INDUSTRY TO WAKE UP TO HARMONICS DISTORTION BY NON-LINEAR LOADS

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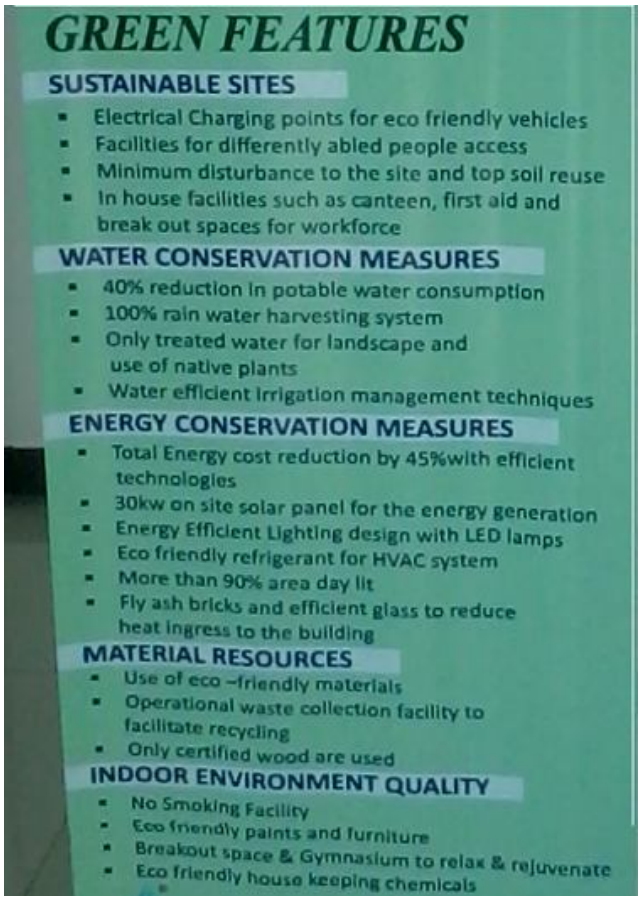
We are pleased to share with you the energy audit case study in a Platinum rated IGBC green factory. Here we showcase to you about the industry's initiative to correct the defects if any before the energy audit and the steps taken by the industry immediately after the audit to reduce the THD harmonics dumped to the EB grid.

"A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building." This industry called us to conduct energy audit+ harmonic audit immediately on commissioning their plant and acted subsequently to implement the energy conservation measures proposed in our Energy Audit Report.

About the IGBC Platinum energy rating to the Industry:-

The industry is platinum energy rated by IGBC and is one of the Greenest Factory in India. The industry manufactures precision injection moulds and finishing machinery for plastic products. This is expected to result in a reduction of carbon dioxide emission by over 500 Tonnes annually, a 45 per cent reduction in energy consumption through provision of energy efficient LED and Plasma lighting systems and energy efficient utilities in HVAC, air compressors, UPS etc., onsite waste management systems to facilitate recycling. They have utilised only about 15% of the site for the buildings and allowing the expansion in 10% more of the site space. This leaves about 75% of the site as landscaped all the time.



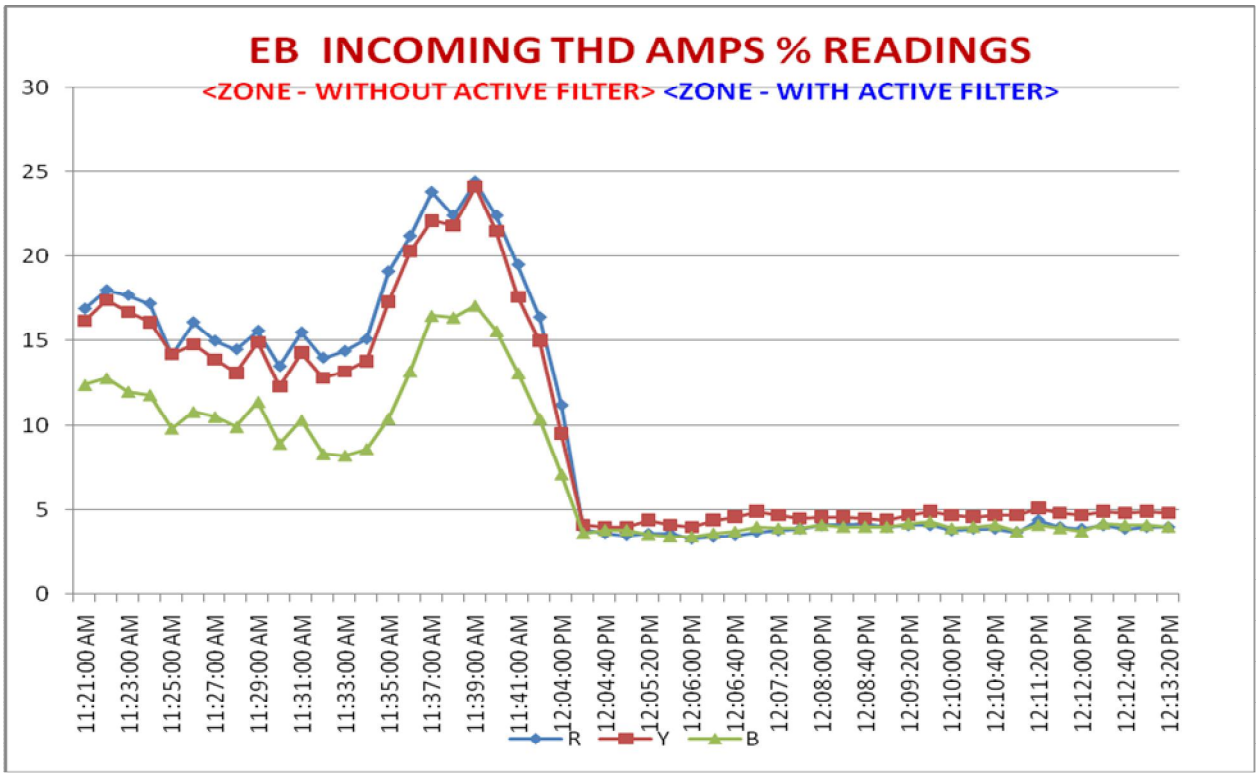
INDUSTRY LOAD DETAILS :-

The industry is a HT consumer and the loads are mostly non-linear. The production machines are CNC machines and VFD driven Injection molding machines, the utility machines like the HVAC packages are also VFD operated, the Air Compressors are VFD type and even the lighting is LED and organic LED type. The Auxiliary included 500 KVA

OLTC transformer, 180 KVAR APFC standard panel, 160 KVA and 400 KVA DG sets, 160 KVA IGBT type UPS for the production machine backup safety.

ENERGY AUDIT OBSERVATIONS & RECOMMENDATIONS:-

1. The earthing was conventional type and we suggested the client to check and change the conventional earthing to Maintenance Free Earthing type. And maintain the Earth grid single looping from the neutral to ground at one location near Transformer secondary instead of multiple stand-alone loopings, causing potential differences.
2. When the APFC is switched ON at the MV panel end, automatically the THD increases and the PF goes to the Leading region at the EB incoming. So we have told to switch off the same now.
3. Later, we have suggested to detune the existing APFC bank by using Reactance Coupled Capacitors to suit to the required KVAR demanded by the EB to maintain at 0.95 to 0.97 PF.
4. We suggested to the client to talk to their Production & Utility Machine vendors like the Injection moulding machine, CNC machine, HVAC packages, Air compressor utility to provide Line Reactor Choke immediately in front of their VFD as the same is not provided by the vendors till date.
5. After taking the initial step of reducing the harmonic distortion from drives, then we had suggested the client to take a trial of Active Harmonic Filter to bring down the THD levels as per IEEE 519 norms enforced by the EB now.
6. Since the client had already done the Incoming energy parameters monitoring and net working to the computers, we had asked them to add a Energy Multi Function Meter with Harmonic monitoring + Alarm locally and the same to be networked to the computer for studying the trends etc
7. Because of non-linear loads, the DG set vendor offered higher sized 400 KVA DG set considering the future expansion as well. So now, 400 KVA set needs to be operated now for even 25 % of the loading, as the industry fears to run DG 160 KVA facing the alternator overloading possibility due to the existing non-linear load ends.
8. Hence the industry gets only 1unit per liter of Diesel on sample study on 400 KVA DG set . So we suggested to oversize by 50 %, the alternator of 160 KVA and that the industry can get 3 units per liter of Diesel. And plan to run the DG to suit to load KVA so that it is around 60 % loading and above.
9. The client initiated to take trial of the Active Harmonic Filter and he decided to fix the same after the successful trial, at the transformer secondary; so as to curb the harmonics dumping into the EB grid.
10. We had suggested to the client to put the Active Harmonic Filter at the common PCC between the EB and the DG so that the AHF can function now for both the EB and the DG rated 160 KVA.



POINTERS TO THE INDUSTRY SEGMENT:-

1. To brief the electrical contractors and consultants; before the start of the project itself about the nature of non-linear loads, the ratio of linear and non linear loading to the proposed K rated transformer in turn to EB.
1. Try to locate capacitor to motor end panel to suit to any equipment motor above 5 HP.
2. To check with vendors what is their motor no load KVAR before commissioning and add the capacitor rated 90 % of no load motor KVAR size near the motor end panel.
3. To plan to procure capacitor voltage rating to 440 volts instead of 415 volts when the industry has OLTC settings at 400 volts and for a non-OLTC transformer industry to go for 480 / 525 volt rated capacitors.
4. In case of capacitor banks to be mounted on MV panel, plan for Reactance coupled cap banks.
5. Strictly speaking, never allow the capacitors mounting at the incoming / SSB of non-linear loads like VFD etc.
6. To buy the VFD etc drives from vendors after ascertaining the harmonic compliance from the OEMs.
7. The vendors to commit that the PF will be maintained at say PF 0.95 for any loading levels and the harmonics to be reduced to the minimum level to the partially loaded machines.
8. Since the majority of loads essential in production and in utility is non-linear, it is not required to fix only the standard linear capacitor banks or standard APFC systems to maintain PF of above 0.95
9. The EB norms call for maintaining the PF of around 0.95 and EB does not specify that the standard capacitor banks or APFC or RPFC to be installed strictly.
10. "That is KVAR to be sized to 40 % rating of sanctioned KVA" – this standard need not be followed, but achieve the result of 0.95 & above PF by the matched PF compensation.
11. It is suggested to the industry that the EB wants an optimum PF of 0.90 to 0.95 as monthly KWH / KVAH to maintain their distribution safely from the industry end to the substation.
12. But the industry is overacting now to maintain unity PF and show case to others that they are efficiently managing their electrical distribution. On the contrary, this causes instability within the industry electrical distribution and in the incoming route from industry to substation. Also the capacitors are added more in the unity PF region; hence consuming more, failing and amplify the electrical distribution instability.
13. EB suggested maintaining PF at 0.95 and above and the industry manager is provoked to maintain at 0.996 PF so as to get PF incentive in Rupees. The same has been withdrawn by EB as this was overdone. Since the existing APFC was operated in single CT mode sensing, always this resulted in leading PF region resulting in damages and penalties.
14. Now by foregoing 5 % KVA by maintaining 0.95 to 0.97 PF region, the industry to certain extent, can avoid the EB penalties due to leading KVARH, exceeding Harmonic Distortion limits etc.

IN GENERAL ASPECTS:-

1. The capacitor compensation done at the linear load incoming ends like the motor; is equal to the Line reactor choke / Filter addition to the incoming of non linear loads like VFD so as to reduce the harmonic distortion feeding back to Incoming MV panel. Hence we can equate as:-

Load end Capacitor + fixed bank + Automatic PF controller for linear loads =
Filter Choke + Reactance coupled Capacitor + Active Harmonic Filter for non linear loads.
PF improvement IN STAGES done before & now Harmonic distortion reduction IN STAGES required.

This hybrid working will be economical now for the initial costing, reduced running KWH cost of harmonic suppression & filtering, reduced Line losses since fraction of harmonics is arrested at the VFD load end.

2. Before, what was done by the industry towards PF improvement in stages to suit to EB requirements, the same concept to be applied for non linear / mixed loads to reduce the harmonic distortion in stages from say 40 % THD to say < 20 % in first step at load end and at SSB. Next step and the final stage is to bring down less than 8 % THD, using Active Harmonic Filter (similar to APFC) within EB norms & limits.
3. Many caps are already de-rated / die silently or does not improve the PF but consume much more KW power than anticipated especially, in the Leading PF region. This is shocking to many in industry!

Existing capacitors are becoming Fast Moving Consumable when fed to non-linear loads.

4. Many industries are keeping decade-old capacitor bank in the power house MV panel. We find during our energy audits, that many of the capacitors are having de-rated KVAR, dead, very less improvement in PF but amplify the harmonics distortion that comes from non linear VFD loads.

5. The DG sets also can run at PF 0.9 at the load ends. Frequent switching on & off the isolators at SSB leads to single phasing of the capacitors in many cases and here caps consume 10 times more the Watts! Motor single phasing can be noticed early. But capacitor single phasing silently happens. Please make it fool-proof.

6. Till now, the VFD vendors have sold their products to perform the variable frequency drive function only to the process and the harmonic arrest at the source of VFD was not given the priority then at the time of sale to the industry. Now when you buy a VFD hereafter; ask the vendors, what the harmonics it will dump to the incoming and what harmonic compliance the vendor gives to the VFD.

7. The partly-loaded motor always have poor factor and similarly, the Harmonics is more during part loading of VFD and that is where the vendor must state the harmonic distortion at each quarter of VFD loading.

8. If the industry is using DG set to feed to non-linear loads, the above hybrid harmonic stage reduction will save the DG alternator. If your DG is feeding to the existing VFD loads, the DG alternator will fail quickly and you may have to replace with 50 % higher sized alternator to face that loads. Better alternative is to prevent the harmonics distortion to enter into the DG alternator now.

9. By following the above practical steps,

- we from the industry now, have taken care not to dump harmonics to the incoming EB side,
- **but also we have prevented the negative effects of harmonics to multiply horizontally inside.**
- Reduce the Harmonics spilling to other horizontal areas in our distribution network components,
- Reduce failures in the electronic modules malfunction, heating of Neutral & other conductors,
- Reducing the Line losses in KW and in KVA due to higher harmonic current, unbalance etc.
- **Arresting the Harmonics at the Source is beneficial to the industry first and next to the EB grid.**
- **Let us collectively work towards reducing the Distribution Losses inside our industry FIRST and this will automatically reduce the Transmission Losses in the EB grid.**

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