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Analysis and diagnosis of electric power quality at ITSH facilities

Análisis y diagnóstico en la calidad de la energía eléctrica en las instalaciones del ITSH

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Abstract

This article presents the study and diagnosis of power quality in the internal electrical network of Building J, within the facilities of the Instituto Tecnológico Superior de Huauchinango that arises from internal research Project in which parameters such as maximum and minimum voltage and current values, frequency, harmonic level are analized, as well as apparent power, active power and reactive power. With the support of the network analyzer of the HIOKI brand, model 3197, the measurements were carried out with the protection protocols (use of gloves, glasses, helmet, etc.), and the results obtained revealed that the values of the electrical parameters of the aforementioned power quality were within the limits allowed by the current standards, also these parameters were plotted with which it was possible to observe the maximum demand of the hours of service, demonstrating that there is a good quality of energy.

Power quality, Voltaje, Current, Harmonics

Resumen

Este artículo presenta el estudio y diagnóstico de la calidad de energía en la red eléctrica interna del Edificio J, dentro de las instalaciones del Instituto Tecnológico Superior de Huauchinango que surge del proyecto interno de investigación en el cual se analizan los parámetros tales como los valores máximos y mínimos de voltaje y de corriente, frecuencia, nivel de armónicos, así como la potencia aparente, potencia activa y potencia reactiva. Con el apoyo del analizador de redes de la marca HIOKI, modelo 3197 se llevaron a cabo las mediciones con los protocolos de protección (uso de guantes, lentes, casco, etc.), y del cual los resultados que se obtuvieron revelaron que los valores de los parámetros eléctricos de la calidad de la energía antes mencionados se encontraban dentro de límites permitidos por las normas vigentes, además se logró graficar estos parámetros con lo que se pudo observar la demanda máxima de las horas que se tiene en el servicio, demostrando que se tiene una buena calidad de la energía.

Calidad de la energía, Voltaje, Corriente, Armónicos

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Introduction

Nowadays, energy problems are becoming more and more visible; therefore, new alternatives are being sought every day to save energy and optimize processes, to be efficient in energy expenses, and to be able to reduce the ecological impact of the misuse of resources [1]. The electricity sector must keep pace with this reality since it is a vital input for any industry.

Over the years, awareness of the proper use of energy and the importance of having a quality energy supply began to be raised, added to the development of new technologies with electronic devices sensitive to voltage variations, can cause distortions, contaminating the waveform that affect the power grid and thus its quality, causing deformations in the waveforms in voltages and currents produced by harmonics. The IEEE 1100 standard defines power quality as the process of feeding and grounding electronic equipment so that it is suitable for the operation of such equipment and compatible with the wiring system of the premises and with other connected equipment, but even with this definition all equipment is not exempt from having a failure or not having a proper functioning if they are connected to a contaminated power grid [2]. Another definition states that power quality is a set of electrical limits that allow a piece of equipment to function as intended without significant loss of performance or expected life. [3] Another definition is that power quality is nothing more than a set of characteristics of electricity at a given point in a power system at a given time, which allow the required electrical needs to be satisfied [2]. The efficiency of electric power is generally defined by a condition of its consumption that ensures the availability of the required quality of electric power while the minimum production losses will have been inherent in the process [4].

Poor quality of electric power brings with it increased energy losses, damage to production, economy and business competitiveness. In recent decades with the introduction of nonlinear loads such as computers, variable frequency drives and others, the negative effects on power quality have been manifested more frequently [5].

Nowadays, the analysis and diagnosis of power quality must be strict, measurements of many parameters must be carried out continuously, such as maximum and minimum values of voltage and current, frequency, harmonics and power. To carry out these measurements should be performed with specialized equipment such as network analyzers to analyze the properties of an electrical network with good accuracy and thus measure such parameters as voltage and current, which also graphs us to have a better view of any disturbance and thus solve problems from occasional tripping, harmonics and phase imbalance [6].

Carrying out a diagnosis of the quality of electrical power in the helps to find the affectations in the electrical installations to be analyzed as they determine the variations of voltage and current, based on this it is necessary to perform an analysis of the quality of power in order to eliminate or reduce all kinds of electrical disturbances, avoiding variations in the quality of the power supplied can easily make the equipment in first not work well and second to be damaged [7].

Development

The Instituto Tecnologico Superior de Huauchinango is located in the northern highlands of the state of Puebla and consists of different facilities, including building J which consists of two floors where are located the classrooms of the careers of Electrical Engineering, Industrial Engineering, the Laboratory of time and motion, the offices of School Control, Library, Storage, Psychology, Administrative Services, teachers area of Electrical Engineering, Cashier and toilets, Library, Warehouse, Psychology, Administrative Services, Electrical Engineering teachers' area, cashier's office and restrooms. Inside the building there is computer equipment, machinery, electronic devices, lighting and power systems, as well as computer equipment, machinery, electronic devices. For all these reasons, it is necessary to conduct a study and diagnosis of the quality of the energy supplied to the J building to ensure the safety of students, teachers, administrative staff and visitors; also, preserving the environment; in order to seek alternatives to reduce or mitigate any type of electrical disturbance [8].

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The data collection was carried out in the 150 KVA transformer bank that feeds building J. This data collection of electric power quality was done 7 days a week, 24 hours a day.

To carry out the diagnosis, a HIOKI network analyzer, model 3197 Figure (1), which is a portable single-phase and three-phase RMS power quality analyzer, was installed; the equipment has USB communication interfaces; with LCD display. This analyzer measures electrical parameters such as: voltage, current, active, reactive and apparent power, frequency and harmonic distortion, among other electrical parameters. The analyzer compares several data points in real time and builds a complete picture visualizing the electrical energy usage, these data are stored to the PC with the help of the software.

Figure 1 HIOKI power analyzer model 3197

Students and teachers participated in the analysis and diagnosis. The connections were made at the transformer output, taking into account the safety requirements for working with energized electrical equipment, as well as interpreting the data provided by the network analyzer.

The process that was carried out was to connect the three phases of the voltages and then connect them to measure the currents, all this was done with the transformer working.

It is important to follow a protocol in the handling of an electrical network analyzer:

– Verify the safety systems.

– To prepare the measuring equipment.

– Configure the equipment (network topology, date and average frequency).

– Establish the connection of the equipment starting with this order: grounding, voltage clamps and amperimetric probes.

– Switch on the analyzer and check the signal.

– Start recording the measurements (daily, weekly, monthly).

– Disconnection of the equipment and data download.

Figure 2 shows the connection of the network analyzer, where the clamps of the device were placed around the phases and neutral.

Figura 2 Three-phase HIOKI connection

Analysis of results

The data collected with the analyzer were obtained by monitoring in 7 days in a period of 5 hours, Figure 3 shows the behavior of the voltages of each phase.

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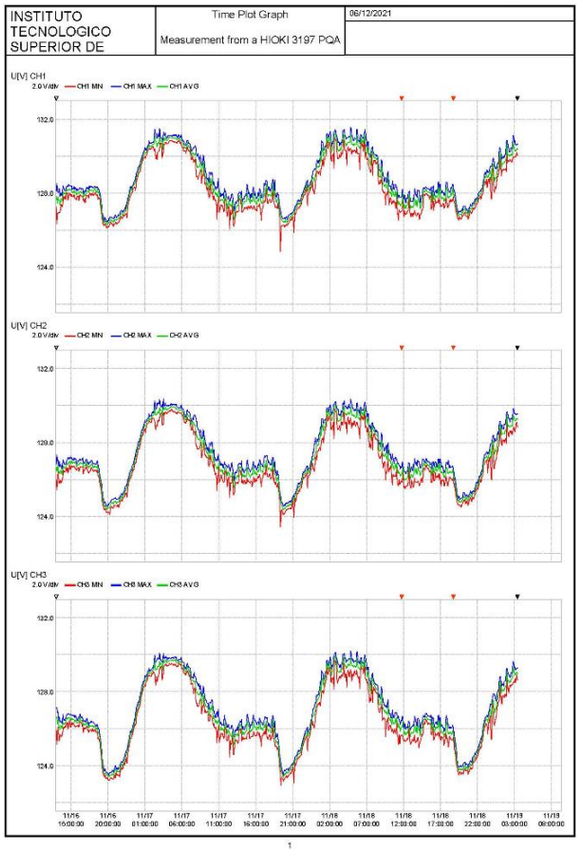

Figure 3 Voltage behavior in each phase

Figure 4 shows the behavior of the current in each phase.

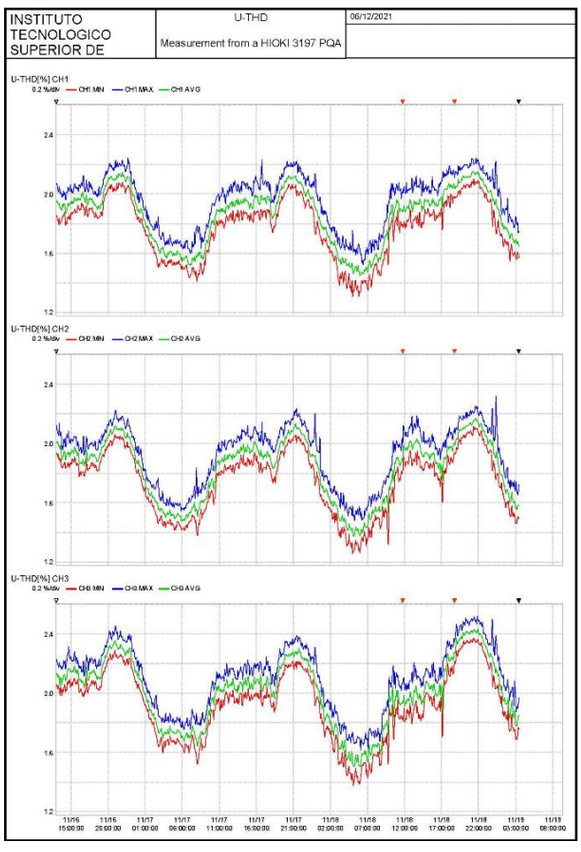

Figure 4 Current behavior in each phase

In 7 days, for 24 hours, the following levels of voltages and currents were obtained, as shown in Figure 4.

V	RMS		
	CH	MIN [V]	MAX [V]
	CH1	124.8	131.6
	CH2	123.4	130.4
	CH3	122.9	130.2
		MIN [A]	MAX [A]
I	CH1	7.3	135.9
	CH2	0	138.9
	CH3	0	114.8
		MIN [Hz]	MAX [Hz]
F		59.89	60.11
	CH	MIN [W]	MAX [W]
P	sum	-0.039M	-0.001M
	CH	MIN [VA]	MAX [VA]
S	sum	0.001M	0.047M
	CH	MIN [VAR]	MAX [VAR]
Q	sum	-0.029M	-0.001M

Figure 5 shows the voltage and current waveform where a deformation in the current waveform can be observed.

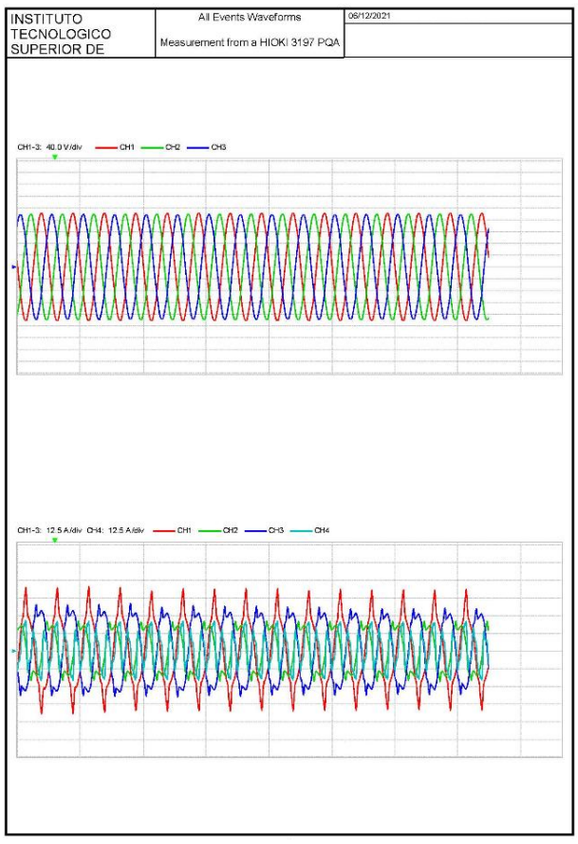

Figure 5 Voltage and current waveforms

Figure 6 shows the maximum active power demand value of 12.7 KW and the average demand value of 5.69 KW.

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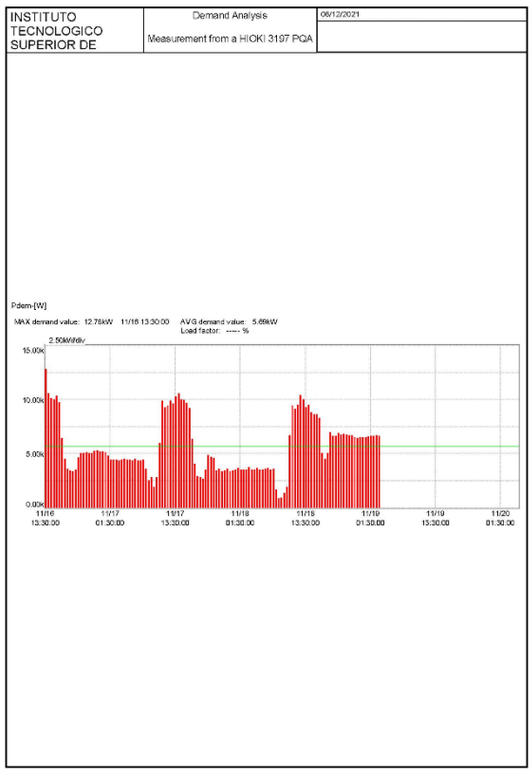

Figure 6 Maximum active power demand

The value of the maximum reactive power demand as well as its average demand is shown in Figure 7, whose values were 5.27 KVAR and 2.994 KVAR respectively.

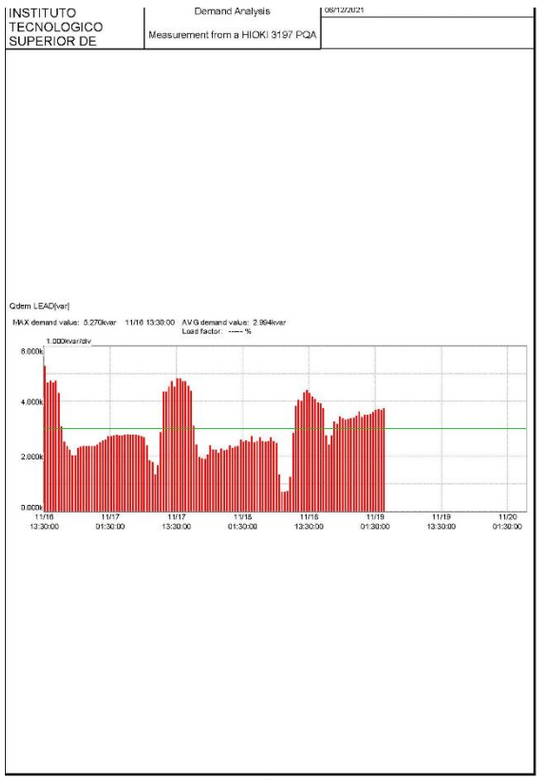

Figure 7 Maximum reactive power demand

Figure 8 shows the maximum value of the active power consumed in KW-H. Finally, Figure 9 shows the behavior of the reactive power in KVAR-H.

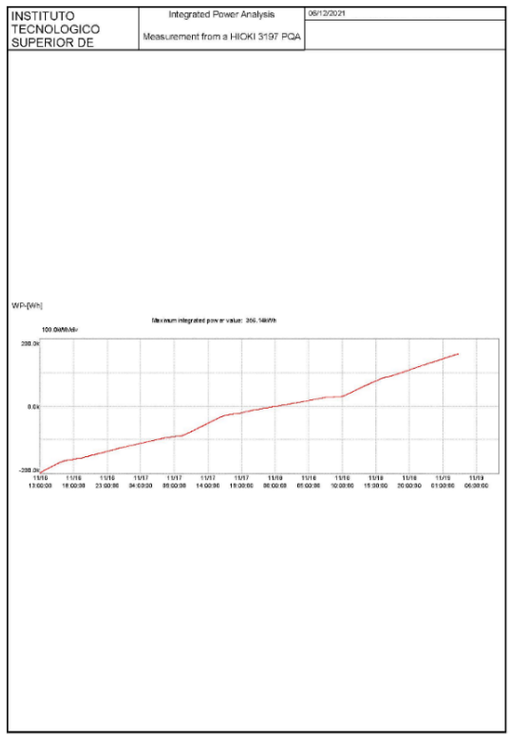

Figure 8 Maximum active power value

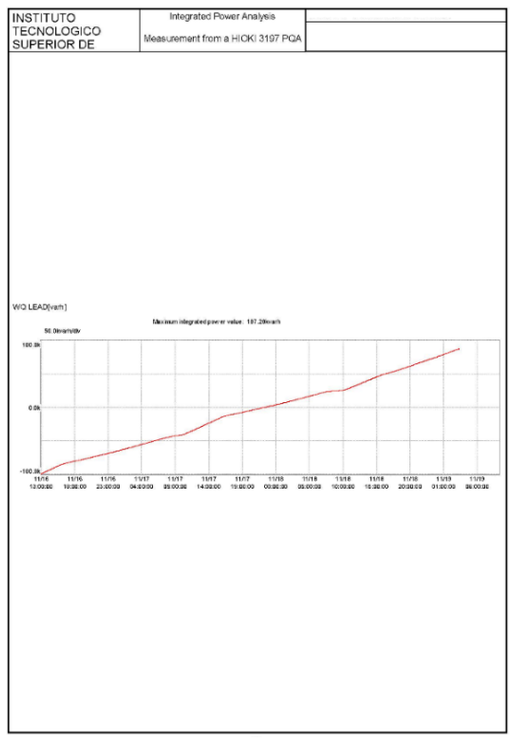

Figure 9 Maximum reactive power value

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Conclusions

In this research it was possible to make a diagnosis of the electrical installations of the ITSH, it was determined that the physical installations where the 150 KVA transformer is located are in optimal conditions, however, it is recommended to perform preventive maintenance in order to prevent failures due to false contacts.

The power system operates at optimal levels, however, it is compromised when harmonic distortion is integrated into the system since it generates a deficient operation of the equipment due to the need to increase power consumption.

The readings obtained establish that the voltage and current ranges are within the normalized values and/or levels.

This type of analysis served to see our type of consumption where there are no disturbances in our network, as this can affect us in what the CFE company does not price values to pay a little high than what our network really has.

In the future we plan to have a wireless electric consumption monitoring system as well as a power quality analyzer.

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