INTERNATIONAL JOURNAL OF
ARTIFICIAL INTELLIGENCE AND EMERGING
TECHNOLOGY

ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

Methodology of Automation and Supervision of an Industrial System

El Khaldi Jihen, Bouslimi Lotfi, Khorchani Oussama, Lakhoua Mohamed Najeh

Research Laboratory Smart Electricity & ICT, SEICT, LR18ES44
National Engineering School of Carthage, University of Carthage, Tunisia

Abstract:

The aim of this paper is to present on the first hand the architecture of a supervisory control and data acquisition system (SCADA) and on the other hand the modeling and the supervision of a hydrogen station of a thermal power plant (TPP). The cooling by hydrogen of an alternator and the description of the hydrogen station of a TPP are presented. Our contribution in this work consists in integrating a module for the calculation of hydrogen flights to a SCADA system of a TPP.

Keywords: SCADA, hydrogen station, thermal power plant.

1. Introduction

Supervision consists of commanding a process and supervising its working. To achieve this goal, the supervisory system of a process must collect, supervise and record important sources of data linked to the process, to detect the possible loss of functions and alert the human operator (Dimitrios and Panagiotis, 2020; Figueiredo et al. 2012; Walrand et al. 2000; Meha, 2008).

The main objective of a supervisory system is to give the means to the human operator to control and to command a highly automated process. So, the supervision of industrial processes includes a set of tasks aimed at controlling a process and supervising its operation (Clarke et al. 2003; Aamir et al. 2018; Horng, 2002; Marihart, 2001; Mc Clanahan, 2002).

The objective of this paper is to show interests of the use of a SCADA system in a hydrogen station of a thermal power plant (TPP). An example of a SCADA system of a TPP in Tunisia is presented. Next, the interests of the application of the SCADA system are developed. The last section presents a discussion about some advantages of the application presented.

2. General Context

Every day, we use the electric energy without even to be conscious of it. The electric energy serves in all domains including those where we think that it is not used (central heating of gas, thermal motor-driven vehicles...). Means of production of this energy are very various; we classify them today depending on whether they are to basis of renewable energies or fossil energies. With regard to these last, reserves not being inexhaustible, we tries to replace them by the renewable energies that have for main advantage to be less polluting (STEG, 2018; STEG: Revue de l'électricité et du gaz, 2009).

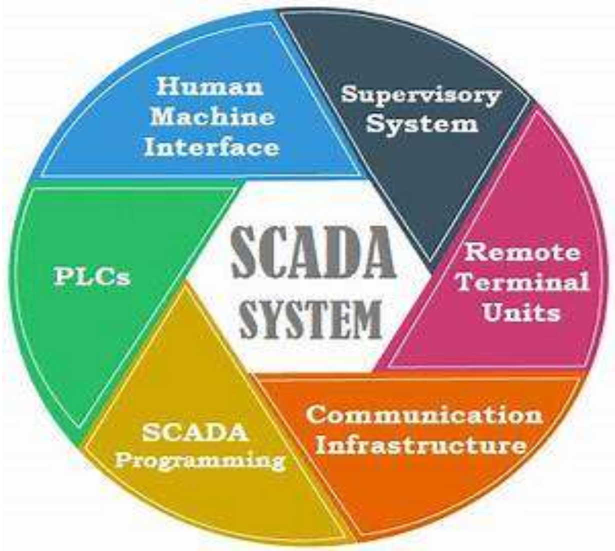
Among centers of electricity production, we mention the center of RADES that represents one of the most important centers of the STEG in Tunisia of the point of view power installed (700 MWS). It has been inaugurated in May 30, 1986. It is about TPP producing electricity while using dry water steam to drag the alternator in rotation, this steam is generated in a furnace that transforms the chemical energy of the fuel (natural gas, heavy fuel-oil) in calorific energy (STEG, 2018; STEG: Revue de l'électricité et du gaz, 2009).

The center of RADES is equipped of a SCADA network. Stations belong to a network superior Ethernet (10 Mb/s). Mainly this network permits to do exchanges of files between the various stations. It avoids so the overcharge of the node network bus (Lakhoua et al., 2020).

The intended role to the SCADA system is to collect data instantaneously of their sites and to transform them in numeric signals and by following to send them through the network of communication toward the main and secondary stations (Fig.1).

ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

Fig.1. Principle of a SCADA system



3. Presentation of the hydrogen circuit of a TPP

In this part, we present a description of the hydrogen circuit of a TPP. In fact, we present on the one hand the interior cooling technique by hydrogen of an alternator and on the other hand a general description of a hydrogen circuit.

The turbo-alternator group of the center of RADES is cooled internally by gas hydrogen. As shows the diagram of the circuit (Fig.2).

The pressure of gas hydrogen inside the alternator is maintained to a face value of 3 to ABS 6 bars, thanks to a pressure regulator gone up on the collector of feeding in hydrogen.

In the same way, the purity of hydrogen in the alternator is always maintained to more of 95% and, when it descends to 90%, an alarm is given out, preventing the internal gas to compose an exploding mixture (STEG, 2018; STEG: Revue de l'électricité et du gaz, 2009).

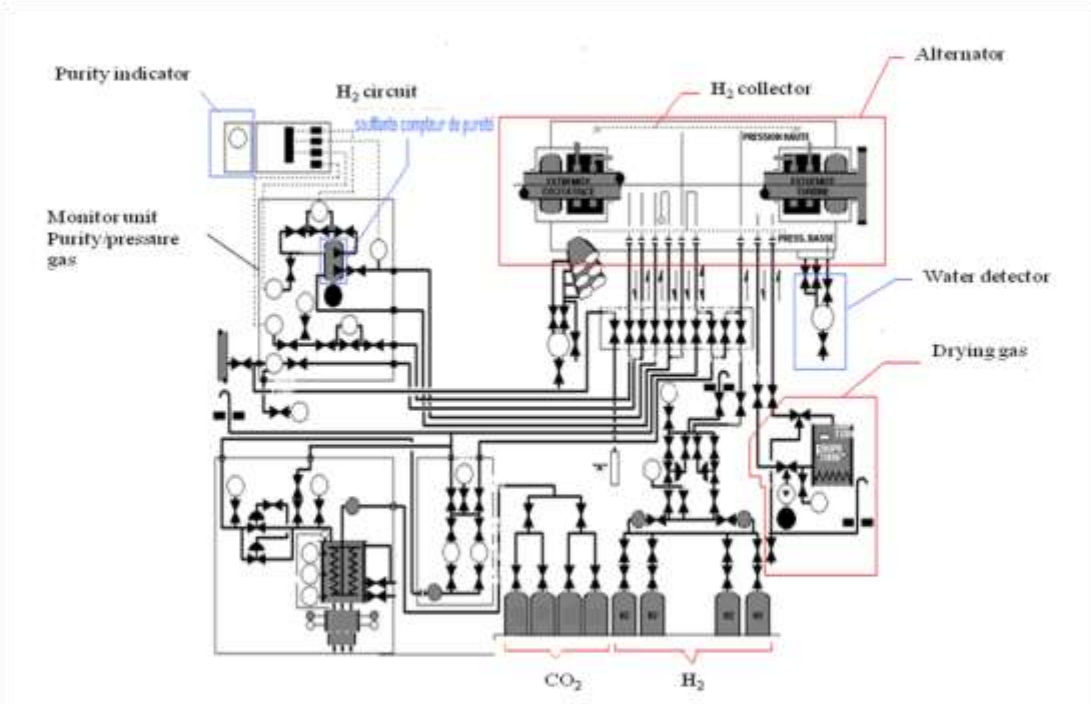
In the same way, the puff of the meter of the purity is starting up in the alternator with the spray in start. When the purity of carbon dioxide gotten on the meter of purity is besides 75%, the feeding is stopped and hydrogen is by following introduces to its room.

By reason of its relatively weak weight in relation to the CO_2, gas hydrogen is provided with the help of the superior hose of distribution of the alternator.

INTERNATIONAL JOURNAL OF
ARTIFICIAL INTELLIGENCE AND EMERGING
TECHNOLOGY
ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

The purity of gas hydrogen must be measured to the bottom of the alternator that is for it the valve of command is opened appropriately and closed. A regulator of pressure is installed between the hose of gas feeding and the station of gas hydrogen in order to maintain the pressure of the internal gas to a value wanted of 1 to 8 ABS bars.

Fig.2. Circuit of the gas hydrogen of the TPP



Gas hydrogen is introduced in the alternator while manipulating the pressure regulator or the regulator. When the purity of hydrogen measured is 95% or more on the meter, its feeding is stopped, the regulator of pressure is adjusted foreseen at the level and the pressure of the alternator is increased. Thus, gas hydrogen is introduced in the envelope, giving back the ready alternator to the working. The diagram of circuit of the system of gas control represents the position of every floodgate during the working.

Otherwise, the drier of gas, composed of a full reservoir of alumina activated (absorbing agent), of a heating device, of a puff, of a thermometer…, is installed between the circuit high pressure and the circuit bass pressure of the alternator so that gas crosses the drier all along the working of the alternator (STEG, 2018; STEG: Revue de l'électricité et du gaz, 2009).

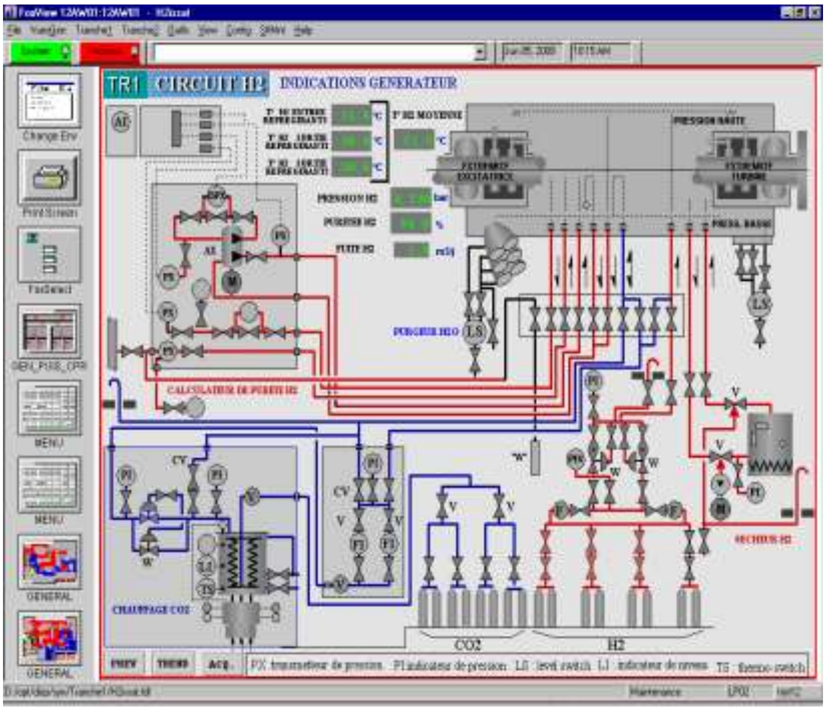
ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

3. Results of the application

In order to achieve the retained solution permitting to integrate a module for the calculation of hydrogen flights, we proceeded to the following three stages: programming of blocks, configuration and conception of the tabular (Millot, 1988; Wertani et al., 2020).
The algorithmic of treatment is based on the concepts of block and diagram (or compound). Indeed, a block is a software entity that achieves a specific function more less complex (stake to the ladder, conversion, filtering, calculation, test of alarms, etc.) definite by its algorithm.
The CALC block permits to achieve some logical and arithmetic operations in chain to the manner of a programmable calculate.
The AIN block does the reading of the raw value (0 to 65535 points) a way of entrance of a module FBM217 achieves then on a read data of conditioning functions (characterization, stake to the ladder, limitation), of filtering and alarm.
The SIGSEL block arranges eight analogical entrances (INP1 to INP8) and deliver to its exit (OUT) a value based on those of its entrances and the criteria of selection kept (maximal value, minimal value, middle value or median value).
For the configuration stage, we used the ICC software (Integrated Control Configuration). This software permits the creation and configuration of the resident program in the CP60.
For the conception stage of the tabular, we used the FoxDraw software. This software possesses a library of components permitting to represent the various elements of an industrial installation.
Figure 3 presents the new tabular elaborated of the hydrogen circuit containing the new modifications.

INTERNATIONAL JOURNAL OF
ARTIFICIAL INTELLIGENCE AND EMERGING
TECHNOLOGY
ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

Fig.3. New tabular of the hydrogen station of the Thermal Power Plant



4. Conclusion

In this paper, we presented on the one hand the architecture of a SCADA system and on the other hand an application of automation and supervision of the hydrogen station of a thermal power plant.
The application of the SCADA system consists in integrating a module for the calculation of hydrogen flights in the alternator. The proposed solution permitted us to elaborate a new tabular for circuit hydrogen containing the new modifications.

INTERNATIONAL JOURNAL OF
ARTIFICIAL INTELLIGENCE AND EMERGING
TECHNOLOGY
ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

References

1. Aamir, S. and Young-Gab, K., (2018). Secure SCADA-IoT Platform for Industrial Automation and Control: A CollaborativeCommunication Designed Model. The First International Conference on Symmetry, Barcelona, Spain.

2. Clarke, G., Reynders, D. and Wright, E., (2003). Practical Modern SCADA Protocols, Elsevier.

3. Dimitrios, P. and Panagiotis, S., (2020). A Survey on SCADA Systems: Secure Protocols, Incidents, Threats and Tactics, IEEE Communications Surveys & Tutorials.

4. Figueiredo, J. and Costa José, S., (2012). A SCADA system for energy management in intelligent buildings Energy and Buildings 49 85–98.

5. Horng, J. H., (2002). SCADA system of DC motor with implementation of fuzzy logic controller on neural network, Advances in Engineering Software 33, pp. 361–364.

6. Lakhoua M.N, Ben Salem J., Battikh T., Jabri I. (2020), Review on Modeling and Design of Mechatronic Systems, International Journal of Mechatronics and Automation, vol.7, No.2.

7. Marihart, D.J., (2001). Communications Technology Guidelines for EMS/SCADA Systems, Power Delivery, IEEE Transactions on, Volume: 16, Issue: 2, Pages: 181–188.

8. Mc Clanahan, R.H., (2002). The Benefits of Networked SCADA Systems Utilizing IP- Enabled Networks, Rural Electric Power Conference. 2002 IEEE, Pages: C5 - C5_7.

9. Meha, G., (2008). SCADA Software Architecture. Dept Of Computer Science and Engineering Florida Atlantic University, Boca Raton, FL, USA.

10. Millot, P., (1988). Supervision des procédés automatisés et ergonomie, Paris, France: Hermès.

11. Morsi, I. and El-Din Mohy, L., (2014). SCADA system for oil refinery control Measurement 47 5–13.

ISSN: 2735-4806 VOLUME 4, ISSUE 2, 2021, 13 – 20. www.egyptfuture.org/ojs/

12. STEG (2018), Société Tunisienne de l’Electricité et du Gaz.

13. STEG: Revue de l’électricité et du gaz, Société Tunisienne de l’Electricité et du Gaz (2009), N°14.

14. Walrand, J. and Varaiya, P., (2000). High Performance Communication Networks, Second Edition, San Francisco: Morgan Kaufmann Publishers.

15. Wertani H., Ben Salem J., Lakhoua M.N. (2020), Analysis and supervision of a smart grid system with a systemic tool, The Electricity Journal, Vol.33, Issue 6.