

Automation of Soda Ash Handling System using PLC and SCADA in Glass Production Line

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Abstract

Automation is a one of the most popular technology. Now a day's all production based industries need automation, because it gives more advantages over manual control system such as it reduce the man power, it reduces the operational errors, it reduce the failure rates, Easy to trouble shoot the system, it reduce the maintenance cost, it eliminate the hard wiring, it gives less rejection etc. The main aim of the paper is to automate the soda ash handling system in glass production line at leading glass production industry. The glass production line all systems are controlled by DCS (Distributed control system) but some sub systems are controlled by electromechanical relay system (Hard wired control system). The relay control system looks toward many issues. To limit that issues the system change from relay control system to PLC (Programmable logic controller) control system, because it gives more advantages over relay control system. In this proposed system all parameters are controlled, processed and monitored with help of Allen Bradley PLC and Wonderware intouch SCADA software.

Keywords: *Automation, electromechanical relay, soda ash, programmable logic controller, SCADA*

1. Introduction

Soda ash is a main source to produce the float glass. It is used to make common type of glass like flat glass and glass container etc. it plays the major role to reducing the melting temperature of silica sand in furnace. The soda ash handling system is used to convey the soda ash from pressure vessel into silo by using high pressure air [1]. This system is controlled by PLC (Programmable logic controller) and SCADA.

1.1. Programmable Logic Controller

PLC (Programmable logic controller) is a solid state electronics device is also known as industrial computer, which is used to control sequence of operation and also it perform some operation like timer, counter, arithmetic operation, logical operation, compare operation, control operation etc. the plc has four main parts are CPU (central processing unit), memory, inputs/outputs interface and power supply [2]. The PLC get input signal from field instruments like sensor, switches *etc.* The controller processes the input signals and generate the output signal to give output devices like motor, solenoids, valves, lamp etc. this operation is achieved by programming. The PLC program is a set instruction, which controls the

sequence of operation. There are different types of programming methods are Ladder logic, statement list, function block diagram. In this system ladder logic programming language is used, because it is a user friendly, easy to make the logic [3].

1.2. SCADA

SCADA (supervisory control and data acquisition) is a software based application for controlling, monitoring the system and also it gathering information from real time and remote location [4]. The SCADA system is used to control the different types of plants such as glass production plant, thermal power plant, cement plant, nuclear power plant, oil and gas plant etc. SCADA gets the data from plant and convey the data to plant. The SCADA system has three main elements are RTU (Remote telemetry units), communication and HMI (Human machine interface). Remote telemetry unit collect the data from the plant using communication system and the data is displayed by using HMI [5]. The HMI displays the data to understand by graphics form. In this system SCADA perform data acquisition, networked data communication, data presentation and process control.

2. Problem Description

The Existing system of soda ash handling system is controlled by electromechanical relay control system (hardwired control system). In hardwired control system no. of hardwires are connected to the relay according to the sequence of operation. This hardwired control system facing lots of issues such as less reliability, fault occur frequently, difficult to trouble shoot, difficult to modify the sequence because of hardwiring, low response compare to PLC, separate relay for timer and counter function, if fault occur in one relay then over all sequence will be collapse, overall system monitoring is not possible. To overcome above issues, the system change from relay control system to PLC control system, because it is soft wired control system. It gives many advantages over relay control system.

3. Proposed System Description

Soda ash conveying system is used to transfer the soda ash from hopper into silo via pneumatic conveyor. In Pneumatic conveyor system all materials can be transported conveniently to various places by means of high velocity air through pipe lines. The pneumatic conveying system only used for such materials free flash or light powder materials like soda ash or fly ash. The main parts off soda ash conveying system are hopper, pressure vessel, pneumatic system like cylinder, Directional control valves, rotary actuator and pneumatic limit switch, poppet valve, pressure switches and programmable logic controller. A hopper is a large pyramidal shaped container used in industrial processes to hold particular matter that has been collected from expelled air. In this system hopper is used as a pre storage chamber. Soda ash is manually fed into the hopper, after some period it will gradually transfers into pressure vessel. Pressure vessel is the main part of pneumatic conveyor system. It is a closed chamber. It is used to conveying the soda ash to silo by using high pressure air the pressurized air control by poppet valve. The Schematic diagram of soda ash handling system is shown in Figure 1.

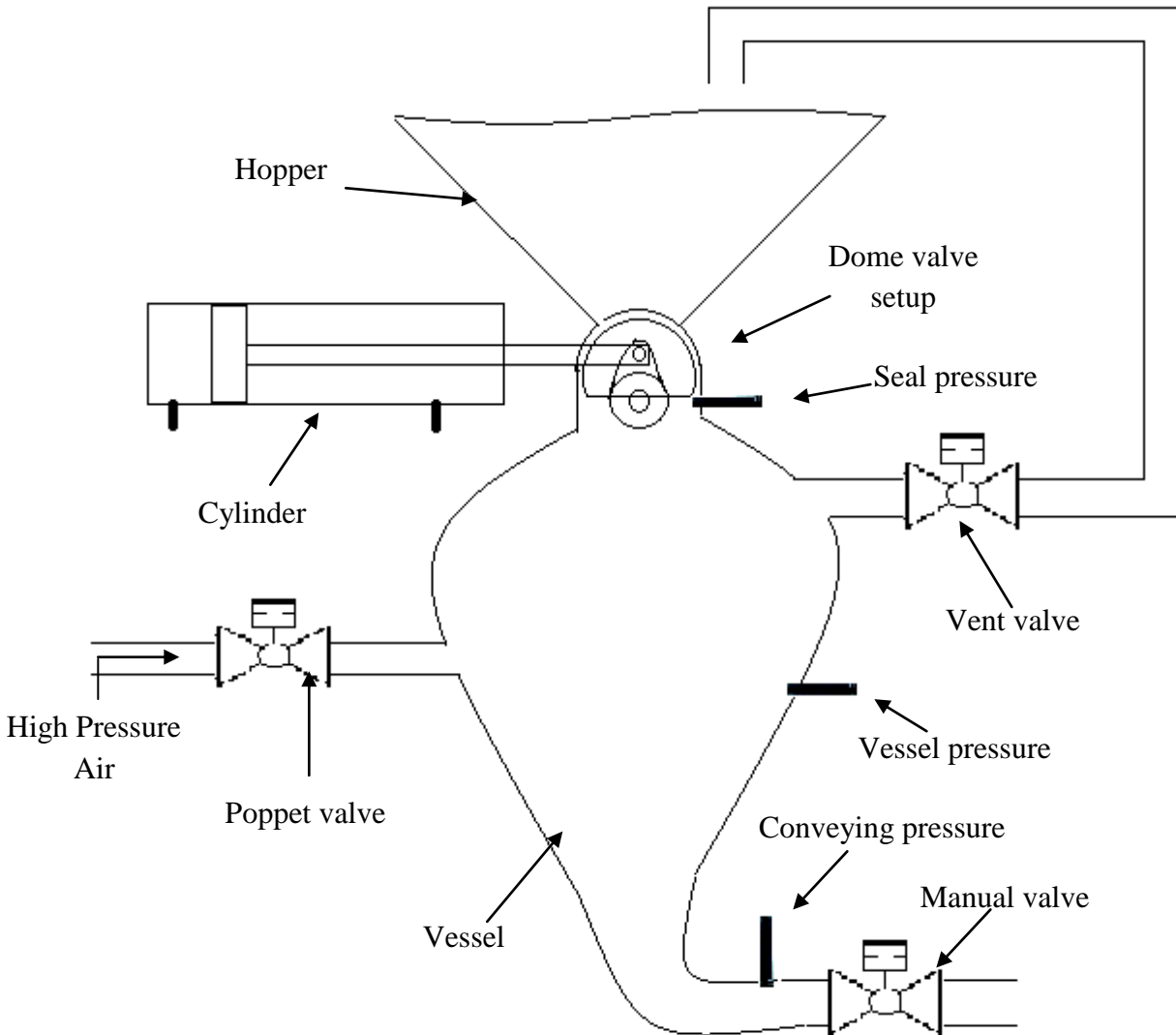


Figure 1. Schematic Diagram of Soda Ash Handling System

3.1. Pneumatic System

In this system most of the operation are done by pneumatic system that are cylinders, directional control valve, poppet valve, pneumatic limit switches and pressure switches. Pneumatic Cylinder is a device which is used to converts pneumatic energy into linear motion. The linear motion creates the useful work. In this system the pneumatic cylinder is connected to dome valve. Dome valve is type of valve equipped with dome shaped moving columns of material. When the valve is closed position, it will maintain steady pressure with tight seal condition. It is used to open/ close of pressure vessel. Directional control valve is a device which is used to control the direction of the cylinder piston movements [6]. In this system there are three directional control valves were used. It controls the three actuators are dome cylinder, vent valve (rotary actuator) and poppet valve. Pneumatic limit switches is a mechanical device, which is operated by mechanical motion, when an object contact with switch the valve operates the actuators open or close. In this system the pneumatic limit

switch is used to control seal pressure valve to open or close. A poppet valve is a type of control valve used to control the quantity of air or gas flow into the system [7]. In this system blow type poppet valve is used. The blow type poppet valves are used in pneumatic conveying system for transferring the air into the soda ash line. This system blow type poppet valve is used to control the pressurized air. If poppet valve gets open the pressurized air will go to pressure vessel in that time soda ash conveying from pressure vessel to silo. Pressure switch is a common type of switch which is used to control the outputs depends upon the set pressure. When pressure reaches the set point then it gives signal to controller and finally controller makes decision. In this system pressure switches are used to control and measure the pressure in different area is seal pressure, vessel pressure, conveying pressure. In seal pressure switches is used to measure the dome seal pressure and control the poppet valve. In vessel pressure switch is used to measure the vessel pressure and control the poppet valve. And conveying pressure switch is used to only measure the conveying pressure. It does not control any parts in this system.

3.2. Electrical System

The electrical system consist of power supply, master circuit breaker, selector switch, emergency stop switch, solenoids, fused terminals blocks, indicators etc. in this system all electrical components are operated on 24vdc supply because it gives many advantages such as easy to handle, equipment safety, easy to troubleshoot on energized condition. Maintenance can be performing safely, 24v dc supply has no shock, safe use in oil and gas area because it does not produce spark. Electrical panel diagram is shown in Figure 2.

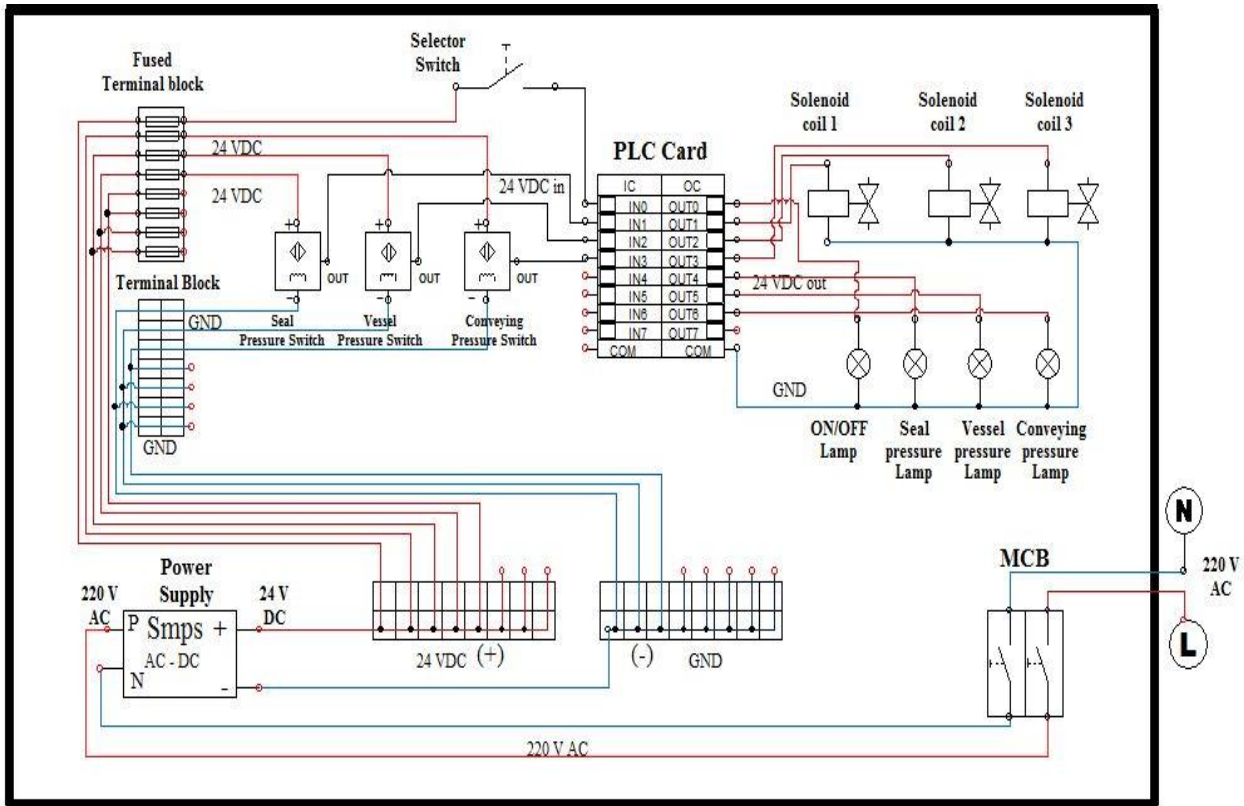


Figure 2. Control Panel Diagram for Soda Ash Handling System

4. PLC Software & Hardware

4.1. Software:

Software is any information in a form that a computer or PLC can use. Software includes the instructions or programs that direct hardware [8]. In this system RS logix 5000 software is used to program the process.

4.2. Hardware:

Hardware is the actual equipment. The PLC, the programming device, and the connecting cable are examples of hardware. In this system Allen Bradley SLC 5/04 hardware is used.

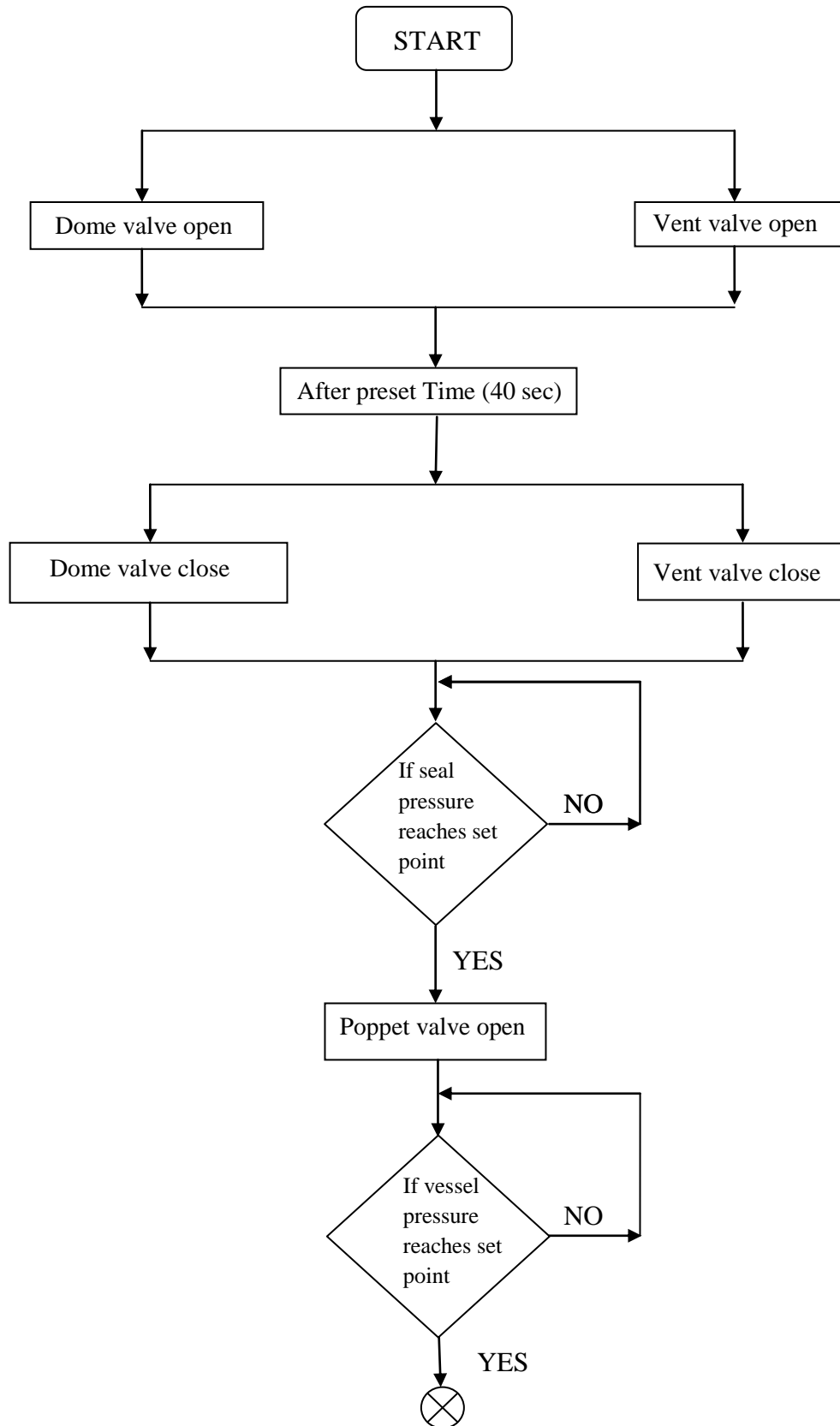


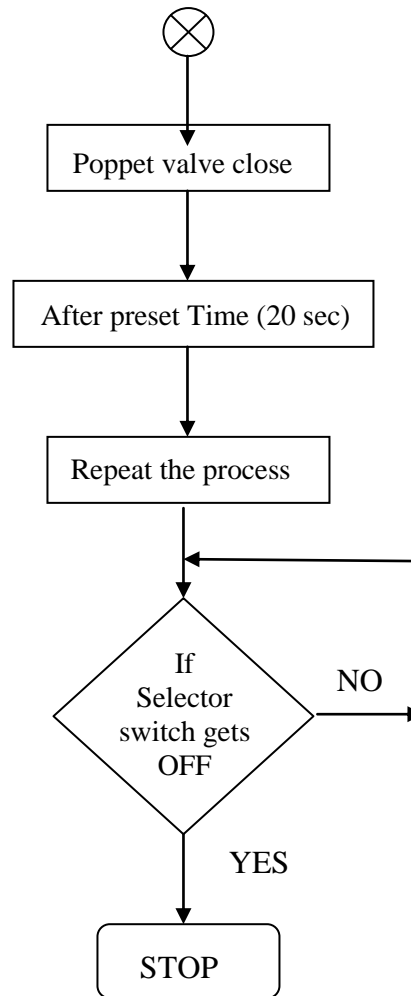
Figure 3. Allen Bradley SLC 5/04 Hardware

5. System Working

The system is start by using selector switch. After start the system dome cylinder retracts to open the pressure vessel. At that time some amount of soda ash transfers from hopper to pressure vessel. Simultaneously vent valve open. Vent valve is used to transfer the excess material from vessel to hopper. After some preset time dome cylinder forwards to close the pressure vessel. The time is preset in PLC program it can also change by SCADA system in online. Simultaneously vent valve also close. If dome cylinder forwards then the pneumatic limit switches actuated and it gives pressurized air to dome seal. If the seal pressure reaches the preset pressure then poppet valve opens by actuating solenoid valve. If poppet valve opens then the pressurized air comes to vessel and it transfers the soda ash from vessel into silo. If vessel pressure reaches the preset pressure then the poppet valve closed. After some preset time the process will repeat.

5.1. Flow Chart

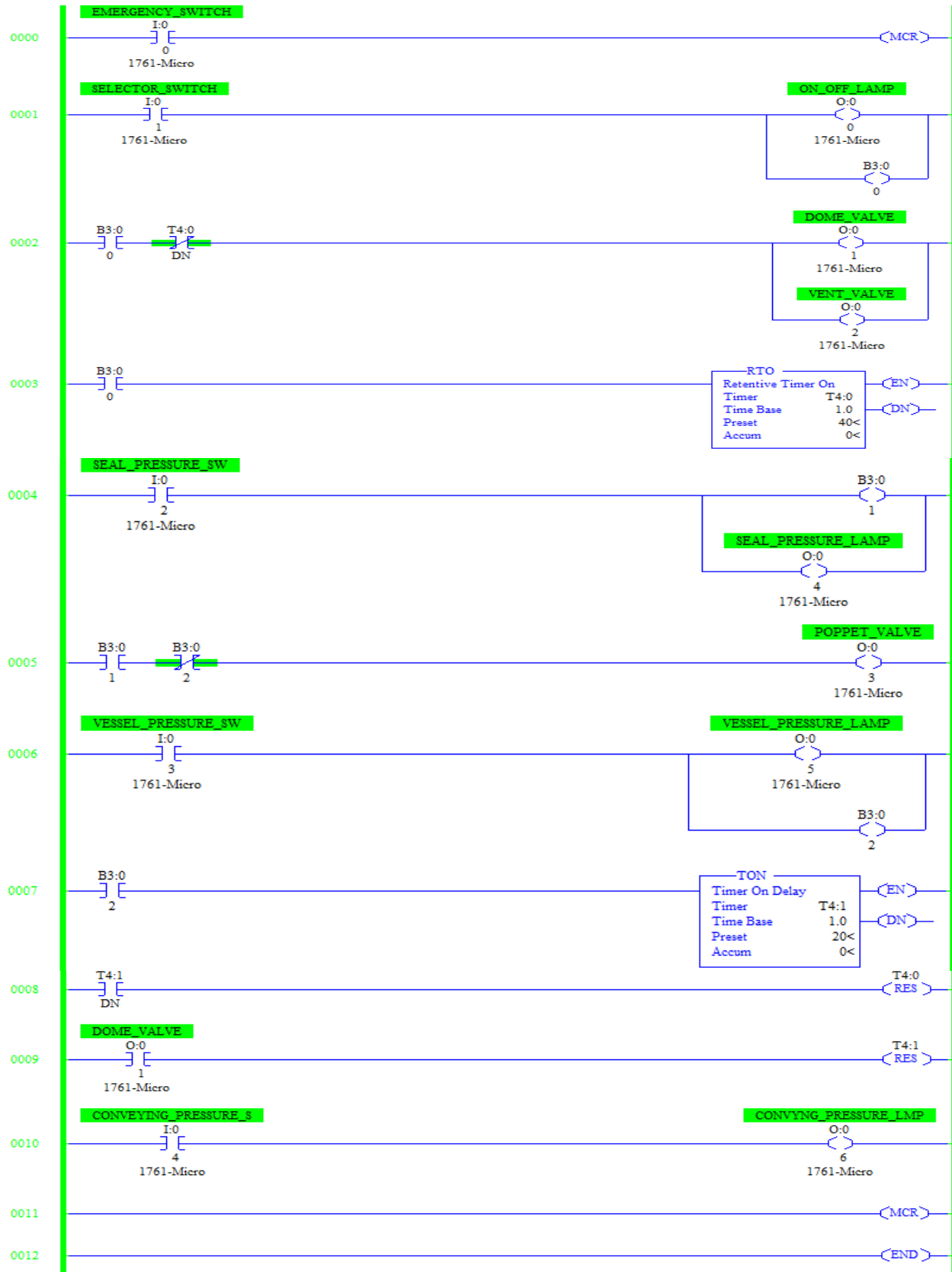




6. Result and Discussion

In this section result of soda ash handling system using Programmable logic controller and supervisory control and data acquisition are discussed. In that the ladder logic programming is created by using Rs logix 5000 software and then the purpose of real time monitoring and data gathering from system by using SCADA Wonderware intouch software. For implementing PLC and SCADA they gives more advantages such as it reduce the manpower, it gives high reliability, it increase flexibility, it improves the operation speed, it reduce the failure rates, it reduce the maintenance cost, it reduce the hard wiring, maintenance of the system is easy, Easy to trouble shooting, Easy to modify the logics at any time, easy to monitoring the system and also easily get the information from system using SCADA.

6.1. Ladder Logic Program for Soda Ash Handling System



6.2. Addressing for Ladder Logic Program

Table 1. Addressing Table for PLC Program

INPUT ADDRESS		OUTPUT ADDRESS	
Address	Description	Address	Description
I:0/0	Emergency switch	O:0/0	On/off Lamp
I:0/1	Selector switch	O:0/0	Dome valve
I:0/2	Seal pressure switch	O:0/0	Vent valve
I:0/3	Vessel pressure switch	O:0/0	Poppet valve
I:0/4	Conveying pressure switch	O:0/0	Seal pressure Lamp
B3:0/0	Internal memory 1	O:0/0	Vessel pressure Lamp
B3:0/1	Internal memory 2	O:0/0	Conveying pressure Lamp
B3:0/2	Internal memory 3	T4:0	Timer 1
		T4:1	Timer 2

6.3. SCADA Graphics

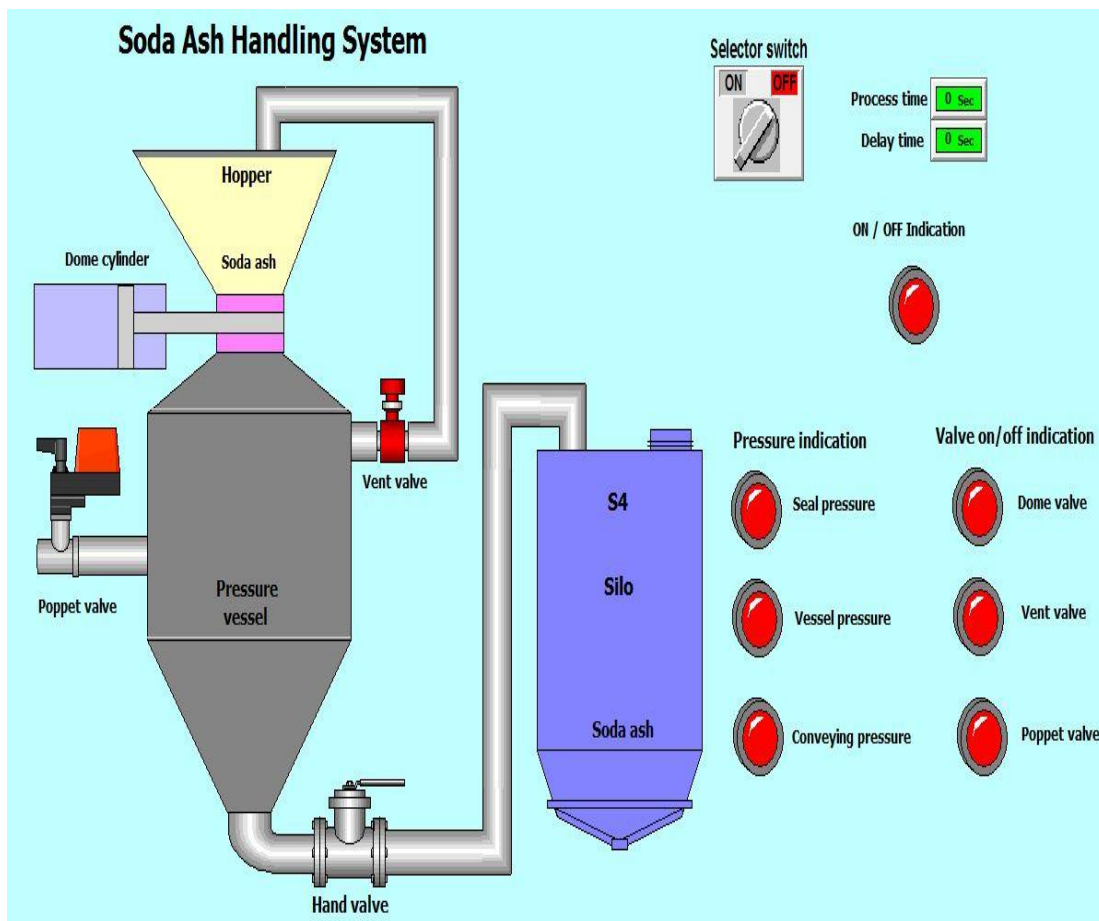


Figure 4. SCADA Graphics for Soda Ash Handling System

7. Disadvantages of Existing System

- ❖ Less reliability
- ❖ Difficult to troubleshoot
- ❖ Switching response is slow
- ❖ Difficult to change the sequence of operation
- ❖ High maintenance is required
- ❖ The system can't be interface with SCADA

8. Advantages of Proposed System

- ❖ Easy to troubleshoot
- ❖ Switching response is fast
- ❖ Easy to modify the sequence of operation without changing the circuit
- ❖ Less maintenance
- ❖ High reliability
- ❖ Easy to monitor and control the system using SCADA

9. Conclusion

In this paper soda ash handling system is automated by using programmable logic controller, supervisory control and data acquisition and field instruments. This proposed system was implemented for overcome the drawbacks of existing system. This system gives high reliability, easy to trouble shoot, easy to modify the sequence without changing of wiring, it reduce the fault occurrence, it eliminated hardwiring, easy to monitoring and data collection from system, easy to find out the problem occur in the system using SCADA. So the system improves the overall productivity and also it reduce system breakdown because of using soft wired control system (programmable logic controller).

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