

AUTOMATION OF VACUUM FURNACE USING S7 1200 PLC

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Abstract:We proposed the automation of vacuum furnace using S7 1200 PLC and monitoring using HMI software. We will see the detail working of the vacuum furnace without manual control and with less electrical wiring, here we use Siemens S7 1200 PLC as hardware and WINCC TIA portal as software. The control of the vacuum furnace is done on the HMI screen which is programmed using WINCC TIA portal software which is of version 13. The inputs to the PLC comes from the sensors in the field and the outputs are given from the PLC to the actuators to make the vacuum furnace run step by step by considering all the interlocks. The code written in the S7 1200 PLC is ladder language.

Keywords—*hmi ,s7 1200 plc,wince tia protal,vacuum furnace,ladder language.*

I. INTRODUCTION

The High vacuum furnace is made of cold wall, and a batch type vacuum furnace designed. The furnace system consists of the following:

- A cylindrical vacuum changer which is water cooled with front and rear dish end
- A modular hot zone that heats the work from 360 deg.C surroundings. The entire hot zone assembly is

removable for easy maintenance of the heating elements

- A Thyristor with LV transformers for smooth temperature for hot zone.
- A panel with auto operation and manual operation in the furnace with all necessary controls and instrumentation.
- A furnace pump consists of water cooling, system, and power supply.
- A highvacuum pumping system..

The equipment is of heavy industrial quality to provide durability and reliable operation. The design follows standard safety specifications. The furnace is completely painted and primed with machinery enamel.

CONTROLS

Controls and instrumentation for the system are housed in IP54, Rittal enclosure. This factory assembled and wired control cabinet contains all the necessary switches, indicating pilot lamps, circuit breakers, control relays, , contactors, motor starters and marked terminal strips for connection of wiring between the panel and junction boxes of furnace. It is also included is system graphic display, and instrumentation for vacuum and temperature.

The control system is designed for automatic sequential operation of the vacuum pumping system with manual operation . All necessary

Interlocks are provided for safety. After placing the vacuum pumps in operation,

actuation of a single push button initiates the full cycle. Control of the temperature in the hot zone is done by A Eurotherm 2404 processor digital temperature controller. A separately wired 3216 furnace over temperature controller is provided. The vacuum instrumentation includes a Pfeiffer Gauge heads (for pirani and penning) for measuring the vacuum in to the furnace chamber. Adjustable set points are provided for automatic actuation of the vacuum valves.

II. LITERATURE SURVEY

A Flammini, P Ferrari, D. Marioli, E Sisinni, A Taroni proposed the use of sensors in industrial communication improves overall plant performance since sensor information can be used by several equipment [6]

Francesco Basile, Pasquale Chiacchio, Diego Gerbasio proposed Industrial automation is largely based on PLC-based control systems. Ladder language in PLC are the mostly programmed languages of the IEC 61131 standard which are not ready to meet the new challenges of widely distributed automation systems. We reduce the problems in the paper is shown in a novel approach based on supervisory control and IEC 61131 can be immediately used to meet the availabilities . [7]

Dong Yulin, Cui Wencong proposed Through analyzing the system which builds by CP 5611 and S7-200 PLC and RS-485 protocols, distributed system is based on bus architecture is built by using PC and multiple PLC. In order to stop using the OPC, it is converting the RS232 to RS485 from serial port. The fast communication of data is realized in PC and multiple PLC by the use of custom command word, free-port mode, and data packet format. The application is proved that this distributed application system is flexible, real-time control is very good and data transmission is also good . [9]

Mohamed Endi, Egypt, Y. Z. Elhalwagy This paper presents the State-of-the-Art and recent trends of SCADA system Architecture, which is 3 layer SCADA system architecture it is depending on open system technology rather than a vendor controlled, proprietary technology [10]

André B. Leal This paper deals with the implementation of supervisory control of discrete event systems into Programmable Logic Controllers (PLCs). It discusses the problems that arise in this type of implementation and presents an implementation methodology that solves these problems. The local modular approach is used to synthesize the supervisors and a case study problem is presented in an example. [11]

III. IMPLEMENTATION

The implementation phase of any project development is the most important phase as it yields the final solution, which solves the problem at hand. The basic goal in system implementation is to specify the logic for the different modules that have specified during system design. In other words, the implementation involves the actual materialization ideas, they are expressed in the document of analysis and developed in the design phase.

(a) PLC Programming

There are many types of programming languages to represent logic sequences and the IEC (international electrical committee) classifies the programming languages into the following types.

- 1) Ladder Diagram
- 2) Function Block Diagram
- 3) Instruction List
- 4) Structured Text
- 5) Sequential Function Chart

In this project ladder diagram is chosen as the programming language. Ladder logic was invented to replace relay control systems; ladder diagram programming is a

mainstay today, used in probably 95 percent of all applications. Ladder diagram language has experienced such widespread adoption that almost every programmer in any country or industry can read and write this language. Because it is in standard electric circuit format, even a normal person with an electrical background can understand the program for purposes of troubleshooting a problem. It's also easy to start writing a program in ladder diagram as shown in figure. 7.1. With just a basic outline input and output signals, one can sit down and start churning out code.

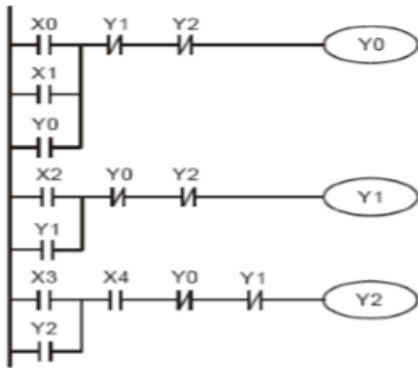


Figure 7.1: Ladder diagram example

1.1 Configuration of the programming software

The programming window of the software Siemens simatic S7-1200 is called as STEP 7 Basic. STEP 7 Basic provides a user-friendly environment to develop the logic for the controller, configure the HMI screen visualization to provide network communication. STEP 7 Basic provides two different views in the project, and a task-oriented set of portals which are arranged on the functionality of the tools, or a project-oriented view in the project (Project view) of the elements. We can choose which view helps us work most efficiently. The Portal view provides a functional view of the project and organizes the tools according to the tasks to be done. We can easily find the way and which task to choose

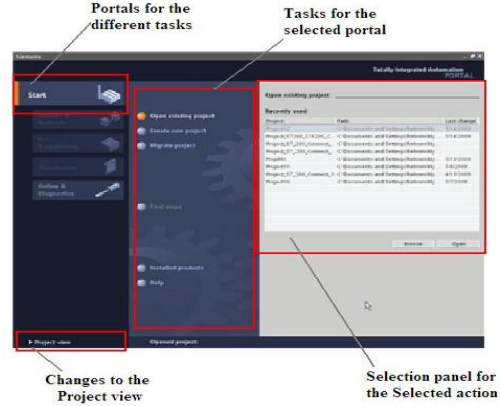


Figure 7.2: Portal view of STEP 7 Basic

The task views in portal view are

- 1) Portals for the different tasks
- 2) Tasks for the selected portal
- 3) Selection panel for the selected action and
- 4) Changes to the Project view

The Project view enables easy access to all the components in a project.

- 1) Menus and toolbar
- 2) Project navigator
- 3) Work area
- 4) Task cards
- 5) Inspector window
- 6) Changes to the Portal view
- 7) Editor bar.

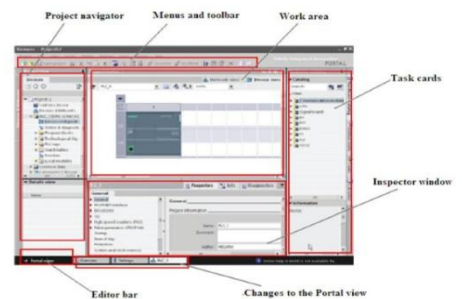


Figure 7.3: Project view of STEP 7 Basic

1.2 Creating a new program or project

To create a new project in the Start portal, click the "Create new project" task then enter a project name and click button "create". Select the device after creating the project, & Networks portal. Click the task "add new device". To add to the project select the CPU:

1. in the "Add new device" button click the

"SIMATIC PLC" button.
 2. Select a CPU in the list.
 3. To add the selected CPU to the project, click the "Add" button
 Note that the "Open device view" option is selected. Clicking "Add" with this option selected opens the "Device configuration" of the Project . The Device view shows the CPU that you added.

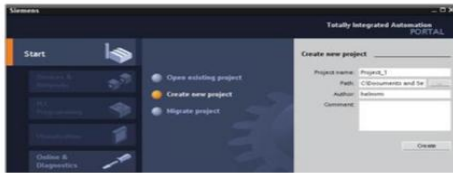


Figure 7.4: Adding new device in STEP 7 Basic

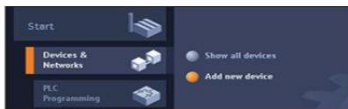


Figure 7.5: Devices & Networks portal

1.3 Creating the network or ladder diagram in the programming window

The program code consists of instructions that the PLC executes in sequence. Here we use ladder logic (LAD) to create the code. The LADDER program is a order of networks that resemble the rungs of a ladder. To open the program editor, have to follow these steps:

1. Expand the "Program blocks" folder in the Project tree to display the "Main block" [OB1].
2. Double-click the "Main block" [OB1]. The program gets opened in the program editor. Block contacts and coils onto the network:

- Click NO (normaly open)button on the "Favorites" to add a contact to the network.
- For this example, add second contact.
- Select the Output coil button and click on it to insert a coil in the program

1.4 Creating input and output PLC tags in the program

"PLC tags" are the symbolic names for input and output addresses. All of the editors in the project (the program editor, the device editor, the visualization editor, and the watch table editor) can go through the tag table. With the device editor open, then open a tag table and enter the I/O addresses directly which creates the PLC tags. After creating the PLC tags, STEP7 Basic stores the tags in a tag table.



Figure 7.7: Creating of PLC tags

1.5 Human Machine Interface (HMI)

HMI stands for Human Machine Interface which is the user interface in a manufacturing . It gives a graphics-based visualization of an industrial control and monitoring system. The KTP 600 Basic PN is the HMI type chosen for this project.

1.6 Adding the HMI device to the project

To add the new HMI device we have to follow the steps below

1. Double-click the "Add new device" icon.
2. Click the "SIMATIC HMI" button in the Add new device" dialog.
3. Select the specific HMI device from the list, and choose to run the HMI wizard to help configure the screens for the HMI device.
4. Click "OK" to add the HMI device to your project.

The HMI device is added into the project. The basic STEP 7 provides an HMI tool that helps to configure all the screens and structure for the HMI device. If HMI wizard is not selected then, STEP 7 Basic creates a simple default HMI screen.

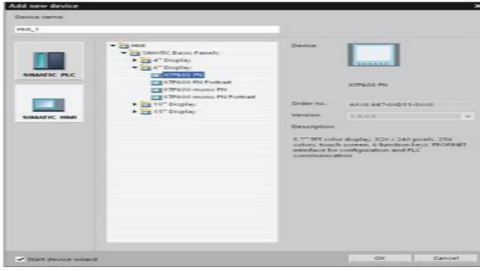


Figure 7.10: Adding a new HMI device

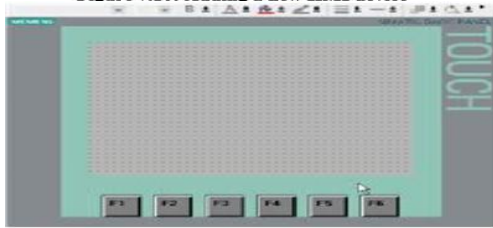


Figure 7.11: Default HMI Screen

1.7 Creating HMI Screen

STEP 7 Basic provides a standard set of libraries for inserting the shapes, elements, and even general graphics. To add an element, we can drag and drop one of the elements into the screen. Use the properties for the element (in the Inspector window) to configure the appearance and behavior form the element. We can also do the elements in screen by dragging and dropping PLC tags either from the Project tree or from the program editor to the screen. In the screen the elements contain the tags. Then we can use the properties to change the parameters for this element .

1.8 Selecting a PLC tag for an HMI element

After creating the element on a screen, use the properties of the element to select assign a PLC tag to the element. Clicking the button by the "Connections" field displays the PLC tags of the CPU. We can also drag and drop PLC tags from the Project tree to the HMI screen. Display the PLC tags in the "Details" view of the project tree and then drag the tag to the HMI screen.



Figure 7.12: HMI Screen with toolbox

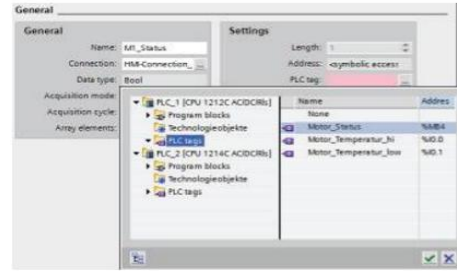


Figure 7.13: Tag for HMI element

IV. EXPERIMENTS RESULT

The temperature ,pressure and vacuum reading are taken from the controller by writing the vb script . The result is taken in the Microsoft excel as showm in the below tabular colloum.

Test ID	Batch name	Weight	Process name	Material grade	Recipe name
ID_03	trialIn1	200	h13 temp-2 d	H13	H13 TEMP -2
Date Time	Chmbr	Job	Chamber	Chamber	
	temp	temp	vacuum	pressur	
03/02/2015 10:04:00	24	23	1207.56	-0.24	
03/02/2015 11:10:00	590	506	0.0293	-0.91	
03/02/2015 12:00:00	590	506	0.0272	-0.92	
03/02/2015 13:00:00	590	584	0.0272	-0.92	
03/02/2015 14:00:00	590	598	0.0247	-0.91	
03/02/2015 15:00:00	66	263	2.935452	2.01	

V. CONCLUSION

PLC based temperature control of an vacuum furnace is designed and implemented completely. Using a S7 1200 PLC for temperature control provides effective, efficient, reliable and robust results. The automation of the furnace was realized by evaluation of the obtained information that was taken by the thermocouple in the furnace. By implementing these project which involves automating the vacuum furnace has reduced the cycle time and thus increasing the production rate. The advantages after automating the vacuum furnace are

1. Less wiring
2. Reduction of man hours
3. Increase in the quality of the product.

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