sector, on the other hand, barely attracted the Private Sectors attention.

This is established by data showing that while banks lent trillions of dollars financing new fossil fuel assets from mines to Power Plants, it was left to the government to invest about 50% of the annual investment in the American Solar Sector as late as 2004.

Today, the equation is reversing fast.

The cost to finance new fossil-fuel infrastructure, especially coal, is rising while the cost of new renewables is falling fast.

High carbon businesses were borrowing money at much higher rates in 2020 than in 2010.

Over that decade, the loan spread for Coal Mines and Coal Fired Plants rose 38% and 54% respectively with declines of 20% for Solar segment.

(Data Source: The Sustainable Finance Programme of Oxford University, UK).

For now, oil and gas have emerged relatively unscathed, seeing only moderate increases in lending cost.

To add to this, new Coal Fired Power Plants in India are on the verge on being halted by the government as the country works out a plan to meet commitments made at COP-26.

The world COP stands for “Conference of the Parties”. In the climate change sphere, the parties are the governments which have signed in United Nations Framework Convention of Climate Change.

COP-26 is the 26th such annual meeting held in Scotland this year.

At the COP-26 meeting in November 2021 the Prime Minister announced India’s aim to achieve Net Zero Emissions by 2070 and also pledged to attain 500 GW of installed capacity from non-fossil sources by 2030.

From the above it is clear that all connected with the future of Coal Fired Plants need to realistically plan future capacity additions very carefully.

Information security: From personal, enterprise and national perspective

Abstract:

Beneath the glow of this era of information technology, there is growing darkness of cyber crime. This article deals with some major concerns in this area and some awareness which may protect our personal data.



Sabyasachi Samanta

DGM(IT&C), Corporate Office

Joined WBPDCI in 1991. 13 years' experience of Electrical maintenance at KTPS. 15+ years in IT&C including Two End-to-End ERP Implementations, ISMS Implementation in WBPDCI for ISO 27001: 2013.

Major IT & ISMS Certifications: ISO 27001:2013 Global Lead Auditor, Machine Learning on Stanford University Online etc.

Introduction: Information security and cyber threats

It is often said that "if the service is free, you're the product". The free online services, you are using like Email, file transfer service like Google drive etc., free Social Media apps and so on, are taking away your data - personal data, enterprise data, even the data of national importance and all that data is up for sale or for any other kind of use that benefit the service providers and its associates. Now-a-days, your privacy and information security is nothing but a myth. However, this is just one kind of cyber threat.

Even greater threats are coming from the criminal hackers, self / enterprise sponsored and government sponsored. They are more than ready to spy on you and to take away your data. The government sponsored hackers are especially interested in a country's important data. Not only that, they are also very keen to damage critical infrastructure like the electrical power system to cripple a nation, at least temporarily.

Our area of interest should be to safeguard data and infrastructure at our personal level, enterprise level and of course, at the level of power generation infrastructure of our organization, which is of national importance.

Now, let us first explore a few cases of very common scenarios, related to these three different levels of information / cyber threats. The awareness about the common threats may help us to safeguard effectively against these attacks.

Social Engineering Attack:

Almost everybody now-a-days uses any sort of mobile phone. Somebody calls you to give him / her an OTP (One Time Password) for your KYC (Know Your Customer) obligations, otherwise, you are threatened, your payment card / bank account / mobile connection etc. will be terminated. Once you provide the OTP, which is most likely your payment card or bank payment OTP, you will lose money within the next few seconds.

To be safe, never ever give in to this kind of requests. Banks, payment card institutions, mobile operators have repeatedly notified that they never ask for KYC in this manner over the telephone.

Spyware Attack from Internet:

When you receive an Email or a Smart phone message [SMS, Whatsapp, Facebook Messenger etc.] with a link to click. It may be a link to download a Virus / Malware / Spyware. This Malware will be quietly installed in your device (Desktop / Laptop / Phone / Tab) and more quietly steal data and / or damage your device. Sometimes

later, you may find that the compromised device is slowing down / crashing. In the case of data theft only, you might notice nothing for some time until you notice some unwanted activities in your online accounts like bank accounts or credit cards. In this scenario, apart from your data, the enterprise applications like ERP, office online accounts may be compromised. Even such Malware from your device, if connected to the organization's network, may creep into your organization's OT (Generation) network and create serious damage to the power generation system.

To safeguard from this attack, please think twice before clicking on these links. If the source is very much known to you and if your anti-virus software (If already installed in your device) does not warn you, then only, you proceed. Otherwise, mark it as Spam / Junk and never ever look at it.

Moreover, the organization's production network must be protected through strong Firewall policy and Anti-virus software at Desktop level to protect end-points.

Spyware Attack without internet:

This is a curious scenario. A classic example of this type of attack is called STUXNET attack. By the year 2010, Iran nuclear facilities discovered that a deadly Malware named STUXNET has been planted in the it's Uranium Enrichment facility for the last couple of years. Surprisingly the target system was not connected to the internet (usual source of cyber attack). Then, how did it happen? This attack method is called "Parking-Lot Flash Drive Attack". Malware loaded several flash drives were thrown in the parking lots of the facility. Some curious employee picked up at least one such drive and out of curiosity, plugged it into his / her desktop / laptop (connected to the facilities network). As soon as the flash drive had been opened, the Malware crept into the production system and damaged the whole process of Uranium enrichment, thereby delaying the production by several years.

Now, this kind of incident can happen here too. So, it is strongly advised to block USB storage drives for all those devices connected to the company's production network, specially the OT / Power generation network.

Information theft by service providers of internet services:

As mentioned at the beginning of this article, free services like Gmail, Facebook, Whatsapp etc. are not really free. You simply pay them by your data. These so-called services come with absolute no warranty. If you use these services for your personal communication, then you give them your personal data. And if you use these services for your official communication, then you give

them your organization's data. You may not feel it all the time. But, when you see that travel dates are automatically added to google calendar from your travel tickets in your email, you surely feel the pinch. Likewise, your organization's classified data is continuously consumed by these service providers. If you create a WhatsApp group for official communication, you can be double assured that all these communications are also continuously consumed by the service providers.

So, to safeguard against this type of information theft, it is not recommended to do any official communication on these free platforms. Only, the paid versions of Google / Microsoft or any other globally reputed platform is only recommended for this purpose. The Internet has always been a great source of information and a great source of cyber threats as well. Now, beyond the visible part of the internet, which is searchable with search engines like Google, Bing, there is an unknown part of it. It is called 'Darknet' or 'Darkweb'. It is not accessible by conventional search engines and browsers. It is estimated that Darknet constitutes no less than 95 per cent of total internet space. That means what we can find through search engines is less than 5 % of total internet space. This vast Darknet is accessible only through a special protocol called TOR (The Onion Router) and TOR browser, a special type of browser. This layer of the internet is notorious for complete anonymity and that's why it is the home for all criminal hackers. Here, you may find that your private data like health vitals, credit card / bank account details and credentials are up for sale. So, please do not venture into this Darknet / Darkweb without sufficient knowledge about it. Otherwise, serious consequences may happen.

However, these are only a few of the highlights of today's global information and cyber threat scenarios. The real game is too big to discuss all of them here.

It may also be mentioned that "Information" may be in both forms - electronic and printed. So far, protecting electronic information has been discussed. Printed information is also to be protected by various means - like information classification, secured physical storage & transportation, proper access control.

At the end note, it may be mentioned that WBPDCI has been awarded ISO 27001:2013 ISMS (Information Security Management System) Certification on October 14, 2019 for three years with two annual surveillance audits. This means that we need to follow a certain policy framework of information security, which is based on 114 controls, specified in ISO 27001:2013 specification manual.

And we need to follow it strictly in order to hold on to this ISMS certification.

Journey with HYDROGEN – A new horizon

Abstract:

Coal and oil economy has so far made us what we are, playing their crucial and important role in progressing humanity. Now, our energy security is at great risk and we are in a period of great transition towards sustainability. One of the immediate alternatives is Hydrogen.



Abhijit Nandi

DGM(Engg.), O&M – Incharge,
SgTPP, WBPDC.

Joined WBPDC in 1991. Handled different responsibilities at KTPS, STPS and SgTPP over three decades.

Introduction:

Synopsis: Civilization demands energy to propel. Our energy security is at great risk. Coal and oil economy has so far made us what we are, playing their crucial and important role in progressing humanity. But many questions we now are facing and the equity we may transfer to the future are compelling us to have immediate alternatives. So we are in a period of great transition towards sustainability. We can do so with many answers but lesser solutions – one is, the HYDROGEN.

Coal once laid the foundation stone of modern civilization. Oil and gas cemented it and that together are leading us what we are now and would be. Carbon and hydrocarbon economy is shaping our world since long and will have to be continued with those pioneers and pathfinders, greatly benefitting from them and through our near future. Playing very important and plausible role in human history, these fossil fuels are now putting question and exclamatory marks in their path of journey and likely to be so for many generations to come. To match with the aspirations of whole populace of the world, much more that of those poorer and underdeveloped, demands of energy which is the basic of present conscience of growth and development will ever be increasing. We cannot put it onto reverse gear overnight. We must need energy as we need food, now. We have to have it; we have to make it, to be made it equitable and at levelised cost available to the commons.

So what to think of next, how to carry over the civilization we cherish and to flourish that is to sustain! One answer can definitely be the Hydrogen – from beginning to end is the non-controversial fuel of the universe, galaxies and beyond, probably multi-verses. Trillion of trillions stars are glittering with the help of this great magic element. Although lying very low, in fact in the lowest possible humble position, lightest one, as we read from our early age periodic tables – is truly igniting all, powering the whole. But it so far escaped from our ambience, from the earth denying that great opportunity. We are distant away from harnessing that astronomical bonanza, though are moving fast towards that grandeur of fusion-energy to be effectively useful for commons opening a new era of enormous energy reservoir. When two nuclei fuse, a small amount of mass is got converted to large amount of energy following $E=mc^2$ law of Einstein. This fusion requires energy and is lesser for lighter nuclei like hydrogen, helium. Still now we need more energy to combine or fuse elements than we can extract from the reaction. Isotopes of hydrogen – deuterium and tritium are the common

reactants. Fusion reactors, most favourable are the toroidal confinement types commonly known as Tokamak, are operational worldwide and many are coming to "burn" fusible elements to harness useful energy. Researchers and experimentalists are relentless.

Hydrogen is a fascinating energy carrier. Though it is a very common chemical element, does not exist in the nature in pure elemental form, is to be produced separating from chemical compounds. Its conversion to heat energy is simple but tricky. But to operate a hydrogen economy, how much energy we need to sustain it, that is important and is being now answered in many ways.

Demand of hydrogen for industrial use increasing day by day – more than three folds since 1975 and its usual production is carbon intensive. But very less is used in energy and transportation sector. Natural gas is the primary source of production; can also be produced from coal, oil, biomass, water. There is a great prospect of water electrolysis using electricity from green energy to produce nothing but hydrogen. Sourcing natural gas for hydrogen is carbon-intensive and per kg produces 9.2 kg of CO₂, which will not be desirable at the present juncture of time. So we necessarily have to think other ways.

Hydrogen with ammonia can be used in gas turbine for power generation which in turn is a great option for use as storage of fair weather renewable. Highly energy intense, hydrogen, may play the role of raw store of many powerhouses to generate heat and electricity.

Hydrogen simply combined with air can produce energy and water vapour and more energy intense containing higher per kg energy than many fuels. Apart from uses as fuel it is an important feedstock for many industries like refining, fertilizer, other chemicals and also replacing carbon in iron and steel industry.

Hydrogen economy is potent enough to replace oil and coal economy, day by day progressing so and thus will shift many directions of energy-economics, exim policy and administration. Supply of hydrogen may come from various sources, abundant and available to masses. Obviously, nobody will have authoritative control over its supply uses and may truly empower a common man. It can easily be produced in a much more distributed fashion at the doorsteps of the users where energy demand actually is there - because it can be obtained from varieties of abundant sources. In present socio-economic – political scenario, world's energy security is vulnerable and at stake. Whole of the world urgently needs a breakthrough towards an equitable sustainability.

India produced around 4250 terawatt-hour of energy in 2020 and of which more than 80% is from fossil fuel. Projected energy production by 2040 is 9950 terawatt-hour per annum. In Glasgow at COP-26 – UN climate change summit, Nov.'21, India committed to reduce carbon emission, net zero by 2070 and sourcing capacity of electric energy of 500GW from non-renewable by 2030. All of these are having indications to halt installation of any more conventional coal based power plant. India contributed 2.62 Giga tonnes of CO₂ emission in 1919. Changing our track with hydrogen as base energy, that can definitely be a great hope to put it onto reverse gear. With the launching of National Hydrogen Mission we forward footsteps in that direction. De-carbonization of electricity is progressing worldwide, India is no exception.

Production of hydrogen from hydrocarbons, mainly from natural gas, done through steam reforming, partial oxidation or both combined. Coal gasification is also a process through producing syngas comprising of hydrogen and carbon monoxide - process is endothermic and requires huge energy input. Almost all of these production accounts go to fossil fuel and consequent emissions. Thermo-chemical or biological conversion of different biomass can produce hydrogen and such process is very promising. Among thermo-chemicals, one is pyrolysis – heating temperature below 800 degK at reduced ambient air pressure and other one is gasification – at temperature above 1000 degK.

Biological methods employ different algae and bacteria and bio-photolysis and fermentation are the underlying process of production. These methods require low energy and that from solar can serve the purpose. Solar energy can effectively be used through photo-voltaic, photo-thermal, photo-electrolysis and bio-photolysis to produce hydrogen. Solar photo-voltaic electricity is used for electrolysis to split water into hydrogen and oxygen. As the cost of such electricity is progressively reducing, so also the cost of hydrogen production and is an option to make storage of solar energy as well. Solar thermal process uses concentrated solar power as source of heat for endothermic water decomposition. Photo electrochemical cells are used to directly produce hydrogen from water through electrolysis. So, hydrogen can be produce using zero emission energy sources like, solar wind, tidal, hydro power and such produce is truly green. Processes involving emissions are referred as grey and if most of CO₂ emitted is captured are termed as blue.

Storage of hydrogen is a point of challenge. Compressed storage in pressure vessel is common.

Hydrogen being the lightest element, its energy density per unit volume of storage is a limiting factor. Cryogenic storing is where liquefied hydrogen at -253 degC is stored but very energy intensive. Obtaining and sustaining that cryogenic temperature demands large amount of energy expense. Absorption and desorption properties of some materials such as metal hydrides, some metals and metal oxide clusters, carbon nano tubes are highly promising and are continually evolving towards great options of efficient storing of hydrogen. Hydrogen atoms are trapped in interstitial lattice structure of such adsorbing materials. Highly porous structure of carbon nano tubes help to adsorb large quantity of gaseous substances.

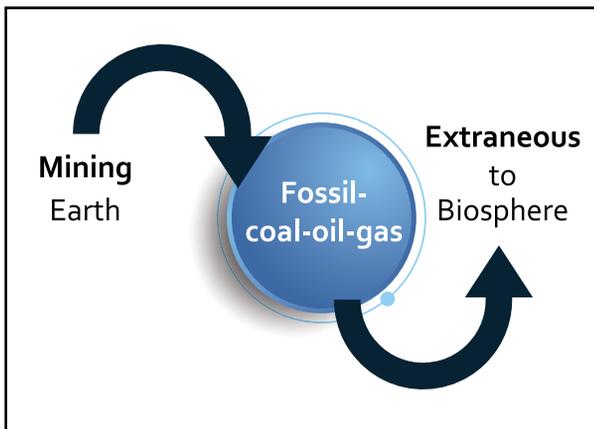


Fig 1: Conversion to useful energy mostly non-reversible, burdening biosphere

Some of the general uses of hydrogen in industry are - in petroleum refining, as reactant in fertilizer and food industry, metal treatment etc. More special uses are as propellant in aerospace application, fuel for automobiles and production of electricity using fuel cell. Most prominent use is as reactant for production of petroleum or petrochemicals. Hydro cracking is the process where hydrogen is used to crack and hydrogenate heavier hydrocarbons, thus producing refined fuels. In hydro-processing hydrogenating reaction occurred with nitrogen and sulfur compounds for their removal and end use. Nearly half of the total hydrogen produce is used in Haber process worldwide to produce ammonia for fertilizer. Ammonia, on the other hand, can viably be converted to hydrogen and is a safer option to transport than hydrogen. Mentionable amount of present use is as well in food industry.

Having energy density roughly of 33.5 KWH/Kg of usable energy, hydrogen is highest among the known source of fuels, around two and half times than even gasoline and that too potentially clean. Projects to replace coal in boilers by hydrogen and natural gas mix and ultimately by hydrogen have already been undertaken worldwide. Efforts are being also in place to run gas turbines. Internal

combustion engines are in trial to use hydrogen in transportation. Fuel-cell driven vehicles has been rolling over the roads. In India, industries are going to execute green hydrogen project of storage producing hydrogen by use of solar energy and electrolyser and then electrifying that through fuel cells. Fuel Cells produce electricity combining hydrogen and oxygen to water, a process may be narrated as reverse of electrolysis. Some of those are also contemplating to use hydrogen blended with natural gas for combustion. Hydrogen can become an intermediary of many of the renewable sources and end-use energy requirements.

Closed CO₂ cycle is a clever concept to use hydrogen side by side with much discussed closed hydrogen (water) cycle where end product, as we know, is water. In closed carbon (CO₂) cycle, synthetic liquid hydrocarbons like methanol, di-methyl-ether - where carbon from biomass, wastes or recycled CO₂ is chemically transformed to carry hydrogen energy and the carbon from biosphere i.e. biocarbon will remain in a closed loop of cycle. This process of chemical transformation is less energy intensive. Moreover, if we use biocarbon from the biosphere and after extraction of energy it goes into the biosphere that will have a very good prospect as hydrogen-energy carrier without stressing global climate. Liquid hydrocarbons are much more suitable for transportation and handling and we already have such accessories operational throughout the world. Methanol can be directly used in fuel cells to produce electricity or can be transformed to hydrogen for further use.

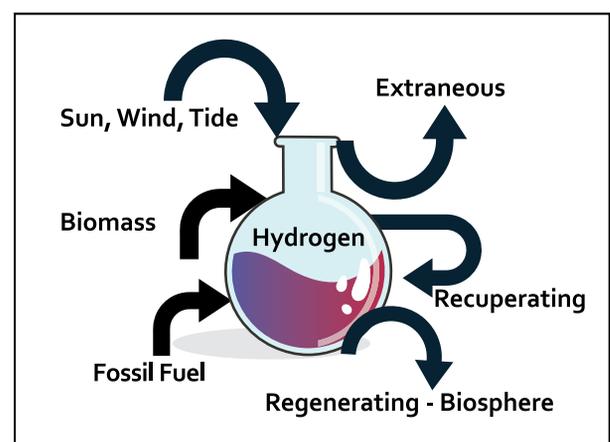


Fig 2: Energy Conversion can largely be intrinsic to biosphere

Our point of concern is use of hydrogen as primary fuel to produce energy. Main hindrance is in its cost, of production, processing, storage and transportation. Use of hydrogen as energy through fuel cells or combustion is now in main stay. To fulfill zero carbon promises made by so many nations, hydrogen is sneaking through many peepholes and warming up to jump into the arena of ever growing energy needs of human

as entity, sapiens as species. So called many of the green energies are not so green. Underlying emissions are not at all ignorable. As we have seen, conventional production of hydrogen is no greener but very much carbon intensive. But it has remarkable potency to appear green and more and more green in coming days and a strong contender for replacing carbon-economy – not only propelling space voyages but energy-monger for commons; truly empower us leaving water in its footprint - another life sustaining magic material.

Of course, challenges are there - concerning with safety, reliability and cost implications. But nothing of such concerns could restrain human ever as we also have seen in many cases of science and technology in the past. So we are looking up, what once escaped from the nature of the green planet is signaling from the distant, is to energize days ahead. This may overwhelm many others in the fast changing 21st century.

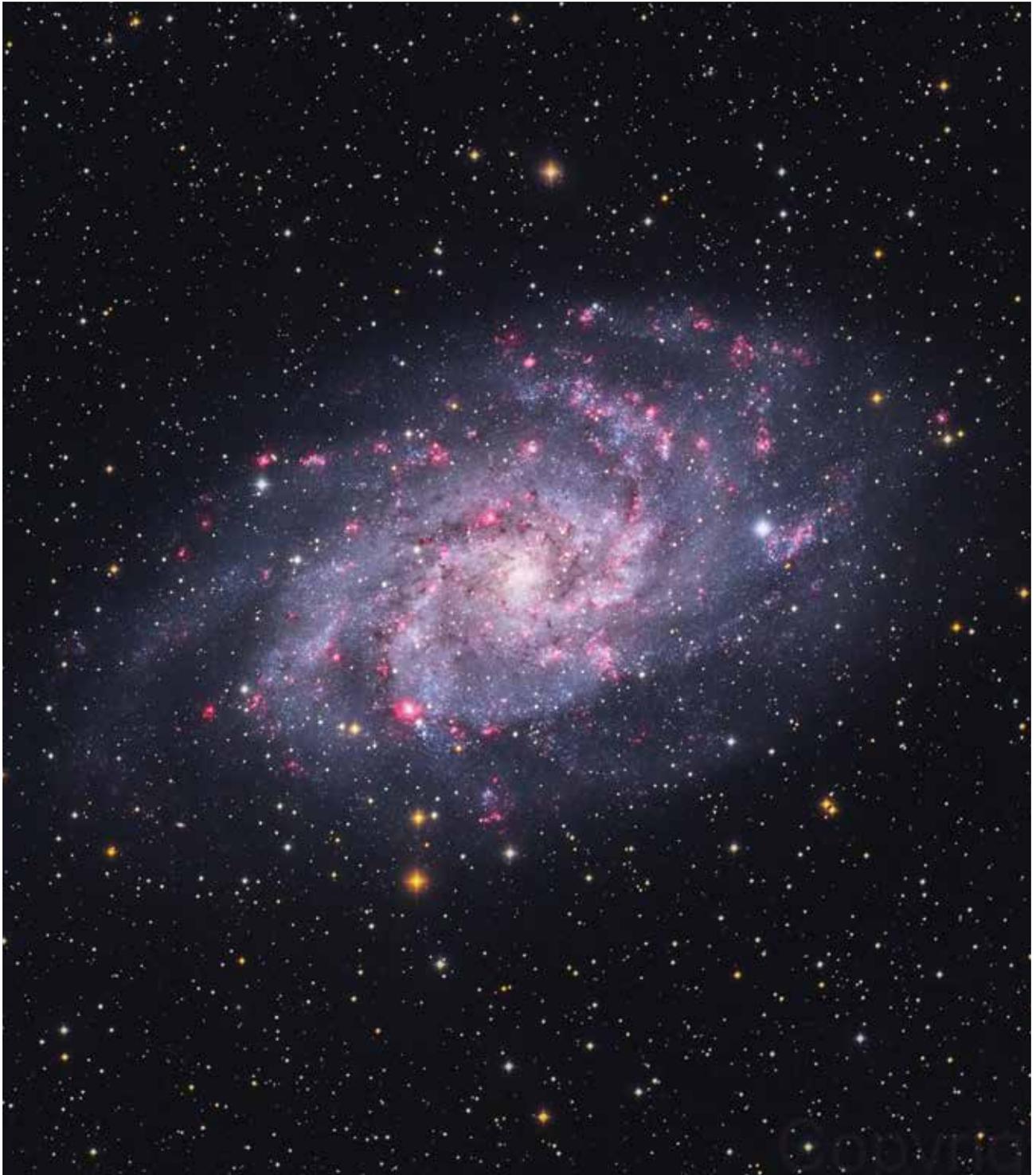


Fig 3: Galaxy M33-Hydrogen cloud. Empowering stellar nurseries and formation of Stars

Chlorine Dioxide Dosing System as an alternate technology for replacement of conventional Chlorination Plants

Abstract:

In the field of microbiocides, chlorine dioxide is emerging as an alternative to hazardous chlorine. This article deals with its effectiveness in water cooling systems.



Sudhansu Sekhar Mandal
Advisor (Chemical), WBPDCCL

The author is MSc in Physical Chemistry & M. Tech in Cryogenic Engg. from IIT, KGP. Joined NTPC in 1983 and served chemical departments at different NTPC stations upto 500 MW capacity. Superannuated as GM (Chem) from Vindhyachal thermal power plant - the country's largest. Recipient of 2nd best ET award.

The use of chlorine as a microbiocide for industrial cooling systems is declining because of safety, environmental & community impact considerations. Various alternatives have been explored, including bleach, bleach with bromine, non oxidizing biocides, ozone & chlorine dioxide among others. Out of these, chlorine dioxide has some unique advantages, due to its selectivity, effectiveness over wide pH range & speed of killing of algae, fungus, excellent bio-film removal & rapid penetration capacity on bio-film removal. This paper reviews the chemistry of chlorine dioxide & its use in cooling systems. In this paper comparisons have been made with conventional chlorine dosing.

Chlorine is the traditional chemical disinfectant of choice in drinking water, cooling tower water, industrial water treatments used since the early to inactivate or chemically kill microorganisms in the water. Chlorine provides a degree of public health reliability in the water safety, which regulatory officials cannot easily replace. However, certain chlorinated, brominated, and poly-substituted organic compounds result from the interaction of chlorine with natural organic matter in raw water. Some of these compounds have been linked with potential long-term effects. Permissible levels of some of these halogenated organic byproducts are currently in the process of being reviewed and will likely be reduced due to potential long-term health effects observed in animal studies. Should the disinfection of water be changed without caution, or simply abandoned, the microbial related risk of becoming sick from use inadequately disinfected water is much greater, quantitatively estimated to be thousands, if not more, times higher than the chemical risks. As ClO_2 does not form these halogenated byproducts when it reacts with the same precursors, it is possible to produce microbiologically safe water that has been chemically disinfected without encountering the high cost of ozone or causing the production of the chlorine-related disinfection by-products (DBPs) result from chemical reactions between organic and inorganic matter in water with chemical treatment agents during the water disinfection process.

Criteria for Ideal Biocide

What criteria would be expected for an "Ideal Biocide?" These criteria are summarized into four basic categories:

Performance: It must exhibit rapid kill of target organisms & able to keep systems clean of biofilms; ideally it should be able to clean up already fouled

systems. It should not be consumed by materials commonly encountered in cooling systems e.g., hydrocarbon, wood, plastic or other treatment chemicals. Finally it must be effective over a wide range of operating conditions.

Environment: Side or byproduct reactions should be minimized and reaction products should be environmentally friendly; neither it, its byproducts, nor its reaction products should persist in the environment .

Safety: It must be safe & easy to handle.

Economics: It must be affordable.

Chlorine & its hazards

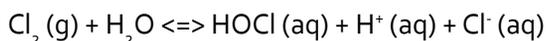
Chlorine is a strong smelling, greenish-yellow gas with pungent odour which is extremely irritating to mucous membranes.

Other Properties Of Chlorine:

- Hazardous
- Heavier than air
- Strong oxidizer
- Low capital requirements
- Produces chlorinated byproducts
- Efficacy - pH dependent

Chemistry of Chlorine:

- **Reactions for free chlorine formation:**



Hypochlorous acid dissociates to produce the hypochlorite ion

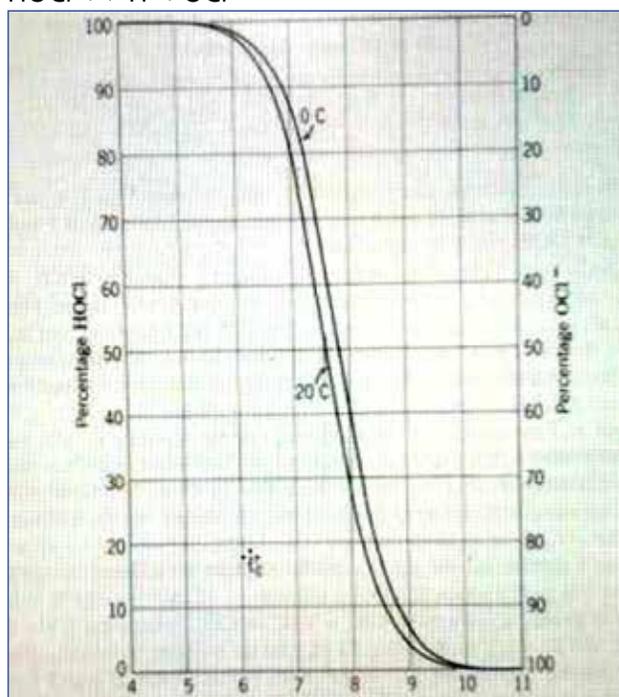
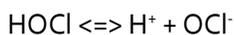


Fig 1: Efficacy of chlorine in water at different pH & temperature

The extent to which these reactions occur and therefore the proportions of HOCl and OCl⁻ in solution, is a function of pH and temperature. At low pH (more acidic), hypochlorous acid dominates while at high pH the hypochlorite ion dominates. Hypochlorous acid is a much stronger oxidant than the hypochlorite ion, and thus disinfection is more effective at neutral to acidic pH than at alkaline pH (typically pH-8.5 to 9.0 CW system in Power plant). See fig :1.

Effect of pH on Percentages of HOCl and OCl⁻ :

A typical chlorination System



Fig 2: Conventional Chlorine dosing system

- Chlorine is a toxic gas and hence storage and handling of chlorine poses severe risk to EHS
 - Chlorine leaks/spills affect large area
 - High levels in air can be fatal.
- Effect of chlorine with different concentration in air is depicted below:
- Chlorine reacts with organics to produce

Concentration of Cl ₂ gas in air	Effect on Exposure
0.06 ppm	Odour threshold
1-3 ppm	Can be recognized by nose and preventive action should be taken immediately
3.0 ppm	Irritation of eyes & mucus membrane
15 ppm	Immediate irritation of throat
50 ppm	A dangerous health hazard, even for a short period of time. Prolonged exposure may result in death
1000 ppm	Potentially fatal after a short exposure

Trihalomethanes (THM) which are known carcinogens.

- Chlorine does not have the ability to penetrate and remove biofilms.

The best alternative to Chlorine is now available:

The alternate disinfectant chemical is Chlorine dioxide which is most effective and safe for microbiological control of water. Unlike chlorine it works as strong biocide over a wide pH range. Chlorine dioxide does not dissociate in water, remains as true gas & disinfection occur by oxidation.

Properties Of Chlorine Dioxide:

Physical properties:

- Color: Yellow-green
- State: Gas
- Odour: Similar to chlorine
- Solubility: 2.9 gm/L
- Rapidly act on biofilms, lower contact time for microbiological kill compared to chlorine;
- Less corrosive compared to chlorine;
- Does not hydrolyze to form acid;
- Does not react to form chloramines;
- Does not form Trihalomethanes(THM) with organic matter like chlorine;
- Does not produce any chlorinated compounds;

Chlorine Dioxide Generation & Dosing Method

Chlorine dioxide can be generated by either reaction of sodium chlorite with chlorine or by reaction of hydrochloric acid & sodium chlorite. Here the second reaction commonly called as Acid-chlorite method will be discussed. The input chemicals are:

- Hydrochloric acid 31% - 33%;
- Sodium chlorite 25% - 31%;

The chemical reaction:



Comparison of Chlorine dioxide and Chlorine

PROS:

- Substantially lower dosing rate to achieve the same grade of water disinfection
 - o Typical ClO_2 dose ~ 0.25 - 1.0 ppm
 - o Typical Cl_2 dose ~ 1.5 - 3.0 ppm (continuous and shock)

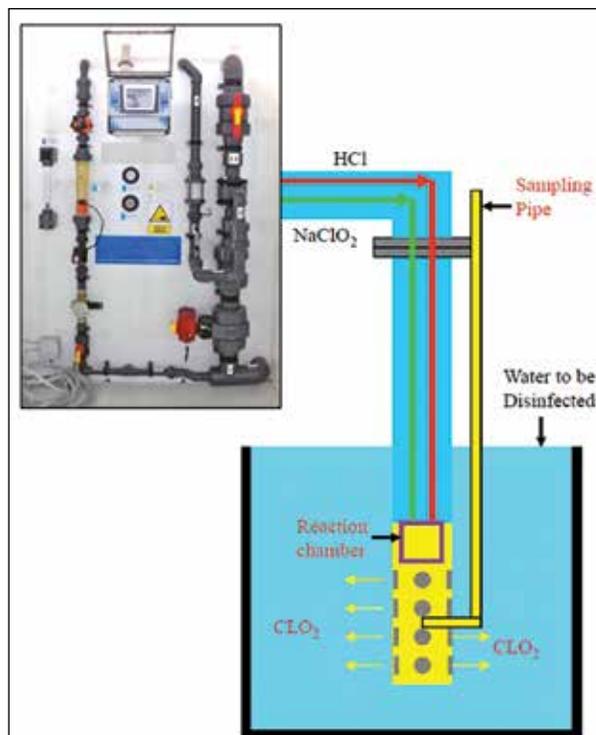


Fig 3: Submerged Chlorine dioxide Generation System



Fig 4: Chlorine dioxide Generation Plant with Encapsulated Generators



Fig 5: Chlorine dioxide dosing in Cooling Water

- No toxic byproducts like Trihalomethanes (THMs), Haloacetic acids (HAAs), chlorophenols or other non-removable organic halogens formed in water
- Effectiveness over a wide pH range of water specially suitable for CW system operating in alkaline range of 8.5 -9.0 pH

(effectiveness of Cl_2 reduces at $\text{pH} > 7$).
(Fig :3)

- Less Footprint requirement compared to Gas chlorination plant handling of large number of Cl_2 tonners eliminated.
- Unlike Chlorine as it is being generated On-site so no storage license is required.

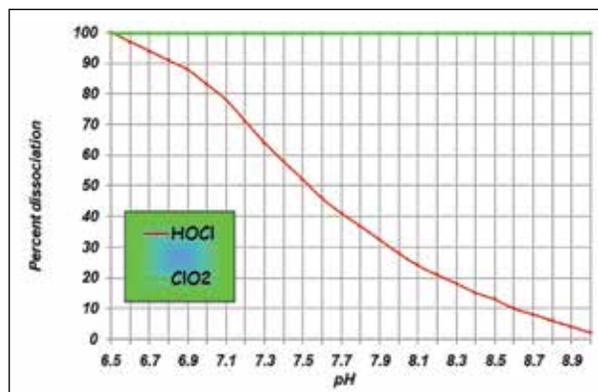


Fig 6: Comparison of Efficacy of Chlorine & Chlorine dioxide with pH of water

Cons:

- Chlorine dioxide is never stored, transported or used as a gas because it is explosive under pressure;
- It is produced on-site as a solution on demand;
- Controlled methods of generation under water;
- High operating cost due to high cost of NaClO_2 chemical

Effectiveness on Biofilms Control / Removal

The chlorine dioxide has a superior role over

Acknowledgements

The author is thankful to Sri Subhasis Ghosh, Director (O&M) WBPDC, Sri Goutam Biswas, ED(OS) WBPDC & MD DPL for their encouragement & motivations in bringing out the article. Last but not the least my special thanks to team WBPDC for giving me the opportunity to publish the article in this professional journal.

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- 1) Technical journals on Power Plant Chemistry
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- 3) Chemical Engineers' Handbook – R H Perry
- 4) NTPC's guidelines in phasing out of conventional chlorination plant

chlorine gas of disinfection requirements of an open recirculating industrial cooling system in removal or minimization of any biofilms, which retards heat transfer, causes biofouling.

Conclusion:

Till now Chlorine is being much used as a water disinfectant chemical to control microbiological growth both in industry & portable water treatment purpose due to low cost of operation, but risks involved with respect to hazards in transportation, storing & handling are much higher. User of chlorine must have proper safety compliance to mitigate the chlorine leakage, have offsite & onsite emergency disaster management plan depending on the storage capacity & also have to comply statutory environmental regulations. Additionally efficacy of chlorine is pH dependent & reacts with organic present in water with the formation of THM & HAA which are carcinogenic compound.

Unlike Chlorine, chlorine dioxide has many unique advantages like very fast rate of disinfection, excellent control of Bio-films, non reactive with organics (no THM or HAA), non reactive with ammonia, disinfection less dependent on pH, safer handling, effective at low dosage rate, slow bacterial recovery after disinfection.

Safety in any industry is an area that always needs attention and continuous improvement. Considering the above factors and also because of safety hazards & environmental regulations restricting the use of chlorine, chlorine di-oxide is found to be technically acceptable and also commercially can be a viable substitute for Gas Chlorination Plant.

Optimisation of MTTR of 300 MW Turbine by removing its defective fourth stage of LPT at unit #1, SgTPP

Abstract:

During capital overhauling, severe damage was observed at 4th stage of LP turbine at unit #1 of SgTPP with 300 MW capacity. A set of systematic and calculated decisions were taken to minimize downtime. The major decision was to run the turbine eliminating the damaged 4th stage LPT.



Manoj Debnath

Senior Manager (PS), Turbine

SgTPP, WBPDCCL

Joined WBPDCCL in 2004. Served Mechanical Operation and Turbine Maintenance Dept. at KTPS & SgTPP.

Introduction:

Power is the basic need and key driver for economic growth and poverty alleviation as per capita energy consumption as an index for standard of living. In India, the important challenge is that the supply of electricity should be reliable with quality and available at affordable price. One of the major contributors of power in the State of West Bengal is West Bengal Power Development Corporation Ltd. Sagardighi Thermal Power Project is the highest generating unit under WBPDCCL. Presently it is installed with 300x2 MW DEC make turbine at phase-I and 500x2 MW BHEL make turbine at phase-II and installation of another 660x1 MW BHEL make turbine is under erection process at phase-III.

For smooth and trouble free running of machine and uninterrupted power supply, major overhaul of machine at some intervals is required. Unit#1, 300 MW DEC make turbine, was planned for capital overhauling in the month of Sep-Oct, 2021. It was the first capital overhauling of the main turbine since commissioning (COD on 06.11.2008). Accordingly M/S. GE Power was awarded service order to perform the same. There is a combined HP & IP rotor (say HIP rotor) mounted on the same shaft and a double flow (6x2 stages) LP rotor installed in the main turbine.

MAJOR FINDINGS AND CORRECTIVE ACTIONS

Findings on HIP turbine & corrective actions:

1. All bolts & nuts found severely seized in HPCV-1&2 steam admission pipeline flanges. Hence removal of bolts needed damaging of all related fasteners and replaced by new ones. Most of the fasteners of inner casing, gland housing, and diaphragm carrier were severely seized and got damaged during removal and replaced by new ones.



Fig 1: Damaged fasteners

- In between inner and outer bottom casing, accumulation of huge foreign materials found through borescope probe. Hence, the inner bottom casing was lifted and foreign materials were cleaned thoroughly. Some dent marks were also observed on IP 1st stage moving blades but no repair work was performed on it and left as it was.



Fig 2: IP first stage moving blade dent mark

- Severe cutting observed in the trailing edge at most of the guide vanes on IP 1st stage diaphragm.



Fig 3: Cutting of IP 1st stage diaphragm blades

M/S. GE Power performed repairing work through metal build up by TIG welding with a special electrode suitable to parent metal of diaphragm followed by grinding & polishing of vanes.



Fig 4: IP first stage diaphragm guide vane after repair

FINDINGS ON LP TURBINE & CORRECTIVE ACTIONS:

Initially on opening of LP turbine, one major crack was found on one shroud at LP rotor 4th stage (Generator side) on visual inspection and it was decided to replace the same through re-riveting of tenon through special fox-holing solution proposed by M/S. GE Power.



Fig 5: Crack at LP rotor 4th stage shroud

After performing alumina blasting & coil MPI some other cracks were also found :: (I) Crack on one shroud, one blade root at 4th stage blade and on one lacing wire at 6th stage on turbine side (II) Crack on another shroud and two blade roots at 4th stage on generator side. M/S. GE Power was asked to repair the same and accordingly they started deblading job as required.



Fig 6: 4th stage blade root crack

During deblading job, some more cracks were found in other blades also which didn't reflect on the MPI report.



Fig 7: Crack on lacing wire at 6th stage



Fig 8: Broken blades

After deblading job, yoke MPI performed on the bare disc portion and several cracks were found there. It was then decided, consulting with M/S. Dongfang Electric Corporation, the OEM, complete deblading at both stages and machining of disc up to crack depth will be done. The machine will be run without 4th stage moving blades on both sides as repair of disc & fitment of new blades would have required another one year or so which would have resulted in huge generation loss.



Fig 9: Visually detectable crack on disc

Accordingly, M/S. Gangotri Turbo Tech Pvt. Ltd. was communicated to perform machining of disc. Machining was done on both side discs with a portable lathe machine (arranged by the party) keeping the LP rotor on a slow speed balancing machine.



Fig 10: Unmachined disc

M/S. Dongfang Electric Corporation, the OEM of the machine, suggested going for slow speed balancing of rotor after disc machining. But it was decided internally that slow speed balancing will not be performed. If any vibration during rolling of machine appears due to unbalance that will be taken care of by trim balancing.

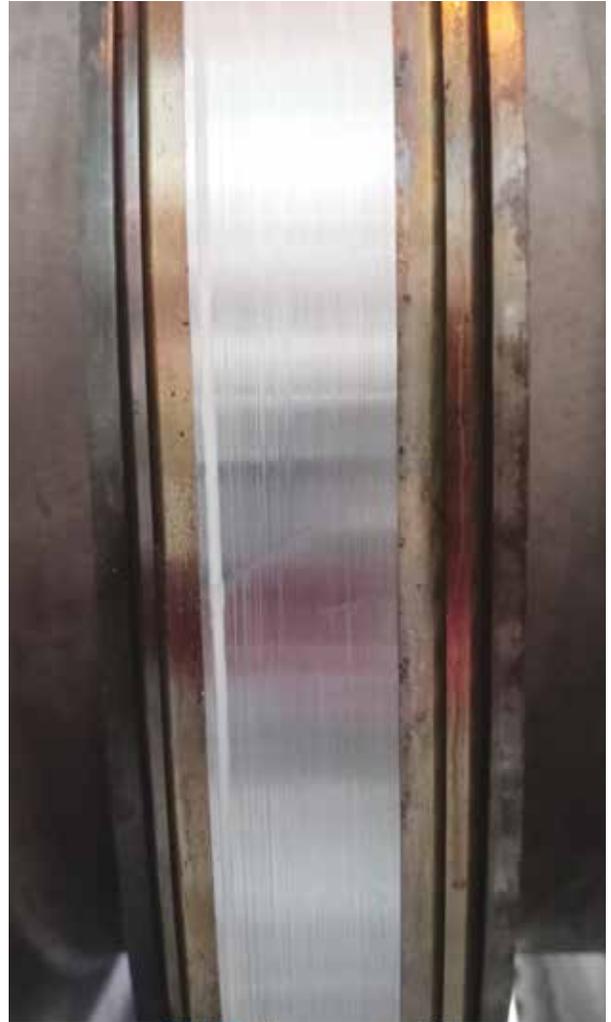


Fig 11: Machined disc

The OEM was also asked whether to keep diaphragms (fixed blades) of corresponding stages and they suggested keeping those. As a stage consists of a combination of fixed & moving blades, keeping fixed blades without the presence of moving blades will lead to increased steam velocity (due to passing through two consecutive stages of fixed blades without moving blades in between) with improper inlet velocity angle along with abnormal turbulence at the entry to 5th stage. This in turn will affect the performance (vibration/erosion/reduction of efficiency) of the LP turbine. Hence it was decided internally that the machine will be boxed-up keeping diaphragms of corresponding stages left out.

SUMMARY:

No abnormal vibration at any stage during rolling of the machine was noticed and the machine was finally synchronized and now running with full load with no such abnormal parameter.

FUTURE WORK:

It is planned to replace LP Rotor with a new one at the earliest opportunity and procurement process for the same is under process.



Fig 12: Box up of LP rotor without 4th stg moving & fixed blades (both side)

ACKNOWLEDGEMENT:

The whole endeavour and success was achieved by following team members:

Shri Kausik Datta, GM, SgTPP, WBPDCI
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Shri Jyoti Sankar Poddar, DGM (MM), SgTPP, WBPDCI
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Shri Manoj Debnath, Sr. Manager (TM), SgTPP, WBPDCI
Shri Pronab Guha, Sr. Manager (TM), SgTPP, WBPDCI
Shri Hiranmoy Palui, Sr. Manager (TM), BTPS, WBPDCI
Md. Kamaluddin, Manager (TM), SgTPP, WBPDCI
Shri Samir Sarkar, Manager (TM), SgTPP, WBPDCI
Shri Madhab Chandra Ghosh, Manager (TM), SgTPP, WBPDCI
Special thanks to Shri Abhijit Banerjee, Site lead, GE Power India Ltd.

Survival of units during Grid Collapse: The experience of implementing Islanding Scheme at BkTPP

Abstract:

During a major fault in a grid, cascade tripping of its generating stations occurs and may lead to total collapse of the grid. For survival of the grid, an Islanding scheme helps in survival of the generating stations with some radial loads which may play a crucial role towards quick restoration of grid. Experience of implementation of Islanding scheme at BkTPP is briefed here.



Sanjib Pal

Sr. Manager (C&I), BkTPP, WBPDCCL

Joined WBPDCCL in 1994. Served at C&I Department of KTPS and BkTPP.

Prologue:

Two consecutive severe Grid Disturbances occurred on 30th and 31st July 2012. The severity of the Grid disturbance of 31st July 2012 triggered Failure across the whole Eastern Grid and Northern Grid except some local zones, which could isolate themselves during that time.

The enquiry committee set up by Ministry of Power, Govt. of India recommended to “design islanding scheme based on frequency sensing relay so that in case of imminent grid failure, electrical islanding can be formed. These electrical islands can not only help in maintaining supply to essential services but would also help in faster restoration of the grid”.

Subsequently major decisions were taken in the 14th PCC meeting (held on 21/11/2012) and 81st OCC meeting (held on 18/01/2013) towards implementation of the proposed Islanding Schemes at different thermal power plants. Bakreswar Thermal Power Plant was selected as one of the major thermal power plants where the said islanding scheme would be implemented.

Scheme in brief:

The Islanding concept is to isolate the system from rest of the electrical grid with some isolated electrical load i.e. the Generators will be islanded with some radial feeder acting as house load.

At BkTPP, Gokarna (220KV Double Ckt.) & Satgachia (220KV Double Ckt.) are decided to act as radial feeders. Therefore in case of grid disturbance (sensed by drop in frequency) the generators will be isolated from the system by tripping all the feeders except radial feeders. After immediate tripping of these feeders there will be a mismatch between generation & load which is compensated by tripping of generators or by fast opening of HP/LP Bypass system first & then residual mismatch will be taken care by Turbine droop. The detail logic is described hereunder.

System Description:

The detail network diagram of BkTPP system is shown in Fig 1. The feeders Arambagh (400 KV single Ckt.), Jeerat (400 KV single Ckt.) & Bidhannagar (200 KV Double Ckt.) will be tripped during disturbance. After Islanding the generated power will be evacuated through dedicated radial feeders Satgachia (Max load: 333 MW and Min load 155 MW) and Gokarna (Max load: 382 MW and Min load 179 MW). So, during peak load time, the proposed islanding load would be

around 715 MW and during Off-peak load, it would be 334 MW.

During Islanding operation, Satgachia and Gokarna would remain in Radial mode and the

necessary isolation for this radial operation to be done through under-frequency relays placed at other end of the substations i.e. feeders from other generating stations to these substations will be isolated.

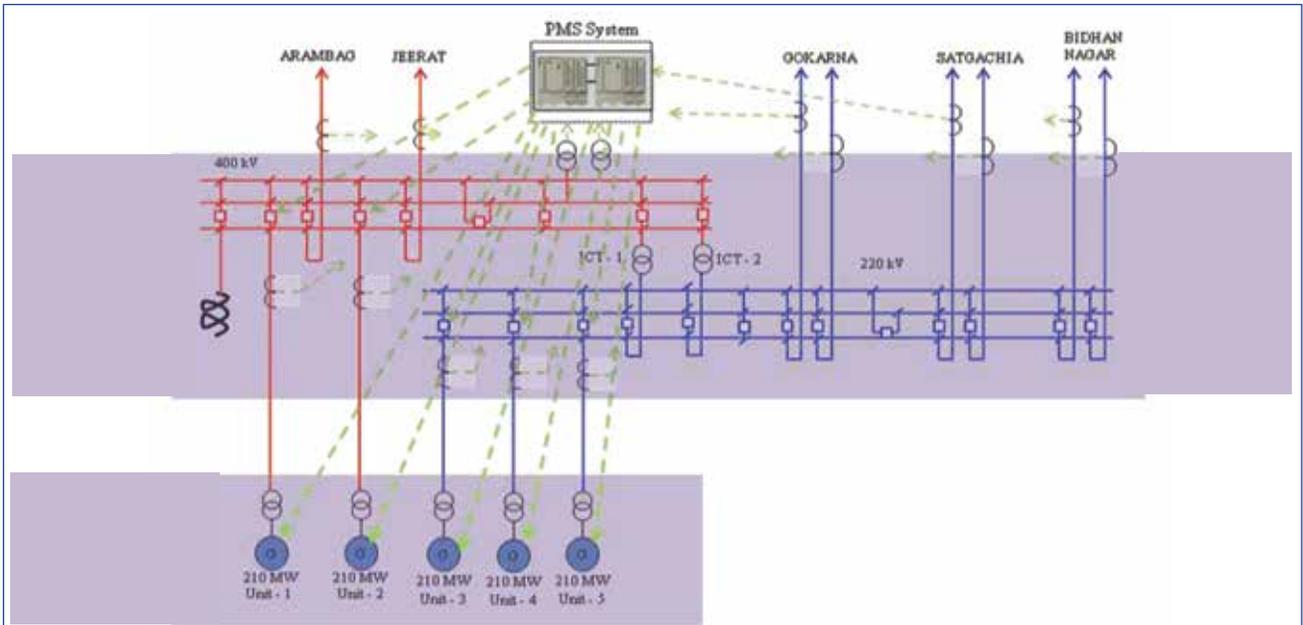


Fig 1: Detail network diagram of BkTPP system

The Islanding frequency, which is the most critical parameter for triggering the Grid Islanding phenomenon, was decided to be fixed at 47.7 Hz. In the grid network, the Satgachia and Gokarna Feeders are not perfectly radial feeders for BkTPP. Sagardighi TPS and Bandel TPS are connected to Gokarna and Satgachia feeders respectively and so it became necessary to disconnect these two feeders at a certain frequency (higher than 47.7 Hz.) so that the actual Power Calculation can be done properly at BkTPP end for these two feeders when Islanding is to be triggered. The frequency at which all other generating stations are to be

disconnected from these two feeders was fixed at 47.9 Hz. (with 250 msec time delay). The Islanding condition trigger can also be initiated from the Rate of Change of Frequency. In such case if the rate of change of frequency (df/dt) is high ($>=0.5$ Hz. per Sec), the arming of the frequency count will start from 48.5 Hz. and if the rate continues to remain like this, the Islanding will happen at 47.7 Hz. without any time delay. This logic is currently kept under Alarm mode only for observation purpose. The general architecture of the scheme implemented at Bakreswar Thermal Power Plant is given in Fig 2.

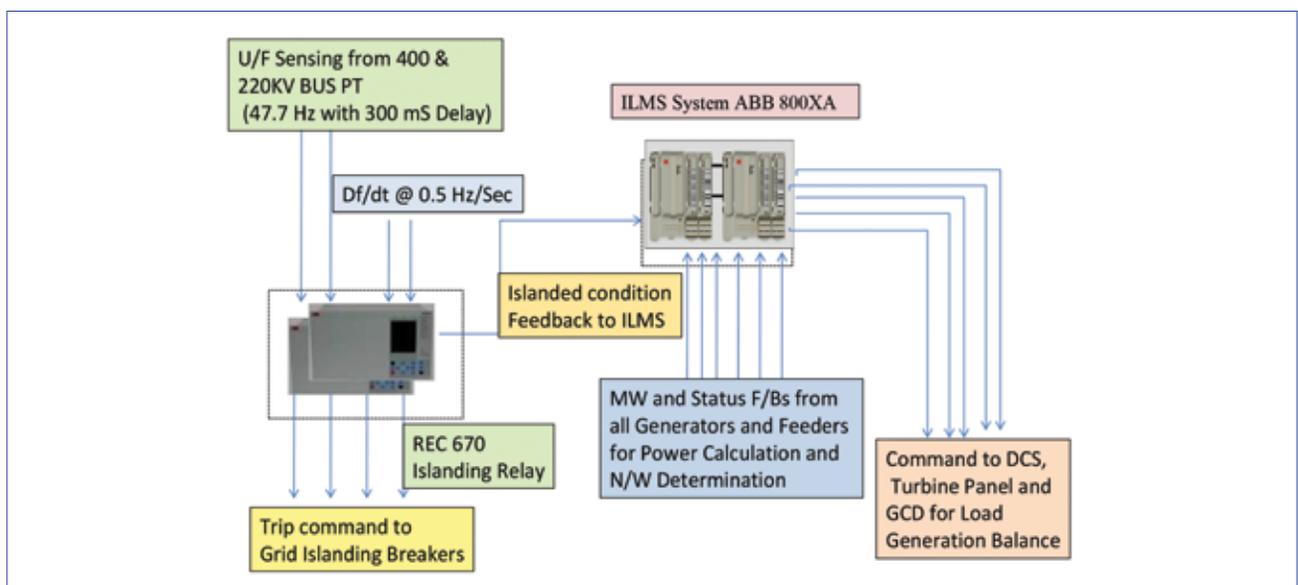


Fig 2: BkTPP Islanding Scheme general architecture

From the scheme it can be understood that the Islanding relays (Relay model REC 670), installed at BkTPP Grid Control Room will sense the underfrequency and also df/dt of the 400 KV MB₁, MB₂ and 220KV MB₁, MB₂. In case the underfrequency reaches the values as mentioned above, they will initiate Trip Command to the Grid Islanding Breakers (Arambagh and Jeerat) from Relay 1 and Bidhannagar 1, 2 from Relay 2. After getting the open feedback from these grid islanding breakers, the relays will issue one Islanded status feedback to the PLC (Model ABB 88XA). This PLC will perform the job of Load Generation Balance by putting all the EHG's (Electro Hydraulic Governors) connected Generators (Turbines) into Power Control Droop Mode and shedding the excess generation (if any) as per the prescribed logic. In

case the ensuing total load upon BkTPP during that very instance remains at higher side than the total generation of BkTPP, then it will be very difficult to control the already downward frequency by increasing generation instantaneously. This will open up the Turbine control valves but it may lead to boiler starvation. To take care of this situation, under-frequency relays are installed at the Satgachia and Gokarna end to shed part of the ensuing load in two stages so that the total load becomes somewhat less than the total generation at Bakreswar end. The underfrequency settings at which these loads are to be shed is decided at two levels, 47.6 Hz. (with 500 msec time delay) and 47.5 Hz. (with 750 msec time delay).

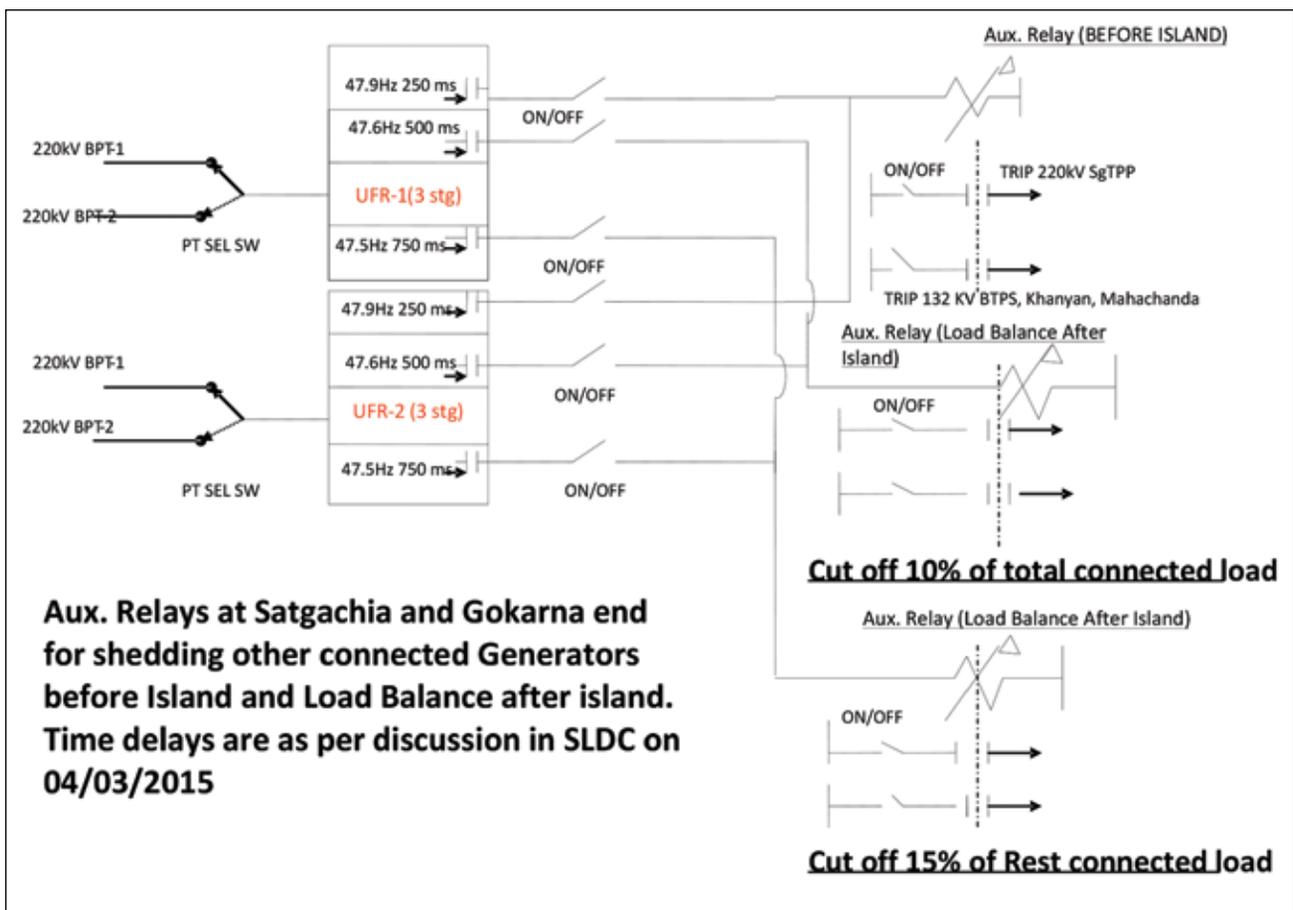


Fig 3: U/F Scheme implemented at Gokarna & Satgachia S/S (WBSETCL)

Generation Shedding:

At 47.7 Hz. frequency (with 300 ms Time delay) all other feeders except Satgachia and Gokarna are to be tripped (400 KV Arambagh, 400 KV Jeerat and 220 KV Bidhannagar 1 and 2).

After this tripping the residual load will be the summation of the load in Satgachia and Gokarna double circuit feeders with station load and the load in some other circuits which are connected from 33 KV side of BkTPP

(Dubrajpur and Suri circuit).

Now at this very moment the generation will be at higher side than the load & generation shedding will occur as per following logic. This shedding logic has been considered keeping two conditions under consideration:

- When two IBTs are in service and
- When only one IBT in service

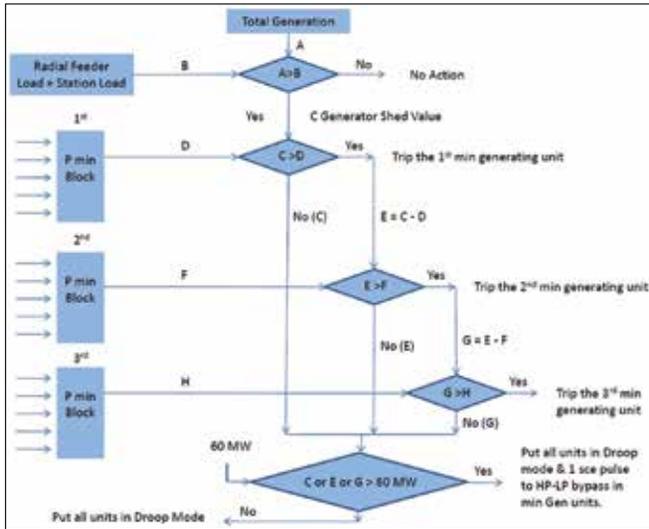


Fig 4: Generator Shedding Flowchart (When both IBTs in service)

When Both IBT in service (Table 1):

Generation shedding will occur with least generating unit getting first tripping priority. If the mismatch is > 60 MW but $<$ the GT output of least generating unit---Only HB Bypass of that unit will get fast opened.

If Mismatch is $>$ the GT output of least generating unit---That GT will be tripped.

Again after tripping of that GT, if the remaining mismatch is still > 60 MW but $<$ the O/p of next priority unit----HP Bypass of that unit will be opened. The flow chart of Generator shedding priority is given in Fig 4. It may be noted that this flowchart is applicable only when both the IBTs are in service. When only one IBT in service, then the logic is given separately.

Equipment Tag	Generation shedding (MW)	Priority
Generator 1	133.81	8
Generator 1 HPLP	60.00	7
Generator 2	138.36	10
Generator 2 HPLP	60.00	9
Generator 3	130.05	6
Generator 3 HPLP	60.00	5
Generator 4	120.44	2
Generator 4 HPLP	60.00	1
Generator 5	128.66	4
Generator 5 HPLP	60.00	3

Table 1: Auto Priority Table (when both IBTs in service)

Equipment Tag	Generation shedding (MW)	Priority
Generator 1	133.27	2
Generator 1 HPLP	60.00	1
Generator 2	138.36	4
Generator 2 HPLP	60.00	3
Generator 3	129.73	10
Generator 3 HPLP	60.00	9
Generator 4	119.27	6
Generator 4 HPLP	60.00	5
Generator 5	128.36	8
Generator 5 HPLP	60.00	7

Table 2: Auto Priority Table (when one IBT in service)

When any one IBT in service (Table 2):

In this case the excess generation will be shed through UNIT 1 & 2 first i.e. among Unit 1 & 2 the least generating unit will get first priority of tripping and then the next one. After tripping of both the UNIT 1 & 2, again the priority will be decided among Unit 3, 4 & 5 based on the same logic. The screenshot for priority tripping selection for single IBT given hereunder.

After generation shedding & HPLP bypass opening in both the above mentioned cases & when the

mismatch lies below 60 MW, all the survival Units will be put under EHG Man with Droop mode active to bring down the frequency near to 50 Hz.

Simplified Network Architecture of CILMS System

The Simplified Network Architecture of BkTPP CILMS (Composite Islanding Load Management System) is shown here. The communication is TCP-IP based and the dual redundant network (Net A & Net B) consisted of both CAT 5e (shown

as solid lines) & Fibre Optic lines (shown as dotted lines).

The PLC consists of AC 800M controllers & its associated Input Output cards. Two Nos. AC 800M controllers are functioning as hot redundant to each other. Normally primary controller is in

service and control change over will occur in case of failure of Primary controller. The IOs are placed as local IOs (placed at GCR) & remote IOs (placed at UCR #4). The controller accesses the IOs through FO cables (shown as Blue dotted line). The IP addresses of the controllers are 172.16.80.101 (NET-A) & 172.17.80.101 (NET-B).

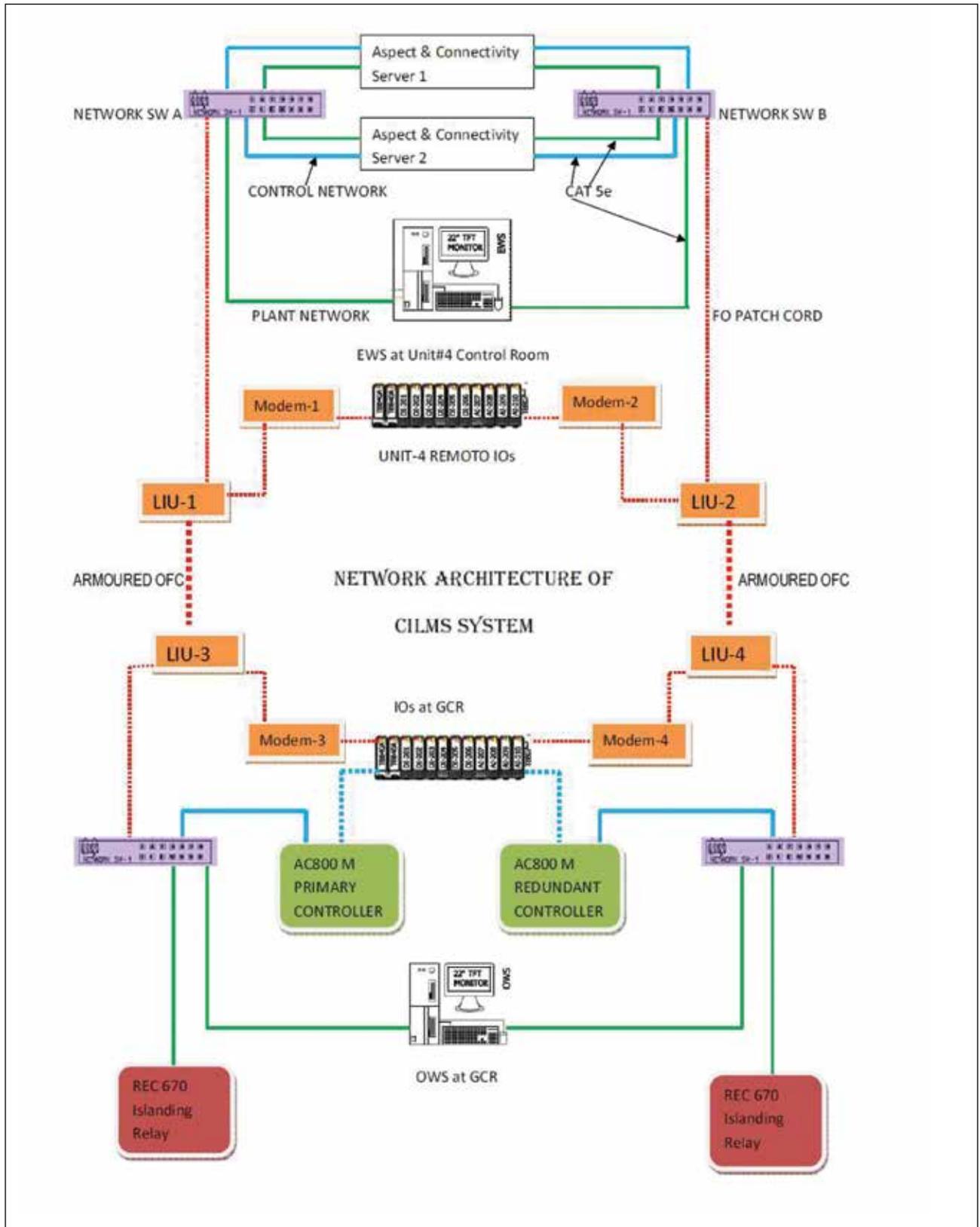


Fig 5: Simplified Network Architecture for the CILMS System

Two Aspect & Connectivity Servers (ACS1 & ACS2) are there for communication with Controllers & HMI interface with Work Stations. These servers fetch data from the controllers through CONTROL NETWORK (Blue Lines).

Control Net IPs for ACS1 172.16.80.11 & 172.17.80.11

Control Net IPs for ACS2 172.16.80.12 & 172.17.80.12

ACS1 & ACS2 share these data with the workstations through PLANT NETWORK (Green Lines).

Plant Net IPs for ACS1 172.16.4.11 & 172.17.4.11

Plant Net IPs for ACS2 172.16.4.12 & 172.17.4.12

As the UCR#4 is far away from GCR, communication done between controllers & servers done through Fibre Optic cable (shown as Red Dotted Lines). Engineering workstation(EWS) placed at UCR-4 & Operating Workstation (OWS) placed at GCR. Both the EWS & OWS has dual redundant network for communication with controllers through Plant Network.

Plant Net IP Addresses of EWS 172.16.4.101 & 172.17.4.101

Plant Net IP Addresses of OWS 172.16.4.95 & 172.17.4.95

Interface of the CILMS System with Electro Hydraulic Governor and HP/LP Bypass System

For Load Generation balancing, there may be a requirement of tripping some of the generators. But there will also be a requirement to put all the running / connected Turbo generators in the Power Control Droop mode. The HP/LP Bypass system of

the connected generators may also require to be opened (as shown in the flowchart). The interface between the CILMS System and Turbine governing system is shown in the following diagram:

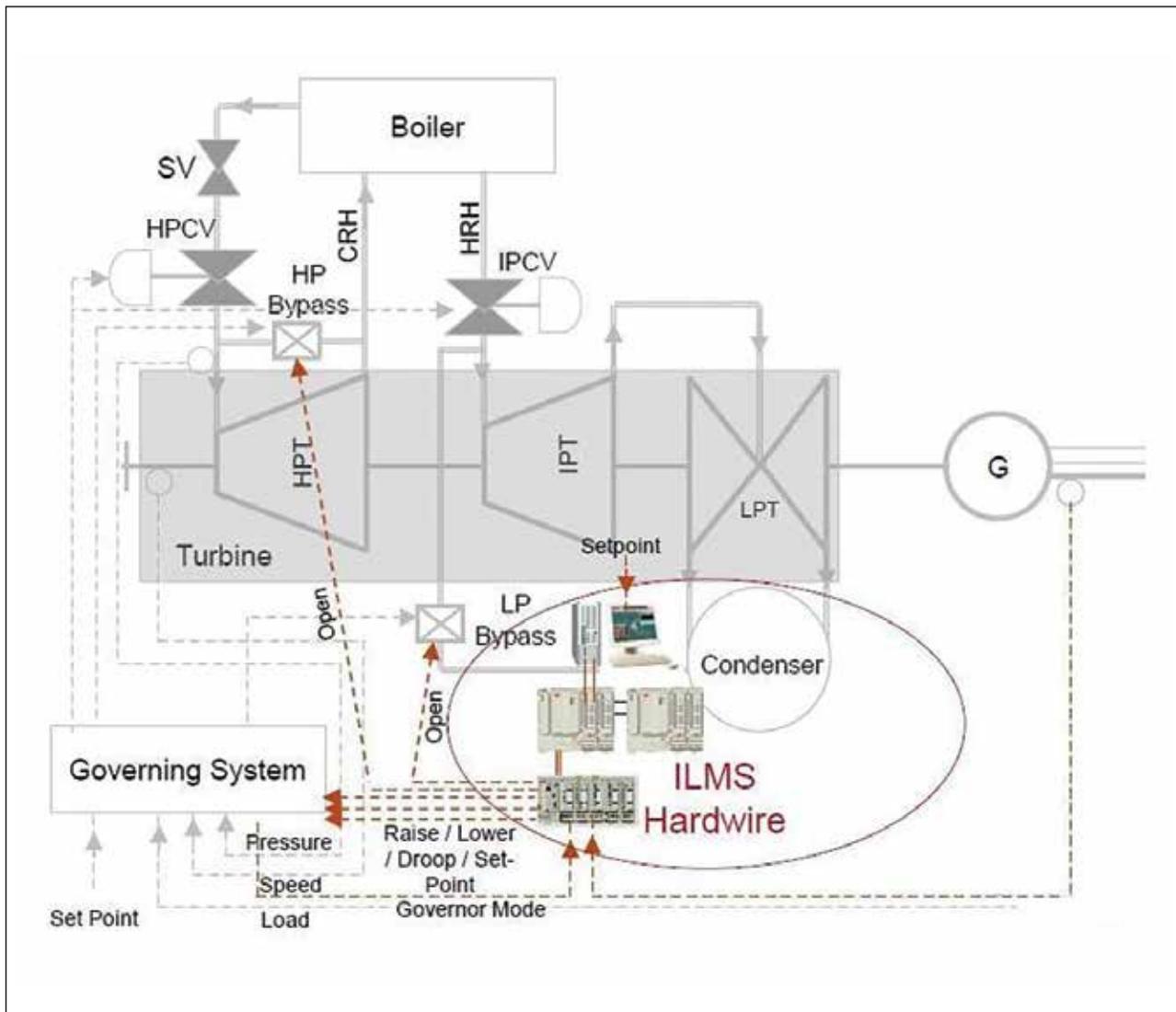
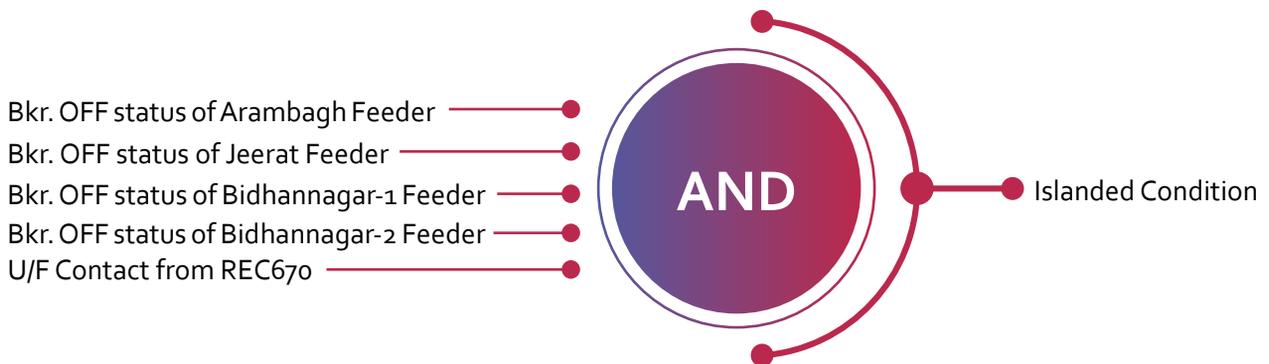


Fig 6: ILMS Interface with Governing System

Modification of EHG Logic in Islanding Condition:

First of all the EHG has to get the feedback of the "Islanded condition" signal which is generated at PMS panel as per below mentioned logic.



As mentioned in system description, REC670 relays sense the under-frequency at the respective bus & trip the designated Feeders. It also provides the U/F contact to the PMS system (PLC). On the other side at PMS the Islanded condition generated when it gets OFF status of all the designated Feeders along with the U/F signal. It is a logical 'AND' operation with the five inputs as mentioned above.

This generated Islanded condition or Isolated mode signal goes to EHG panel. Then the EHG's of the surviving units go to Power Control with Droop mode provided the unit load is greater than 40% of rated.

In normal running condition, EHG can be put under auto or man mode, and can be acted as power/pressure controller depending on the various mode selections. But the EHG droop can be active only when EHG acts as Power Controller.

In this case, as soon as the EHG get the "Islanded condition" feedback from PMS panel, the EHG changes to Man mode with power controller & Droop active. This change occurs irrespective of any earlier operating mode like Pressure Controller or Power Controller. This Droop is somewhat different from existing EHG Droop because in islanding condition the activated Droop has no dead band like normal Droop characteristic.

After stabilization of the islanded system one also can increase / decrease the load of any surviving unit from the PMS Workstations located at UNIT4 & GCR. For this operation one AFC Permissive signal need to be generated from EHG panel itself, which in turn goes to PMS panel & used as permissive signal for load change from PMS workstation. In this condition, the EHG Power Setter Raise/Lower command of the units can be issued from the ILMS Workstation.

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7. Sri Kaushik Katari, Sr. Manager (PS), KTPS
8. Sri Chandan Banerjee, Sr. Manager (PS), SgTPP

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2. POWER GRID RESTORATION OPTIMIZATION CONSIDERING GENERATING PLANT ISLANDING SCHEME By Joyesh J Joglekar & Y P Nerkar

Major models of Flue Gas Desulphurization System for SO_x Control

Abstract:

De-sulphurisation of flue gas is a major challenge for thermal power stations. This article summarises different available technologies in this field.



Sanchari Deb

Manager (PS), Project & Planning Dept,
Corporate Office, WBPDC

Joined WBPDC in 2007. Served
at R&I Department, KTPS; OS Cell,
Corporate and presently at Project
and Planning Department, Corporate.

Preamble:

The thermal power plant emissions have both local and global impact. Combustion of coal in Conventional boiler results in generation of harmful gases like SO_x. Coal with 0.5 % Sulphur, generates SO₂ of range 1800 - 2200 mg/Nm³. SO_x emission results in acid rain, affect human health and corrode buildings and structures.

On December 7, 2015, the Ministry of Environment, Forest and Climate Change (MoEF & CC) introduced stringent environmental standards for coal-based TPPs under the Environment (Protection) Act, 1986.

New Environmental Norms, December 2015:

Date of Installation of Thermal Power plant	Capacity of Power plant	Maximum Permissible SO ₂ Emission level
Before December 2003	< 500MW	600mg/Nm ³
	>= 500MW	200mg/ Nm ³
January 2004 to December 2016	< 500MW	600mg/ Nm ³
	>= 500MW	200mg/ Nm ³
January 2017 onwards	All Plants	100 mg/ Nm ³

Flue Gas Desulphurization (FGD) systems help to comply with the stringent environmental norms notified by the Ministry of Environment, Forest and Climate Change (MoEF & CC). In order to reduce the sulphur dioxide (SO₂) emissions, FGD system is installed after the boiler to absorb the sulphur content in flue gas. One of the most widely used technologies for SO_x control is wet FGD, based on limestone. The other post combustion SO_x control technology is Dry Sorbent Injection (DSI).

Dry Sorbent Injection (DSI):

Dry Sorbent Injection is the practice of injecting a dry alkaline mineral into a flue gas stream to reduce acid gas emission. In DSI, Sodium sesquicarbonate (or Trona) and sodium bicarbonate are sorbent materials, though hydrated lime can also be used sometimes.

Sorbent injection involves adding an alkali compound to the coal combustion gases for reaction with the sulphur dioxide. Typical calcium sorbents include lime and variants of lime. Sodium-based compounds

are also used.

This process is preferable for small unit sizes in the 60-250MW range. Since the cost of reagent in this technology is relatively higher than that of wet limestone FGD, DSI is preferable for units running with low residue operating life. DSI has an SO_x removal efficiency of 50-60%. The time required for erection and commissioning of DSI system is around 12-15 months which is much lower than the time needed for other technologies.

A Dry Sorbent Injection enables smaller power plants to remain in business while the capital investment of a wet/dry flue gas desulphurization (FGD) system is too high for the smaller captive power plants and also when available space is a constraint. Additionally, DSI based technologies have considerably low CAPEX and very little auxiliary power consumption (APC) compared to wet limestone FGD system. But in DSI system the sorbent injection generates extra dust loads on ESPs which is generally 2-3% of total ash generated.

DSI typically employs hydrated lime as a low cost, high-efficiency sorbent. The hydrated lime can be injected into several locations throughout the flue gas path, depending on preferred operation. Performance can vary based on mixing, injection location, and whether the station employs an electrostatic precipitator (ESP) or fabric filter (FF) as their particulate removal device. Traditionally, sorbent was injected after the air pre-heater and before the particulate collection device.

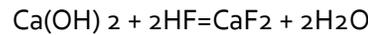
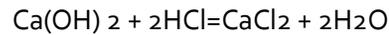
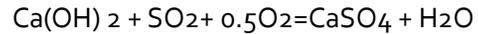
DSI is an easily retrofitted, low capital cost system that is capable of relatively high SO₂ removal.

The chemistry associated with DSI technology:

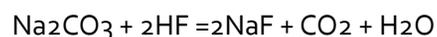
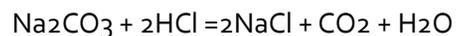
- The two primary chemistries being utilized for acid gas control with DSI are based on calcium

and sodium-based reagents.

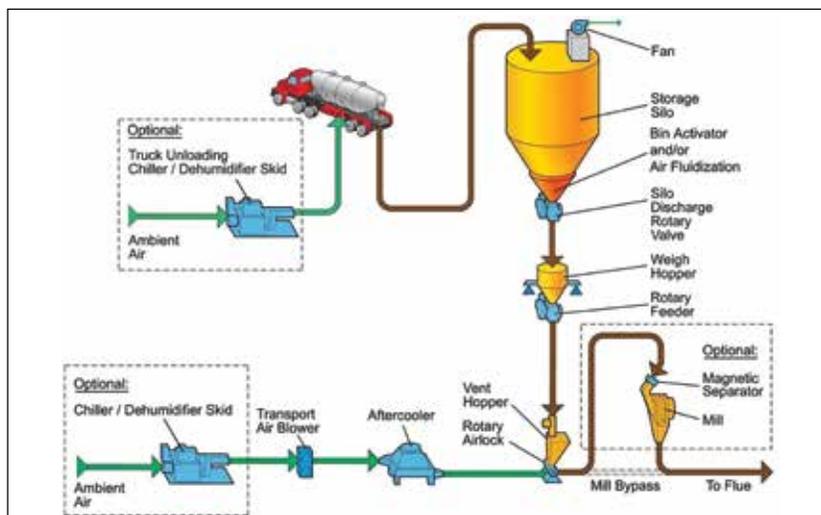
- The primary calcium reagent being widely utilized is hydrated lime or calcium hydroxide
- Ca(OH)₂, and the important reactions that result in the capture of the primary acid gases present in industrial flue gas streams are outlined below.



- Accordingly, the primary reaction products of calcium-based DSI are calcium sulfate, calcium chloride and calcium fluoride. The relative volume of the reaction products is a function of relative initial acid gas concentrations and the capture efficiency for each pollutant.
- The sodium-based chemistry is a bit more complex in that either Trona (Sodium sesquicarbonate - Na₂CO₃.NaHCO₃.2H₂O) or sodium bicarbonate can be injected into a gas stream for DSI applications where it thermally decomposes to a more porous sodium carbonate particle upon heating, which then reacts with the acid gases present in the flue gas stream. The basic Trona reaction for sulphur capture is outlined below.



- With SBC, temperature is very important. Temperatures below 135°C will cause the SBC to remain crystalline with very few pores. Temperatures above 345°C cause the SBC



Reference: Visit Report of NTPC Dadri plant dtd. 1.12.2020

Fig 1: Block diagram of a DSI unit

particles to soften, which reduces its porosity and therefore reactivity. At NTPC Dadri the injection is found to be applied before APH (Air pre heater) at Flue Gas Temperature of 345 deg C.

- DSI is successfully commissioned and running in NTPC Dadri (4X210MW) units.

O&M Challenges:

1. The sorbent has a natural tendency to absorb moisture and clog at atmospheric condition. Storing in bags or in open store is not possible.
2. Suitable vendor in India for mass production supply of SBC for Industrial use is very less.
3. The sodium content in fly ash may affect the ash quality which may find restricted applications, if any limitation of Sodium Content is imposed by the cement industries.

Wet FGD System:

The most commonly installed Sox removal technology solution is wet FGD. In wet FGD process, the flue gas is brought into contact with the sorbent in a separate absorber unit. A reagent such as limestone in a slurry form reacts in a spray tower with sulphur oxides to form calcium sulphite or gypsum. The wet limestone FGD has removal efficiency greater than 98% which is outstanding for all fuels (lignite, hard coal, oil, biomass, waste).

Key features of limestone flue gas desulfurization systems:

- SO₂ removal efficiency >99%
- Maximum HCl and HF removal levels
- Gypsum as a saleable end product

- Limestone as a favourably priced absorption agent
- Low operating costs and power consumption
- Open spray tower, low pressure loss
- Options for materials of construction (high alloy, carbon steel with rubber lining, concrete with PP-lining, glass fibre reinforced plastics)

For Wet FGD of a typical 500 MW unit is designed for:

- 1) In India, Limestone Based Wet FGD Systems are being designed with 0.5-0.6% of Sulphur content in coal and units operating under BMCR worst coal condition.
- 2) Units are considered for SO₂ removal efficiency of 96 % or higher under guarantee point conditions at 500 MW (TMCR) unit load with worst coal firing.
- 3) SO₂ in flue gas = 4428 kg/hour (2214 mg/ NM₃)
SO₂ in clean flue gas = 177 kg/hour (90 mg/ NM₃)
Efficiency = 96%.

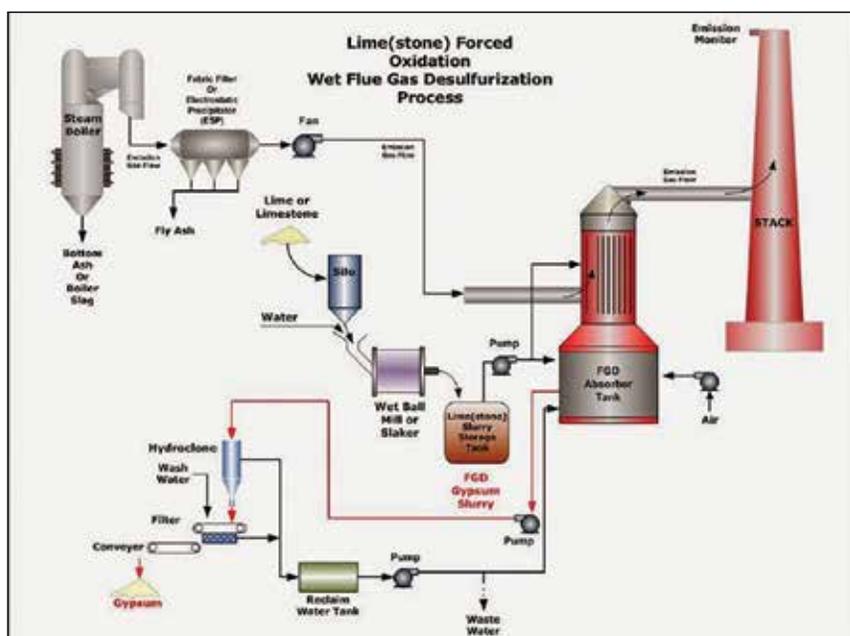
Process:

During combustion, Sulphur in the coal reacts with oxygen, resulting in the formation of SO₂.

SO₂ is converted into an easily handled and disposable substance by using limestone slurry (CaCO₃) and spraying it into the flue gas.

Following the absorption of SO₂ into the water, the limestone combines with SO₂ and forms solid crystals of calcium sulphite (CaSO₃) and calcium sulfate (CaSO₄).

Air is injected into the solution to convert the



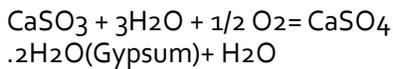
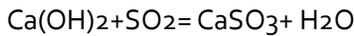
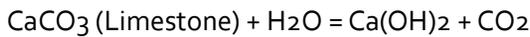
Reference: Power Line Magazine

Fig 2: Block diagram of a Wet FGD unit

CaSO₃ to CaSO₄, which then crystallizes as CaSO₄•2H₂O, or gypsum.

Basic Chemistry:

Sulphur dioxide (SO₂) + Limestone (CaCO₃) = Gypsum (CaSO₄•2H₂O)



There are two types of Limestone Based Wet FGD System:

- 1) Single/Multiple Spray Tower type absorption.
- 2) Bubbling Bed type absorption.

Spray Type Absorber:

Here the flue gas enters into the Absorber Tower from the bottom and encounters with the limestone spray while bearing the Absorber Tower. The Limestone slurry sprayed in the Absorber Tower may be at a single level with spray nozzles directing the limestone slurry both above and below the nozzle level whereas in multiple Spray type absorbers, nozzles installed in multiple levels (Three or more) spray the limestone slurry on the incoming flue gas.

Bubbling Bed type Absorber:

Here the entire flue gas is forced to pass through the limestone slurry at the bottom of the reaction tower. The outlet plenum through which the gas exist is placed above the reaction chamber.

Important Equipment:

Flue gas handling system

- Booster fan
- Duct, gates, damper

Limestone handling system & Reagent Preparation System

- Unloading hopper
- Conveyor belt system Reagent crusher
- Ball mill
- Reagent feed tank
- Reagent feed pump

Absorber & Oxidation System

- Gypsum bleed pump
- Recycle spray pump
- Oxidation blower
- Spray nozzle Mist eliminator

Secondary Dewatering & Gypsum handling system

- Hydro cyclone classifier
- Belt filter
- Conveyor belt system

- Travelling tripper

Equipment details:

Flue gas handling system:

The addition of the ductwork, equipment into the flue gas path imposes a higher draft demand on the existing ID fans beyond that for which they were originally designed. To satisfy increased demand, the existing ID fans are supplemented with Booster Fans to provide the additional motive force for driving the flue gas through the WFGD equipment into the existing stack.

Limestone handling system:

- To transport the limestone (less than 250mm) from delivery trucks to the unloading hoppers through a limestone crushing system (less than 20 mm).
- To store limestone in Silo and deliver the same for the reagent preparation process.

Reagent Preparation System

- Limestone from silo is fed to the mill via a gravimetric feeder where the limestone is further broken down to a fineness of 90% through 325 mesh.
- The mill is of Wet Ball type where the pulverised products are mixed with process/ filtrate water to form limestone slurries.
- Required fineness of the output product is achieved by classifying the limestone slurry in a cyclone separator and recycling the heavier particles to the mill till it achieves the desired fineness.
- The end product is stored in a storage tank from where it is pumped to the respective absorber by a set of limestone slurry transfer pumps.

Absorber & Oxidation System:

- Absorber Open Spray Tower:
The upper part of the Absorber vessel where the slurry is sprayed, and the SO₂ is absorbed and neutralized.

It is also referred to as absorber, scrubber, wet scrubber, open spray tower or spray tower or Jet Bubbling type reactor.

- Recycle tank:

It is the lower part of the Absorber vessel where slurry is held and where some of the chemical processes take place.

Its function is to provide adequate residence time for sulphur oxidation, gypsum precipitation, and limestone dissolution reactions to occur.

Forced Oxidation System

- The Forced Oxidation System provides compressed air to the Absorber Reaction Tank.
- The Oxygen in air reacts with CaSO_3 and oxidizes it to CaSO_4 .
- Some of the CaSO_3 produced in the absorber is naturally oxidized to CaSO_4 . If left to natural oxidation, however, the combination of CaSO_3 and CaSO_4 forms a precipitate sludge with water. Since the desired by product is gypsum (calcium sulfate dehydrate), the sulfite form of the product must be removed.
- The most economical way to remove the sulfite form is to oxidize the sulfite to its sulfate form.

Gypsum Handling System

- Primary dewatering system
- Secondary dewatering system
- Auxiliary storage system
- o The purpose of the Gypsum Handling System is to transport the gypsum cake from the Secondary Dewatering Belt Filter to the Gypsum Stack Area.
- o The gypsum dewatering and handling system shall be fed into gypsum dewatering system through adequate capacity gypsum bleed pumps. Gypsum slurry coming from all the FGD units shall be fed into Gypsum Slurry Storage Tank. 1st Stage Hydro cyclone Feed pump will further feed the slurry to 1st Stage hydro cyclones where it shall be classified and separated into a solid enriched under flow and over flow with reduced solid content. The underflow which contains the coarser gypsum particle shall be fed to vacuum belt filters. The overflow shall be collected in 2nd Stage Hydro cyclone Feed tank and then taken to 2nd Stage hydro cyclone. The underflow of 2nd Stage hydro cyclone shall be collected in a filtrate tank and then taken to the wet ball mill / unit Absorber system. Water from vacuum receiver tank(s) shall also be recycled to the wet ball mill / unit Absorber system. The overflow from 2nd Stage hydro-cyclone, as waste water, shall be collected in a waste water tank.
- o Gypsum Generated shall be conveyed by the

Gypsum transfer conveyor (individually from each Vacuum Belt filter unit) to common Gypsum Storage Yard. Gypsum transfer conveyor shall transfer the gypsum produced to Gypsum storage yard.

- o The gypsum from the storage Shed/yard shall further be transported through Trucks / Dumpers.
- o The purity of the Gypsum by-product of a typical FGD system:
 - Gypsum purity of 90 % minimum
 - Moisture content of 10 % maximum
 - Chloride content 100 ppm maximum for the specified range of specified coal(s) and design limestone.

Wet FGD and DSI At A Glance:

Description	Wet Lime-stone FGD	DSI FGD
Reagent	Limestone	Sodium bicarbonate/Trona
Byproduct	Gypsum	Sodium chloride
Removal Efficiency	>96%	<70%
Water Requirement	Base	Not Required
Opex	Base	Higher
Capex	Base	Lowest
APC	Base	Lowest

Steps of WBPDCCL towards De-sulphurisation of its units:

- WBPDCCL is going to implement DSI for SOx control in BKTTP (5X210 MW) and BTPS (1X215 MW) and KTPS (4X210MW) accordingly. Tendering process is going on.
- WBPDCCL is also going to implement Wet Limestone Based FGD for SOx control in STPS (2X 250 MW), SgTPP (2X300MW +2X500 MW). Also the ongoing super critical Phase#3 project of 660MW of SgTPP includes Wet Limestone Based FGD system. Tendering process is going on.

Acknowledgement:

Mr. Kalyanbrata Chakraborty, GM(Project), Corporate, WBPDCCL
 Mr. Proloy Biswas, DGM(Engg), Corporate, WBPDCCL

Modernisation of 132kV Busbar Differential Protection of BTPS

Abstract:

The old EM relay based busbar protection system of BTPS switchyard had some major gaps in protection. This article explains the challenges and solutions to upgrade the system to present day protection standards with numerical relay system.



Shantwanu Kumar Samal

Manager (PS), Testing Dept., BTPS,
WBPDCCL

Joined WBPDCCL on 2006. Served
at different electrical maintenance
departments of STPS and BTPS.

BANDEL THERMAL POWER STATION:

- Bandel Thermal Power Station is one of the oldest Thermal power plants of India and was commissioned in the year of 1965-66 with an installed capacity of 4 X 82.5MW.
- The total capacity of BTPS was enhanced to 510MW by commissioning the Fifth unit with a capacity of 210 MW installed in 1982. At that time Unit-5 was the first of its kind in Eastern India & fifth in India.
- Due to continuous deterioration and subsequent low performance of the capital equipment Unit-1, 2, 3 & 4 have been de-rated to 60MW each in the year 2006.
- During the period 2013 to 2015, renovation of Unit-5 was carried out and the capacity of Unit-5 has been enhanced to 215MW from 210 MW.
- As Units- 3 & 4 were operating beyond their useful life and also to prevent any further human-made disasters and public health issues, both the units- 3 & 4 were decommissioned in the year 2018.
- At present, BTPS is successfully meeting the power demand for the state with a capacity of 335MW.
- Though the life period of the units is more than four decades, Bandel Thermal Power Station still remains a prominent player in the state's power supply chain.

BTPS SWITCHYARD:

- The switchyard of BTPS is connected to two Nos. of 60 MW generators (Gen 1 & 2), One 215 MW Generator (Gen 5), two Nos. of 25 MVA reserve Transformers (Plant Transformer - 1 & 2 in stage 1), two Nos. of 35 MVA reserve Transformers (Stage 2) and 12 Nos. of 132kV outgoing feeders.
- The generating voltage of Generator -1 & 2 is 13.8kV and the generating voltage of Generator -5 is 15.75kV. All these generating voltages are stepped up to 132kV by respective GTs. So, the desired system voltage level at BTPS is 132kV.
- The 132kV system consists of one main bus and one Transfer bus system. Single Line Diagram is mentioned in Fig-1.
- The main bus is divided into two sections known as East Bus & West Bus by the Bus section breaker and associated isolators. Similarly the transfer bus is divided into two sections by the Z7 isolator.

- The CT positions of the different bays of the 132kV switchyard of BTPS makes it different from other conventional switchyards. This can be easily observed from the SLD.
- Use of 132kV Bulk Oil Circuit Breakers in four Nos. of bays i.e.GCB-1 & 2 and Plant Transformer -1 & 2 is another difference of this switchyard.
- The closing time of these Bulk Oil Circuit Breakers are approximately 250 msec and the tripping time of these breakers are within 2 cycles.
- The 132kV CTs for these four bays are installed inside the Circuit Breakers and are not approachable.
- The 132kV East Bus connected with Generator 1&2 (80MW each), Two Reserve Transformers known as Plant Transformer 1&2 (25 MVA each) and six Nos. of outgoing feeders namely Dharampur - 1 & 2, Adisaptagram - 1 & 2 and Bigati - 1 & 2.
- The east bus has one Bus tie bay.
- Similarly, West Bus is connected with Generator 5 (215 MW), Two Reserve Transformers (35 MVA each) and six Nos. of outgoing feeders namely Dharampur -3, Kalyani, Khanyan 1 & 2 and Liluah 1 & 2.
- The west bus has one Bus tie bay.
- All the East Bus bays (Generator bays, Transformer bays and outgoing feeders) are diverted through East Bus Tie Bay and Generator- 5, Two Reserve Transformers (Both 35 MVA Transformers) and two line feeders (Dharampur- 3 & Kalyani) of West Bus are diverted through West Bus tie bay.
- Remaining four Nos. of West Bus outgoing feeders (Khanyan 1 & 2 and Liluah 1 & 2) are connected to West Bus but diverted through East Bus Tie Bay.
- The CT position of all the bays of East Bus and six outgoing feeder bays of West Bus are between the circuit breaker and the 89B Isolator. While the CT position of Generator - 5 and two Reserve Transformers (35 MVA each) of west bus is different from other six line feeders of West Bus.

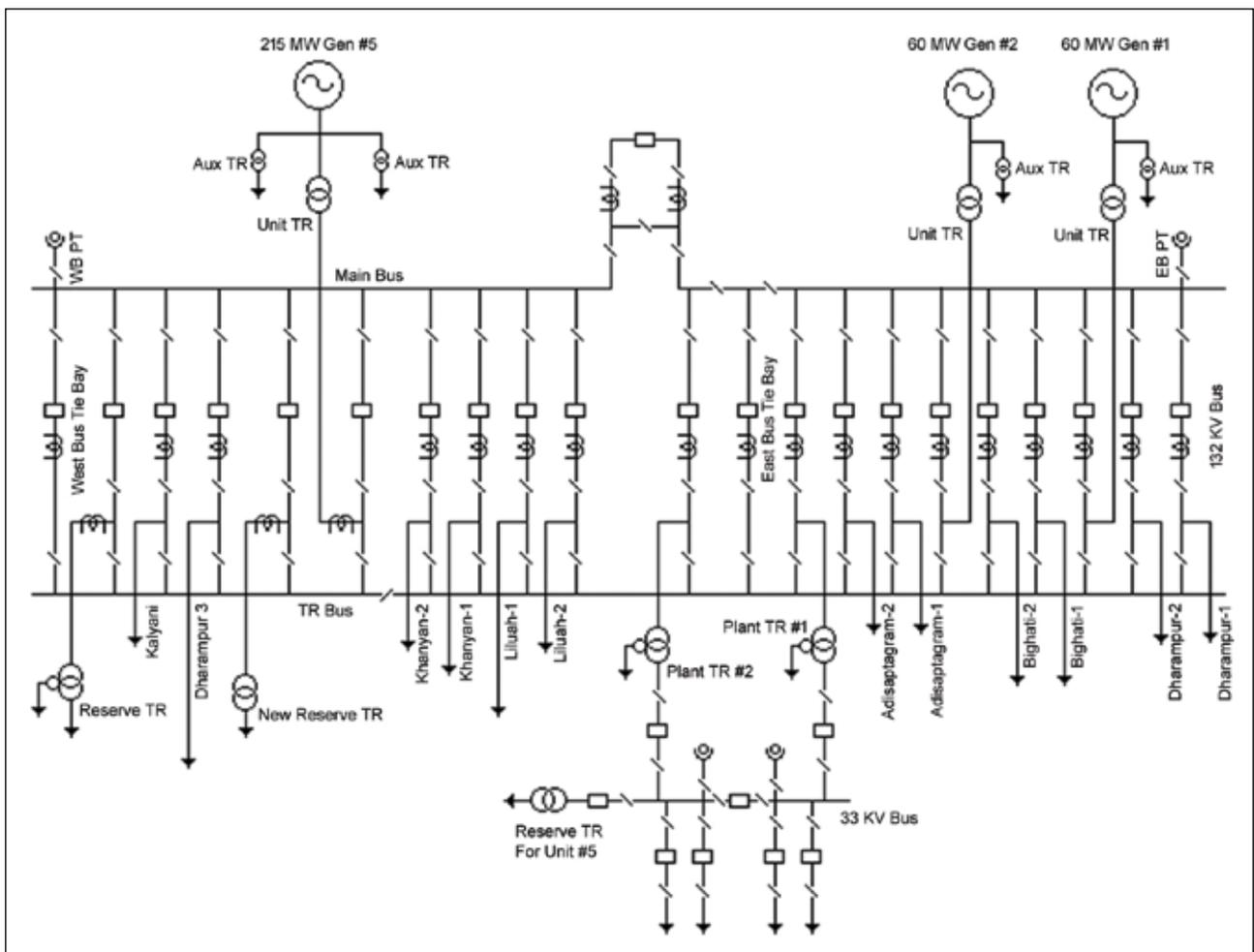


Fig 1: BTPS Switch Yard

- During any shut down or non-availability of Bus section bay, the West Bus and East Bus are interconnected through Transfer Bus via East Bus Tie Bay and West Bus Tie Bay. During that time both Main Bus and Transfer Bus act as a single bus system.

PREVIOUS BUS BAR PROTECTION OF BTPS:

- In the previous differential scheme of busbar protection, the main Bus was fed by generators, and power to the loads were supplied by outgoing feeders from the Main Bus.
- The current transformers were connected to each circuit of the incoming and outgoing feeders of the busbar and secondaries of current transformers were connected in parallel.
- A protective relay coil was connected across the parallel connection of the pilot wires so that the secondary current of all the CTs will

flow through the protective relay and the relay will operate.

- Under normal operating conditions, the sum of the currents flowing through outgoing feeders from the busbar to the loads is equal to the currents fed to the busbar by the generators i.e., currents entering the busbar are equal to the currents leaving the busbar. Thus no current flows through the protective relay and will remain inoperative.
- A current in the relay indicates a fault i.e. when a fault occurs in the protected zone, the currents entering and leaving the busbar will no longer be the same. Therefore, the difference between the currents entering and leaving will flow through the protective relay and initiate the opening of the circuit breaker of each generator and feeder.
- When there is a fault in the protected section, the vector sum of currents in the circuit connected to the busbar is equal to the fault current.

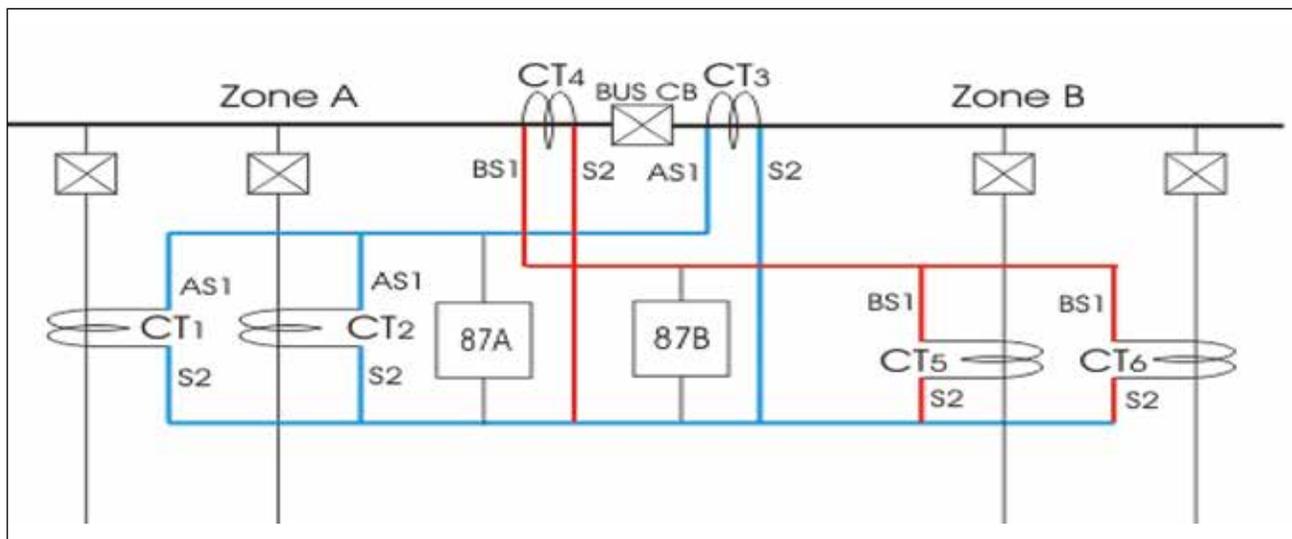


Fig 2: Busbar Protection Scheme

LIMITATION OF OLD BUS DIFFERENTIAL SYSTEM:

- All the CTs connected in the feeder circuits must be of the same ratio, regardless of feeder load capacity.
- In case of shut down or non-availability of the bus section bay, the bus differential protection was kept out of service due to non-availability of bus section CT.
- Any bus fault between the overlapping zone (between two CTs of Bus Section) initiates tripping of total Main Bus

(Both East & West sections).

- Any fault on Transfer Bus, during any feeder diverted condition initiates the tripping of corresponding Main Bus.
- As all the CT secondaries are looped in & looped out at switchyard, any job related to bus differential core of CT secondary of even any shut down bay leads to bus differential protection out of service.
- LBB protection was not in service.

NEW BUS BAR SYSTEM:

- M/s GET&D make Low Impedance distributed Busbar protection system of is implemented in new Busbar protection system.
- In distributed Busbar protection system, the bus differential core of individual bay CTs are connected to an IED known as Peripheral Unit (PU).
- All the PUs are connected to another IED known as Central Unit (CU).
- The PUs are connected to the CU through fibre optics cable. The individual PU of each bay continuously monitors the respective bay currents and reports to the CU with status of corresponding bay breaker, Isolators and master trip relays.
- The CU is made understood about the positions of the individual bays by a pre-programmed topology and accordingly the CU select the protection zones.
- The protection devices include a real-time vector processor and determine one or more bus differential protection zones, and implement a differential protection function within each of the protection zones. One or more protective control signals may be transmitted to the IEDs to trip the corresponding breakers and clear the bus fault.

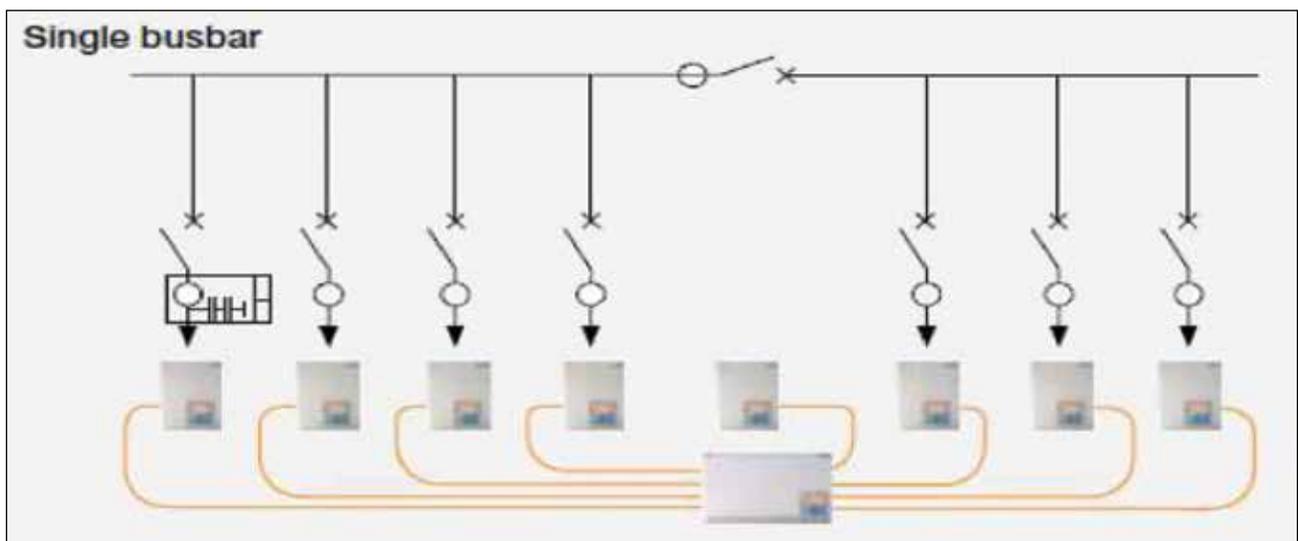


Fig 3: Distributed Bus Differential System

ADVANTAGES OF DISTRIBUTED BUSBAR PROTECTION SYSTEM:

- Low-impedance busbar protection.
- High functional reliability with stabilized differential current protection.
- Low CT performance requirements.
- High through-fault stability even in case of CT saturation.
- Neutral current measurement for impedance-grounded networks.
- Flexible solutions at system extension
- Extensive self-supervision.
- Access to station monitoring data such as events, single line diagram, differential currents and primary values.
- User management and authority handling.
- Simplified field wiring.
- Reduced cost from design, commissioning to maintenance.
- Ease of use and implementation.
- Support for simple to complex bus arrangements.

THE HURDLES CROSSED DURING UPGRADE OF BTPS SWITCHYARD TO INCORPORATE NEW BUS DIFFERENTIAL PROTECTION SYSTEM:

- As the 132kV CTs are installed inside the BOCBs, it is difficult very much to identify the polarity of the CTs (both primary & secondary sides).
- Though the tripping time of the BOCBs are

within 2 cycles but the arc quenching period through oil during a fault condition is more than the LBB time (200 msec). Due to this BTPS already witnessed one unnecessary LBB operation in East Bus due to tripping of Plant Transformer-1 through transformer differential protection. Accordingly, the setting of LBB operation time for abovesaid four Nos. of bays has raised to 400 msec.

- 132kV Liluah - 1 & 2 and Khanyan- 1 & 2 feeders are actually connected to West Bus but they are diverted through East Bus Tie Bay.
- Any bay of East Bus, when diverted through the Transfer Bus the CTs of the respective bay remain out of service and only East Bus Tie Bay CTs remain in service. So, during diverted condition of any bay through East Bus Tie Bay, a differential current always remains in the Transfer Bus zone.
- Similarly, differential current has been observed when two feeders i.e., Kalyani & Dharampur -3 feeders are diverted through West Bus Tie Bay but no differential current has been maintained in West Bus Transfer bus zone when Generator -5, and two 35MVA Transformers are diverted through West Bus Tie because the CT positions are different.
- Any fault in Transfer Bus (Both sections) during any feeder diverted condition, is a Transfer Bus zone fault for Bus differential protection and a Zone-1 fault for distance protection.
- Similarly, due to non-availability of one CT (self CT of diverted bay) during diverted condition, the bus differential zone is extended up to

132kV side of GT-1&2 and Plant Transformer 1&2 when these bays are diverted through East Bus Tie Bay.

ADVANTAGES OF NEW BUS DIFFERENTIAL PROTECTION SCHEME OVER OLD BUS DIFFERENTIAL SCHEME:

- CTs having different ratios (bay wise) can be used without any difficulty.
- Bus differential protection remains in service during shut down or non-availability of the bus section bay.
- Any bus fault between the over lapping zone (between two CTs of Bus section) initiates tripping of any one section of Main Bus along with Bus section breaker depending upon fault location.
- Any fault in Transfer Bus, when two sections of Main Bus are connected through Transfer Bus via East Bus Tie Bay and West Bus Tie bay, only Transfer Bus will be isolated keeping both the sections of Main Bus live.
- Any fault in Transfer Bus, during any feeder diverted condition will initiate the tripping of Transfer Bus only.
- As individual bay CTs are connected to individual PUs, there is no issue carrying out any job in CT secondary of Bus differential core of a shutdown feeder.
- LBB protection is in service.
- Annunciation facility is available for any CT circuit failure of any individual bay.

ACKNOWLEDGEMENT:

- I am highly indebted to our General Manger, Shri Alok Kumar Ghosh, Deputy General Manager (E/M), Shri Saibal Kar for their constant guidance, and moral support, inspiration, co-operation and encouragement for successful completion of the project in time. I am thankful to the dedicated team of BTPS and specially mention my teammate Mrs Manasi Goswami, Manager (PS), Testing Dept., who have efficiently executed this difficult task.
- With great affection and gratitude, we would also like to express our deep appreciation to Shri Avinash Desai from GE T&D Ltd, who shared his time, expertise, assistance, guidance and inspiration for the realization of the project.

Sacrificial Anode - Cathodic Protection System for Condenser Water Box

Abstract:

A new corrosion control procedure is being used for heat exchangers using water having high ionic load considering the electrolytic properties of metals. This article shows application of this sacrificial anodes to protect condenser walls of thermal power plants



Rishiraj Tripathi

AM (PS) T&A, STPS

Joined WBDCL in 2017

Introduction:

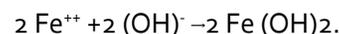
Sacrificial anode-cathodic protection system is now being extensively used in ships and heat exchangers using sea water/water having high ionic load. Now this concept is used in thermal power plants to protect condenser walls.

Condenser Water Boxes are predominantly made of Mild Carbon Steel. This makes it highly susceptible to Corrosion. Corrosion is a naturally destructive phenomenon that occurs when some metals are exposed to the environment. The reaction between air, moisture and the metal give rise to specific chemical reactions that cause the metal to convert to its more chemically-stable oxide, hydroxide or sulphide form. In iron-based metals, such as steel, corrosion comes in the form of iron oxides, also known as rust.

Electro-Chemical Process of Corrosion:

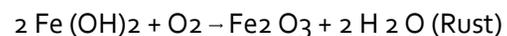
Iron is an electrochemically positive element and has a tendency to give up electrons to become free ions.

- 1) Anodic Reaction that takes place is $2\text{Fe} \rightarrow 2\text{Fe}^{++} + 4\text{e}^{-}$
- 2) Water is composed of oxygen and hydrogen, and it produces electrochemically negative hydroxyl ions $\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-} \rightarrow 4(\text{OH})^{-}$ which can accept the electrons given by Iron.
- 3) The Iron ions combine with the hydroxyl ions in water to form Ferrous Hydroxide.



This is called the Oxidation of Iron.

- 4) This Ferrous Hydroxide in the presence of excess oxygen in water is oxidized to form Ferric Oxide & Water, which we call Rust.



In order to prevent the Condenser Water Boxes from Corrosion, it is a routine practice during Overhauling to do the job of de-rusting by chipping and painting of Condenser Water Boxes with Anti Corrosive Protective Painting (Epoxy Based Zinc Rich Primer Paints).

Galvanic or Bimetallic Corrosion:

When 2 dissimilar metals are in contact with each other in the presence of a corrosive medium (electrolyte), the more active metal in the galvanic

series acts as an anode and undergo corrosion. This means, in a galvanic series of metals, the more active metal acts as anode and undergoes corrosion and the less active metal acts as a cathode and stays protected.

The heterogeneity of mild steel in Condenser Water Box, along with factors such as

non-uniformity of plate, thickness, paint thickness and quality, variations in the structure welding seams, dissimilar metals and oxygen content in the Cooling Water combine to cause areas in the Water Box to work cathodes and anodes respectively and thereby forming a galvanic cell, with the CW Water acting as the electrolyte.

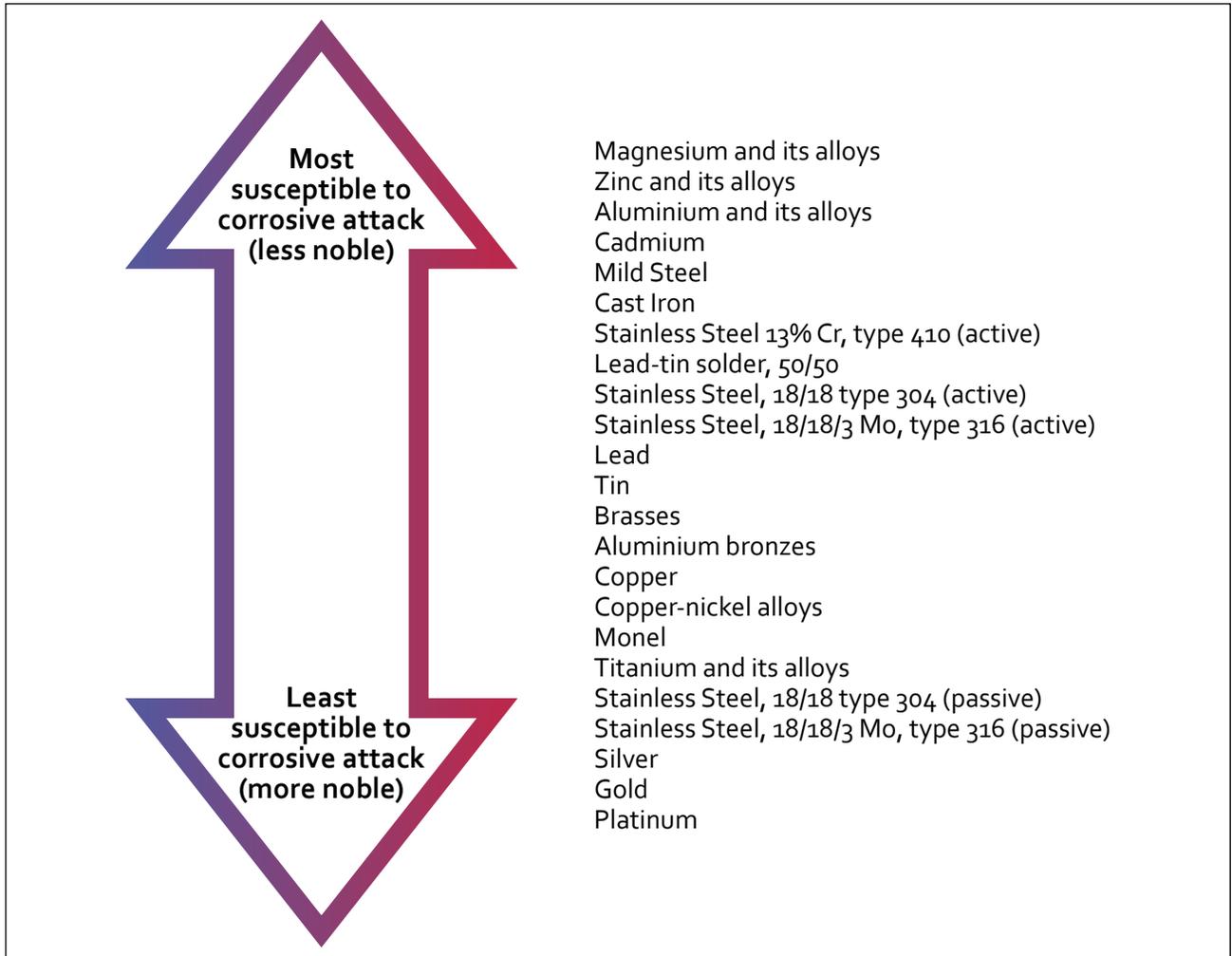


Fig 1: Galvanic Series



Fig 2: Sacrificial Anodes Installed on Ship Hulls

Sacrificial Anode-Cathodic Protection System:

Thus as seen from the galvanic series, we now know that a more active metal (anode) can corrode in place of the lesser active metal (cathode).

These Sacrificial Anodes are made of more active or less noble metal (usually magnesium, zinc or aluminium). The sacrificial anodes are attached



Fig 3: Sacrificial Anodes Installed in Heat Exchangers

to the steel structure and since they oxidize more easily, they turn the structure itself into a cathode. The electrons leave the structure through the anodes which slowly dissolve, thus protect the

steel structure against corrosion. Sacrificial anodes need to be submerged in the electrolytic medium (Cooling Water).

Composition of Anodes to be installed:

Magnesium Anode [Aluminum (Al) : 5.3 – 6.7 %, Zinc (Zn) : 2.5 - 3.5 %, Copper (Cu) : 0.08 % Max, Silicon (Si) : 0.3 % Max, Iron (Fe) : 0.005 % Max, Manganese (Mn) : 0.25 % Max, Nickel (Ni) : 0.003 %Max, Lead (Pb) : 0.03 % Max, Magnesium (Mg) : Remainder].

The job will be carried out after Chipping of Condenser Water Box Surfaces. After then the required number of Sacrificial Anodes will be

installed, according to the Condenser Water Box Surface Areas. After Installation of the Anodes, Anti Corrosives Painting Job will be done. The Service Life of these Anodes is estimated to be 5 years.

It is expected that the Cathodic Protection System in conjunction with Anti Corrosive Painting will provide much better Corrosion Control and therefore enhance the Service Life of the Condenser Water Boxes.

During forthcoming Overhauling of Unit#5 in January 2022, Sacrificial Anode Cathodic Protection System is proposed to be installed in the Condenser Water Boxes.

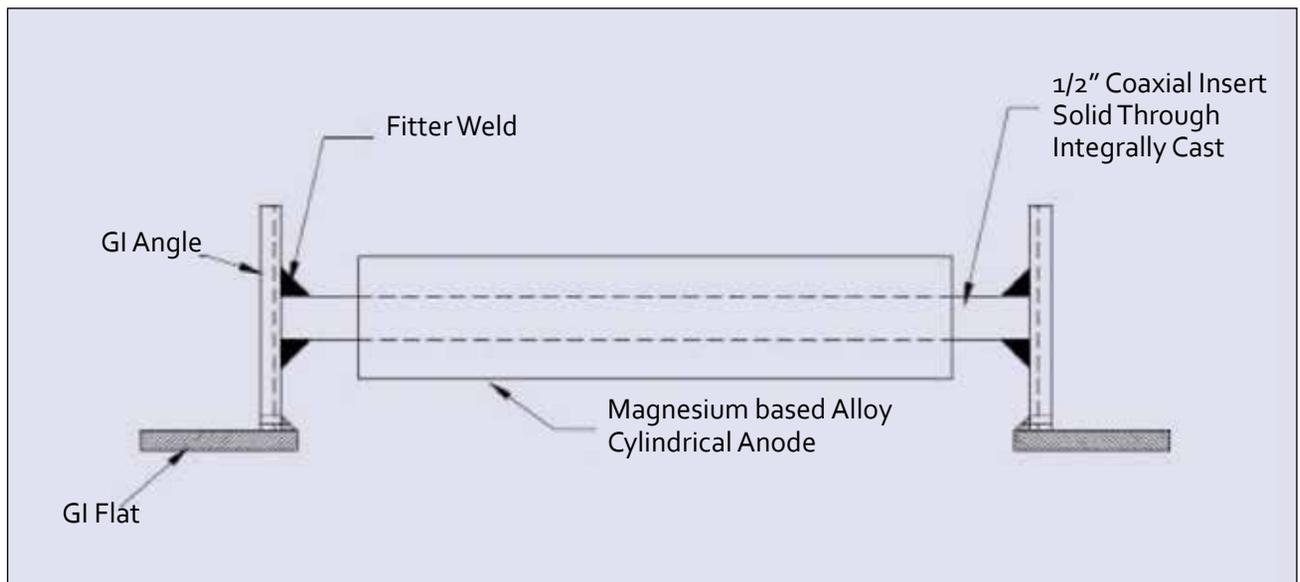


Fig 4: Magnesium Anodes Design

Acknowledgement:

1. Sri Susnata Aich, GM, STPS.
2. Sk. Maruf Hossain, Sr. Mgr.(TMD, STPS).

The systematic analysis and rectification of the problem of high dissolved oxygen in condensate and feed water at STPS unit#5

Abstract:

Dissolved Oxygen (DO) in feed water & condensate is a major concern for corrosion in thermal power plant water chemistry. This article depicts a systematic approach to arrest congenital high DO at unit #5, STPS.



Nirnoy Chakraborty
MANAGER (PS), O&E, STPS

Joined WBPDCCL in 2006. Served different operation and maintenance departments of KTPS and STPS.

Introduction

Good Boiler health is attained by maintaining good water chemistry. The dissolved oxygen (DO) in condensate and feed water is one of the main parameters to monitor corrosion and reliability of Boiler. High DO in condensate and in Feed Water accelerates corrosion which in turn causes Tube failure of Boiler. DO in condenser water cycle and Feed water cycle started increasing at STPS Unit#5. A committee has been formed to find out the fact. There were several reasons behind the sudden raise of DO levels. This report describes the systematic identification process, few corrective actions undertaken as well as proposed future implementations to mitigate high DO.

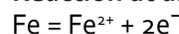
PREFACE

Normal Water / DM Water is fully air saturated. It contains approximately 8000 ppb of DO. In solution, oxygen is very corrosive to most metals, including boiler tubes. It can cause pitting of metal. Very small amount of oxygen can cause severe damage, a mixture of oxygen and water is a highly corrosive combination. This corrosive nature doubles with every 18°F increase in temperature. Removal of DO is necessary to prevent corrosion in Deaerator, Feed water circuit, boilers drum, water piping etc. Acceptable DO Levels for STPS are as stated:

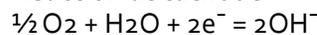
- For Condensate water DO should be maintained < 20 ppb.
- For Feed water DO should be maintained < 10 ppb.

How DO enhances corrosion

Reaction at anode

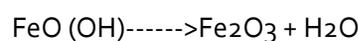
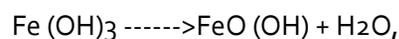


Reaction at cathode



Fe²⁺ ions are combining with OH⁻ ions to form Fe(OH)₂, ferrous hydroxide,
 $\text{Fe}^{2+} + 2\text{OH}^{-} = \text{Fe}(\text{OH})_2$.

The ferrous hydroxide then combines with oxygen and water to produce ferric hydroxide. Ferric hydroxide dehydrates to rust.



PROBLEM IDENTIFICATION

Santaldih Thermal Power Station is running with 2X250 MW capacity. After commissioning of

online SWAS, it was noticed that Unit#5 DO level is very high in comparison to design data and Unit#6 DO level. DO Level comparisons of both Units are mentioned in table.

DO LEVEL AT ONLINE SWAS(ppb)			
SERVICE DESCRIPTION	PERMISSIBLE LIMIT	UNIT#5	UNIT#6
CEP DISCHARGE HEADER	< 20	Not available due to sample line chokage. (SCALE MAXIMUM)	26-30
FEED WATER TO ECONOMIZER INLET	< 10	With CEP 5A-5B: 259 With CEP 5B-5C: 119 With CEP 5A-5C: 54	10-12

Table 1

Chemical Laboratory also measured DO by portable DO analyzer (HACH make) at CEP DISCH HDR Locally, BOILER FEED SUCTION & FW TO

ECO I/L(At Wet Panel) for cross checking. The result is mentioned in Table-2.

DO AT PORTABLE DO ANALYZER(ppb)(DT:31.05.2021)			
SERVICE DESCRIPTION	PERMISSIBLE LIMIT	UNIT#5	UNIT#6
CEP DISCHARGE HEADER	< 20	184	29
FEED WATER TO ECONOMIZER INLET	< 10	52	5

Table 2

For observation a plan has been prepared that

- First hydrazine dozing to be done for 07 (Seven) days.
- Then stop the dozing and observe.

As per planning,hydrazine dozing was started on 14/06/2021 at unit#5 for 07 days. Then It was stopped on 20/06/2021 and continuously observed. Observation is stated in Table 3.

DO LEVEL(in ppb) BEFORE & AFTER HYDRAZINE DOZING			
SERVICE DESCRIPTION	UNIT#5 (ONLINE SWAS)	UNIT#5 (PORTABLE ANALYZER)	REMARKS
CEP DISCHARGE HEADER	Not available due to sample line chokage. (SCALE MAXIMUM)	1039	Date:14/06/2021 Before start of Hydrazine Dozing
FEED WATER TO ECONOMIZER INLET	290	104.7	Date:14/06/2021 Before start of Hydrazine Dozing
CEP DISCHARGE HEADER	Not available due to sample line chokage. (SCALE MAXIMUM)	45.4	Date:21/06/2021 After Hydrazine Dozing was stopped
FEED WATER TO ECONOMIZER INLET	8.29	7.8	Date:21/06/2021 After Hydrazine Dozing was stopped
CEP DISCHARGE HEADER	Not available due to sample line chokage. (SCALE MAXIMUM)	276.1	Date:22/06/2021 After Hydrazine Dozing was stopped
FEED WATER TO ECONOMIZER INLET	132.8	82.2	Date:22/06/2021 After Hydrazine Dozing was stopped

Table 3

From Table 3 it is clear that DO level became normal at FW TO ECO I/L after Hydrazine dozing. And at CEP DISCHARGE it was still at higher side from normal value but very much lower than previous high value.

So it is clear that online SWAS & Portable DO ANALYZER are showing right value i.r.o DO Level.

During that period Helium Leak Test was

going on for Unit#5 by TM Dept. And as per recommendation / findings air leakage has been arrested at 1) MAL-20(High Energy Drain V/V) & 2) Manual Valve at Condenser Steam Chest. But DO level was still at higher side. So, it was planned to measure DO at individual CEP discharge by portable DO Analyzer and as per planning DO was measured on 16.07.2021. Detail result is as stated in Table 4:

SL NO	CEP	CEP HDR DO AT ONLINE SWAS(ppb)	DO(ppb) AT PORTABLE ANALYZER	STATUS	REMARKS
1	5A	200 (MAXIMUM DCS SCALE)	32.4	CEP-5C WAS IN S/B	Suspected air ingress at CEP-5C or at CEP-5B
2	5B		1609.2		
3	5A	115.7	14.9	CEP-5B WAS IN S/B	Suspected air ingress at CEP-5C or at CEP-5B
4	5C		370.5		
UNIT#6 Test result is taken for Comparison					
5	6A	22.9	20.5	CEP-6C WAS IN S/B	Normal
6	6B		19.9		

Table 4

ACTION TAKEN

TM Dept. worked at different areas

- Whole areas of CEP-5B & CEP-5C have been checked.
- DP test has been done all CEP suction bellow and found normal.
- One gasket has been replaced at CEP-5C Suction strainer Flange.
- Tightness has been checked both at CEP-5B & CEP-5C at all suspected air ingress areas.
- Asbestos rope with grease has been wrapped at

suction strainer flange & suspected flange area.

C&I Dept. also worked at sample line for Online SWAS DO Analyzer of CEP Discharge Header.

Note: One interesting incident was occurred during complete isolation of CEP-5C. Whenever CEP-5C Suction valve, Discharge Valve, Vent to Condenser Valve & Discharge Vent to LP flash Tank kept closed, noticeable amount of water was coming out from Suction Strainer Flange. Astonishingly there was a drastic falling of DO at CEP Discharge Header as well as at Feed Water to ECO I/L Line. So gasket of Suction Strainer Flange has been replaced.

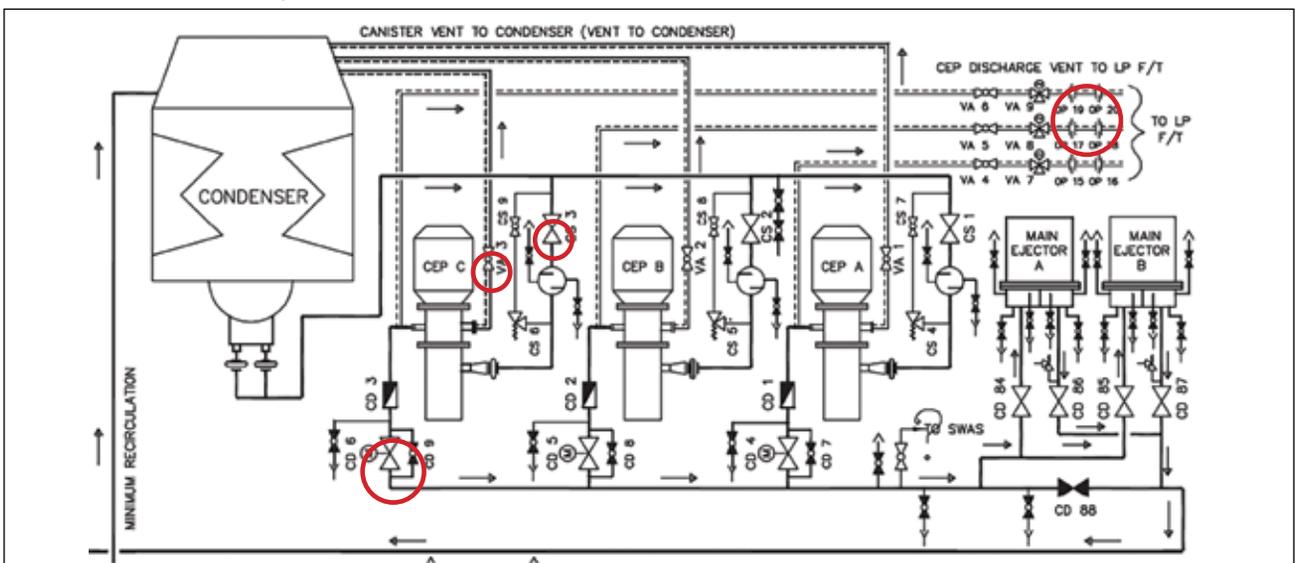


Fig:1 CEP-5C schematic diagram ○ Indicates the isolation of these areas.

Case 1 (Fig 2): When CEP-5A & 5C running & CEP-5B in standby condition, at marker of Fig 2, CEP DISCH HDR DO:65 ppb & FWTO ECO I/L DO:43 ppb.

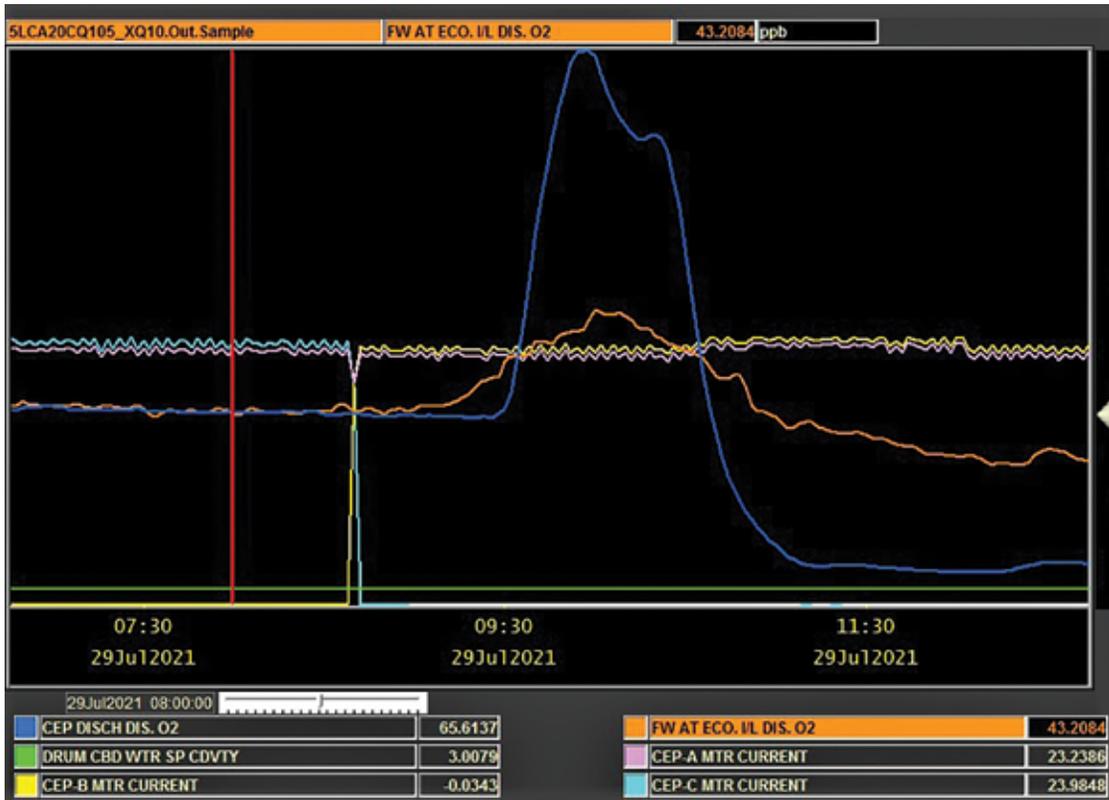


Fig 2: Trend of DO analyzer from DCS -CEP-5A & 5C running & CEP-5B in standby condition.

Case 2 (Fig 3): CEP-5B was cut in and CEP-5C was put into standby, but no isolation was done at CEP-5C. Whenever CEP-5B was cut in, DO started increasing. At marker of Fig 3, CEP DISCH HDR DO: 176 ppb & FW TO ECO I/L DO: 60 ppb

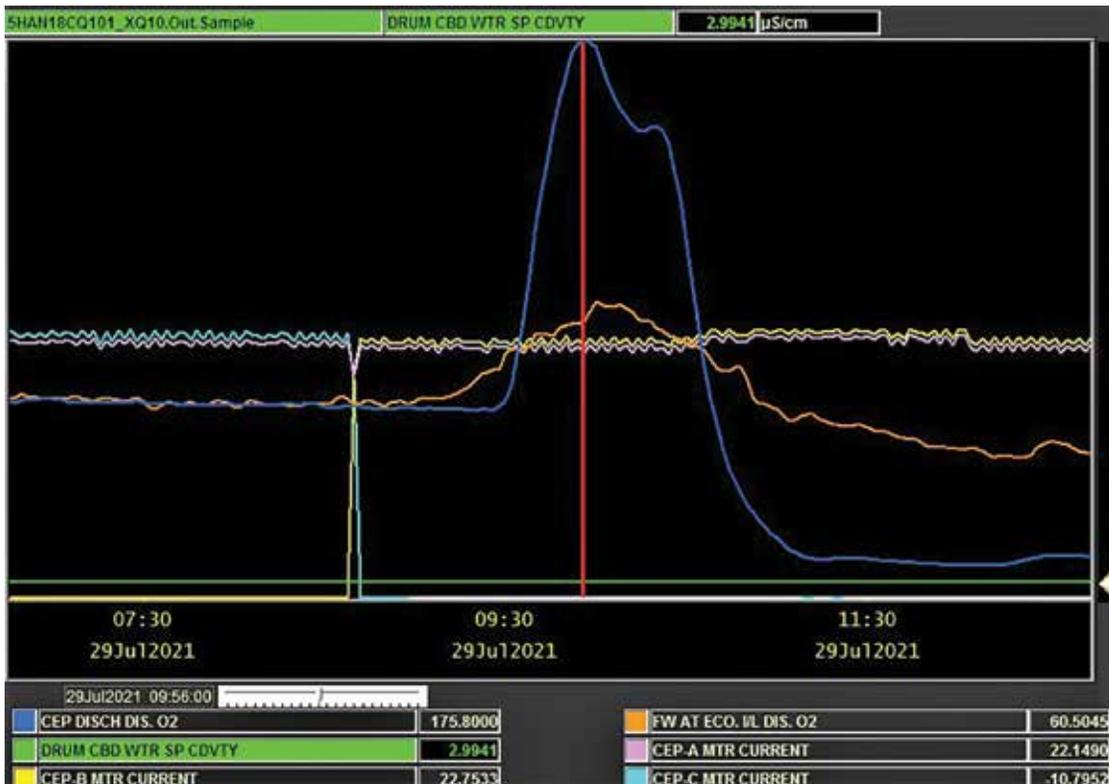


Fig 3: Trend of DO analyzer from DCS -CEP-5A & 5B running & CEP-5C in standby condition.

Case 3(Fig 4): But when CEP-5C had been isolated from Condensate cycle, within one hour DO came down to a good value. FW TO ECO I/L DO also came down. At marker of Fig 4, CEP DISCH HDR DO: 16 ppb & FW TO ECO I/L DO: 33 ppb. When CEP-5A & CEP-5B were running, CEP-5C totally was isolated from Condensate Cycle and DO became normal.

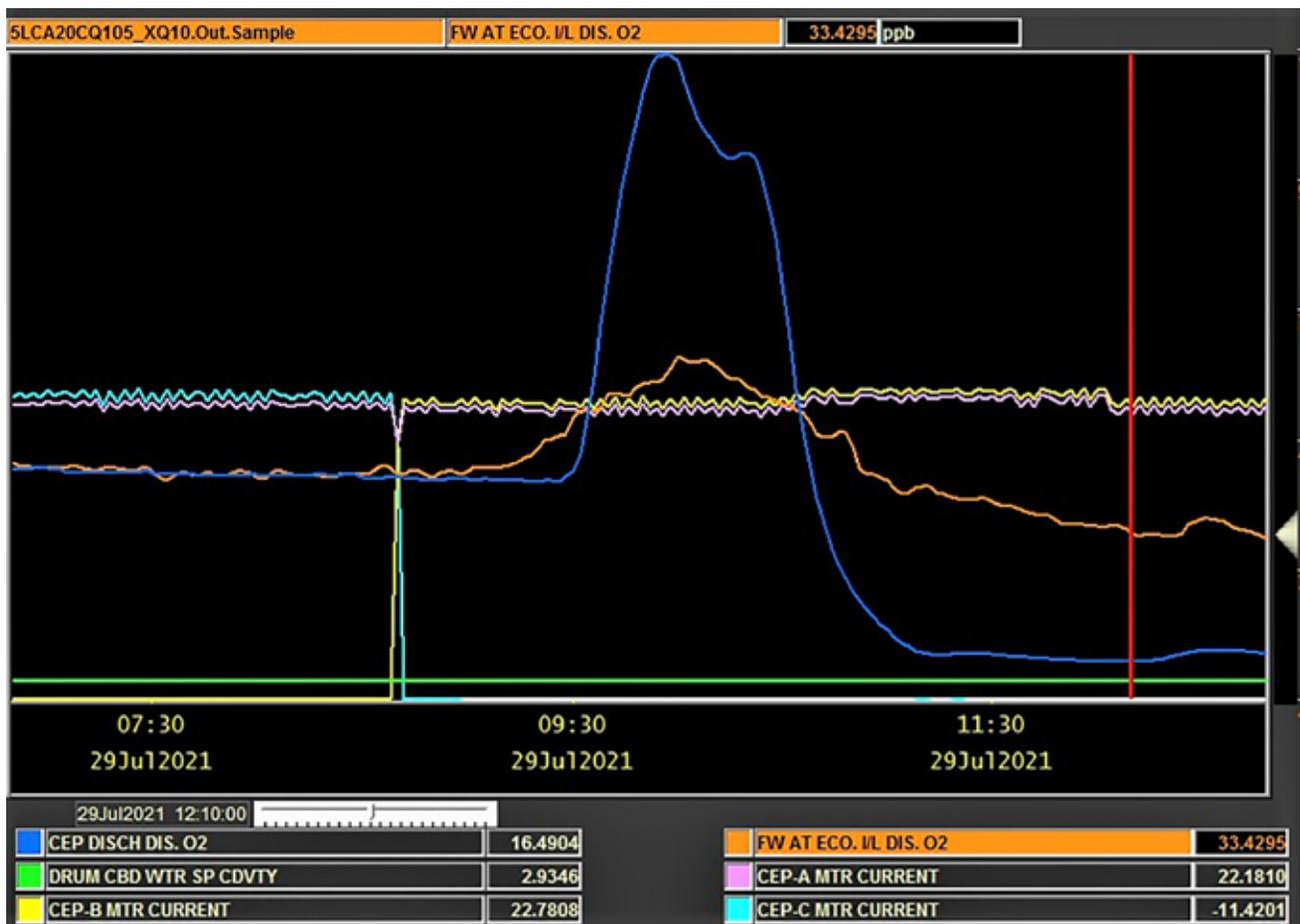


Fig 4: Trend of DO analyzer from DCS -CEP-5A & 5B running & CEP-5C in isolated condition.

FURTHER OBSERVATION

Though all necessary measures have been taken but DO was still at little higher value than permissible limit. So physical checking was done at all tapping point of SWAS system, SS Tubing & pressure regulating valves etc. and also at different gland sealing valves connected to vacuum circuit. Water spillage was found from thread of pressure regulating v/v at Primary chiller O/L of FW to ECO I/L DO Sample Line. Tightness was checked and wrapping done by Teflon tape. There was no further spillage.

Increasing DO trend was also observed when CEP-5B & 5C running(CEP-5A on standby). Another good observation is that, CEP-5A gland was found comparatively dry i.r.o CEP-5B & CEP-5C. During

maintenance work it was found that there is an orifice (4 mm) in gland cooling cum sealing line from CEP discharge header. This orifice was found choked. So it was replaced.

Water sealing at gland was not found at three manual valves connected to LP Flash Tank as below:

- 1) DR-30(Gland cooler O/L),
- 2) DR-37 & DR-39(Manual Isolating V/V of Deaerator Over Flow Controller). Necessary steps were taken for sealing of these valves' glands.

Finally decreasing trend of DO was noticed both at CEP Discharge & FW to ECO I/L sample line, value is CEP DISCH HDR DO: 22 ppb & FW TO ECO I/L DO: 19 ppb dated:12/08/2021 Time:09:20 Hrs.

After successfully completing all the tasks DO comes down to a good value but little higher than the permissible limit (Fig 3).

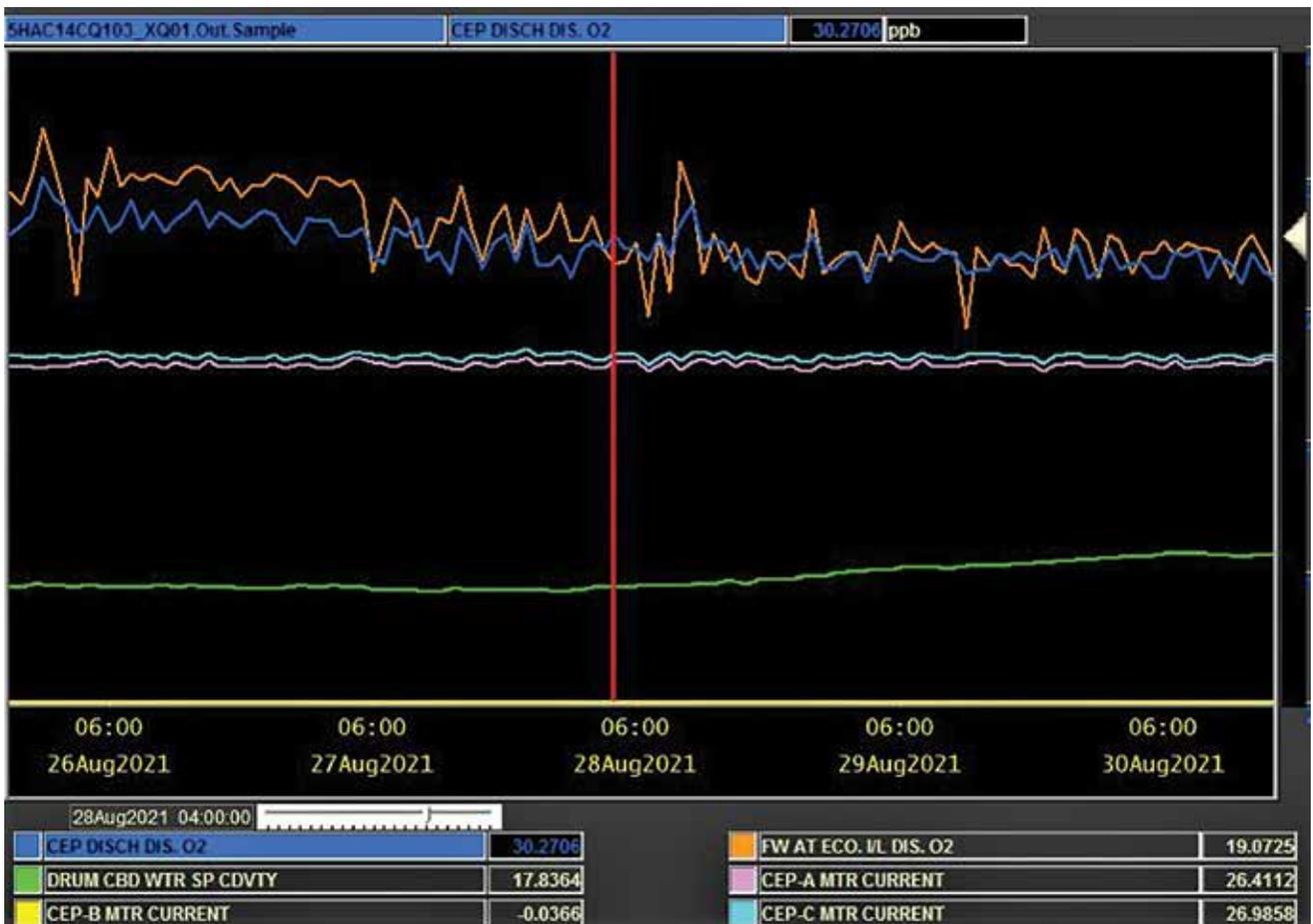


Fig 5: Trend of Online SWAS DO analyzer from DCS after trouble rectification

From 26/08/2021 to 30/08/2021, average DO level at CEP Discharge & FW to ECO I/L are 30 ppb & 19 ppb respectively. Specific Conductivity also was found within limit (Fig 5).

CONCLUSION

Though DO of Unit#5 comes down to a very good value; but still it is little higher than permissible limit. Action plan for coming overhauling is as follows.

- Deaerator internal checking
- Laying of New BFS sample line.
- Water sealing at gland for DR-30, DR-37 & DR 39.
- HP / LP Heater drip line to Flash tank checking.
- Primary Chiller/ Secondary Chiller servicing.

ACKNOWLEDGEMENT:

The whole endeavour and success was achieved by following team members:

Shri Susnata Aich, GM, STPS, WBPDCI
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 Shri S. Sahoo, Sr MGR (CHEM), STPS, WBPDCI
 Shri B Mondal, MGR (SCE), STPS, WBPDCI

Replacement of HP Heater assembly: A major challenge vanquished

Abstract:

Replacement job of a HP Heater has many unusual challenges – handling its height and refixing of existing HP & LP lines are the major ones. The experience of replacement of HP Heater #6 of KTPS unit #3 is explained in detail in this article.



Debapriya Roy

Asst. Manager (PS),
Turbine Maint, KTPS.

Joined WBPDCCL in 2013. Serving
Turbine Maintenance Department of
KTPS.



Sujit Das

Manager (PS), T&A, KTPS

Joined WBPDCCL in 2007.
Served mechanical operation,
commissioning, AHP maintenance
at STPS and presently at Turbine
Maintenance Dept. of KTPS.

Preface:

HP Heaters are supremely essential equipment employed to increase the overall efficiency of the regenerative cycle. Running a Thermal Power Unit without HP Heater will incur huge losses. After deterioration of certain amount of performance if it can be replaced, that will be very much fruitful for a Thermal Power Plant. But replacement of a whole HP Heater assembly is highly challenging due to its size and piping criticality. After properly calculated steps it has been a success for KTPS.

Functional Needs of HP Heaters:

They provide Efficiency gain in the steam cycle by increasing the initial water temperature to the boiler, so there is less sensible heat addition which must occur in Boiler. They also provide efficiency gain by reducing the heat rejected by the condenser. Steam is extracted from the selected stages of Turbine to pre-heat the feed water. KTPS HP Heaters are Shell & Tube type Heat Exchangers where feed water flows through tubes and extracted steam condenses in the shell.

Parameters for Performance Monitoring:

Two variables are used to monitor feed water heater efficiency.

- TTD: The Heater Terminal Temperature Difference (TTD) is a measure of how close the outlet feed water temperature is to feed water heater saturation temperature.

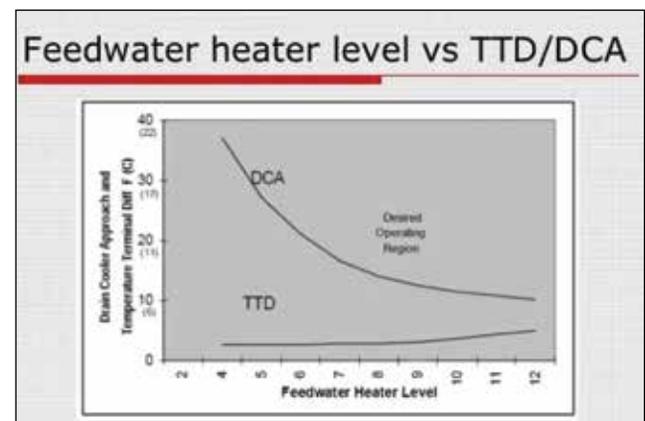


Fig 1: The impact of 1 Deg F/0.56 deg C increase in TTD of an HP Heater is approximately 0.013% - 0.016% increase in heat rate.

- DCA: The Heater Drain Cooling Approach (DCA) is the measure of how close the heater drain outlet temperature is to the feed water inlet temperature.

Similarly if there is a 1 deg F/ 0.56 deg C increases in DCA, the corresponding increase in heat rate is 0.005%.

Now both the parameters will deteriorate if HP Heater tubes leaked, tube fouling etc.

For a tube leaked HP Heater two types operation can be done:

- i) During unit running condition all or individual HP Heaters can be bypassed and continue unit operation. But, this will decrease turbine cycle efficiency. And as the feed water inlet temperature at Boiler inlet will be much lower, the amount of fuel for the same generation will be much higher. If all HP Heaters are out of service, fuel requirement for same generation increase up to 10%. So, there will be a significant heat rate penalty for this.
- ii) Or, the leaked Tubes can be plugged after shut down of unit.

In this case also pumping power requirement will be higher. And after plugging of more than 10% of total number of tubes performance will deteriorate considerably.

HP Heater Parameters (210 MW)				
S.N	Parameter	Unit	Design HPH 5	Design HPH 6
1	Bleed Steam Press	Kg/cm ²	17.03	37.52
2	Bleed Steam Temp	°C	431.4	336
3	Inlet Feed Water Temp	°C	164.2	197.8
4	Outlet Feed Water Temp	°C	197.8	240
5	Drain Temp	°C	170.9	207
6	Drip in Temp	°C	199	--
7	Saturation Temp	°C	203.1	245
8	FW Temp Rise	°C	37	42.2
9	TTD	°C	3.1	5.00

Condition influencing replacement of HP Heater-6 of KTPS Unit#3:

- 96 Nos. of tube plugged out of 550 Nos. of total tubes which is more than 17% of total tubes.
- There is no provision of individual heater isolation. In case of tube leakage, all the HP heaters are being bypassed.

Both of these conditions will eventually incur huge efficiency or heat rate loss. So, it was decided

to replace the whole HP Heater assembly with another HP Heater assembly from Unit#1* as the condition of that HP Heater of Unit#1* is much better (only 3 Nos. of tube were in plugged condition) and Unit#1* supposed to be declared for demolition.



Fig 2: Lifting & Movement of HPH-6 of Unit#1 to Unit#3

Major Challenges:

- HP Heater height: It is around 11.4 mtrs and most of it stays below the TG Floor. So, to move through TG Floor and TG Roof space it is to be lifted up more than 12 mtrs with sling. The TG floor and gravity limit switch distance was found 11.8 mtrs. So, the distance between crane hook and gravity limit switch has to be set upward for safe LT & CT of crane.
- Piping Criticality: Several High Pressure and low pressure piping were connected with HP Heater. So, positioning and alignment is very critical.

- Welding: Several high pressure weldings are to be done with precision so that it won't develop any crack or porosity. For that stress relief and different types of NDT are to be done.
- Initial placement of HP Heater-6 of Unit#3 after cutting.
- Suitable Vendor: This was also a major hurdle to find a suitable vendor to execute the job.



Fig 3: Welding Process opposite side simultaneously

The Process/Activities:

- Detail operation of all the three (03) EOT cranes were checked and then Crane No.-3 was selected for entire operation. So, Preventive maintenance of Crane No.-3 was done.
- Gravity limit switch of EOT Crane – 3 has been lifted up for 500 mm after joint preparation of SOP and checked several times.
- Mock lifting and movement was checked and a corridor of movement has been marked after cutting some guard rail of TG floor. A place for initial placement of heater has been identified and prepared.
- Hydro test of HP heater-6 of Unit#1 had been done for final condition check, Cell side – 30 Kg/Cm², feed water side- 90 Kg/Cm² and found OK.
- After proper scaffolding work, all the instruments have been dismantled and all critical pipes were locked for zero displacement after cutting.
- All connected pipes were cut.
- In similar way HPH-6 of Unit#3 pipe lines were disconnected.
- HPH-6 of Unit#3 was lifted and placed at previously identified place with arrangement of rigid support.
- Edge preparation of all the pipes connected to HP Heater-6 of Unit#3 was done accordingly.
- HP heater-6 of Unit#1 was placed at the base of unit#3.
- After proper positioning and piping alignment welding done as per proper welding schedule. Materials of all the pipes are carbon steel, SA106 Gr.B.
- Stress relieving done at temp. 620-630 deg C.

NDTs Performed for welding joints:

1. Die-penetration test.
2. Ultrasonic Test.

All instruments were connected and re-insulation done.

The low performance HP Heater of Unit#3 has been placed at Unit-1 and fixed at position by bolting and welding of some piping.

Conclusion:

After rigorous discussion and calculation the decision for replacement has been taken. With all possible safety measures and proper procedure the replacement has been successful. After start up of Unit#3, it has been running continuously with all HP Heaters in service making this decision and activity a major milestone of success, an engineering epitome.

BASE METAL : (QW-403)					
P.No.	1	To	P.No.	1	
OR					
Specification type and grade :			SA 106 GR B		
To					
To Specification type and grade :			SA 106 GR B		
Thickness Range					
Base Metal			38MM		
FILLER METALS (QW-404)		GTAW		SMAW	
Specification No. (SFA)		5.18		5.1	
AWS No (Class)		ER 70S-A1		E 7018-1	
F.NO.		6		4	
A.NO.		1		1	
Size Of Filler Metal		Dia 2.4 MM		Dia 2.5 MM, 3.15 MM, 4.0 MM	
Electrode -Flux (Class)		E 7018-1		SUPRATHERME-SPL	
Flux Trade Name		ADOR WELDING LTD		D & H SCHERON	
Consumable Insert		ARGON		N/A	

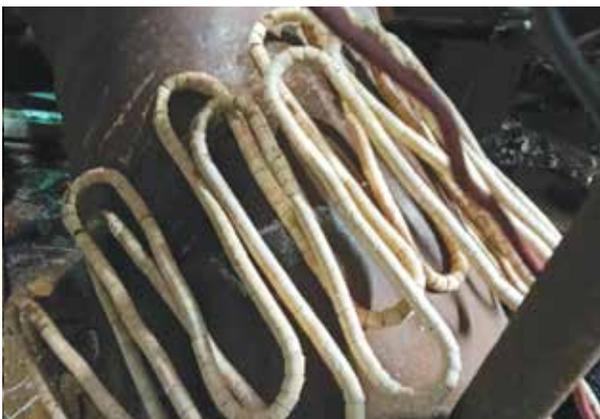


Fig 4: Stress Relieving



Fig 5: DP Test

ACKNOWLEDGEMENT:

We would like express my gratitude towards Mr. Apu Majumdar, GM, KTPS; Mr. Pradipto Mukherjee, DGM-IC, Mr. Pratap Ch. Saha, DGM-MM for allowing and guiding us to execute our Endeavour. My sincere thanks to Sri Chandrapeep Chakraborty, HOD-TM for his help, stimulating suggestions and encouragement towards making this job a successful one. I am immensely obliged to my Managers, TM Sri Biswanath Adak & Sri Manoj Maity and other departmental colleagues and subordinates for their unconditional support, elevating inspiration and thorough supervision.

I would also like to acknowledge with much appreciation the crucial role of the technician and workers who have actually handled this enormous job.

Green Building: A step towards sustainability

Abstract:

A new concept for construction of buildings is emerging which would have the least adverse effect on the environment, conserve natural resources and provide the inhabitants quality life. This green building concept is discussed in this article.



Arunabh Sen

Manager (Civil), BkTPP, WBPDCCL

Joined WBPDCCL in 2014. Serving at Civil Departments of BKTTP.



What is a Green Building?

A 'green' building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment. Green buildings preserve precious natural resources and improve our quality of life.

Green building can improve the way buildings use energy, water, and materials, to reduce negative impacts on human health and the overall environment - both during construction and over its lifetime.

Compared to a conventional building, a **green building uses less energy, water and natural resources, creates less waste, uses renewable, sustainable and non toxic materials and is healthier for the occupants.**

Advantages of Green Building

A **green building uses less energy**, there is an overall reduction in usage of energy, whether it's from energy-efficient appliances, passive heating and cooling, or sustainable architectures, green building can dramatically shrink a building's overall carbon footprint or even make it a net positive on the environment.

For many green buildings, the raw materials and components themselves are purchased from green suppliers. These suppliers adhere to strict standards

and controls to ensure that their production methods conserve natural resources and reduce overall carbon dioxide emissions.

Green Building helps to safeguard water resources. Green buildings are sustainable buildings demanding water conservation as well as preventing pollution and reuse of grey water with recycled treated water ensuring potable water use for potable purpose only.

Use of water sensed fixtures for bathroom sink and faucets and accessories causes less use of water than standard flow. This type of building uses water efficient toilets, like vacuum toilets, in which waste is evacuated from the toilet through a vacuum created by a vacuum pump or like waterless toilets which is based on dry sanitation system and does not use water at all.

Rainwater harvesting is a part of green building, it is the active collection and distribution of rainwater which rather than going to the sewage is put into use in daily life. Typically, rainwater is collected from the rooftops, deposited in a reservoir with filtration. Once the water is purified, it can be used for cultivation, gardening, and other domestic uses.

Green building promotes health and well-being. Indoor air quality is a key area of focus for the green building, which works to improve human health. These buildings focus on delivering high indoor air quality, avoiding materials that create harmful emissions while incorporating natural light to ensure users' comfort while cutting lighting energy. It utilizes proper acoustics and sound insulation that play a key role in the comfort and enjoyment in their everyday environments. These green building is environment friendly at any climatic condition.

Green Building can increase the captive energy of our plant. As green buildings cause a reduction in overall usage of energy. Hence transforming our main buildings and quarters of township into green building, we can reduce the auxiliary power consumption to some extent, and thereby increasing the captive energy of our plant.

Steps towards implementation of green building practices

Whether we are building a new or retrofitting an existing structure, there are many ways to implement green building practices. Some of the more common green building practices include:

- Use of sustainable building materials such as recycled glass and steel, as well as renewable materials such as bamboo and rubber.
- Installing energy-efficient windows and doors, smart windows.

- Using lower-VOC (volatile organic compounds) paints and stains.
- Constructing green roof systems (i.e. plants on your roof), that offer many benefits, including onsite gardens, rainwater management and protection from the effects of harmful UV light.
- Adding water harvesting and purification systems that both manage and make the most use of rainfall.
- Installing commercial solar panel carports to provide covered parking and integrated charging stations for electric vehicles.
- Maximising natural light, which can not only save on lighting requirements (and subsequently energy costs), but can also help keep buildings warm in colder months.

Types of Green Building

- A. Net Zero Energy Building:** A Net Zero Energy (NZE) building is a building with net zero energy consumption, meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy (energy created by sources that are naturally replenished, such as wind, rain, or solar) created on-site.

This means that NZE Buildings will continue to consume energy, but this energy will have a low impact over the environment, as they won't consume energy from non-renewable sources such as oil or petroleum, natural gas, coal or uranium.

- B. Nearly Zero Energy Building** is a building that has very high energy performance, where the nearly zero or very low amount of energy required should be extensively covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.
- C. An energy-plus building** produces more energy from renewable energy sources annually than it imports from external sources. This is achieved using low-energy building techniques, such as passive solar building design, insulation and careful site selection and placement.

Ratings for Green Buildings

Green Rating for Integrated Habitat Assessment (GRIHA)

GRIHA is our country's own rating system which was jointly developed by the Ministry of New and Renewable Energy, Government of India and TERI. This rating system consists of 34 different

categories under 4 main sections i.e. Site selection and site planning, Conservation and efficient utilization of resources, Building operation and maintenance, and Innovation.

Leadership in Energy and Environmental Design (LEED, INDIA)

LEED, India Green Building Rating System is a standard point of reference both in India as well as worldwide for the design, construction and further operation of high-performance green buildings. This is one of the main councils that provides green ratings to a building structure, whether an

apartment, independent home or commercial property.

Some noteworthy Green Buildings in India are

- Infinity Benchmark, Kolkata
- Suzlon One Earth, Pune
- Rajiv Gandhi International Airport (RGIA), Hyderabad
- Infosys Limited, Mysore
- I-Gate Knowledge Centre, Noida

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I gratefully acknowledge the resourceful guidance, active supervision and constant encouragement of our respected Sri Alok Kr. Maity, The General Manager (Engg) , BkTPP, WBPDCCL who despite their other commitments could find time to guide me in bringing this article to its present shape. I do convey my sincere gratitude and thanks to them. I also acknowledge my gratitude to my HOD, seniors and colleagues of the Civil Engineering Department, BkTPP, WBPDCCL for extending all facilities to carry out the present study.

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Demographic study of Sagardighi Thermal Power Project Township as a part of preventive measure against COVID-19 pandemic

Abstract:

The Medical unit at SgTPP assessed its probable patient load during early COVID-19 days through a demographic study of SgTPP township and got prepared on the basis of the study which yielded a satisfactory performance of the medical team in handling the COVID-19 situation.



Dr. Koel Krishna Sinha
M.B.B.S., A.F.I.H.

Senior Medical Officer and Factory Medical Officer, SgTPP, WBPDCCL

Served as B.M.O.H. under Dept. of Health and Family Welfare, Govt. of West Bengal. Joined WBPDCCL in 2007.



Dr. Soumyadeep Roy
DMCW(AIHH&PH), AFIH

Senior Medical Officer, SgTPP, WBPDCCL

Ex M.O. NRHM, Ex MO SNCU Raigunj, Working at WBPDCCL since 2012. Completed Occupational Health and Radiology course from Central Labour Institute Mumbai

Introduction:

Corona virus disease (COVID-19) is an infectious disease caused by SARS-COV₂ virus. Most people infected with the virus have experienced mild to moderate respiratory illness. However some have become seriously ill and required medical attention. Anyone who became sick can be seriously ill or die at any age. Older people with underlying medical conditions are more likely to develop serious illness.

During the early stage of Pandemic of COVID-19 in India, Sagardighi Thermal Power Medical Unit formulated a plan for preparedness to combat the situation before outbreaks of the disease in the township. It was necessary to analyze the situation of demographic composition of the township to prepare future plans.

Objective:

Result obtained from the demographic analysis would be used in the following:

- 01 Identification of the high risk population.
- 02 Estimation of the medicine and oxygen demand if needed.
- 03 Identification of the residence of the COVID-19 suspects for quick isolation if needed.
- 04 As a tool for administration for further policy making.

Materials and Methods:

It was a cross-sectional survey based study conducted by the SgTPP medical unit. Being the only medical facility with laboratory, X-ray, OPD & emergency services in the township, this medical unit is the first contact center of the sick people. All the COVID-19 patient will have been first screened and diagnosed here.

For the purpose of the study a survey form was created by doctors of medical unit. A door to door survey was conducted throughout the township by the employees of the medical unit. The survey was in phasic manner by the same group of persons starting from the remote quarters and proximal quarters later on.

As all the quarters of the township were surveyed there was no chance of selection bias. The questionnaire was such that there was less probability of recall bias. The consent of the study population was taken before recording the data under evaluation.

The following assessments were recorded in the survey:

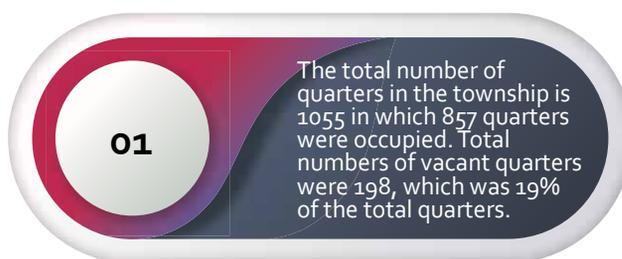
- 01 Quarter No.
- 02 Employee name
- 03 Emp. number
- 04 Number of children
- 05 Age and Sex of the Children
- 06 Number of Adults
- 07 Name and age of the adults
- 08 Any recent history of travel
- 09 Any recent history of contact with known COVID positive person

After collecting the data, one datasheet was prepared by computerized entry of the data. Following that segregation of the population was

done by age of the person. The children below 15 years and the adults above 50 years were considered as high risk population.

Statistical analysis of the data done estimate the percentage of the high-risk population of COVID-19 and the percentage of the empty quarters to achieve a organized home isolation as per protocol if needed.

Results:



Conclusion:

- The present study found that there were 181 persons above 50 years who were at risk of developing serious illness due to COVID-19 if outbreak happens.
- The medicine needed for treatment of COVID-19 patient as per protocol of ICMR, WHO, WB Health Govt. was estimated before the outbreak happened and availability of those was established.
- The number of separate bed dedicated to COVID-19 patient in case of hospitalization was estimated and prepared considering the national data of "percentage of COVID-19 patient needed hospitalization".
- Prediction of oxygen demand was calculated beforehand and procurement of new oxygenator machine in addition to the previous one and two oxygen cylinder in addition to previous two cylinders was done.
- Procurement of laboratory reagents needed to establish the diagnosis of suspect COVID-19 and prognosis of the case were done.
- The result was also forwarded to the higher administrative officials for further evaluation and as an aid to policy making.



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Remote working - A new normal: Challenges and opportunities of HR post pandemic

Abstract:

Our industries are facing tough challenges from the devastating advent of COVID-19. This article focuses on the emerging HR trends and strategies through and post-pandemic situation.



Soumita Ghosh (Roy)
AM(HR&A)

Joined WBPDCCL in 2013. She is an engineering graduate and completed her PG in MBA (HR) from IISWBM. Served HR Departments of BkTPS and Corporate Office.

Preface

The COVID-19 pandemic has given a serious jolt to the entire economy and workplace scenario forcing them to adapt to digitalization which is the new virtual reality and transformation to new ways of working and living. The first part of the article speaks about the transition of remote working as a flexible HR practice to the new workplace reality and its possible fate. The second part of the article will reveal the challenges of such remote working vis-à-vis physical attendance at workplace. The third part of it will speak at length about the competencies and role that should be undertaken by HR professionals in the light of such a crisis. The fourth part reflects the top HR trends that are likely to represent the industrial scenario. Therefore, a post-pandemic systemic and process approach require new approaches to leadership, people engagement and customer focus and the further development of trust in interpersonal relationships. The conclusion of the matter is driven from the thought that the competencies and strategies to survive in post pandemic era is to be aligned with the business objectives in order to develop HR as strategic business partners from being just functional experts.

1. Work from Home (WFH) or Living at Work?

The digital era dictates new ways of working and job creation while COVID-19 has sped up the transfer to a greater usage of technology. This technology brings with it many opportunities, and at the same time many risks. Since the outbreak of the pandemic, organisations have had to adapt in order to survive on the market. At the same time, human resource managers faced the great challenges of protecting people's health and lives in the workplace and providing help and support to employees working remotely. Many organisations are assessing whether the practices and the ways of performing activities prior to the pandemic will last or be applicable in the post pandemic period. The latter implies that organisations need time to adapt and succeed in the post-COVID era (PWC, 2021).

-“Will you please lower the TV volume Maa, I am on an office call!!!”

-“Will someone please take him (the child) out of this room for a while? I have urgent work to do.”

-“Give me a formal shirt only, will wear it over my night suit, I need to be on a video call with my boss.”

-“Sir, please excuse me till power is restored back in my area.”

-“Can you please switch off the mixer grinder till my meeting is over?”

(Also meanwhile, TV serial and advertisement jingles, baby crying or fussing, loud chatting within the house in the background while concentrating on some work or attending important office call.)

The scenario mentioned above is indeed the new normal in any household nowadays with working professionals engaged in “work from home” (WFH) mode. Not everyone has the privilege of getting a separate room for uninterrupted working nor it can be expected that the usual household chores or activities inside a bustling household will or can stop since the entire work scenario has shifted to a new mode altogether as a result of the ongoing pandemic.

When the WFH mode started off, the employees who used to bargain and plead earlier with their bosses for this flexible and convenient mode of working from home were delighted with this change, but as time progressed people are realizing that this is not that attractive a proposition for long term anymore as it appeared when it was offered as an “occasional allowance” or “relaxation”.

Making a living and living a life are totally different and that’s why there needs to be a healthy balance between the two. Yet, for the longest time, work life Balance has been presumed to be an excuse for less work and more life. Presenteeism has been confused with productivity and cultures steadfastly reinforced the archetypal view that the best employees are those who are available 24*7, 365 days a year (Anupreeta Lall, CEO & Founder Intellsearch, New Delhi, People Matters August 2021 edition).

Probably, the future of work will be some kind of hybrid model where people will work from home or in the office, or a combination of both. However, the majority of the workforce may have little or no opportunity for remote working while it is highly concentrated among highly skilled, well-educated workers in a handful of industries, occupations, and countries (McKinsey, 2020a).

2. Challenges of Remote working and role of HR

The large increase in employees working remotely is the most obvious effect that COVID-19 has had on the workforce, and McKinsey (2020a and 2021) analysed how extensively remote working might persist in the post-pandemic period. The analysis consisted of 2,000 tasks in some 800 occupations in China, France, Germany, India, Japan, Mexico, Spain, the United Kingdom and the United States. The result showed that in cases where remote

working did not lead to a loss of productivity, up to 20 to 25 per cent of the workforces in advanced economies could work from home between three and five days a week (McKinsey, 2021). This included 22% in the US, while in India it applied to only 5% of the workforce (McKinsey, 2020a).

Although one may argue that remote working has enabled them to work from any place without having to apply for leave unnecessarily while being available for work and can be around the family more often, attend to more personal commitments, saving them time and exhaustion from the daily office commute, yet there are problems that are cropping up as the tenure of this WFH mode has started to get extended indefinitely. Reports coming in whereby companies are deciding this mode as a permanent mode of operation are only adding to the woes of employees. Let us have a look at the cons of WFH mode:

- Space constraint - Not getting a workplace where one can freely concentrate and work without having various distractions of a bustling household.
- Uninterrupted power and internet supply- this is a very common problem which is also often misused by the employees as an excuse to stay away from work for a couple of hours.
- Absence of social life - Workplace where employees spend about not less than 70% of their working hours is also like a home and colleagues are like members of family where one gets to interact, discuss things over cups of coffee, share their problems as well as lunches and celebrate achievements. Getting stuck at home with no outside interaction and relief from the everyday monotony of staying at home is increasing anxiety and depression amongst employees.
- Blurring the line of personal and professional space – Often, the office bosses expect round the clock availability of an employee owing to the fact that laptop / desktop and internet connectivity is present at his/her disposal. Also, on the other hand being present at home gives an impression that the person will be available for helping with small household chores or a quick visit to the market whenever need arises. Especially it is difficult for the small children at home to fathom why their parents wouldn’t be free for them despite being at home.
- Increased work hours - In a physical space like the office certain issues get resolved when a team sits and discusses or brainstorm together or a colleague is available right beside your

desk to help out/coordinate which often is not possible virtually over chat-bots or phone calls. Often it is not possible to coordinate with everyone together to sort out an issue apart from virtual meetings that follow a fixed timing. This often increases the effort one has to extend towards completion of work coupled with expectation of the Management to be available all the time whenever need arises since there is no commute time for the employee and is expected to put some extra hours at work as there is apparently no need to allot time to family since the employee is always 'at home'.

- Financial Insecurity - The lockdown in last year churned out huge losses for industries and the Covid protocol being in force and spike in cases again this year, most employees are burdened with the insecurity of losing employment or accepting pay cuts.

As a result, the fact that staying at home has become 'all work and no play' with no other forms of entertainment or relaxation, clinical depression and other forms of mental illness is slowly and steadily devouring a person. It is also reported that domestic violence and marital discord has also gone up significantly post lockdown. According to official data, the National Commission for Women (NCW) registered an increase of 2.5 times in

complaints of domestic violence in April last year. The NCW received 1,477 complaints between 25 March and 31 May 2020.

Organisations are making efforts to investigate whether the ways of operating, that have served them well previously, will be fit for the future. Human resource management is in a unique position to lead enterprises as they recover and thrive in the new world of work. They must play an important leadership role in shaping the way enterprises recruit and develop talent, build on employees' experiences, and diverge from traditional operating models (Deloitte, 2021). The lessons from the past build the successes of the future.

The re-establishment of organisational culture will become the highest priority for human resource departments as organisations try to adapt to the post-pandemic world. Accordingly, there will probably be a major shift towards hybrid working models that take advantage of both remote and office working. The latter, although considered a positive change, brings with it the risk that this transition threatens the existing organisational culture. The social dynamic between employees will not be the same due to differing working conditions, including less face-to-face interaction and an increasingly dispersed workforce (PWC, 2021).

3. Competencies and role of HR

Below is a table which is not exhaustive about the required HR competencies during this troubled times and the approach required to handle the situation.

SI No	Role of HR	Initiatives that can be taken	Approach	Competency required
1	Adaptability	Flexible timings for employees having small kids at home, proposal of meetings during afternoons when kids are resting, proposal to develop employee friendly chat boxes connected to office systems so that all employees can pool in together to resolve a problem without distraction, vaccination drive for employees and family members	Empathetic	Empathy, innovation, foresight
2	Compensation designing	Introduction of broadband connectivity reimbursement, electricity allowance, attractive incentives for working extra hours than usual whereby extra work done should be measurable, providing Covid insurance at payment of minimum premium, other medical allowances, concierge services newly introduced	Strategic Planner	Efficiency in planning, innovation, area knowledge

3	Bridge of trust	Keeping employees updated about the companies' new moves, policies, health benefits, new schemes, provide assurance	Advisory	Counseling, empathy, good listener, effective communication
4	Facilitator	Co-ordinating various video conferences, updates in company websites, addressing employee concerns, team management	Proactive	Quick and effective communication, organizing skills,
5	Creating positive impact	Creating internal channels that communicate good news and positive stories, conducting helpful webinars with medical professionals, sufficient importance to be given for holding motivational & morale boosting sessions	Motivational	Good influencer, positive mindset
6	Genuine concern for safe workplace	Giving a patient listening to the insecurities and apprehensions of employees, when an employee returns to physical workplace after Work from home mode, the hygiene maintenance right from the entry point to usage of elevator everything needs to be considered- one in which employees may demand some "guarantee" of cleanliness to ensure their wellbeing.	Listen and act	Patient listener, Dynamic

For white-collar employees, most of who have been working from home since the pandemic began, many companies have modified perks to suit the work-from-home lifestyle. Some employers introduced a one-time allowance for staff to buy a chair, desk or any other equipment needed to set up their home office. Lennox India Technology Center, a manufacturer of heating, cooling and refrigeration systems has been giving every employee 10,000 rupees for this purpose since last year and the benefit extends to any new employees. "The safety and well-being of employees has been predominant in whatever actions we take," said Hema Mani, Chennai-based Regional Director of HR, Lennox. This year, Lennox added medical insurance coverage specifically for COVID-19 for its employees and their family members. It also created policies to support any other financial needs of employees that might not be covered by medical insurance, Mani said.

NEC Corporation India Pvt, a provider of IT and network technology solutions, increased employees' medical coverage earlier this year when it renewed the company's insurance policy. In addition, employees now receive a subsidized top-up option to further raise the coverage for their dependents. At NEC Corp., where around 95 per cent of staff is currently working from home, a long-standing broadband Internet connection

policy has been revamped, Kashish Kapoor, head of HR at NEC Corp., based in Delhi said. For employees who moved back to their native towns or villages in remote locations, the company bore the initial Internet connection charges.

To provide financial security for its sales staff, Hershey India Pvt Ltd. decided early on not to cut the incentives that make up a large part of their income. Instead, "we changed the design of our incentives," Abhishikta Das, Mumbai-based HR Director for Hershey said. Because sales executives could not visit clients in person, the company decided to assess the sales team based on the number of phone calls they were making to retailers and other clients. "That worked well," Das noted (Shefali Anand, SHRM, Sept 2021 issue).

4. Top HR trends post pandemic

Martucci and Biu (2021) identify five human resource trends for the post-pandemic workplace. Those are:

- **More employees will work from home** - Although before the pandemic some managers thought that those who were not in the office were not really working, the pandemic has proved them wrong. On the contrary, companies have been reporting increased productivity from employees working at home, as long as they have the autonomy

and flexibility to organise their schedule around the work. According to the “Harvard Business Review,” knowledge workers who did their jobs remotely spent 12 per cent less time in large meetings and 9 per cent more time interacting with customers and external partners. Furthermore, the number of tasks judged as “tiresome” fell from 27 per cent to 12 per cent.

- **Collaboration and personal connections will become more critical** - A disadvantage of remote working is the lack of personal connections that comes from being in an office environment. As a result, it is expected that human resource specialists will create a diversity of new ways to gather people such as hybrid schedules which combine in-person and remote working; reimagined workspaces that enable better connections between people in the office; retreats and planning sessions where employees can come together and brainstorm for several hours or days.
- **The debate over location-based pay will continue** – During the pandemic, many knowledge workers moved to relatively lower-cost places to live, often far away from their offices as they no longer needed to commute and pay for transportation. The latter raises questions about workers compensation and whether if employees move to lower-cost areas, their level of salary should be cut. Another option is that for existing employees the salary should remain the same, although the pay of new staff from these areas doing the same jobs reduced to reflect the actual cost of living. However, there will be more discussion on this issue.
- **A globalised workforce will present new challenges and opportunities** – The world was interdependent prior to coronavirus pandemic and afterwards it will be even more so. Companies have to balance the need to maintain a company’s brand, identity, and vision with embracing a new variety of workplace cultures.
- **Companies will focus on employee growth and wellbeing**–Although efficiency will always be a goal for successful corporations, it is not enough anymore. The pandemic has shown that the needs of every person as an individual demand in a broader perspective. In this way, there can be a growth of opportunities, these designed to bring about more flexibility, more responsibilities and more trust all around.

5. CONCLUDING NOTE

In the post-pandemic period it is the most

important to recognize, identify and implement what has been learnt from COVID-19 in order to raise awareness of the crisis and increase organisational resistance to any that may occur in the future. Primarily, it means that it is necessary to review, improve and innovate human resource management plans that were used during the pandemic, as well as business continuity plans that are especially important for successful crisis recovery.

Bearing in mind that numerous and significant visible and invisible changes impacted on people during the pandemic, both economically and socially, as well as in their physical and mental health, human resource management has become even more important. Now that we see that the hybrid model of working is here to stay and the organizational culture has transformed, it is imperative on the part of HR department to nurture the same. In order to do that, the policies and regulations of the company should be employee friendly, pragmatic, open minded and flexible and should reflect the trust they put on their valuable employees who have supported the organization barring the hurdles that lockdown and the pandemic has bestowed upon them. Having said that, it is also important that the employers respect the work life balance that an employee is entitled to. Since the employee is working from their personal space, in presence of their family members doesn’t mean that the time spent with them is qualitative. So, it is also important that a reasonable work hour is maintained according to acceptable standards and an employee is given time off to attend to other duties and chores with complete dedication. So as we see, for the very well known functions and roles of HR, the attributes and competencies are continually being modified and getting aligned with the business objective. The presence or absence of it in HR function directly affects the level of job satisfaction in an employee, brand image of the organization and subsequent attrition rate. When a company loses out on trained employees it is obvious that it not only loses precious man days but also the training cost coupled with the expense of going for additional recruitment. The effective compensation designing keeping in mind statutory obligations to keep the organization safe as well as shelling out attractive incentive and insurance schemes for the employees makes or breaks the deal nowadays. Additionally, the HR professionals cannot be content with keeping the workforce engaged, motivated and connected as mentioned above, they also need to rethink and improvise on how to provide better health care facilities or monetary support to the employees and their family members during the pandemic

while being under the strain of processing the paperwork and providing solace to the millions of workers who have been laid off etc. This applies in particular to the introduction and application of “soft management variables”, such as more frequent meetings of those employees working from home with those still working in the offices, encouraging more frequent gatherings and socialising, joint planning and the preparation of new methods and ways of working, carefully balanced between the needs of organisations, individuals and families. The application of new technology has to be an opportunity and not just a threat to jobs. In the post-pandemic era, managers trained to meet the new reality will further increase their skills and potential to build the organisation into the future. Additionally, the

entire notion of workplace or premises has shifted and mere service rule oriented approach would no more suffice. HR professionals need to rethink, brainstorm and modify the policies and guidelines of the employees with changing environment of work. For example what situation will comprise workplace injury in case an employee meets with an accident while at home and working? What leave will that employee be entitled to?

These are some points to ponder as the role of HR is undergoing a sea change in these turbulent times. Some of the attributes as mentioned above if channelized in the right direction with innovative thinking as leverage, can bring HR to the level of being strategic partner in an organization whose role is attuned to the business policies and objectives.

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Bidhannagar, Kolkata-700106 | Email: wbpdc@wbpdc.co.in | Website: www.wbpdc.co.in