

Power Quality Analysis and Monitoring of EEE Department in Academic Institution



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Abstract: Power Quality analysis is the starting point of the energy management. This power quality analysis is carried out in the Electrical and Electronics Department of an Academic Institution. The Power Quality analysis is aimed at, Conducting Power Quality analysis in all the different panels of the Electrical and Electronics department. To identify and measure the power quality instability similar to voltage, current, harmonics, quality of power factor and reactive power flow of the various panels in the EEE department. Performance of various panels will be analyzed. It also helps to decrease the heavy economic losses to customer and major break of the loads. We provide the implementation strategy with readings and the recommendations for each problem. This project also provides the improvements in the energy conservation and reducing harmonics in all the loads in the EEE department.

Keywords :Harmonics, Power Quality Analyser, Power Factor, RMS

I. INTRODUCTION

The college consists of two transformers 500 KVA and 800 KVA. Hence energy auditing and power quality analysis is important for improving the power factor. The college consists of four feeders to supply the electrical energy throughout the college campus. Each feeder has both overhead lines and underground cables. In this project, we are analyzing the electrical parameters like variation of voltage, variation of current, the quality of power factor, variation of energy and variation of power in each feeder. From the analysis and results we give remedies and recommendations have been given to enhance the power factor and to subside the power loss. In this project we are concentrating on the fields like equipment survey, load analysis etc. Departments connected with the particular feeder lists are given below, and the feeder configuration.

- FEEDER 1: Administrative Block, ladies Hostel.

- FEEDER 2: MCA Block, canteen, CSE Block, EEE Block.
- FEEDER 3: EIE Block, ECE Block, IT Block.
- FEEDER 4: Auditorium, Autonomous Block, Mechanical Block, Civil Block and Boys Hostel 1 and 2.
- FEEDER 5: Science and Humanities Block and Library.

Fig.1. Block Diagram of Feeders

II. LITERATURE REVIEW

M. Izhar.,et.al., gives results of power quality analysis of electrical and electronics engineering department. Data group has been done with power quality instrument BMI over one week. This one week reading help to determine give higher accuracy of power quality analysis. In this paper, power quality parameters are considered such as total harmonics distortion, order harmonics, power factor, and Current, voltage distortion. These parameters are measured effectively.

In this paper author observed that power consumption is more in ground and second floor of building as compared to other floor of building. Finding of this paper is higher neutral current in system due to disturbance of 3 phase 4 wire system and increased total current distortion at ground terminal. [1]

P.Vasmi kumar Reddy.,et.al. presented the results of power quality analysis carried out in VIT, University at various load or feeders. The measurement of power quality parameters like total harmonics distortion, sparkle, voltage and current imbalanced has been done by using PQ-Box-200.

Author has initiate that power quality of educational institute or power quality events like voltage dip, voltage swell, flicker, and disturbance, transient have increased and are degrading the entire system. [2]

M. Rajesh.,et.al., present power quality anal of academics & hostel building of educational institute. Readings has been taken with help of Win PQ mobil-200 power quality analyzer for 24 to 48 hrs. In this study and analysis of power quality parameters like voltage & current harmonics, voltage sag/swell, flickers are done. Collected data is analyzed power quality of academic and hostel building and results are used for to design of new power quality development device. [3]

Christopher.,et.al., discussed the power quality disturbances in power system. The power quality measurement devices and data analysis techniques are also discussed in that paper.

Author said that power quality may be impact on end user facility but it may be consist of communication between all levels of the system.

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Author also said that instrumentation should be able to process data during data analysis process and it is very important to be able to review variation in power quality with time. [4]

Haroon Farooq, et.al., present the power quality analysis of various non linear home appliances. Harmonics analysis is performed in Electrical Transient Analyzer Program (ETAP). This paper also discussed and analyzed the level of harmonics with their impact on system. In this research work, author found results from trial, simulation process and it help to calculate the impact of various non-linear loads on power quality of system. Result has higher level of total harmonics levels which are beyond the suitable standards values [5]. The authors also observed voltage and current at consumer's end is highly distorted which effect on equipment connected in system. [6]

The issues of power quality, effects of non linear loads, remedial measures are discussed in [7] and [8].

III. POWER QUALITY ANALYZER

Krykard is the India's leading energy administration product, serving customer measure protect and conserve energy pan India for more than thirty years. Krykard products have been approved as reliable and trusted products all over India with over 4lakhs installation and counting. Krykard today has highly satisfied customers across all manufacturing segments.

Our energy products viz., servo stabilizers, ultra-isolation transformers, power quality analyzers, panel mounted power & energy meters, lighting energy savers and energy managing software provide successful clarification for power conditioning & energy management needs of industries and institutions.

A. ALM 35

ALM device is an unique device for those involved in Power quality analysis being a device with huge memory. It is also appropriate for long and detailed field studies where large data is predictable to be logged. Four-CT Comprehensive power quality and energy audit and analyzer power.

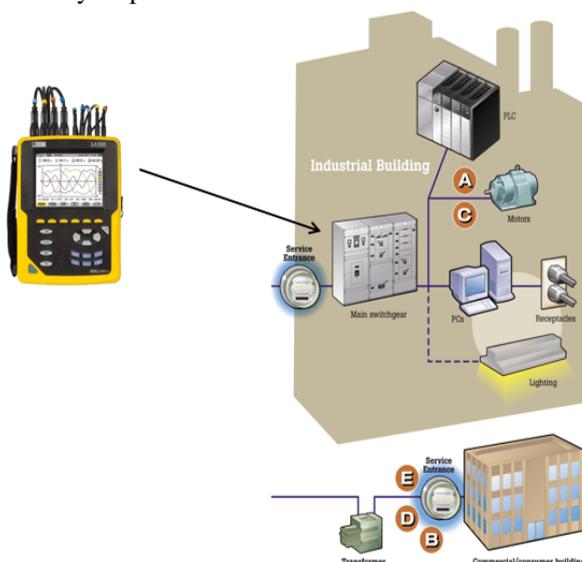


Fig.2. Krykard ALM 35 Analyzer

B. Common Features of ALM 35

Common Features of ALM 35:

- Large Colour TFT Screen.
- Data Collection for 1sec to 15mins.
- Battery backup up to 13hrs for operation & 40hrs for data logging.
- True inrush Measurements

IV. ANALYSIS OF EEE DEPARTMENT PANEL

A. Analysis of Panel Voltage of EEE Department

Voltage variation

Long term voltage variations: When the RMS value of voltage deviate for more than 1 minute; it is called as long term voltage variation.

Sources: Load deviation, Switching operations. It can be divided into following types.

Over Voltage: An overvoltage is an increase in the RMS value of AC voltage above 110 percent at the power frequency for interval greater than 1 minute. Sources: (a) Typically, Overvoltage is due to load switching, (b) incorrect tap changing on transformers

Under Voltage: A lower voltage is a dip in the RMS value of AC voltage below 90 percent at the power frequency for greater than 1 minute. Sources: switching on heavy loads or removal of capacitor bank.

Short-term voltage variations: When the RMS value of voltage varies for less than 1 minute; it is called as Short-term voltage variation. Each variation can be categorized as as immediate, temporary, based upon on its duration of existence. It may be classified into subsequent types: Interruption: It occurs when the supply voltage or load current reduced below 0.1 pu for a time duration of not greater than 1 minute. Sources: Faults in power system, fault in equipments and malfunction of controllers.

Sags (dips): Sag is a decrease in RMS voltage or current between 0.1 pu to 0.9 pu at the power frequency for the time period of 0.5 cycle to 1 minute. Sources: Voltage sags due to system faults, energizing large loads and inrush current of huge motors.

Swells: A swell is termed as a raise in the magnitude of RMS voltage or current between 1.1 pu to 1.8 pu at power frequency for the time period from 0.5 cycle to 1 minute. Sources: Momentary increase in voltage on the healthy phases for Single Line-Ground fault, by connecting a large load or energizing large capacitor banks.

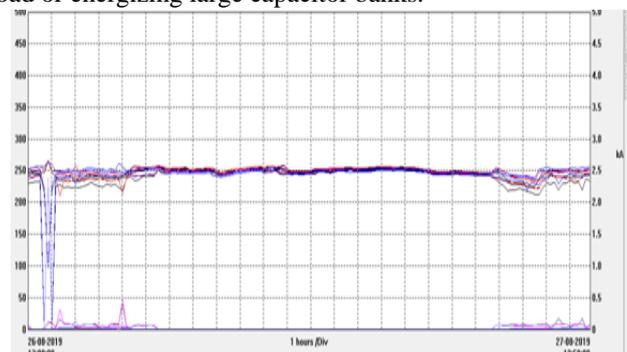


Fig.3. RMS Voltage from Panel 1 of EEE Dept.

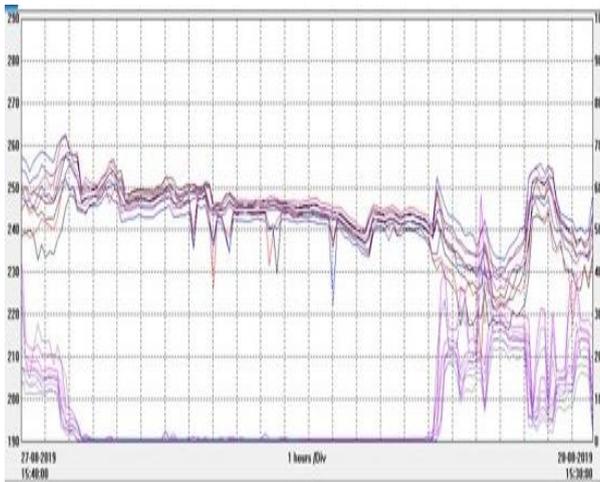


Fig.4. RMS Voltage from Panel 2 of EEE Dept.

Table.I. Voltage Variation

PANEL	MIN. VOLTAGE (V)			MAX. VOLTAGE (V)			AVG. VOLTAGE (V)		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
EEE OLD PANEL	231.3	238.8	242.3	266.0	267.7	264.9	245.3	248.3	247.9
EEE NEW PANEL	216.6	209.5	222.6	258.3	262.2	262.8	242.5	243.8	244.2

INFERENCE

From the table.1 voltage variation violates the Indian standard limit in panel 1, voltage sag occurs due to motor load has been ON during the 2.20pm-2.30pm interval of time on 26-08-2019. In panel 2, the Indian standard limits have not been violated.

B. Analysis of Power

Real power is the power which is actually transferred to the load. Load in an ac circuit can be an induction motor, it can be lighting load or any device which converts electrical energy to some other form of useful energy. Now reactive power is the power which oscillates back and forth between source and load. The product of the RMS voltage and RMS current is termed as apparent power. When the impedance is a pure resistance, the apparent power is the same as the real power. When it is reactance, the apparent power is more significant than actual power.

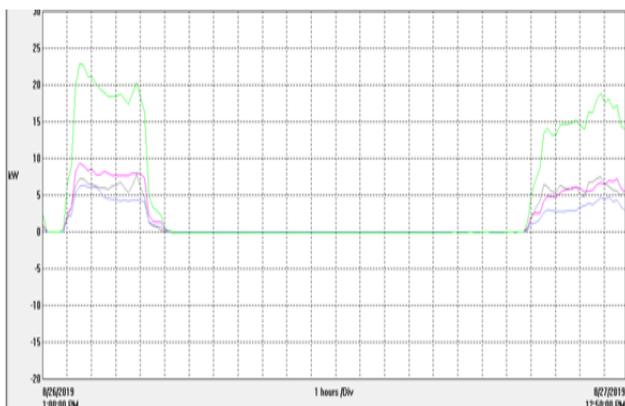


Fig.5. Real Power from Panel 1 of EEE Dept.

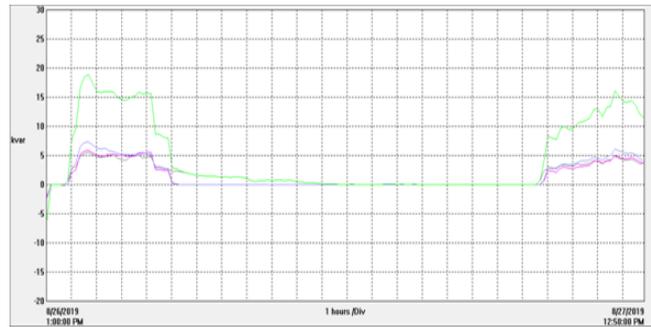


Fig.6. Reactive Power from Panel 1 of EEE Dept.

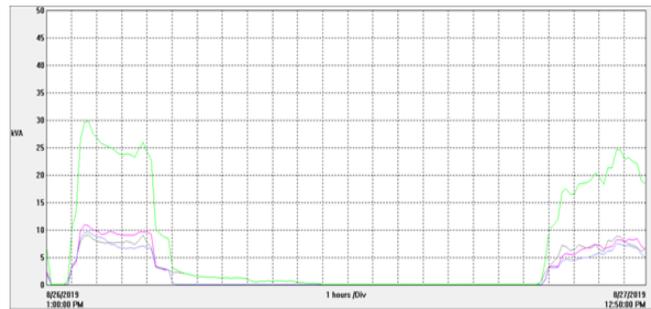


Fig.7. Apparent Power from Panel 1 of EEE Dept.

INFERENCE

The table 2 & 3 explains that Power is equally distributed in all the phase and all the loads are equally shared in each phase. At the time 2.00pm to 5.00pm power demand is high due to 3 laboratories are connected in same time. Power is equally shared.

Table.2. Analysis of Power in Panel 1

PANEL	MIN. POWER			MAX POWER			AVG. POWER		
	A	B	C	A	B	C	A	B	C
REAL POWER (W)	-77.10	0	0	7922	9343	6354	1807	2021	1240
REACTIVE POWER (VAR)	-1888	-2171	-1901	5588	5923	7404	1688	1365	1590
APPARENT POWER (VA)	0	0	0	9203	1103	9773	2648	2471	2051

Table.3. Analysis of Power in Panel 2

PANEL	MIN. POWER			MAX POWER			AVG. POWER		
	A	B	C	A	B	C	A	B	C
REAL POWER (W)	22.20	6.040	30.82	5121	5823	5707	1189	1431	1355
REACTIVE POWER (VAR)	-631.3	-157.3	-124.9	1984	3640	2379	431.7	843.1	583.8
APPARENT POWER (VA)	118.9	128.4	94.11	5425	6842	6154	1377	1789	1562

C. Analysis of Harmonics Distortion

The total harmonic distortion is a measure of the harmonics and is explained as the ratio between the sum of the powers of all harmonic frequencies to the power of the fundamental frequency.

In power system networks, less total harmonic distortion indicated the decrease in crest value of currents, heating and iron loss in motors.

C. Voltage Harmonics Distortion

The Indian standard limit for voltage harmonic distortion below 69KV is 5%

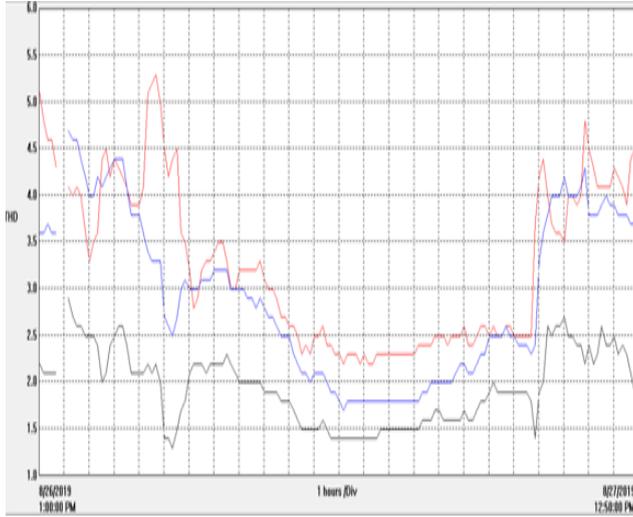


Fig.8. Voltage Harmonics from Panel 1 of EEE Dept.

INFERENCE

From the table 4, the THD value of Voltage does not violate the limits of IE Standards.

Current Harmonic Distortion

The Indian standard limit for current harmonic distortion even harmonics is limited to 25% and odd harmonics are limited above.

Table.4 Results of Voltage Harmonic Distortion

PANEL	MIN. THD (%)			MAX THD (%)			AVG. THD (%)		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
EEE OLD PANEL	1.3	2.2	1.7	2.9	5.3	4.7	1.945	3.271	2.924
EEE NEW PANEL	0.7	0.9	1.0	2.5	4.5	4.0	1.427	2.205	2.152

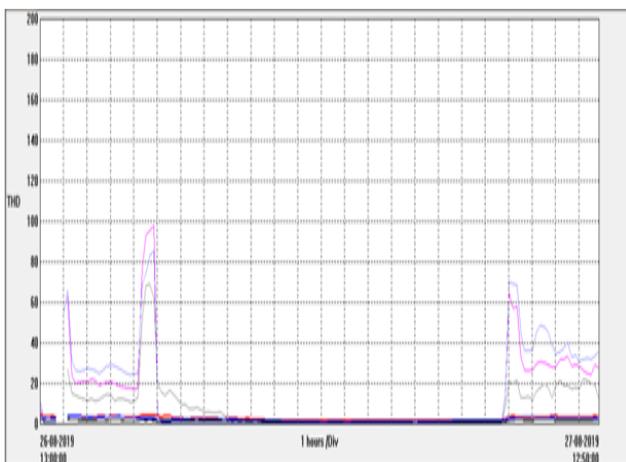


Fig.9 Current Harmonics from Panel 1 of EEE Dept.

Table.5. Current Harmonic Distortion

PANEL	MIN. THD (%)			MAX THD (%)			AVG. THD (%)		
	A1	A2	A3	A1	A2	A3	A1	A2	A3
EEE OLD PANEL	0	0	0	69.30	97.90	85.80	8.139	11.34	13.68
EEE NEW PANEL	12.30	15.10	15.30	100.20	112.35	139.4	52.41	54.79	44.56

INFERENCE

From the table 5 Current Harmonic Distortion does not violate Indian standard limit in panel 1 because current the rating of panel 1 is 60KA. But in the panel 2, the current harmonic distortion violates the Indian Standard Limits because the current rating of panel 2 is 40KA and the electrical machinery working beyond above the saturation point of magnetization curve and the unbalanced loads such as power electronics equipments, computers and air conditioner loads are connected in the panel 2.

D. Analysis of Power Factor

Power factor is the ratio between the real power to apparent power in a circuit. For two systems transmitting the same amount of active power, the lower power factor system will produce large circulating currents due to the energy that proceeds to the supply from the energy stored in the load. Losses are increased due to the circulating currents and decreases the efficiency of transmission system. The circuit with less power factor circuit will have a privileged apparent power and losses for the same quantity of active power. Indian Standard Limit of power factor is 0.85 to 0.9 lagging

INFERENCE

From the table 6, Power Factor violates the Indian Standard Limits because low resistive loads and high inductive loads are connected in the panel. During the off peak hours the power factor is very low due to the capacitor banks are not turned off properly and LED lights are connected in the panel the power factor of LED light is 0.2.

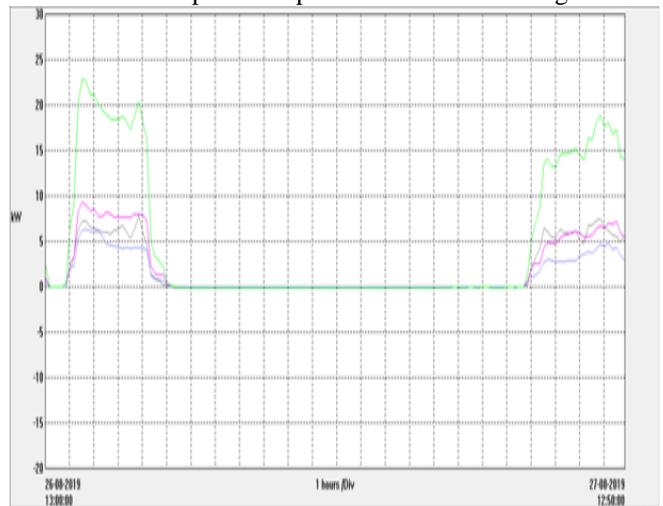


Fig.10 Power Factor

Table.6. Power Factor

PANEL	MIN. PF			MAX. PF			AVG. PF		
	PF1	PF2	PF3	PF1	PF2	PF3	PF1	PF2	PF3
EEE OLD PANEL	0.07	0.48	0.23	0.88	0.87	0.70	0.75	0.80	0.58
EEE NEW PANEL	0.1680	0.045	0.327	0.95	0.9	0.93	0.44	0.36	0.55

V. RECOMMENDATIONS

A. Remedies to Voltage Variation Problems

The loads should be equally shared in each phase to improve the amplitude of each phase.

In electrical machines laboratory, machines should be turned on in the gap interval of 10minutes instead of turning at the same time.

B. Remedies for Equal Power Distribution

By rescheduling the laboratory timings, (i.e.) connecting one or two laboratories at same time, we can reduce the high energy demand.

C. Remedies to Eliminate the Harmonics

To suppress the Harmonic currents generated by the load, active and passive filters can be added to obstruct the current from flowing into the system, or injection of the harmonic currents locally and also by altering the frequency response of the system by inserting filter inductors and capacitors.

D. Remedies for Good Power Factor:

Capacitor bank is automatically switched on and off based on the respective loads. In place of manual operation, we use automatic operation of capacitor bank in order to reduce the manual mistake and to maintain the Indian Standard Power Factor.

VI. CONCLUSION

The value of Total Harmonic Distortion should not be Greater than 5% in Voltage and 20% in Current. In our college THD% value is in stable condition so we don't use any harmonics filters in power house. The value of THD% vary from Department to Department, feeder to Feeder, THD% value is higher where the Super Fan and TUBE 12 size is highly used, for example THD% values in Fan and Super fan is higher than other equipment, because they are used regularly when there is need. Even though THD% values are in acceptable level, in power house we use Filter for Power Factor correction. This filter reduces some harmonics totally. The further loads to be measured in EEE department are Air conditioner, UPS, Systems and several motors in running condition. On comparing the power factors of the tube, fan and motors, the incandescent bulb has the highest power factor due to the reduction in the apparent power. The voltage harmonic distortion of the

tube of size12 is more when comparing with the other loads. The apparent power of LED bulb and incandescent bulb are same. The apparent power consumed by three phase induction motor with 100% load is more when comparing with the single-phase induction motor.

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Power Quality Analysis and Monitoring of EEE Department in Academic Institution

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