TEST-BED AUTOMATION FOR COMPRESSOR TESTING

Payas S Nimje[1], Piyush J Gathibandhe[2]

G.H. Raisoni College of Engineering, Nagpur
Maharashtra, India

[1]*UG Student, Department of Mechanical Engineering, GHRCE Nagpur*
[2]*UG Student, Department of Mechanical Engineering, GHRCE Nagpur*

ABSTRACT:-

The objectives of this paper is to monitor pressure, temperature, F.A.D. (Free Air Delivery) and power consumption automatically in compressor with the help of integrated SCADA system and a Programmable Logic Controller (PLC) interfaced to it, primarily reducing the errors which occurs during manual testing and minimize the human intervention optimizing the accuracy and efficiency of results. After considering the objectives of the project, the P and I diagram comprising all the sensors required for automation was prepared and the Pressure transmitter, Temperature element (RTD) with transmitter, Differential Pressure transmitter, Flow meter and Energy meter sensors were selected according to required specifications. After collecting, the number of sensors and the type of their inputs the specifications of PLC was decided. Supervisory Control and Data Acquisition (SCADA) refers to a system that enables remote monitoring, co-ordinate, control equipment and real-time mode from a remote location with acquisition of data for analysis and planning from one control location. PLC on the other hand is like the brain of the system and acts as a medium between electrical system & Personal Computer for SCADA to take input and output bits. With the joint operation of the SCADA and the PLC, it is possible to monitor the compressor testing remotely. This system enables to intercept the faults at an early stage and helps to take corrective measures. Automating testing procedure for monitoring the compressor by implementing a supervisory control and data acquisition (SCADA) system is the one of the most cost-effective solutions for improving reliability and quality, increasing efficiency, productivity and utilization. Nowadays consumer requires more reliable and turnkey solutions that can be modified as per demand and requirement in future.

Keyword: - *Programmable Logic Controller (PLC). Supervisory Control and Data Acquisition (SCADA), Pressure Transmitter, Resistance temperature detector (RTD), Differential Pressure transmitter, Flow meter.*

1. INTRODUCTION

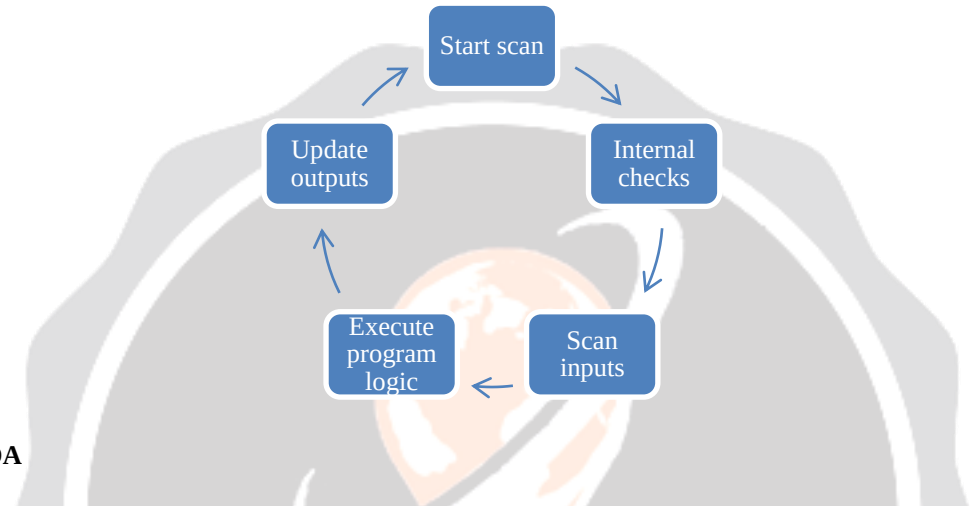
The demand for high quality, greater efficiency and automated machines has increased in the industrial sector over the past few years. Industry requires continuous inspection and monitoring of various parameters at frequent intervals. There are possibilities of error at measuring as human worker is involved at various stages. This project examines the possibilities to automate some activities of final testing procedures of industrial air compressors after it's assembly. Thus this paper takes a sincere attempt to explain the advantages the companies will face by implementing automated testbed into them. The pressure, temperature and Free air delivery (F.A.D.) which are the important parameters of compressor, and its automation is the precise effort of this paper. The final test procedure for compressor model is established to ascertain that compressor is functioning according to specifications and guidelines. In order to automate and minimize human intervention, there is a necessity to develop a PLC (Programmable Logic Controller)-SCADA (Supervisory Control and Data Acquisition) system that monitors and help to reduce human errors.

1.1 PLC

Programmable Logic Controller (PLC) is a digital computer used extensively in industries for the purpose of automation. It is used to automatically control the electro-mechanical processes in the industry and can be also used under harsh conditions.

The PLC comprises of three core parts:
1. The power supply and rack,
2. The central processing unit (CPU),
3. The input/output section.

The CPU follows below operating cycle-



1.2 SCADA

Supervisory control and data acquisition (SCADA) is a combination of system of software and hardware elements that allows industrial organizations to,

- Monitor industrial processes locally or at remote locations
- Monitor, gather, and process real-time data
- Directly interact with field devices through human-machine interface (HMI) software
- Record events into a log file
- Analyse data, create real time graphical displays for operators, and run reports for operators, engineers and management.

SCADA systems plays an important role for industrial organizations as they help to maintain efficiency, process data for smarter decisions and establish communication with system to solve issues.

1.3 HMI- Human Machine Interface

HMI stands for human machine interface is a software application that displays information to an operator for better understanding of the system and helps him to take smarter decisions for further controlling the system. Information is displayed in a graphical format (Graphical User Interface). HMI is usually a part of a SCADA system.

2. PARAMETERS COVERED

i. Pressure
ii. Temperature
iii. Free air delivery
iv. Differential Pressure
v. Power consumption
vi. Sound and Vibrations

3. MANUAL TESTING

Testing of a compressor is the vital part after its complete assembly. It is useful in identifying the flaws (if any) in assembled compressor. Testing associates in determining capacity, power consumption, efficiency, pressure, temperature and other important parameters of compressor. It helps to correlate the actual test parameters with standard parameters decided by company to ensure quality. After the Testing the FAD (Free Air Delivery) and power consumption is calculated.

The reciprocating compressor is subjected for 3 hours (4 hours- total performance test considering flushing, etc.) load test after successful inspection and testing that be done before and during assembly. The load test is considered a routine test in the reciprocating compressor testing.

The compressor is run at rated speed to get stabilization of lube oil temperature, bearing temperatures and vibrations. The period for getting the stabilization is 30 minutes and may be changed accordingly. After stabilization each one hour the test technicians records the performance.

After the performance test, Trip is done. The safety valves are set at 10% or 1kg/cm^2 more than the rated pressure and is checked whether the safety valve works under those conditions or not.

3.1 Equipment's used

i. Pressure gauge
ii. Temperature Gun
iii. Temperature gauge
iv. Flow meter
v. Sound meter
vi. Vibration meter
vii. U-Tube manometer
viii. Thermometer (for ambient temperature)

3.2 Drawbacks of manual testing

i. Conventional equipment systems are prone to error.
ii. Involvement of humans in the data collection.
iii. Processing using complicated mathematical expressions.
iv. More time consumption as compared to the automated testing.
v. Difficulties to analyse and control the location of leakage which are occurred in pipeline.

3.3 Overcoming Drawbacks

i. A system is required that collects raw data, process it and present it in values which can be verified and compared with the standard values.
ii. By implementing PLC and SCADA, the automatic monitoring plays an important role for the continuous operation of the system.

4. AUTOMATED TESTING

To automate the testing and minimize human intervention, a SCADA system is to be developed that monitor the machine and help to reduce the errors caused by humans. Various parameters for which automation is to be done are Temperature, Pressure, F.A.D. (Free Air Delivery), power consumption, loading & unloading of cylinder, safety valve cut-off pressure, sound and vibration, etc.

4.1 Equipment's used

i. PLC module
ii. Computer
iii. SCADA software
iv. HMI
v. Pressure transmitter
vi. Differential pressure transmitter
vii. Flow meter

viii. Temperature element (RTD)
ix. Vibration meter
x. Sound meter
xi. Room temperature–humidity sensor

4.2 Iterfacing and framework

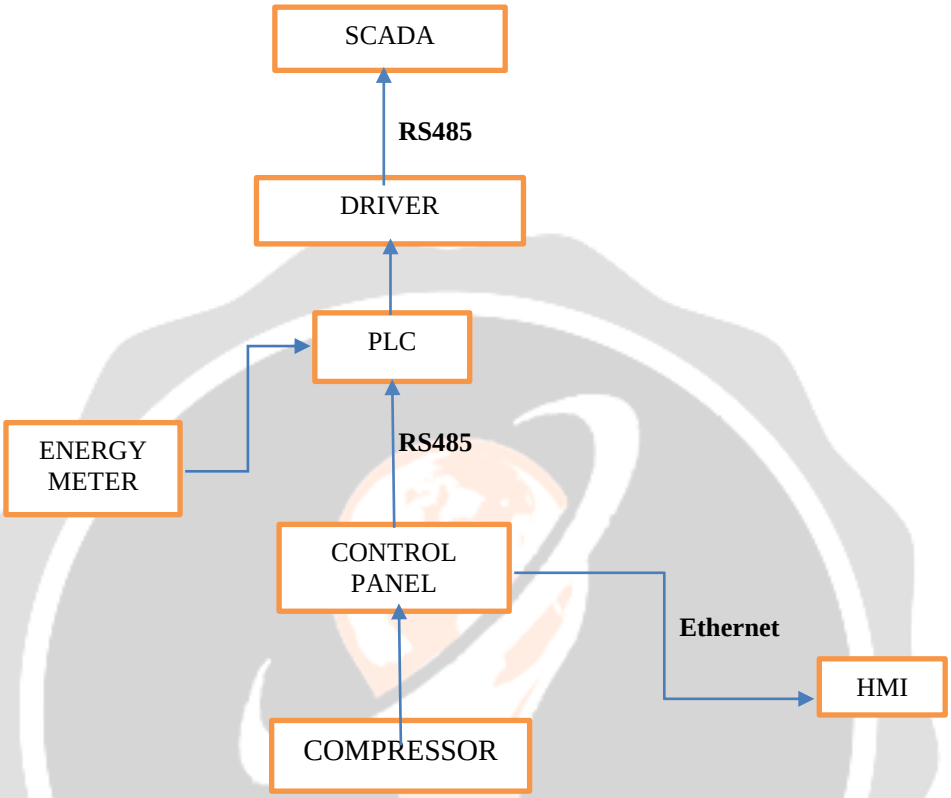


Fig -1: Basic Structure of the PLC/SCADA

The sensors and the transmitters will be attached to the compressor at the defined locations. The sensors are then connected to the PLC through control panel. The HMI screen and energy meter will be installed on the control panel with its connection to PLC. With the suitable driver the PLC will be connected to the computer having SCADA software installed in it.

During testing, starting the system result in the scanning of all the inputs and internal-external checks which is performed by PLC. The inputs are the stored in the internal memory of the PLC. The program is run on the stored inputs and necessary logics are performed which are already uploaded in the PLC. After the execution of logics the required updating is done in the outputs. The SCADA receives and processes the outputs for displaying the result on HMI in desired format. The SCADA saves the results in desired format in the computer memory and cloud space (for remote monitoring) for future use.

4.3 HMI model

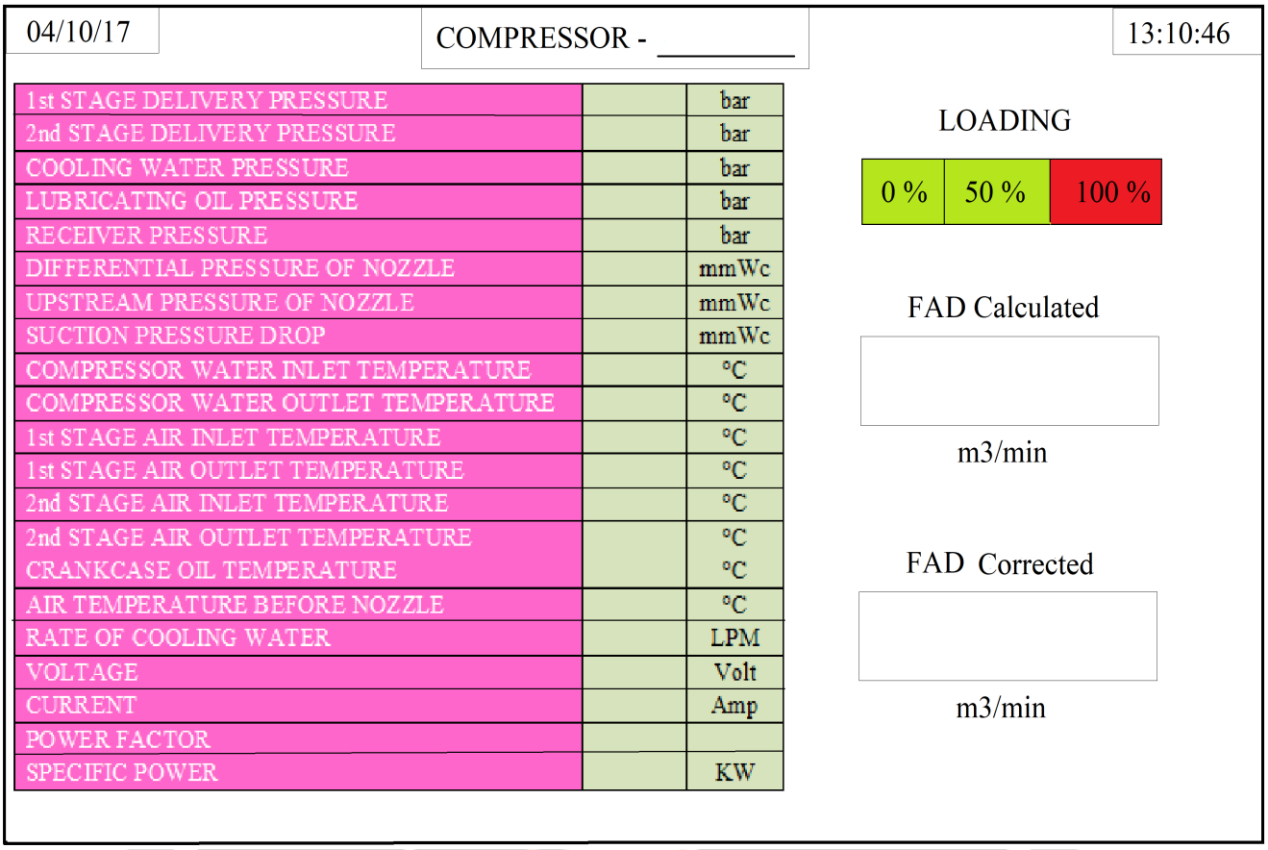


Fig -2: Parameters to be displayed on the screen.

5. ADVANTAGES & DISADVANTAGES OF AUTOMATION

5.1 Advantages

- F.A.D. (Free Air Delivery) and power consumption is achieved directly on the screen.
- The performance can be log at any interval.
- Reduces hard physical or monotonous work.
- Automation can be maintained with simple quality checks.
- In case of power outrage, the system back-ups is available.
- Reduces operation time and work handling time significantly.
- Frees up workers to take on other roles.
- Improved quality and reliability.
- Improves Productivity.

5.2 Dis-Advantages

- As of now, not all tasks can be automated
- Some tasks are more expensive to automate
- Initial costs are high
- Failure to maintain a system could result in malfunction of the system.

6. COMPONENT LIST

Table -1: Component list used for automation

Sr. no.	Component
1	Current transformer
2	Plc Processor Card
3	8 Digital input / 8 Digital output (RELAY) card
4	8 Analog Input (4-20 mA / 0-10vDC)
5	04 Universal AI & 02 AO
6	HMI
7	RS485 cable
8	Comm. Cable PLC to Card
9	Comm. Cable PLC to PC
10	Port Converter
11	Control panel
12	Multi-Function Energy Meter
13	RTD- PT100 3wire with Transmitter
14	SCADA software
15	Computer for SCADA Monitoring
16	Differential Pressure Transmitter
17	Room temperature sensor
18	Sound meter
19	Smart communication cable, required to connect PLC unit to SCADA
20	Pressure Transmitter
21	Flow Meter
22	Vibration meter

7. Conclusion

This is an internship project having possible real life application in compressor manufacturing industries. Applicability of this project is suitable to industrial application with further development and fulfilment of it for covering more test parameters. This project could be helpful for compressor manufactures, as well as for users, in the purposes of automation of test activities, yielding increased productivity.

PLC and SCADA System is used for monitoring the various test parameters. Alternatively, SCADA and PLC communication system make it possible to integrate protection control and monitoring test parameter together for maximum benefit. HMI included will provide easy user interface for test monitoring and control. Hybrid system benefiting from the real time detection capacity of a software based method and the high localization accuracy of a hardware based technique, along with other specific advantages of both approaches, seem to be very reliable for testing.

Result report will generate on the main computer server and these reports can be archived in the computer memory for records. Further, internet based remote monitoring and control will allow managers to directly monitor the testing irrespective of time and place. This technology can be adapted for future improvement in automation system.

8. References

i. Santosh B.Belekar, Abhijit A. Desai, Megharaj H. Parit, Prof. Anup Dakre “PLC SCADA based Distribution Monitoring & Control” Journal of Research in Engineering and Technology Volume 1, Issue 1 (April 2014) Pg. 105-110

ii. Ande Venuprasad, Yeole Shivaraj Narayan “Automatic Monitoring and Controlling of Pressure using PLC and SACDA” International Journal of Innovative Research in Science, Engineering and Technology Vol. 5, Issue 7, July 2016.

iii. Abdul Md Mazid, Ryan Martin “Automation of Compressor Test Procedure using Advantech Data Acquisition Module” 2008 10th Intl. Conf. on Control,Automation, Robotics and Vision Hanoi, Vietnam, 17–20December 2008

iv. http://www.plcmanual.com/

v. https://inductiveautomation.com/what-is-scada