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Electrical Power Quality Analysis - A Case Study in Yarn & Thread Industry

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Abstract: A Quality electrical power supply must be available at all times even within the frequency and magnitude tolerance limits, and always with a perfectly sinusoidal waveform. A reliable, efficient and safe power supply is essential for guaranteeing productivity and precision in any organisation.The Power Quality Audit (PQA), is a service offered to checks the reliability, efficiency and safety of an organization's electrical system.The power Quality Audit was conducted in a leading yarn & thread industry. We have conducted this audit for two days with all human safety measures and also we have follow all the standards from BEE before conducting this audit. The report was presented in this paper about the various issues and recommendation to attain the solution for the same.

Keywords: *Power Quality, thread insdustry etc.*

I. POWER QUALITY AUDIT - INTRODUCTION

The PQA was conducted by using Power Analyzer – FLUKE – Class 0.5 Accuracy , it verifies the following aspects:

- ✓ The Quality of the Earthing system: i.e., that whether there is proper Neutral & Body earthing system was maintained to safeguard the sensitive equipment from failures & human from electrical shocks;
- ✓ The Continuity of the power supply: i.e., that the power in the network is available on a regular basis and is able to ensure the efficient operation of the equipment;
- ✓ The Quality of the Voltage & Current: i.e., Check whether there is any low or high frequency disturbances in the network which is capable of damaging the system components.

Load Details of Company:

SC No	**:**	**376 & 147**
Sanctioned Demand	**:**	**688 KVA & 250 KVA**
CT Ratio Adopted	**:**	**125/5 A**
PT	**:**	**11KV / 110**

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II. POWER QUALITY STUDY AREA

i) SOURCE END & LOAD END

S.No	Purpose	Main Panel	Name of the Feeder
1	Power Quality Study	1000 KVA Transformer @ MV Panel	@ 11 KV H.T Common Breaker
			@ ACB INCOMER
			@ DRIER – OUTGOING
			@ DYEING – OUTGOING
			@ RO PLANT- OUTGOING
			@ SOFT PACKAGE - OUTGOING
			@ UTILITY PANEL - OUTGOING
2		500 KVA Transformer @ MV Panel	@ ACB INCOMING UNDER DG LOADING

ii. OBSERVATIONS MADE DURING HARMONICS STUDY @ SOURCE END

Overall we have conducted a complete Power quality audit in an industry source end side outgoing feeders, we were able to identify some key problems which should be checked and maintained periodically of Power & Harmonic parameters. During the audit, under various conditions of Transformer loadings, we can observe that there is a severe fluctuation between the voltage harmonics VTHD%, current Harmonics ITHD (%) occur at every machine ends.We have monitored the harmonics presence and its analysis for every 1 SEC, because of continuous variation of loading conditions. Harmonics generation in an industry mostly due to Capacitors, some VFD's loads etc. Due to Harmonics Circulation and unbalancing loads, there is a possibility of failures in sensitive electronics parts. So we will focus our audit for arriving the harmonic filter design to mitigate harmonics at critical level of harmonic generation areas.

iii. HARMONICS CONDITIONS @ EVERY FEEDER END

During the audit, fluctuations of Voltage and Current Harmonics THD% were observed according to the various loading conditions. At load end the electrical System get nominally affected by the harmonics because of major electronics load usage. For Ex: AC's, VFD's, and Excessive Dump Capacitors. Basically harmonics generation starts from Non-linear Load end sides. Harmonics Contains various orders (i.e.) According to the multiples of frequency arises from your load ends. In that there is a major impacts caused in particular harmonics orders 3^{rd} Order, 5^{th} Order, 7^{th} Order etc.,

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- 3rd Order Harmonics arises because of Heavy Unbalancing current & improper Neutral system maintained in the electrical system.
- 5th, 7th Order Harmonics arises because of Non-Linear loads presence in the electrical system Ex: 6 Pulse Variable Frequency devices, UPS, Centralized AC's, Computer Networks etc.,Earthing System improvement should be strengthened, we have to upgrade this and maintained this properly to get better life for sensitive electronics loads and also we will get some balanced voltage THD from this activity.

IV.DATA SHEET

SC NO: 376 – @ 1000 KVA TRANSFORMER SECONDARY SIDE – @ MV PANEL

S.No	Measurement Conditions	Voltage (Volt)	Load Current (Amps)	KW	KVA	Power Factor	Voltage THD%	Current THD%
1	@ 11 KV H.T Common Breaker	11064	19	350	373	0.936	2.1%	11.2%
2	@ ACB Incomer CAP ON (172.5 KVAR)	407	450	298	307	0.980	3.4%	14.5%
3	@ ACB Incomer CAP OFF (172.5 KVAR)	404	540	351	367	0.950	3.5%	10.5%
4	@ SSB 4 DRIER CAP ON (40 KVAR)	405	128	77	81	0.95 Lead	3.6%	26.0%
5	@ SSB 4 DRIER CAP OFF (40 KVAR)	401	175	103	108	0.96	3.2%	23.0%
6	@ SSB 2 DYEING	410	148	95	99	0.94	4.5%	28.0%
7	@ UTILITY PANEL	405	51	50	45	0.85	3.3%	46.0%
8	@ RO Plant 100 KVAR ON	413	93	53	60	0.86	4.7%	18.3%
9	@ RO Plant 100 KVAR OFF	414	107	51	76	0.68	4.0%	5.0%

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10	@ Soft Package	404	28	17	19	0.89	3.2%	24.0%

SC NO: 147 – @500 KVA TRANSFORMER SECONDARY SIDE @ MV PANEL

S.No	Machine Name	Voltage (Volt)	Load Current (Amps)	KW	KVA	Power Factor	Voltage THD%	Current THD%
1	@ ACB Incomer Under DG Loadings	409	95	52	53	0.98	3.0%	6 to 8 %

From this data sheets we can observed that the complete parameters especially Current Harmonics Conditions in all Transformers & its load feeders @ Cap ON & OFF conditions.Current THD% was maintained in critical range according to CEA rules. Its nearly 5 to 50 % at some load end feeders. There is some certain unbalance effect at load ends.

According to IEEE standards, If the current unbalancing % was greater than 2%, we have to be provide the separate earth pit near critical SSB Panel end and maintained its very properly. We must provide Neutral Earth pit @ critical SSB end, then it should be properly maintained without any looping with Body earth pit. This will safeguard your sensitive equipments and arrest some THD%.Otherwise its impact was very danger to the nearby sensitive equipment like PCB's, Mother Boards, MCCB's Control Circuits, PLC's etc..Machines under loading Transformer (or) DG, we must maintain the power quality standards.

The above table clearly indicates that the PF conditions @ both Cap ON & OFF conditions. Under dumping of Capacitor , both PF & Current THD rises according to the reactive power injections.So we need to monitor both PF & Current THD under dump capacitor OFF conditions.Under this conditions, we need to note down the Maximum individual orders of harmonics (3^{rd},5^{th},7^{th} etc.,). Mostly 5^{th}& 7^{th} Harmonics was dominated, this will arises because of using completely drive loads under 6 Pulse Technologies.Harmonics impact was very high in mostly all the Transformer loads, we observed that the harmonics individual level in every outgoing feeder @ Load ends.The impacts of harmonics presence was very high in certain feeders

Under 1000 KVA Transformer – SC NO: 376

- ✓ ACB I/C – High Impacts of Harmonics
- ✓ DRIER
- ✓ DYEING
- ✓ UTILITY PANEL
- ✓ RO PLANT

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Under 500 KVA Transformer – SC NO: 147

- ✓ ACB I/C – Moderate Impact of Harmonics

It was clearly noted down that mostly **5th Harmonics** impact was very high in most of the feeder which indicates the Non-Linear Loads.

- DRIER
- DYEING
- RO PLANT

This harmonics distortion makes disturb the sensitive equipments which try to face the failures at one point of time extremely.If the harmonics flow continuously taken place @ this same conditions, there is a possibility of frequent failure in sensitive electronics Parts & control circuits, Derating of Machine capacity, Cables, Overheating, Machine Sensitive electronic parts gets failure (Under Transformer Loading & DG Loading). Current THD% was completely oscillating nature which indicates the abnormality of the source current.

Harmonics current was travelling in nature which also disturbs other conventional electrical system.For the reference, the below figures shows that the harmonics filter requirement status in various ends.

III. POWER QUALIT PROBLEM OVERVIEW

1000 KVA Transformer – SC NO: 376

S.No	Source End @	Power Quality Conditions	Harmonics Filter
1	**@ 11 KV H.T Common Breaker**	Medium	Need
2	**@ ACB INCOMER**	Medium	Need
3	**@ DRIER – OUTGOING**	Poor	Must need
4	**@ DYEING – OUTGOING**	Poor	Must Need
5	**@ RO PLANT- OUTGOING**	Poor	Must Need
6	**@ SOFT PACKAGE – OUTGOING**	Medium	Need
7	**@ UTILITY PANEL – OUTGOING**	Poor	Must Need

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500 KVA Transformer – SC NO: 147

S.No	Source End @	Power Quality Conditions	Harmonics Filter
1	**@ ACB Incomer Under DG Loadings**	Medium	No Need

i. OBSERVATIONS MADE DURING ELECTRICAL PQ STUDY @ LOAD END

We have monitored & analysis the electrical power quality parameter at Critical SSB's load end under various SSB's & various individual machine ends. Current unbalancing & current Harmonics were severely high @ load end; every machine area has the same impacts in it. Because harmonics was generated by Non-Linear loads due to mismatching Non-linear frequency with the supply frequency. This will completely disturb electrical system own characteristics.Harmonics impacts were very high at Load end.

Due to Non – Linear Loads, mostly the 5^{th}& 7^{th}order harmonic effect will be very high compare with other individual orders – Its indicates the very high harmonic distortion taken place in the electrical system.In Transformer end, harmonic effect was moderate because of suppression of harmonic current taken place in UG cable (Due to Inductance).So we were clearly monitored in load end every feeder incoming. We have to mitigate this harmonics @ every high impact harmonic loads. This will help us to make maintenance free electrical system & highly protective sensitive equipment.

- According to IEEE Standards, the Harmonics limitation should be;
  - Current Average THD **<8 %**
  - Current Individual Order **<6 %**
  - Voltage Average THD **<5 %**
  - Voltage Individual Order **<3 %**

If we are maintaining the harmonics flow under control, there is no unnecessary heating, unnecessary tripping of MCCB's, unnecessary failure of sensitive electronic circuits, products etc.,

IV. RECOMMENTATIONS FOR SOLUTIONS

In the industry mostly the current unbalance & the current THD achieve peak levels according to load variations; this causes severe damage to Load end devices, Sensitive Equipment's, Electronics Boards etc. The damage rendered by this level of distortion will be manifested in electronics equipment's. For a perfectly safe environment and proper functioning of equipment's the value between neutral and Body earth link must be around 0 Volts while the accepted value can be around less 0.2 Volts. This Neutral - Body correction make arresting of certain harmonic levels distortions. Mostly 3^{rd}, 5^{th} & 7^{th} level of harmonics present in your system.

Initially we have to strengthening the NEUTRAL Earth pit separately for every critical SSB Panels.We need to erect a Detuned filter for critical SSB ends and then we must provide Active harmonic filter @ MV panel end. This process is mainly targeted for preventing failures, safeguard the devices & improve its life time (or) We are providing Harmonic filter at MV panel area to meet out TNEB norms for avoid penalty at all load conditions.Then provision of Hybrid Harmonic Filter needed to maintain the power quality to safeguard (or) to improve the life of the electronics equipment's @ Load end feeders

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especially. We have to design suitable HYBRID HARMONIC FILTER for your present harmonic conditions maintained in your industry, from this we can meet out @ low investment cost.We are giving the assurance to meet out TNEB norms in Harmonics suppression & also avoiding failures of sensitive equipments.We are using suitable AHF to mitigate harmonics @ Load end feeders, Source End feeders according to your nature of Harmonics current we will design from this audit

DESIGN & LOCATION OF THE SOLUTION PRODUCTS

Filter Design Sheet -1000 KVA Transformer – SC NO 376

S.No	Solution Feeder	Solution Area	Detuned Filter @ 525V	Active Harmonic Filter
1	@ ACB INCOMER	Power House	35 KVAR	60 A (3 Phase 4 Wire System)
2	@ DRIER – OUTGOING	Department	50 KVAR	Nil
3	@ RO PLANT-OUTGOING	Department	140 KVAR	Nil

V. CONCLUSION

Power quality is the important parmeter to be consider at present automated industrial world, also its a prime problem for electricity board similar to PF issues. So most of the industries now following to make control the harmonics THD % in permissable limits similar to that of Power factor control. Reactive power plays different roles in various forms at present industries. We have conducted thorough harmonics observation in one of the yarn and thread industry and submit the detailed report with suitble recommendations to attain the proper harmonics limits. This will make the electricity waveform as a pure one and also reduces the heat losses occur in the cables, also its reduces the deration in the distribution system which makes electrical system more efficient in operation. We meet out the IEEE Std 529-1992 after execute this recommendations and also avoid the customer penalised from electricity board.

REFERENCES

[1]. G. Boopathy, Dr.M. Siva Ramkumar, Dr.A. Amudha, Dr. Viyathukattuva, Dr.G. Emayavaramban, P. Nagaveni, S. Divyapriya and M. Sivaram Krishnan, “Performance Evaluation of Three Phase Shunt Active Power Filter in Power System Using Non-Linear Controller” in Journal of

Advanced Research in Dynamical and Control Systems, 11(12) pp: 1193-1204

[2]. S.N. Senthil Kumar, Dr. Viyathukattuva, Dr.A. Amudha, Dr.G. Emayavaramban, Dr.M. Siva Ramkumar, P. Nagaveni and S. Divyapriya, "Performance Evaluation of Modeling and Simulation of Higher Pulse Ac-Dc Converters for Improved Power Quality" in Journal of Advanced Research in Dynamical and Control Systems, 11(12) pp: 1054-1074

[3]. P. Nagaveni, V. Saravanakuma, Dr.A. Amudha, N. Prasanna, Dr.M. Siva ramkumar, M. Nivetha and Dr.G. Emayavaramban, "Power Quality Audit- An Experience in An Leading Engineering Industry" in Journal of Advanced Research in Dynamical and Control Systems, 11(12) pp: 1075-1085

[4]. B. Lalitha, S. Divyapriya, Dr.A. Amudha, Dr.G. Emayavaramban, Dr. Viyathukattuva, Dr.M. Siva Ramkumar and M. Nivetha, "Design, Analysis and Application of Dynamic Wireless Power Transfer Technique at High Switching Frequency for a Electric Vehicle Battery Chargers" in International Journal of Psychosocial Rehabilitation, 23(4) pp: 567-581

[5]. S. Mohanraj, S. Divyapriya*, Dr.A. Amudha, Dr.G. Emayavaramban, Dr. Viyathukattuva and Dr.M. Siva Ramkumar, "Technical and Economical Analysis of Power Management System for Electric and Hydrogen Vehicles Charging Station Using Solar Powered, Hydrogen and Fuel Cell Technology" in International Journal of Psychosocial Rehabilitation, 23(4) pp: 582--591

[6]. S. Srisanthosh Kumar, Dr.G. Emayavaramban*, Dr.A. Amudha, Dr.M. Siva Ramkumar, Dr. Viyathukattuva and S. Divyapriya, "Single Power-Conversion Ac–Dc Converter with High Power Factor Based On ZVZCS for Dc Drive Applications" in International Journal of Psychosocial Rehabilitation, 23(4) pp: 627-638

[7]. Viyathukattuva M.A.M.M, Amudha A, M.Siva Ramkumar, G.Emayavaramban "Relation between Solar PV Power Generation,Inverter Rating and THD" International Journal of Engineering and Advanced Technology 9(1) pp 4570-4575

[8]. N. Saravanakumar, A. Amudha, G. Emayavaramban, Dr.M. Siva Ramkumar, S. Divyapriya, "Stability Analysis of Grid Integration of Photovoltaic Systems Using Partial Power Converters" International Journal of Recent Technology and Engineering, 8(1S5) pp 203-210

[9]. S.Divyapriya, K.T.Chandrasekaran, A.Amudha, Dr.M.Siva Ramkumar, G.Emayavaramban, "Low Cost Residential Micro Grid System based Home to Grid Backup Power Management" International Journal of Recent Technology and Engineering, 8(1S5) pp 303-307

[10]. N. Thiyaagarajan, Dr.M. Siva Ramkumar, A. Amudha, G. Emayavaramban, M. Sivaram Krishnan, D. Kavitha, "SVPWM based Control of SCIG-Matrix Converter for Wind Energy Power Conversion System" International Journal of Recent Technology and Engineering, 8(1S5) pp 211-218

[11]. N.Pandiarajan,G.Emayavaramban, A.Amudha, Dr.M.Siva Ramkumar, IR.V.Mohamed Mansoor,K.Balachander, S.Divyapriya, M..Sivaram Krishnan, "Design and Electric Spring for Power Quality Improvement in PV-Based Dc Grid" International Journal of Recent Technology and Engineering, 8(1S5) pp 242-245

[12]. V.Jayaprakash, S.Divyapriya, A.Amudha, G.Emayavaramban,Dr.M.Siva Ramkumar,

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ISSN: 0193-4120 Page No. 10055 - 10063

"Nano - Grid Smart Home With Plug-in Electric Vechicle using a Hybrid Solar-Battery Power Source" International Journal of Recent Technology and Engineering, 8(1S5) pp 246-248

[13]. K.T.Chandrasekaran, S.Divyapriya, A.amudha, Dr.M.Siva Ramkumar, G.Emayavaramban, "Modeling and Control of Micro Grid Based Low Price Residential Home to Grid Power Management System" International Journal of Recent Technology and Engineering, 8(1S5) pp 261-265

[14]. D. Kavitha , M. Siva Ramkumar, M. Sivaram Krishnan, S. Kalaiarasi "An Advanced Power Theft Identifier using LabVIEW" International Journal of Management, Technology And Engineering , 8(X), pp 1153-1165

[15]. S.Sriragavi, M.Sivaram Krishnan, M.Siva Ramkumar "STATIC COMPENSATOR IN POWER QUALITY IMPROVEMENT FOR LVTS" in International Journal of Scientific Research and Review 6(11) ,pp 51-60

[16]. Dr.A.Amudha , M.Siva Ramkumar , M.,Sivaram Krishnan ""Perturb And Observe Based Photovoltaic Power Generation System For Off-Grid Using Sepic Converter" International Journal of Pure and Applied Mathematics(IJPAM) Volume no 114 Issue no 7 pp 619-627

[17]. M.Siva Ramkumar, M.Sivaram Krishnan, Dr.A.Amudha "Resonant Power Converter Using Ga For Pv Applications" International Journal Of Electronics, Electrical And Computational System (IJEECS) Volume no 6 Issue no 9 pp 239-245

[18]. M Siva RamKumar, Dr.A Amudha, R.Rajeev "Optimization For A Novel Single Switch Resonant Power Converter Using Ga To Improve Mppt Efficiency Of Pv Applications" in International Journal of Applied Engineering Research (IJAER) 11(9) pp 6485-6488 .

[19]. M.Sivaram Krishnan ,M.Siva Ramkumar and M.Sownthara "Power Management Of Hybrid Renewable Energy System By Frequency Deviation Control" in 'International Journal of Innovative Research in Science, Engineering and Technology' on 3 (3) pp 763-769

[20]. M.Sivaram Krishnan and M.Siva Ramkumar "Power Management Of A Hybrid Solar-Wind Energy System" in 'International Journal of Engineering Research & Technology' 2 (1) pp 1988-1992.

[21]. M.Sivaram Krishnan and M.Siva Ramkumar "Power Quality Analysis In Hybrid Energy Generation System" in 'International Journal of Advance Research in Computer Science and Management Studies' 2 (1) pp 188-193.