DEVELOPMENT OF CONTROL LOGICS FOR FGD SYSTEM USING PLC

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ABSTRACT
This project deals with the development of control logics for flue gas desulfurization (FGD) system in power plant using programmable logical control (PLC). The output of PLC has been used automatically to control and monitor several processes in FGD system like motor turn ON/OFF functions, filling of product storage tank using level switch sensors etc. Generally control logic deals with the controlling process supervised by a program stored in the memory of the device. The PLC has a power supply unit, relay units for input and output, central units with the programmable microprocessor and internal memory. Actuator sensor interface is used for connecting input and output devices such as actuators, sensors, analog input and output and valve position sensor used in FGD process. In this project unity PLC software is used, which is utilized for the development, testing and synthesis of controller algorithm.

Keywords: Flue Gas Desulfurization (FGD), Programmable Logic Control (PLC)

1. INTRODUCTION
The power plant uses coal as the fuel to generate power. The combustion reaction (burning of coal) process produces the flue gas. Flue gas consists of carbon dioxide, water and sulphur dioxide, nitrogen from the combustion air, excess oxygen and fly ash. The fly ash is essentially removed by the electrostatic precipitators located prior to the FGD system. FGD is the process of removing sulphur dioxide (SO2) from the exhaust gas in power plants that burns coal or oil.

In this system, limestone is the reagent which is used to react with the sulphur dioxide. The limestone powder used has to be approximately 87% pure. It is necessary in order to have the maximum amount of limestone particles that can contact the sulphur dioxide molecules in the gas stream. The limestone powder has to be mixed into 15-30% slurry so that it can be pumped and introduced into the FGD vessel.

There are many chemical reactions in this process but the overall reaction is:
1) CaSO3+SO2------>CaSO3
2) CaSO3+1/2 O2+2H2O------>CaSO4·2H2O

The first reaction occurs in the gas portion of the scrubber and the second reaction occurs partially in the gas portion of the scrubber and completed in the liquid portion of the scrubber when oxidation air is passed through the liquid level. CaSO4·2H2O is the by product which is called gypsum, which is very useful in the market. This process of FGD system is controlled and monitored manually in the existing system but when we are approaching the same process by means of giving control logics through PLC everything is automated and efficiency of the FGD process also get increased. To control the emission of sulphur dioxide (SO2) from power plants to the atmosphere using control logics in PLC, to get the by product as gypsum (CaSO4·2H2O), which is a very useful product in the market. Programmable control logics are given for controlling FGD system via PLC.

In FGD system there are several process (motor turn ON/OFF functions, gate open and close, filling of product storage tank by level sensors etc.) is done by damper gates. In this project this whole process is controlled automatically by monitoring and regulating the process desulfurization efficiently through PLC.

2. WET SCRUBBING
The term flue gas desulfurization has traditionally referred to wet scrubbers that remove sulfur dioxide (SO2) emissions from large electric utility boilers (mainly coal combustion). However, because of the requirement to control acid emissions from industrial boilers and incinerators and the evolution of different types of acid control systems, the terms FGD, acid gas or acid rain control are used interchangeably to categorize a wide variety of control system designs. FGD systems are also used to reduce SO2 emissions from process plants such as smelters, acid plants, refineries, and pulp and paper mills. In wet FGD scrubbing systems, the scrubbing liquid contains an alkali reagent to enhance the absorption of SO2 and other acid gases. More than a dozen different reagents have been used, with lime and limestone being the most popular. Sodium-based solutions (sometimes referred to as clear solutions) provide better SO2 solubility and less scaling problems than lime or limestone. However, sodium reagents are much more expensive. Wet FGD scrubbers can further be classified as non regenerable or regenerable.

Non regenerable processes, also called throwaway processes, produce a sludge waste that must be disposed properly. It should be noticed that in throwaway or non regenerable processes the scrubbing liquid can still be
Recycled or regenerated; however, no useful product is obtained from the eventual sludge. Regenerable processes produce a product from the sludge that may be sold to partially offset the cost of operating the FGD system. Regenerated products include elemental sulfur, sulfuric acid and gypsum. 78% of the FGD systems represented are wet systems using lime or limestone as a reagent. Numerous operating variables affect the SO2 removal rate of the absorber.

![Flue gas desulfurization system](image)

### 3. PROGRAMMABLE LOGIC CONTROL

PLCs are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purpose. It has analog inputs devices from temperature sensor, pressure sensor and this analog is converted to digital form through convertors to read in computers. The digital values are then converted to analog outputs given to motors and actuators.

![Block diagram of PLC](image)

### 4. CONTROL LOGICS FOR OPERATION IN FGD PLANT

**Process Automation**

To make this process fully automatic a PLC unit is used. PLC takes real time decision depending upon the various field level input signals from various sensors placed in different critical points and sends the decision to the output devices.

#### 4.1 Input

Push button [PB(1-9)], Upper level detector [S(1-5)].

#### 4.2 Output

RC pumps [C(1-9)].

#### 4.3 Process Description

At first an operator starts the entire process by pressing a push button PB1. As soon as the operator presses PB1, RC pump C1 starts and making other two pump RC2 and RC3 to run. After a delay of 30 seconds GGH system gets started noted as C4, then bleed pump will start as C5, then oxidation blower as C6, then limestone slurry pump as C7, then open outlet and inlet damper as C8, close is C9. If the operator presses the PB2 then in case of...
any shutdown maintenance it is used. There is sequence of steps for transferring ladder program to PLC. Connect programming cable from PC to PLC programming port. Launch the RS Logix500 Software and select File/New. RS Logix500 links AB devices into Windows applications.

Fig: 3. MicroLogix PLC

Select the Processor type and the I/O Configuration. Click the Read I/O Configuration button to display the type of I/O modules is with the CPU. Select Channel Configuration to configure the communication ports. Select the Channel 1, and channel 0 System tab and set the settings. Select Channel user tab and Driver is Shutdown. Select the General tab make sure all settings are done. Now select the baud rate settings as 19200bps. Create simple ladder logic as shown below. The normally open contact is assign with B3:0/0 and the output coil is assign with O0:0/0. Then download the whole project by selecting Commas / Download into the PLC.

RESULTS AND DISCUSSIONS

As this process totally deals with automation it reduces the risk of human. And also the efficiency of SO2 removal is about 98%. As the PLC The whole automation process is done using programmable logic controller (PLC) which has number of unique advantages like speed, reliability, less maintenance cost and reprogrammability of input and output.

CONCLUSION

In this brief, a detailed study on composite on FGD and automation of the plant is presented. The major contribution of our work was the design and implementation of the ladder logics, balanced construction of inputs and output terms, compared to the previous studies. Furthermore, we had explored all of the possible means of improving the efficiency of desulfurization.

REFERENCES