

Real Time Automated Control of Industrial Compressor with PLC-Lab VIEW Communication.

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Abstract—This Paper is representing the primary development of control and monitoring system based on PLC (programmable logic control) with Lab VIEW communication. The primary role of our project is to control the pressure along delivery line of the compressor. We have used reverse action of PI controller. Develop PI control in PID setup of PLC (programmable control logic). We have used OPC server to link LabVIEW with PLC and to plant. LabVIEW is applied as an SMI (software machine interface) in project. The operation of project execution is – Designed PI controller take feedback signal from pressure transmitter along delivery line of the compressor and enable the control of VFD (variable frequency drive). VFD (variable frequency drive) worked as a final control element in close loop system. Compressor is controlled under VFD only. Frequency from VFD varies the speed of the compressor. Thus with such kind of an arrangement PI close loop is formed.

Keywords - PID (proportional integral derivative control), PI (proportional and integral control), Lab VIEW (Laboratory Virtual Instrument Engineering Workbench), SP (set point), VFD (variable frequency drive), OPC (object linking embedding for process control), SMI (software machine interface), SLC (single loop controller).

INTRODUCTION

A Programmable Logic Controller (PLC) is a digital computer used for automation of electrochemical processes, such as control of machinery motion control, amusement rides, or lighting fixtures. The PLC is designed for multiple inputs and output arrangements. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result^[2]. In the present era of Industrial Automation, ease of work is one of the major concerns. This design enables the operator to operate the process sophisticatedly with an ease.

Instead of giving manual inputs to the PI, this designed PI can adjust the input parameters just by mouse clicks^[3].

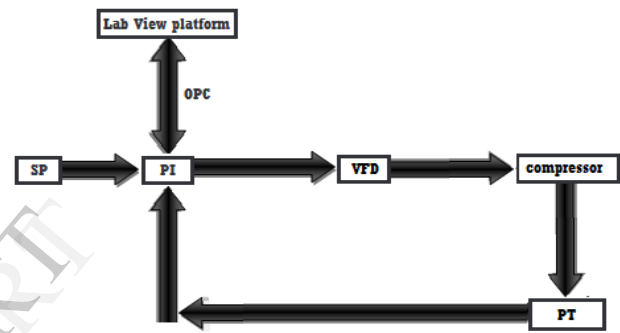


Figure-1 PLC as a PI controller

Above figure shows pressure control loop of PLC as a PI controller. We have used 1766, MicroLogix 1400 programmable controller contains a power supply, input and output circuits, a processor, an isolated combination RS-232/485 communication port, an Ethernet port, and a non-isolated RS-232 communication port. Each controller supports 32 discrete I/O points (20 digital Inputs, 12 discrete outputs)^[6].

The compressor model was Atlas copco GA-18 30 vsd of 30kW size. Which was screw type compressor, having capacity of 12 bar over maximum speed of motor. Axpert Eazy VFD AMT-037 of 37 kW size is used to control the compressor. Axpert easy vfd is product of Amtech electronics India limited ,Gandhinagar. The Input & Output power supply of drive was 380v-50Hz and 380v-600Hz with 72 A.

I. Pi Theory

The ‘P’ stands for proportional control and ‘I’ stands for integral control. Proportional action: It simply amplifies the error based upon the gain. P mode generates offset. Integral action: The integral term magnifies the effect of long-term steady-state errors, applying ever-increasing effort until they reduce to zero. PI control mode is by itself a controller which executes appropriate reaction to every error coming from system. The requirement of a controller is to execute

predefined algorithm. Algorithm provides adjustable output to maintain the system along desired state. The Error is difference between desired value and actual (running) value. The PI controller is special case of PID controller in which derivative control is not used. PI algorithm is given by:

$$\text{controller output} = K_p * e(t) + K_i * \int e(t) dt$$

$$e(t) = SP - PV$$

Where K_p is proportional constant and K_i is an integral constant. Where $e(t)$ is the deviation of actual measured value from the set point at respected time 't'. SP- set point and PV- process variable/actual value.

II. HOW THE PI CONTROLLER WORK

The main role of PI control is to maintain the output with zero error. Proportional action: It simply amplifies the error based upon the gain. P mode generates offset. Integral action: The integral term magnifies the effect of long-term steady-state errors, applying ever-increasing effort until they reduce to zero. PI control is developed in PID setup tool of PLC (programmable logic control) .

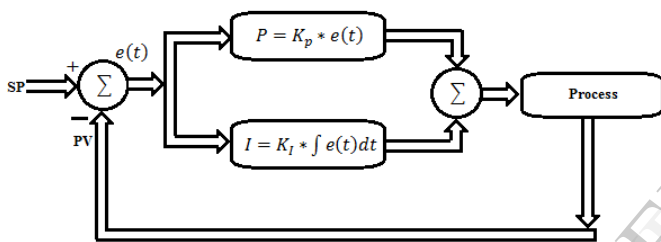


Figure-2 PI loop^[5]

Controller takes the feedback signal from pressure transmitter (4-20mA) along the delivery line of the compressor. With the use of that feedback support controller detects deviation and generates final controller output based on algorithm. Controller enables the control of VFD (variable frequency drive) by varying frequency. VFD controls the compressor-speed with respected controller output. Here VFD works as a final control element. PI controller will not take action during zero deviation from close loop.

III. CREATING AN OPC SERVER

We have used opc server of InGear make AB OPC server. This OPC server is specially designed for Allen Bradley controller.

Steps for build a OPC server are:

1. CONFIGURING PLC DRIVER

Here we choose ENET (Ethernet micrologix) devices and click on Add . Next put the IP address of PLC and then start the configuration in Configure ENET devices.

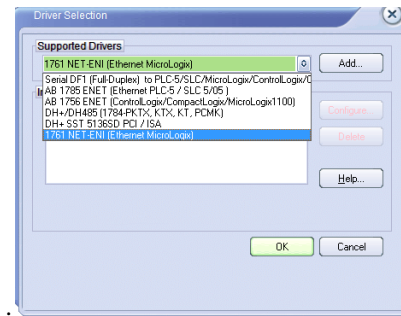


Figure-3 selection of driver

2. CREATING NEW DEVICE

Next we create a new device with defined device name and select SLC/Micro family for device and click ok.

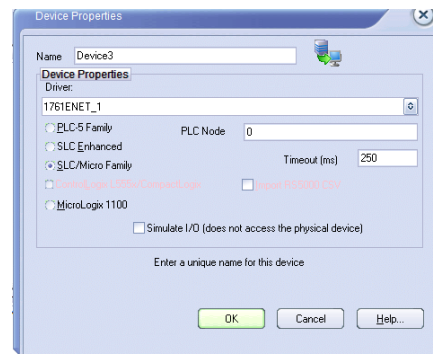


Figure-4 Select Device properties

3. CREATING A NEW GROUP

After creating the new OPC server we create a new group. After assigning a name we leave the other setting to default.

Build a group by variables categorized.

4. CREATING ITEM/TAG

We give the addressing of the input/output variables as per the syntax of the PLC and the data type of the variable can be selected from the drop down menu. Also we can add a description with tag.

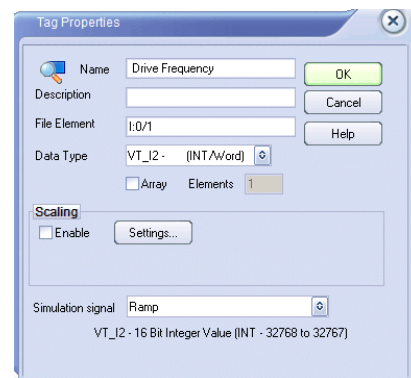


Figure-5 Create tag with properties

After creating an OPC sever we can debug the all tags of group simultaneously. If the configuration build healthy then we may see increased number of sent and receive data packets

IV. CONFIGURATION AND IMPLEMENTATION OF LABVIEW IN CLOSE LOOP

The information development is complicated by the mix of hardware and software that exists in plants and the limitation of traditional systems. We can incorporate Lab VIEW into existing system to add measurements and analysis to processes to gather complex data and convert it into useful information. Additionally, through the openness of Lab VIEW we can connect and provide the information where it is needed, whether that is in a database, available on a web based dashboard, or provided into the existing plant control hardware. We can even use Lab VIEW to close feedback loops and perform complex control operations using the provided information^[2]. In Gear AB OPC (object linking embedding for process control) enable the communication between SLC controller and Lab VIEW. Ethernet channel of PLC is selected for communication channel. OPC provides read/write flexibility to Lab VIEW and PLC. Lab VIEW as a software machine interface is given by below steps:

1. SLC PLC connects to OPC server through Ethernet channel device driver.
2. OPC server contains a group of tags defined by address and data type of respected variable in controller. In Lab VIEW we have bound variables of front panel with respected tags of OPC server. Data binding property of variable provide connectivity with respected OPC server in Lab VIEW. We give the addressing of the input/output variables as per the syntax of the PLC and the data type of the variable can be selected from the drop down menu. This arrangement develops real time system.
3. On online mode of OPC, PLC and Lab VIEW with the healthy configuration we can make monitoring and control system with Lab VIEW as an SMI (software machine interface). Lab VIEW is used as an SMI (software machine interface) in project. Lab VIEW provides graphical programming. The basic need to achieve project objective is Lab VIEW.

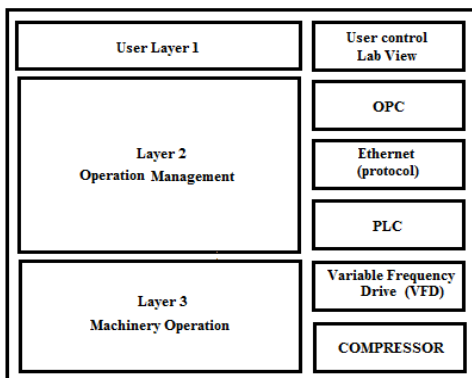


Figure-6 Three Layer Network Architecture^[4]

Lab VIEW software has two parts front panel and block diagram. Front panel is the GUI wherein the operator sets the input parameters as per the requirements along with various graphical and pictorial representations of the process. And the

Block diagram executes the sequential logic and predefined algorithm in the form of G-programming (G-graphical). SMI (software machine interface) development of Lab View in project is given below:-

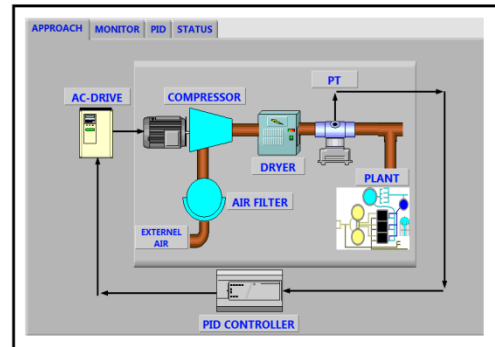


Figure- 7 Model of project

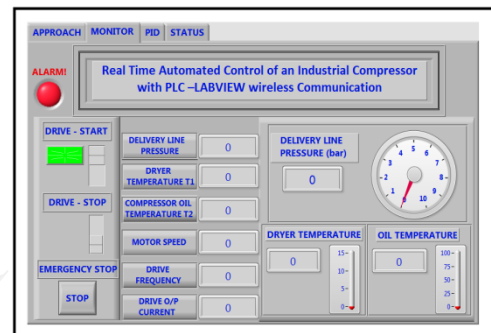


Figure- 8 Monitoring screen

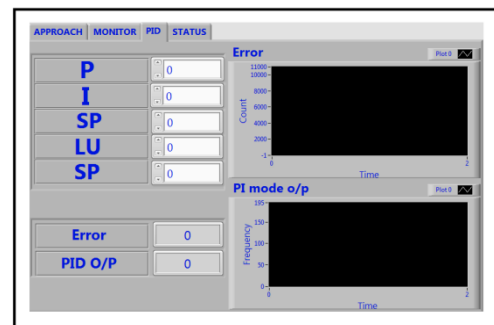


Figure-9 PI control screen

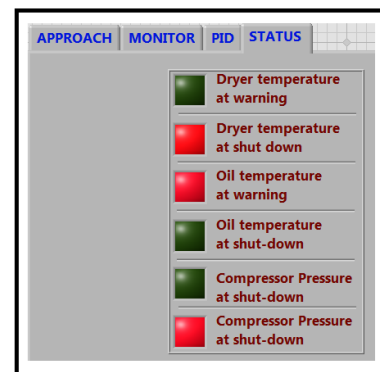


Figure-10 Status screen

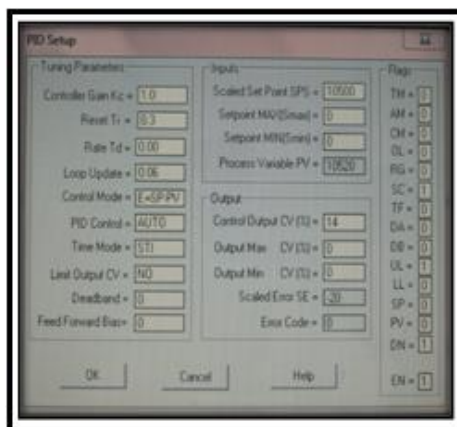
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Above figure 7 shows basic pressure control closed loop of compressor. Where it is shown that feed back signal is given from the PT (pressure transmitter along pressure delivery line of compressor) to the PI controller (PLC) and then controller give output to VFD with the respective error coming from system. Figure 8 shown above only presents the monitoring of running parameters of system. The red led in screen indicate the alarm event generated by the loop. Figure-9 execute PID setup screen for control system. Above screen includes several parameters P (proportional gain), I (integral gain), SP (set point), LU (loop update-scan time of PI algorithm), error, PI output etc. Two trends of error and controller output are also contained. With the help of this screen operator has flexibility to control from remote location away from field/plant. Above figure 10 shows status of discrete level parameters of system. Alarm generate if any of status go on.

4. RESULT

In the part of the result compressor is controlled by PI controller setup in PLC. The values of PI setup key parameters are: Set point (SP) =7 bar, Process Variable (PV) =actual pressure, Control Variable (CV) =frequency of drive, Proportional gain=1, Integral time =0.3s, Loop update =0.06s



5. CONCLUSION

The main idea was to interface Lab VIEW and PLC for more effective and efficient process control. We can easily replace SCADA system by LabView in automation and Process plant area. Used correctly, multithreading offers numerous benefits including more efficient CPU use, better system reliability, and improved performance on multiprocessor computers.