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MONITORING AND CONTROL OF A VARIABLE SPEED DRIVE USING PLC AND SCADA

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Abstract : Supervisory Control And Data Acquisition (SCADA) And Modbus communication are two new approaches to control and monitor a Variable Frequency Drive (VFD) whose output is fed to a Step down transformer and driving a Electrical Submersible Pump (ESP). The ESP has downhole sensor which senses a pressure, temperature, current, torque, vibrations and carries out the necessary data such as motor temperature, intake and discharge pressures, motor vibrations through the medium of a Small signals which rectified by low pass filter and fed to the SCADA servers through third party integration using Modbus (RTU Protocol) communication connected to terminal server of Honeywell DCS and reflected on personal computer (PC). Terminal server convert data from serial to ethernet. The SCADA software installed in the PC in turn enables the human operator to control the entire operation away from the plant and just by using the virtual inputs designated on his computer screen. The results have been verified with a validating experiment.

***Keywords* – Variable Speed Drive. Programmable Logic Controller, Supervisory Control And Data Acquisition, RS-Logic, Honeywell EPKS (experion process knowledge system) Software 9.5**

I. INTRODUCTION

The purpose of optical communication and control is to provide a system for transmission of data and signals from individual ESP to monitor/control the individual ESP from the process complex. The ESP controls shall be tested and verified for safe working operations.

A. Variable Frequency Drive (VFD)

A Variable Frequency Drive is used for applications where in speed control is of an essential importance due to load changes wherein the speed needs to be increased or decreased accordingly. Traditional methods in existence have addressed this issue, each with their own drawbacks such as high motor starting current, lower power factor, energy losses, etc. To address these problems, VFD provides a flexible approach as compared to traditional methods of speed control especially for certain applications which do not require a constant speed at all times. To name an example, a pump delivering cooling liquid supply may require peak load operation only for a requisite period of time and may require only much less amount during the remainder of the day. VFD will allow the speed of the pump to run at a lower rate in such case thereby enabling energy saving benefits.

When the production rate reduce the downhole pressure below the level required to bring fluids to the surface, the reservoir supplemented with artificially

B. Remote Data Communication Module (RDCM)

The remote data communication module (RDCM) is designed to be used with the GCS family of motor protection and control devices. It allows a GCS host device to communicate directly to external non-gcs devices via modbus protocol. The user can configure and communicate to up to three external devices with support for reading or writing up to twelve parameters from each device. The RDCM connects to the GCS host unit via the high speed telemetry interface port (CITI Bus^{TM}) which permits the data retrieved from the remote devices to be transferred to the host controller and used as internal GCS date objects. This also permit the GCS host unit to act as a data gathering hub to concentrate data from site and report it back to central SCADA or telemetry system.

Features

- Modbus Master/ CITI Bus slave unit
- Two RJ-45 jacks for pass-thru CITIBus Connection
- Plugs and socket field termination connectors. One RS232 communication port (5 wire) and One RS 422/485 isolated port (2/4 wire)
- Operating temperature: -40 to +85° C (-40 to 185° F)

Image.1 GCS RDCM Module

C. Programmable Logic Controller (PLC)

With the advent of technology and availability of motion control of electric drives, the application of Programmable Logic Controllers with power electronics in electrical machines has been introduced in the manufacturing automation systems. The use of Honwywell ML-200 PLC in automation processes increases reliability and flexibility and also reduces production costs. To obtain accurate industrial electric drive systems, it is necessary to use PLC interfaced with power converters, personal computers and other electric equipment.

A PLC based control system was set up comprising of an Honeywell PLC, an Electrospeed Variable Frequency Drive, a three-phase induction motor and workstation has been delivered, configured and integrated together for the monitoring and control of a ESP.

Various control schemes have been used to operate the induction motor in speed and frequency control modes of operation using PLC programming developed on the workstation.

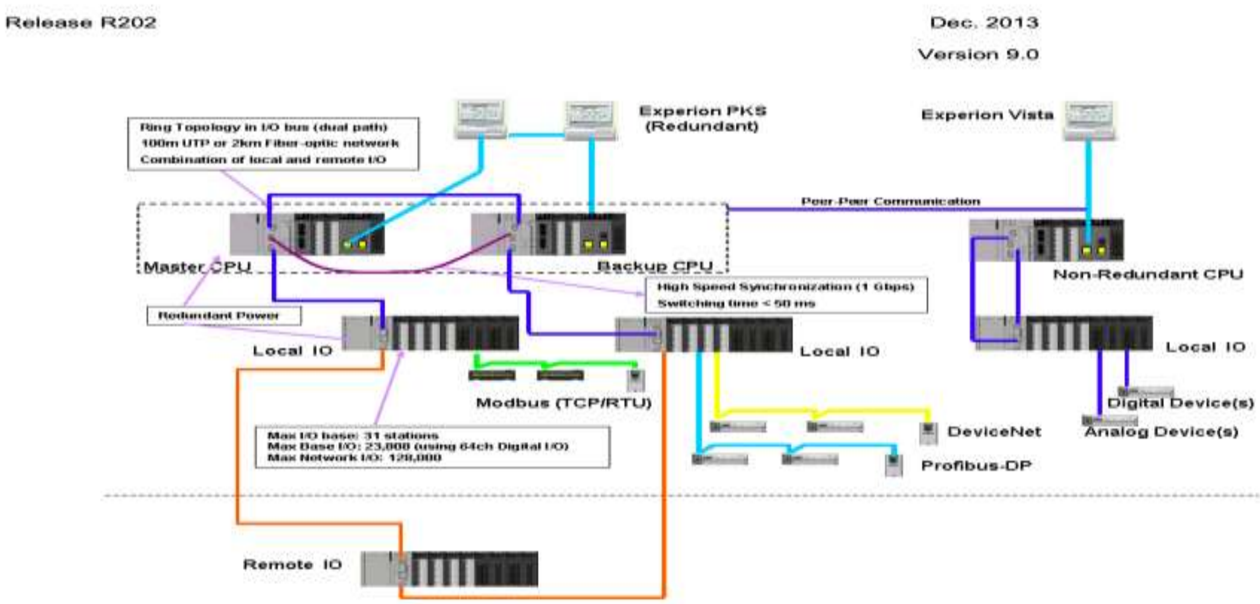

Image.2 Architecture for ML-200 used

D.Supervisory Control And Data Acquisition Systems (SCADA)

SCADA is a system which exercises supervisory control of a particular device from a remote location and the human operator is able to monitor and control the device from his computer screen without being physically present near the device.

A PLC based control system was set up comprising of an Honeywell PLC, an Electrospeed Variable Frequency Drive, a three-phase induction motor and workstation (personal computer) has been delivered, configured and integrated together for the monitoring and control of ESP.

Various control schemes have been used to operate the induction motor in speed and position control modes of operation using PLC programming developed on the workstation.

Figure 1 shows the real time control set up which was configured and tested for the experiment.

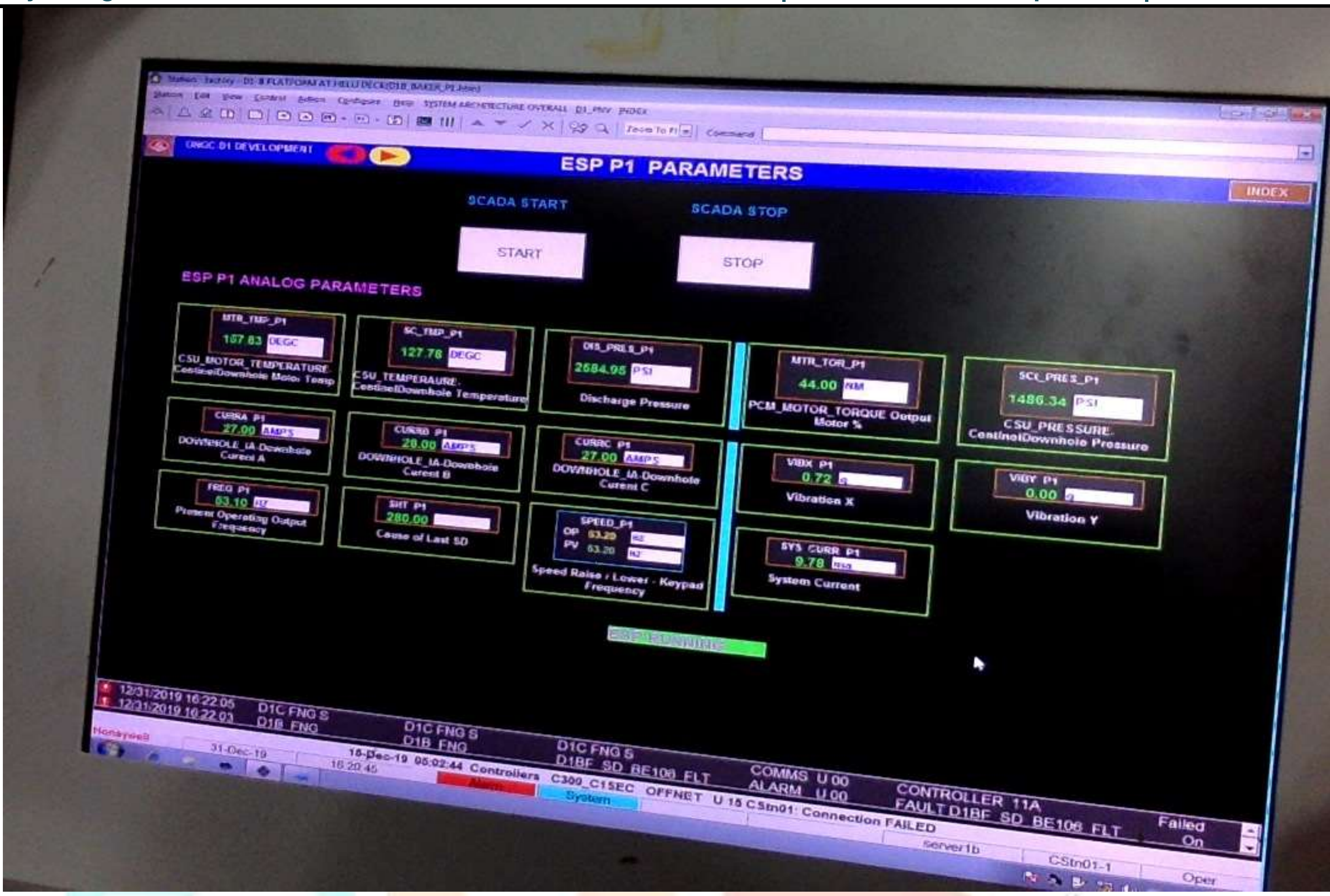

Image.3 Real time monitoring of ESP

II. RELATED WORKS

A few selected research papers related to PLC and Variable Frequency Drive has been done to study the various methodologies used by the researchers.

J Ahir et al. [2] in their research have worked on the design and development of PLC and SCADA based control panel of monitoring of three-phase induction motor. They have continuously monitored measurements of voltage, current,
temperature and speed for protection purposes. It was found that PLC was able to achieve optimum accuracy with a virtually power factor along with easy error detection and correction, along with being more reliable than traditional methods. The monitoring of three-phase induction motor driven by VFD, with PLC as a controller provided high accuracy in the regulation of its speed. **Maria G. Ioannides et al. [3]** has developed a PLC based continuously monitoring and control of a three-phase induction motor. Various types of sensors were used for monitoring the parameters such as speed and current. With the help of PLC ladder logic programming, it was proven that speed control of motor was achieved with high accuracy as well as efficiency. It was found that at high speeds and loads, the efficiency of the system was increased up to 10 to 12%. In brief this paper proved that PLC was a versatile and efficient control tool in industrial electric drives applications. **N D Ramesh [5]** presented a study on PLC which uses a programmable memory for implementing specific functions such as logic sequencing, timing, counting, and arithmetic control through digital or analog input/output modules. The functions of PLC include on-off control, sequential control, feedback control and motion control, to name a few. Industrial PLCs normally operate at an input-output voltage supply of 24V DC. Physical connections from the real world to the PLC are designated inputs such as limit switches, push button switches, sensors or basically anything that works on the principle of "switching" a signal on or off. Outputs of a PLC are usually solenoids, lamps, contactors, relays, etc. The number of digital input/outputs can be increased by adding additional digital input/output modules. One of the most common methods of PLC programming is also known as Ladder Logic programming which is a language using relay symbols as a base in an image similar to a hard-wired relay sequence. It looks like a ladder, whose sides are the power rail on the left and ground rail on the right. The rungs of the ladder consist of virtual relay components which perform certain tasks based on the instructions given in the program. **S. Da'na [4]** has discussed the design and implementation of a platform to remotely monitor and control PLC-based processes over TCP/IP or by using the GSM network. The platform is built using industry-standard off-the-shelf PLCs. Integrated with each PLC are communication processors that can be used for connectivity to the network and to a GSM modem. The communication processor module (Ethernet module) used in this work, provides an industrial compatible protocol over TCP/IP that achieves the same functionality as Profinet but at a much higher bandwidth (10/100 Mbps). Additionally, a mobile-based communication protocol that facilitates remote monitoring and control of PLCs using SMS messages has also been developed. The intent here is to provide system users with a back-up communication mechanism in case of a network failure. **M Zajmovic et al. [6]** presented a paper on the management of induction motors using PLC which executes instructions according to the programmed logic and sends signals to the Variable Speed Drives, from which it receives feedback of the motor speed so as to control its speed by modulation of voltage and frequency. A Zelio PLC was used with the help of a frequency transformer which controlled a 5.5 kW asynchronous induction motor at a speed of 1500 rpm. A windows XP operating system with SCADA software from DAQFactory was used for

interfacing to the induction motor through an Ethernet connection. **W J Weber et al. [9]** discussed about the advent of the VFD system and its benefits, such as greater reliability, smaller size, lower production costs, better performance and increased automation potential as compared to conventional methods of control by which it allows continuous control of motor speed and torque, thereby increasing efficiency and flexibility. Various processes are sensed and fed back to the central plant controller, which after receiving inputs from an operator via the Human Machine Interface (HMI). The controller then instructs the VFD to maintain optimum performance according to the desired inputs. The basic function of VFD is to synthesize the voltages and frequency applied to a motor so as to control and achieve desired speed and/or torque. **A R Al-Ali et al. [14]** proposed a power factor controller for a three-phase induction motor using PLC to improve the power factor of a three-phase induction motor. For the purpose of attaining maximum torque, its voltage to frequency ratio is kept constant. A three-phase squirrel cage induction motor is coupled with a dc shunt generator and an electronic conditioning circuit. Features like interlocking, i.e., disabling the controller until it detects currents, voltage, frequency and power factor angles, switch failure detection, monitoring voltage to frequency ratio constant during correcting the power factor, independent control of reactive currents in each phase and maximum compensation even when switch failure occurs, have been incorporated. **Cristina Anita Bejan et al. [16]** presented a method of practical laboratories for teaching purpose in SCADA system which is focused to develop applications using an integrated automation system from Siemens - Totally Integrated Automation Demo case with distributed peripheral employing Profibus and Ethernet communications. The final application is targeted to control an induction motor with associated frequency touch-screen human machine interface to program the motor speed and to show variables, trends and alarms. **Mihai Iacob et al. [17]** presented the design and implementation of a SCADA system for a central heating and power plant meant to supervise and control field distributed electric devices using Siemens software and equipment. The old equipment were replaced by using PLCs, servers, modern approaches regarding network equipment and topologies and flexible monitoring stations. Remote actions and uninterrupted monitoring were made possible due to redundant servers and web-based applications via web server. The system was shown to have various advantages like remote and safe operation and monitoring from anywhere in the world, evolution charts for one week, archives, easy to interpret alarm system and most importantly-flexibility, scalability and powerful modular structure. **Mini J. Thomas et al. [18]** presented a report about the design, commissioning and functioning of a state-of-the-art SCADA laboratory facility at Jamia Milia Islamia, New Delhi, India which has been designed with a purpose to function as a research and training center for utilities, faculty members and students. This lab provides hands on learning experience on SCADA system, and its applications to the management, supervision and control of an electric power System. One of the unique features of the SCADA laboratory, that makes it the only one of its kind, is the use of a distributed processing system, which supports a global database. Various research activities like adaptive and intelligent control of integrated power systems, preprocessing of data at the RTU level using Fuzzy Logic and Fuzzy-Genetic algorithm, substation automation etc. are already being supported by this laboratory.

Having reviewed some of the work being done in the field of VFD, PLC and SCADA, the next chapter explains about the objective of this present work and the research methodology being used.

II. CONCLUSION

The present work was motivated to develop a scheme to monitor and control a Variable Frequency Drive using PLC. A thorough study of all the hardware components was done including their specifications, functioning and overall performance. Software platform namely
III. Honeywell ladder logic programming RS Linx was comprehended, analysed and implemented.

A 150 KW three-phase Asynchronous type ESP was fully automated using a Variable Frequency Drive and PLC. The drive used in this set-up offered various control modes of motor operation. The configuration and settings to Monitor and Study Downhole pressure and temperatures to maintain required production rate and characteristics. A complete study and practical hands on the PLC and the drive operation have imparted a fairly good idea about the industrial automation systems.

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REFERENCES

[1] Ali, A. 2001.Macroeconomic variables as common pervasive risk factors and the empirical content of the Arbitrage Pricing Theory. Journal of Empirical finance, 5(3): 221–240.

[2] Basu, S. 1997. The Investment Performance of Common Stocks in Relation to their Price to Earnings Ratio: A Test of the Efficient Markets Hypothesis. Journal of Finance, 33(3): 663-682.

[3] Bhatti, U. and Hanif. M. 2010. Validity of Capital Assets Pricing Model. Evidence from KSE-Pakistan. European Journal of Economics, Finance and Administrative Science, 3 (20).

[4] Honeywell Master Logic 200 information manual.