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Power Management using PLC and SCADA

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***Abstract* — Operation, control and protection system can be implemented to cover various industries starting from small scale industries to wide area operation and controlling. Power Control operation with Supervisory Control Data Acquisition (SCADA) System is mandatory to run smooth heater control in industries. High scale SCADA system with enhanced features not only used for wide area system operation, but also covers Distribution Management System (DMS), Energy Management System (EMS), various Network Applications and Metering Management systems. This implementation includes power management for such industries using PLC and SCADA system. Control algorithm measures critical parameters and adjust variable outputs to optimize power by turning ON/OFF the heater with improved performance. Further electricity cost further reduces by around 5%. PLC and SCADA is used to model and realize the complete system and perform the experiment for result analysis.**

***Keywords* — Heater, PLC, SCADA, Dynamic Control, Automation.**

I. INTRODUCTION

The basic idea behind the power management project is to manage the power in various loads .These loads are models for the different areas of the city. If the load in any area increases then there is every chance that the power station may trip.

Hence to avoid this from happening we have proposed a hardware based circuit. When any one load increases then one of the load that is connected out of many is disconnected.

The priority of disconnecting is variable and can be changed from time to time. The current requirement of different load is different as the time varies. Hence according to that changing priority we can assign different priority to different load.

When the current in any one load increases then the total load on the generation process increases. The excess load may cause the power plant to trip. The cost involved for restarting a power plant is much more. So when the load increases it is advisable to disconnect any one of the loads that are connected. This process is implemented in an automatic way in **POWER MANAGEMENT** project.

The process of disconnecting the loads is based on the priority that is provided by the computer. The priority of disconnecting the loads can be changed at any point.3

We use computer for assigning the priorities, a hardware circuit for disconnecting the load in a particular sequence with the help of relay logic .The detailed explanation of each block is provided in the sections to follow.

Energy Saving is an important constraint in the design of induction heater in the industrial revolution. We are using Hardware and PLC ladder logic for optimization energy. We are adopting this technique in order to reach strong conclusion about their actual impact on the power consumption.

Dynamic power management-which refers to selective shutoff or shut-down of systems components that are idle or underutilized-has proven to be a particularly effective technique for reducing power dissipation in such systems. Incorporating a dynamic power management scheme in the design of an already-complex system is difficult process that may require many designs.

Finally we compare the power consumed by all heater when shut on simultaneously and when shut on at different time sharing mode for the same purpose [15].

Power management is also one of the important constraints for industry. This can also be possible by managing the power of various loads. When any one load increases then one of the loads that is connected out of many is disconnected, in this priorities is assigned to various loads and with the help of hardware and relay logic we will try to manage the load automatically.

The priority of disconnecting is variable and can be changed from time to time. The current requirement of different load is different as the time varies. Hence according to that changing priority we can assign different priority to different load.

When the current in any one load increases then the total load on the generation process increases. The excess load may cause the power plant to trip. The cost involved for restarting a power plant is much more. So when the load increases it is advisable to disconnect any one of the loads that are connected. This process can be implemented in an automatic in this kind of project [11, 13].

II. CRITICAL CONTROL PARAMETERS IN HEATER AND SYSTEM DESIGN PLATFORM

A. Pressure Control

Force draft pressure, Induced draft pressure, Steam drum pressure, de-aerator pressure, Turbine inlet steam pressure, balanced draft pressure

B. Flow Control

Air flow, Steam flow, Water flow

C. Temperature Control

De-aerator temperature, Steam drum temperature, Under-bed boiler temperature, Turbine inlet steam temperature, Flue gas temperature.

Wide area controlling and monitoring systems are essentially based on the SCADA system. In contrast to conventional control systems, where e.g. Programmable Logic Controller (PLC) system [4] is used for acquisition of data, Remote Terminal Units (RTU) [5,11] acquire digital and analog current, voltage and frequency measurements for SCADA system. RTUs are installed at selected locations of different grid stations to acquire complete analog and digital data of the station and are time-synchronized via Global Positioning System (GPS) [6] receivers with an accuracy of one microsecond. These RTUs are getting digital data from field instruments connected with relays to show and operate live status of Circuit breakers or isolators, however for analog data, transducers are connected with CT and PT. For power electric system, generating stations are producing electricity and distribute it on the network. Some electricity imported from other electric resources e.g. Independent Power Plants and electric companies etc.

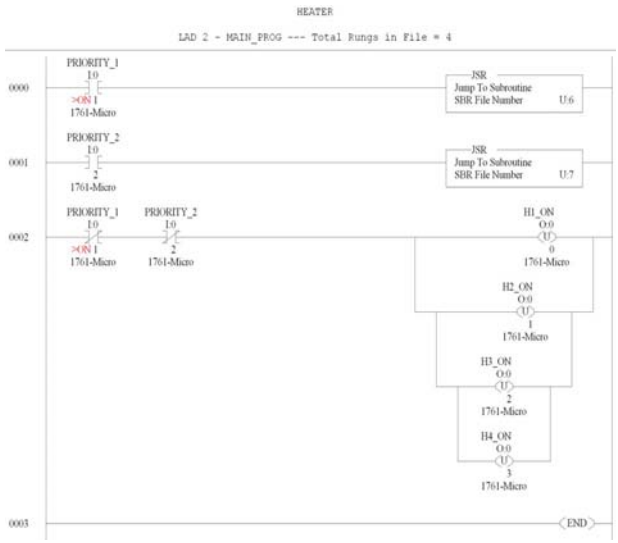

Figure 1: A part of Ladder Logic for heater control

III. PLC AND SCADA

Delegation of Human Control to technical Equipment aimed towards achieving.

Advantages

Higher productivity, Superior quality of end product, efficient usage of raw materials and energy, improved safety in working condition.

In this, the Control and Automation are done by Manual Operations [9, 12, and 13].

Drawbacks:

Human Errors subsequently affect quality of end product.

Hard Wired Logic Control

In this, Contractor and relays together with timers and counters were used in achieving desired level of automation. Bulky and complex wiring, Involves lot of rework to implement changes in control logic, the work can be started only when the takes is fully defined and this leads to longer project time.

Electronics Control with Logic Gates

In this, Contactor and Relays together with timers and counters were replaced with logic gates and electronic timers in the control circuits.

Advantages

Reduced space requirements, energy saving, less maintenance and hence greater reliability.

The Major Drawbacks

Implementation of changes in the control logic as well as reducing the project lead- time was not possible.

Programmable Logic Controller

In this, instead of achieving desired control and automation through physical wiring of control devices, it is achieving through program say software.

Advantages

Reduced Space, Energy saving, Modular Replacement, Easy trouble shooting, Error diagnostics programmer, Economical, Greater life and reliability, The Compatibilities of PLC'S, Logic Control, PID control, Operator control, Signaling and listing, Coordination and communication.

B. How PLC works

Basics of a PLC function are continual scanning of a program. The scanning process involves three basic steps.

Step 1: Testing input status

First the PLC checks each of its input with intention to see which one has status on or off. In other words it checks whether a switch or a sensor etc., is activated or not. The information that the processor thus obtains through this step is stored in memory in order to be used in the following steps.

Step 2: Programming execution

Here a PLC executes a program instruction by instruction based on the program and based on the status of the input has obtained in the preceding step, and appropriate action is taken. The action might be activation of certain outputs and the results can be put off and stored in memory to be retrieved later in the following steps.

Step 3: Checking and Correction of output status

Finally, a PLC checks up output signals and adjust it has needed. Changes are performed based on the input status that had been read during the first step and based on the result of the program execution in step two – following execution of step three PLC returns a beginning of the cycle and continually repeats these steps .

Scanning time = Time for performing step 1+ Time for performing step 2+ Time for performing step 3[4].

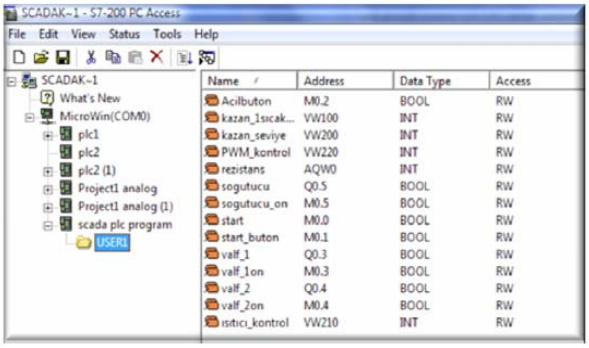

Figure 2: Computer access tag

SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level [12].
It is used to monitor and control plant or equipment. The control may be automatic or initiated by operator commands. The data acquisition is accomplished firstly by the RTU's scanning the field inputs connected to the RTU (it may be also called a PLC – programmable logic controller.). This is usually at a fast rate. The central host will scan the PTU's (usually at a slower rate). The data is processed to detect alarm conditions, and if an alarm is present, it will be displayed on special alarm lists[10].

A. Basics

A SCADA system consists of a number of components [7,13]. The RTU's. Remote telemetry or terminal units. The central SCADA master system.

Field Instrumentation

The SCADA RTU is a (hopefully) small ruggedized computer, which provides intelligence in the field, and allows the central SCADA master to communicate with the field instruments. It is a stand-alone data acquisition and control unit. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system[14].

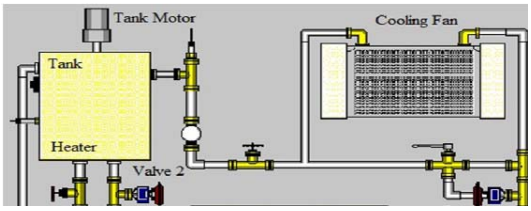

Figure 3: SCADA diagram for the system.

FIX32 software enables you to configure a system environment that provides: [3]

Supervisory control, batch processing, data acquisition, continuous control, and statistical process control for industrial applications. Interfacing of PLC to PC and to SCADA is as follows:

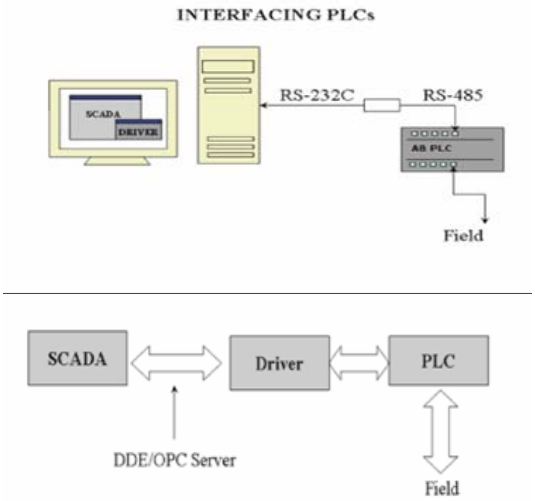

Figure 4: Interface diagram of PC to PLC and to SCADA

IV. IMPLEMENTATION

Effect of power consumption depends on target platform where they are run. Regarding hardware point of view concern, a bunch of heater is arranged in sequential manner and using a property of temp heaters are shut off or shutdown at different time sharing mode, with the help of PLC Ladder logic and in parallel with Electrical switchgear Panel.

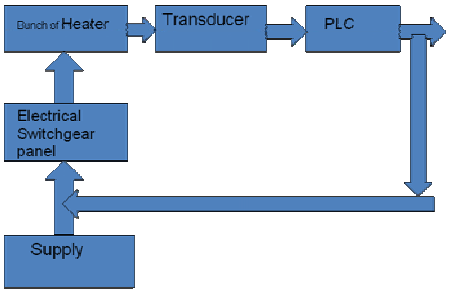

Figure 5: System Implementation

V. CONCLUSIONS

In this study, an appropriate Programmable Logic Control (PLC) ladder diagram for a heater system was created. Additionally, appropriate SCADA software with the program to control and monitor the system from a central point was realized. The messaging between the analogous

and digital data, SCADA and PLC was achieved successfully. The most important aspect of any industry is the heater control. Several techniques can be implemented to control the heater in power plant. The method that has to be used relies on varied objectives like superior quality, increased efficiency, high profit and mainly power management. With the prime objective of catering to these necessities and the needs of the industrial sector, significance has been given here to automation. The paper presented here has kept in mind, the ceaseless changes that are relentlessly taking place in the contemporary scenario of the industrial segment. Emphasis has been given to the automation process that is now rapidly taking its place in all the power plants across the globe. The Paper has furnished itself to study the integral parts of the entire process involved, their implementation and the problems that may show up have also been given their due importance.

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