Implementation of an Electric Energy Monitoring System on Main Boards

Implementación de un Sistema de Monitoreo de Energía Eléctrica en Tableros Principales

QUINTANAR-ENRIQUEZ, Marisol†*, MAYORQUIN-ROBLES, Jesús Antonio, MEDINA-MUÑOZ, Luis Arturo and LOPEZ-VALENCIA, Gabriel Antonio

Universidad Tecnológica de Nogales, Sonora

ID 1st Author: *Marisol, Quintanar-Enriquez* / ORC ID: 0000-0002-0813-1596, Researcher ID Thomson: I-4071-2018, CVU CONACYT ID: 903761

ID 1st Coauthor: *Jesús Antonio, Mayorquin-Robles* / ORC ID: 0000-0002-3438-2098, Researcher ID Thomson: H-4071-2018, CVU CONACYT ID: 471236

ID 2nd Coauthor: *Luis Arturo, Medina-Muñoz* / ORC ID: 0000-0001-9598-1451, Researcher ID Thomson: H-4735-2018, CVU CONACYT ID: 454558

ID 3rd Coauthor: *Gabriel Antonio, Lopez-Valencia* / ORC ID: 0000-0001-9274-395X, Researcher ID Thomson: H-5383-2018, CVU CONACYT ID: 883105

DOI: 10.35429/JTP.2019.15.5.20.25

Received March 17, 2019; Accepted June 23, 2019

Abstract

The cost of electric power has become one of the most representative expenditures in the industrial environment and other organizations, only after human resources. Currently, seeking the reduction of expenses in processes and operations has become a necessity for survival in the market. Therefore, the optimization of any process is the measurement, only what is measured can be managed and therefore improved. The reduction and good use of energy is not possible without having a reliable source of information; that is why the implementation of a useful monitoring system will indicate the expenses and in what way to proceed in order to establish real opportunities for savings, as well as strategies for their maintenance in different networks. Thus, the following paper is the result of the implementation of an electrical monitoring system for an industry in the region.

Energy, Resources, System

Resumen

El costo de la energía eléctrica se ha convertido en uno de los egresos más representativos en el ambiente industrial y demás organizaciones después del recurso humano. Actualmente, buscar la reducción de gastos en los procesos y operaciones se ha convertido en una necesidad para la supervivencia en el mercado. Por tanto la optimización de todo proceso es la medición, solo lo que se mide se puede administrar y por ende mejorar. No es posibles la disminución y el buen uso de la energía sin tener una fuente confiable de información, es por ello que mediante la implementación de un sistema útil de monitoreo nos indicara donde se está gastando y de qué manera podemos atacar para establecer oportunidades reales de ahorro, así como también estrategias para su mantenimiento en las diferentes redes. Por lo que el siguiente trabajo es el resultado de la implementación de un sistema de monitoreo eléctrico para una industria de la región.

Energía, Recurso, Sistema

Citation: QUINTANAR-ENRIQUEZ, Marisol, MAYORQUIN-ROBLES, Jesús Antonio, MEDINA-MUÑOZ, Luis Arturo and LOPEZ-VALENCIA, Gabriel Antonio. Implementation of an Electric Energy Monitoring System on Main Boards. Journal of Technological Prototypes. 2019. 5-15: 20-25

† Researcher contributing first author

Introduction

Currently, energy expenditure control is one of the fundamental factors which should be monitored by large companies using electricity intensively as part of their production process. One of the first points to consider is the adaptation of the contracted power to avoid penalties which make supply more expensive. From this, the monitoring and control of electricity consumption on higher consumption equipment is essential to promote energy savings, as well as the visualization of new actions that lead to the optimization of energy use and awareness regarding its usage.

Every day, the optimization of companies' resources becomes more important, which is why maintenance management plays a significant role in achieving this, since good use and proper implementation enable companies achieve improvements and reduce costs (R&H, 2019). Knowing the energy expenditure is the first step to reduce non-useful consumption. This energy excess not only supposes a greater economic cost due to the energy, but also increases the wear of the equipment and the degree of maintenance that we must carry out (IDAE, 2009.).

Economic growth and technological development lead to an increase in the demand for electricity; therefore it is necessary to encourage the efficient use of resources to avoid unjustified energy losses (OLADE, 2013). The implementation of the electric power cogeneration project reduces the production costs of the company ANGLO PERUANA by reducing the consumption of electric power at the Lurín production plant, which allows an increase in operating profit of up to 14%, generating annual savings of 2.9 million US dollars (Gutiérrez, 2019).

Methodology

1. Energy Quality in the Industry

The industry is a representative economic sector in many countries, which evolves according to the conditions provided in each local economy. For this reason, it is important to implement policies that seek the optimal use of resources and the renewal of poor processes to reduce energy losses, which represent an economic impact for companies.

Wasted energy could be used to meet the needs of another consumer sector or to expand the productive activities of the same customer.

2. Energy audits

Energy audits are reports regarding energy consumption, which allow identifying the subprocesses that generate losses and quantify the possibilities of improvement and their economic viability.

The energy audit can be preliminary, detailed or special. The preliminary audit is based on a visual inspection. Detailed auditing requires the use of equipment that generates a measurement record. The special energy audit takes records by device and performs a fault analysis for a certain period.

The results obtained, once the improvement measures are applied, will be reflected in the medium and long term, with the reduction of costs for the factory and the increase of the useful life of its facilities.

3. Installed Load Verification

The six existing transformers in this factory until 2017 represent a power of 5700 kVA. Three pad-mounted type transformers were installed to expand the power capacity delivered to the factory, representing 51.7% of the current installed capacity.

Table 1 summarizes the load values installed per transformer in the factory.

Substation	Kva capacity	Main board
1	500	800 Amps
2	750	1200 Amps
3	2000	2000 Amps
4	500	800 Amps
6	2000	2000 Amps

Table 1 Substations – Main Boards

Design of the Electrical Measurement and Monitoring System

1. Scheme and Distribution of the Measurement System

The constant monitoring of the electric energy consumption will allow registering, controlling and reducing losses, to optimize the management of resources used in the elaboration of medical products, creating databases for a later analysis. Figure 1 illustrates how the electrical monitoring network will be distributed.

Figure 1 Distribution of Electrical Substations

2. Selection of the Monitoring Equipment

The intelligent measurement system consists of two programmable logic controllers, responsible for centralizing the measurements. An ethernet network with Modbus TCP communication protocol is used for energy measurement equipment. The system includes a Human Machine Interface (HMI), implemented through the devices shown in the figures, to allow constant monitoring of measured values, in addition to the storage of historical data.

Figures 2 and 3, as well as tables 2 and 3 illustrate the equipment used, as well as the characteristics of each of them, respectively.

Figure 2 Multifunction Energy Meter

General Data	
Family	Power Logic
Product Name	Power Logic PM5000
Short Name	PM5110
Type of product	Power Meter
Device application	Energy monitoring
Type of measurement	Energy Voltage Current Frequency Power factor
Frequency	60 Hz 50 Hz
Supply voltage	100... 415 V AC (45...65Hz) 125... 250 V DC
Type of communication	RS 485 port Modbus

Table 2 PM5000 Meter Features

Figure 3 Com'X 510 power server

General Data	
Family	Power Logic
Product Name	ComX
Short Name	ComX 510
Type of product	Energy Server
Supply voltage	Main supply: 24 V - DC
Type of communication network	1 RJ45: RS485, Modbus serial Terminal block: RS485, Modbus serial 1 RJ45: Ethernet, PoE 15W (Power over Ethernet) 1 RJ45: Ethernet, DHCP
Number of inputs	6 Digitals 2 Analogs
Memory capacity	128 MB RAM 256 MB flash 4 GB SDRAM

Table 3 ComX 510 Features

The Com'X 510 power server is a gateway and a compact data logger. It is an essential part of every basic energy management system.

It collects and stores data on water, air, gas, electricity and steam consumption, environmental parameters such as temperature, humidity and CO2 levels recorded inside a building. The Com'X 510 provides access to reports such as built-in summary pages of devices and circuits, as well as integrated data logging functions. The system allows access to data in real time in a secure way or their transmission to a report format to a database server on the Internet.

Results

After the selection of the components and the distribution of the different electrical meters inside the plant, the software installation and configuration of the equipment used for the electrical monitoring network of the plant is continued.

1. Modbus Configuration RS485 Series PM5110 - PM800

Modbus is a communications protocol located at level 7 of the OSI Model, based on the master/slave (RTU) or client/server (TCP/IP) architecture, designed in 1979 by Modicon for its range of programmable logic controllers (PLCs). Modbus enables the control of a network of devices, for example, a temperature and humidity measurement system, communicating the results to a computer. Modbus is also used to connect a monitoring computer with a remote unit (RTU) in data acquisition monitoring systems (SCADA). There are versions of the Modbus protocol for serial and Ethernet (Modbus/TCP). Therefore, the following figure 5 shows its configuration with the respective steps.

Figure 5 Illustration of steps for the configuration

- Step # 1: Select the Maintenance Menu on the screen.
- Step # 2: After selecting the maintenance menu press SETUP.
- Step # 3: As is common in these devices if the password has not been modified, by default it is (0 0 0 0) and press ok.
- Step # 4: Select the COMM option to modify the terminal parameters.
- Step # 5: Select the direction of the Equipment, the baud rate (9600, 19200, 38400) to work and the type of parity (Even, odd or null). Select OK and save the settings.

2. ModBus COMX510 Configuration

Once we have our electrical monitoring equipment configured, the next step is to configure the COMX510 server, as shown in figure 6 with the respective steps.

Figure 6 ModBus COMX510 configuration

- Step # 1: First, connect the COMX510 server through the Ethernet cable, one end connected to the Ethernet 2 port and the other end to the computer.
- Step # 2: Once in the computer, open the internet browser and in the address bar place the IP of the server and place the username and password.
- Step # 3: Select the Configuration tab and go to the Communications menu and press Modbus Series.

- Step # 4: Then, the RS485 Modbus configuration will show up in the portal, select the data previously established in the equipment, such as the baud rate (9600, 19200, 38400), the parity (Even, odd or null); in the number of stop bits select 1, in the waiting time select 1 second (1000), in the termination resistance put YES when having impedance, in the serial line polarization put YES, since it is convenient for the master to polarize the line and save the changes.
- Step # 5: The next step is to select the device configuration tab, where it will show all the properties of the COMX510. In this tab we can change the name, place comments, add the location of the device, as well as the building, floor and area where the server is located or supervised.

Finally, Figure 7 shows an image of how the electrical monitoring devices were mounted on their respective boards, in order to obtain the different records previously established.

Figure 7 Board Monitoring

Conclusions

We implemented an intelligent energy measurement system, which enabled the electrical energy measurements of 6 transformers to be stored on a computer.

Among the stored values are the calculations of electric power consumption. All these data are visible in the HMI installed on each electrical panel.

The installation of this HMI interface for monitoring allows for adequate information management regarding the measurement of important parameters, which are used to record consumption in each production period. Before implementing the meters, we worked with estimated values based on the production periods and quantity of manufactured products. The energy data was taken from the meter of the regional electricity company and some existing meters, without being able to make a complete analysis by production line. Based on the project developed, a system is provided to the factory to manage and monitor the consumption of electrical energy and other resources in an appropriate manner. With the data obtained, a permanent record is generated that will allow the implementation of continuous energy efficiency programs, which seek the rational use of resources without affecting the quality of the products, to obtain savings in the plant focused on the development of medical products. With the system implemented, an initial analysis was carried out, characterizing the demand for electrical energy and identifying the load curve according to the processes and machines that represent the highest consumption. The results obtained are intended to develop measures aimed at reducing unnecessary consumption in machines and processes, representing greater savings.

References

Gálvez, R. & Prinsely, H. (2019). Propuesta de implementación de un sistema de gestión de energía bajo la norma ISO 50001, para la reducción de costos en taller de mantenimiento mecánico de una empresa minera.

IDAE, Instituto para la Diversificación y Ahorro de la Energía. (2007). Plan de Acción 2008-2012. Estrategia de Ahorro y Eficiencia Energética en España 2004-2012.

Organización Latinoamericana de Energía OLADE (2013). La Sostenibilidad de la Eficiencia Energética. Retrieved from: <http://www.olade.org/sites/default/files/publicaciones/PALCEE-2013.pdf> (June, 2015).

PowerLogic power. (2017). Power Meter Series 800. 2017, from PowerLogic power web: chneiderelectric.com/resources/sites/SCHNEIDER_ELECTRIC/content/live/FAQS/177000/FA177526/en_US/PM800%20DataSheet.pdf

Gutiérrez, A., Belisa, K., Chambi Bonifacio, J. A., Chávez Velásquez, F.E., Loayza Quispe, J.C., Mendoza., Ricalde, E.R ... & Francisco Javier, j. (2019). Implementacion de una Isla Cogeneracion de 14 MW de electricidad y 6 t/h de vapor.