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Automation in Distillery for Production of Rectified Spirit

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ABSTRACT

Automation in distillery unit for production of rectified spirit is implemented at the Rajarambapu SSK. Ltd. distillery. The previous plant is based on manual control for the production of rectified spirit. It involves more wastage of time and also manual efforts. This was affecting on production and quality. After implementation of automation the quality of production and accuracy was improved to beyond good limit. This paper mainly focused on the automation in distillery for production of rectified spirit by using PLC.

Keywords: Rectified spirit, distillery, automation.

INTRODUCTION

Distillation of fermented wash is based on the fractional distillation. In this method, ethyl alcohol and other impurities are separated at respective boiling points. The distillation process involves :

Separation of alcohol from fermented wash.

Concentration of alcohol.

Separation of impurities from rectified spirit.

The distillation plant consisting of degasifying column, analyzer column and rectifier column. The analyser column built along with degasifying column. Each column is attached with condensers. The separate cooler for RS are provided.

The previous technology involved the manual control of the RS production process. This involved occurrence of errors with high process time. Hence, in this work, we moved to automation technology where the steam and wash feed are controlled without manual assistance.

The block diagram of this work is shown below which mainly consists of two columns namely analyser and rectifier column. The automation is done with the help of Programmable Logic Controller (PLC). The Supervisory Control and Data Acquisition (SCADA) system is used for monitoring purpose.

RTD - Resistance Temperature Detector

DPT - Differential Pressure Transmitter

PLC - Programmable Logic Controller

SCADA - Supervisory Control And Data Acquisition

The Piping and instrumentation diagram for the automated RS production process is shown in this section. Figure 2 shown here,

It consists of two distillation columns namely analyser column and rectifier column. The objective of this work is to maintain the top and bottom temperature of the analyser and rectifier column and also to monitor the level of the storage tank. The input steam feed is also monitored.

MATERIALS AND METHOD

The degasifying column was used principally for removal of non condensable present in the fermented wash. The degasifying was operated under vacuum. Fermented wash was fed on the top tray of the degasifying column. Feed flow to the column is controlled by using flow valve. The wash flowed from the top of the column to the bottom by gravity.

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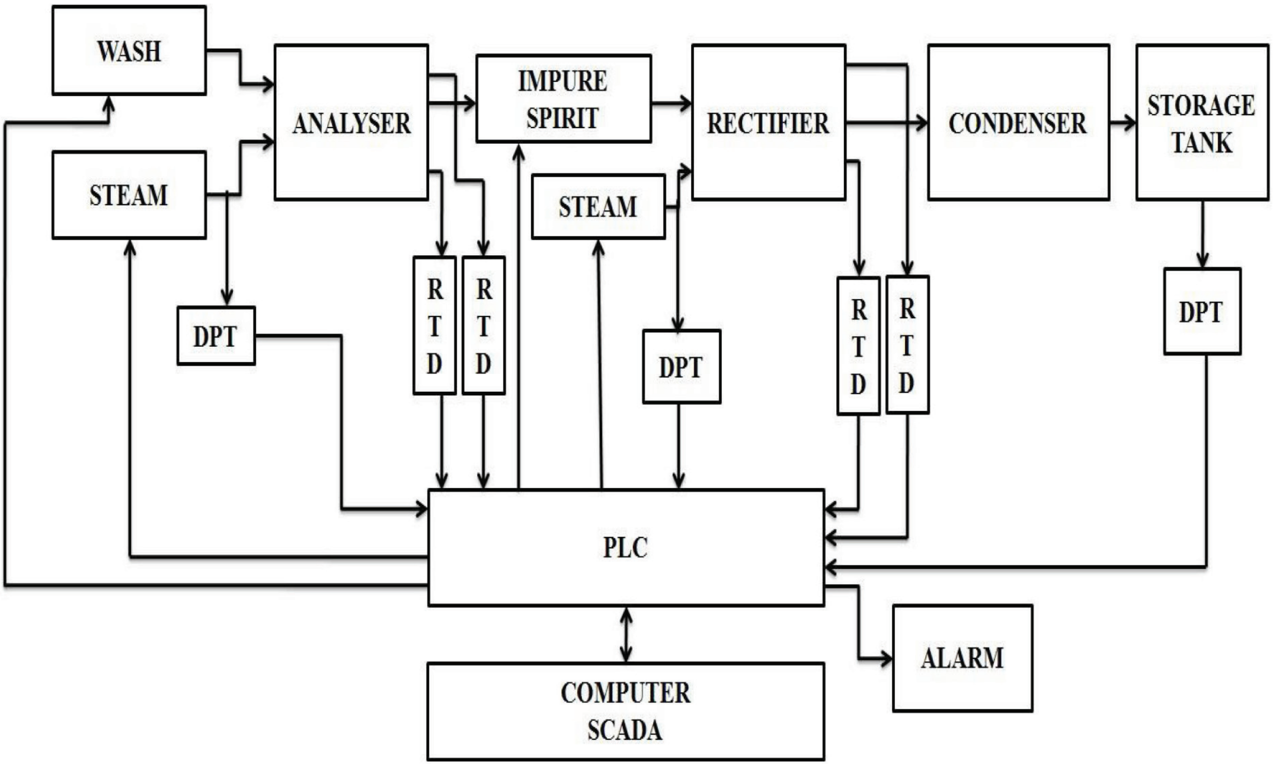

Figure 1 : Piping and instrumentation diagram

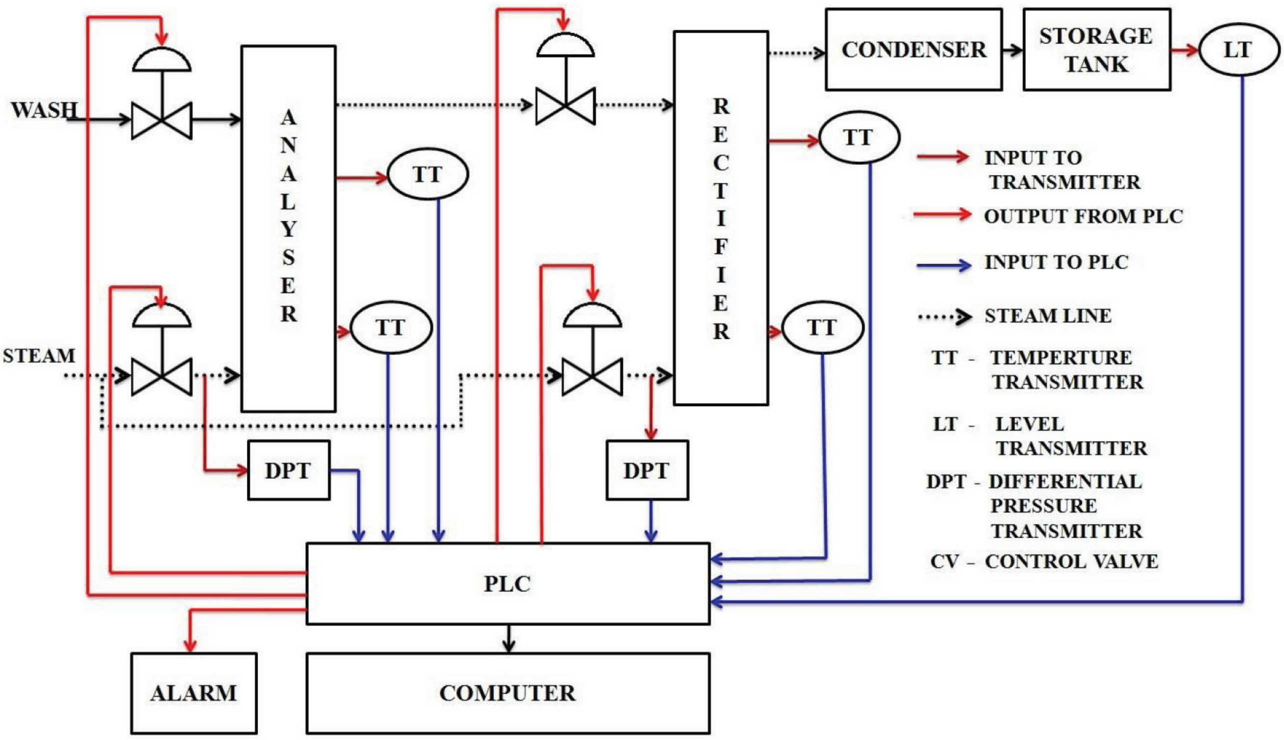

Figure 2 : Piping and instrumentation diagram of process

The fluid flows over each tray and came in contact with rising vapors from the bottom thus getting stripped off non condensable From the bottom of degasifying column the fermented wash flows to the top of the analyzer column through vapor separator where non condensable present in fermented wash was removed before feeding to analyzer column.

Analyzer column strips off the alcohol from the fermented wash before discharging the rest of the material as spent wash. Fermented wash was coming from bottom of degasifying column through vapor separator. The vapors coming out of the top of the column are condensed on the analyzer column condenser-I, where they are partially condensed .Balance alcohol vapors are condensed in analyzer condenser vent II. The non condensable vapors are passed through vent scrubber for scrubbing alcohol before going to vacuum pump. In the scrubber alcohol from the vapors is scrubbed by using soft water and this scrubbed alcohol is taken to the fusel oil washing tank. The condensate from degasifying condenser I,II and analyzer condenser I,II is collected. Spent wash from the analyzer column bottom is sent to raw spent wash settling pit. Rectifier cum exhaust column vapors that are condensed on shell side of analyzer bottom reboiler. The analyzer condensate is fed to the rectifier column.

This column serves to strip out alcohol from liquid stream flowing down. Steam is fed to rectifier reboiler in controlled manner. Flow control valve controls the flow of steam to the reboiler. The vapors coming out of the top of the column are fed to the analyzer reboiler where they are partially condensed. Balance alcohol vapors are condensed in analyzer reboiler vent condenesr. Cooling water is used for condensing the vapors. Condensate is collected in the rectifier reflux tank. Condensed liquid is pumped back to rectifier cum exhaust column from the rectifier reflux tank as a reflux.

Rectifier column was operated under pressure and the pressure was controlled by pressure valve located on the vent line of analyzer reboiler vent condenser. This vent line was further connected to RC PCV condenser. Cooling water is used as cooling medium on tube side. Condensate from reboiler and its vent condenser are fed to the RC reflux tank. Condensed liquid was pumped back to the RC from the rectifier reflux tank as a reflux. Spent lees coming out of RC bottom. RS draw is taken out from 67 or 69 or 71 plates. At the RS draw plate temperature was around 96-97 ^{0}C.

The analyser column was divided into ten segments and 18 trays which were arranged in zigzag manner. Each tray consists of 95 bubble caps. In the analyser column the top and bottom temperature should be maintained in a specified range. The top temperature range was 71-72 ^{0}C. The bottom temperature range is 80-82 ^{0}C.The vacuum at the analyzr at top is 0.42 kg/cm^3 and at bottom is 0.51 kg/cm^3.

The temperature was measured by a 3 wire RTD (PT-100) and passed to the PLC through a temperature transmitter. The steam pressure value was passed to the PLC via a Differential Pressure Transmitter (DPT). If the analyser column temperature goes below the specified range, the steam feed was increased by the PLC by opening the control valve.

Similarly, If the analyser column temperature went above the specified range, it was controlled by increasing the wash input and by controlling the RC vapors to analyzer boiler. The top product of the analyser column (impure spirit) was fed to the bottom of the rectifier column. Steam also fed to RC reboiler. The column is divided into 72 trays are arranged in zigzag manner. RC column works under pressure, each tray consisted of 65 bubble caps. In the rectifier column the top and bottom temperature should be maintained in a specified range. The top temperature range is 97 ^{o}C. The bottom temperature range is 126-128 ^{0}C. In addition to that steam pressure is also maintained at rectifier reboiler. The steam pressure at the RC at top was 2.2 kg/cm^3 and at bottom is 2.48 kg/cm^3.

If the rectified column temperature went below the specified range, the steam feed was increased by the PLC by opening the control valve which was going to RC reboiler. Similarly, if the rectifier column temperature went above the specified range, the steam feed was decreased by closing the control valve by the PLC. The top product of the rectifier column is the rectified spirit in vaporized form that is fed to the condenser in which the vaporized rectified spirit is cooled and stored in receiver in liquid form. The level of the receiver is monitored by PLC with the help of Differential Pressure

Transmitter (DPT). Hence the level is measured and if it exceeds the limit, it triggers the alarm.

In PLC, by means of simple programming techniques, user can automate any industrial process in an easy manner. It has reduced space, energy saving, modular replacement, easy trouble shooting, error diagnostics programmer, economical, greater life and reliability, The compatibilities of PLC'S, logic control, PID control, operator control, signaling and listing, coordination and communication.

Operation of PLC

Basics of a PLC function are continual scanning of a program. The scanning process involved three basic steps.

Step 1: Testing input status

First the PLC checks each of its input with intention to see which one has status on or off. In other words it checks whether a switch or a sensor etc., is activated or not. The information that the processor thus obtains through this step is stored in memory in order to be used in the following steps.

Step 2: Programming execution

Here a PLC executes a program instruction by instruction based on the program and based on the status of the input has obtained in the preceding step, and appropriate action is taken. The action might be activation of certain outputs and the results can be put off and stored in memory to be retrieved later in the following steps.

Step 3: Checking and Correction of output status

Finally, a PLC checks up output signals and adjust it has needed. Changes are performed based on the input status that had been read during the first step and based on the result of the program execution in step two – following execution of step three PLC returns a beginning of the cycle and continually repeats these steps. Scanning time = Time for performing step 1+ Time for performing step 2+ Time for performing step 3.

Allen Bradley PLC

Programmable Logic Controller or PLC is an intelligent system of modules, which was introduced in the control and instrumentation industry for replacing relay based logic. Over a period of time, better I/O handling capabilities and more programming elements have been added along with improvement in communication.

PLC Working

At the beginning of each cycle the CPU brings in all the field input signals from the input signals from the module and store into internal memory as process of input signal. This internal memory of CPU is called as process input image(PII).User program (Application) will be available in CPU program memory. Once PII is read, CPU pointer moves in ladder program from left to right and from top to bottom. CPU takes status of input from PII and processes all the rungs in the user program. The result of user program scan is stored in the internal memory of CPU. This internal memory is called process output image or PIQ. At the end of the program run i.e., at the end of scanning cycle, the CPU transfers the signal states in the process image output to the output.

Interfacing

The PLC connected through different protocols and using drivers. In this work PLC was interfaced with SCADA using RS-232C and RS-485 protocol. The interfacing method in (Figure 3).

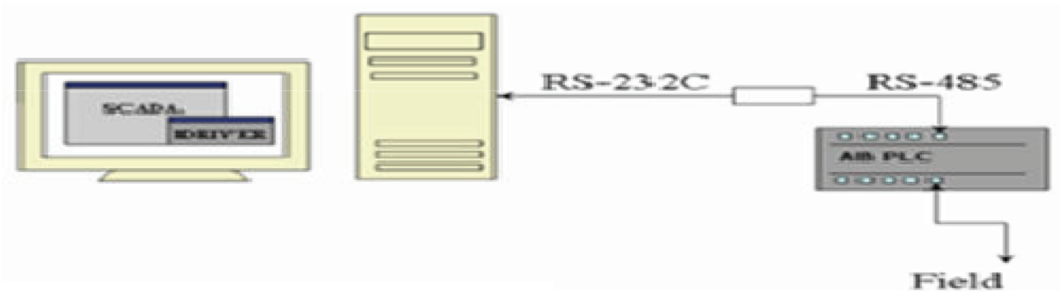

Figure 3 : Interfacing PLC with SCADA

Most of PLC drivers communicate with SCADA package using DDE, DDE requires three parameters namelyname of the DDE server, topic name and item name. In case of reading a number of items from a particular PLC driver application name topic name are common, so this application name that is name of the DDE server and Topic namecombine to form an access name. Access name is required to be defined only once then other items of driver can be accessed by using the Access name and item name.

Role of supervisory control and data acquisition (SCADA)

SCADA is not full control system, but rather focuses on the supervisory level. It is used to monitor and control plant or equipment. The control may be automatic or initiated by operator commands. The data acquisition is accomplished firstly by the RTU's scanning the field inputs connected to the RTU (it may be also called a PLC – programmable logic controller). This is usually at a fast rate. The central host will scan the PTU's (usually at a slower rate). The data is processed to detect alarm conditions, and if an alarm is present, it will be displayed on special alarm lists.

RESULTS AND DISCUSSION

A case study of performance of the distillery with and without automation in Rajarambapu SSK Sakhrale Dist:Sangli

The simulated results of temperature in rectified spirit production are shown below.

Analyzer Column

Below figure shows the top and bottom temperature of the analyser column for five hours that showed both temperatures which are maintained in its range. If temperature exceeded in its range the control action takes place. So top and bottom temperatures are maintained.

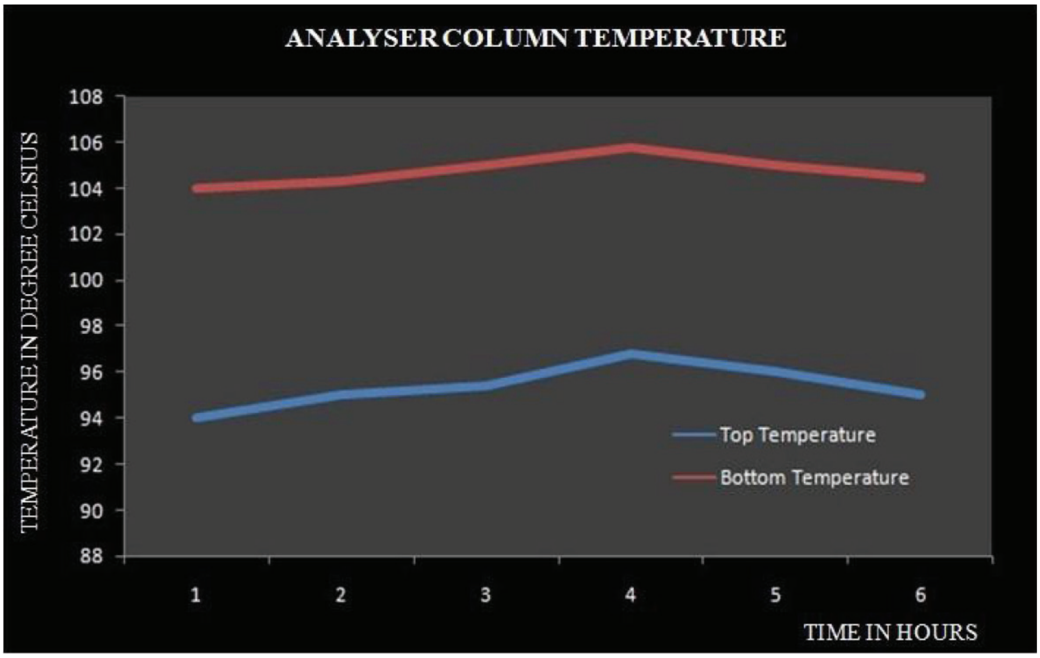

Figure 4 : Analyser column temperature

Rectifier Column

The top and bottom temperature of the rectifier column for five hours showed that both temperatures which are maintained were in its range (Figure 5). If temperature exceeded in range the control action tooks place. So top and bottom temperatures are maintained within the range.

CONCLUSION

In this proposed work, the RS production process was automated with high accuracy and quality. A new protocol called as International Communication Group (ICG) was to be implemented which is the future work of this project. This International Communication

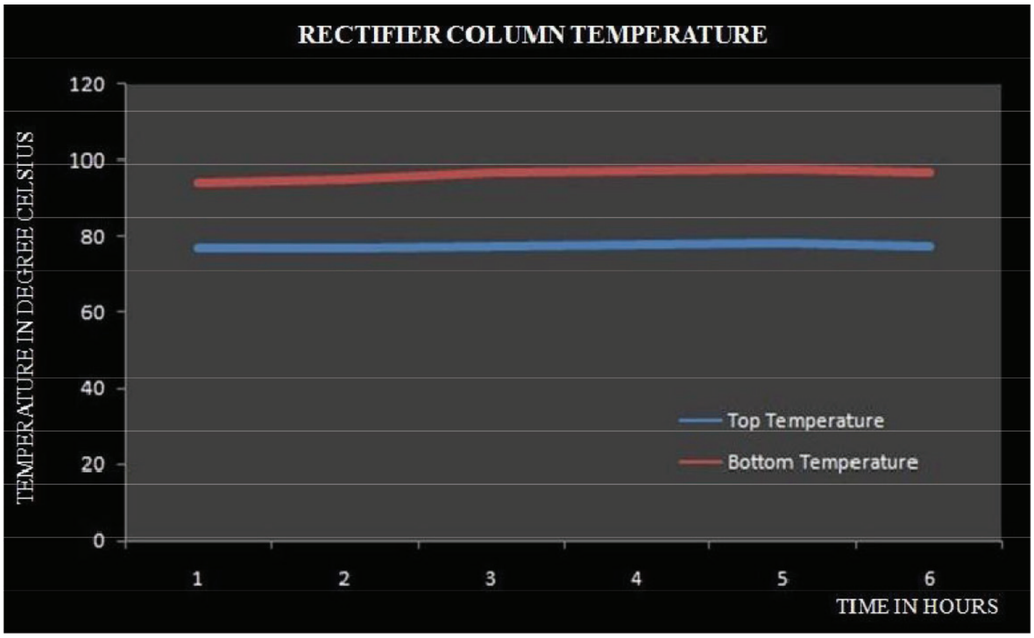

Figure 5 : Rectifier column temperature

Group (ICG) was used for the online updating and monitoring of the concerned values of the plant. It is concluded that the production process is improved to a better quality due to the automation. The overall benefit of the study claimed reduced overall maintenance, reduced breakdown, increased throughput, reduction in cost, increases in accuracy and quality and increased efficiency.

ACKNOWLEDGEMENTS

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