Simulation, Implementation and Tuning of Three Element Boiler Drum Level Control loop without Cascade Control and Feed Forward Signal in DCS and Results

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Abstract - In thermal power plants the steam generator is called boiler. It requires fuel air and water to produce the steam as a raw material. In the boiler water, coal and air should be at specific level for combustion. If it is not in adequate level then the harmful gasses and emissions of unburnt particles are going to atmosphere with the flue gas.So it is very critical to save our environment from polluted gasses and harmful particles in air. It also reduces the efficiency and loss of resourses.It wastes the energy as well as the production loss. Hence to operate the boiler at optimum condition all the parameters are measured and should be control at the desired level. In this paper modified water level control techniques of steam drum is simulated in distributed control system and various parameters are observed at different load and time. Fine tuning of PID controller of modified closed loop control of three element drum level have been done and achieved the final P,I and D value. P,I and D Values of the fine-tuned PID is used to control the running process of steam drum level control in DCS.Results and trends are analyzed at different load and optimum tuning is used to further control of running process of boiler.

Keywords —Cascade Control, Drum Level, Three Element, Feed forward, Boiler, Single Element, Thermal Power Plants, Level Control

I. INTRODUCTION

A modified closed loop control technique is used for drum level control without cascade control and feed forward signal. Most important modification in the proposed closed loop control of three element boiler drum level control is the elimination of cascade loop and feed forward signal in new closed loop control scheme. Feed forward signal directly affect the controller remote set point value and vice versa opening and closing of control valve. Sudden change in load cause change in feed forward signal value. It causes change in the controller output suddenly and hunting occurs in drum level. Hence after elimination of feed forward signal it is clear that closed loop become more stable and precise for drum level control. Similarly in cascade loop two PID are controlling but in proposed control Loop only single PID is controlling the drum level process. So it is more enhanced control loop for drum level control. It is faster and provides less hunting in the drum level monitoring and control. It also reduces the time of PID tuning due to single PID controller in place of two PID controllers. Single PID is more reliable then the master and salve configuration.

II. DEVELOPMENT OF GRAPHIC PAGE

Initially graphic page development in progress as per process flow diagram and piping and instrumentation drawing in DCS. Graphical Object library is designed for the specific project and standard object is for the related project is also designed. Now graphics are going to developed.in the graphics builder and we gave the name to graphics page called feed water circuit. In the feed water circuit page steam and water related piping and other equipment's like motorized valves, control valves, flow nozzles, orifices, and many more are given on the graphics page.in this page incoming of water to steam drum and outgoing of steam from steam drum has been given.in the graphics page all the equipment's related to this piping and process are also shown with different colors and shapes whatever it is designed in standard libraray.In the attached page of graphics it is more clear to understand about water and steam supply in boiler. The most important things are the measured variables related to process like pressure, temperature, flow, and level are given to show the real measured value of process during the operation mode. You can also control the equipment from the graphical faceplate. A control valve can be opened are closed from graphics and

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similarly motor can be start or stop from graphics of DCS.

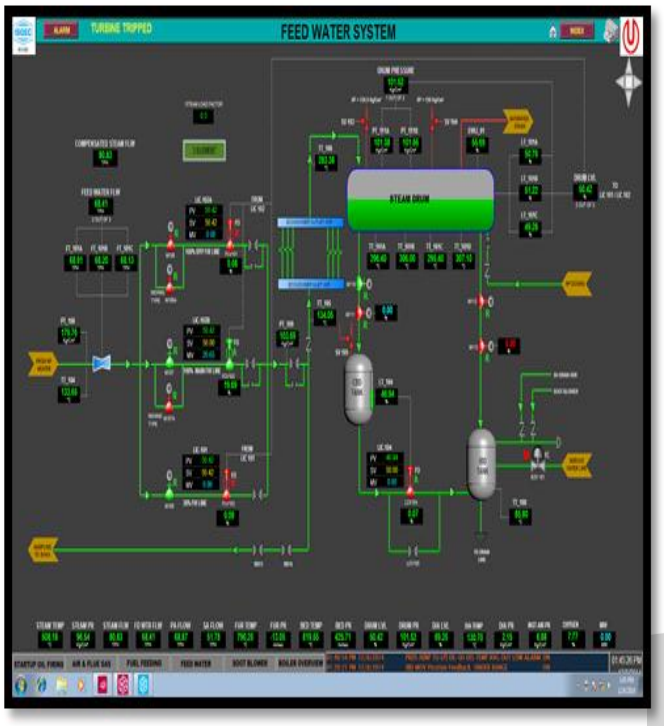

Fig.1.1 Feed Water System

III. Graphic Faceplate of PID Controller

Faceplate is a graphical representation of the control of any equipment from HMI of DCS.If we consider the any equipment in drum level control that is given on feed water page called control valve. It is used to control the flow and control of the valve can be done from HMI.A figure of faceplate is given below. In the given figure it is clearer about the faceplate.

Fig.1.2 PID faceplate for level controller

In the figure 1.2 three faceplates are given.one is called level indicator and controller 102 B and second one is called level indicator and controller 101.In the faceplate PV called process variable and SV called set value. MV is called manipulated variable and also called the output value of PID to control the final control element. All faceplates are related to drum level controller and controlling the position of control valve in manual as well as in auto mode. Manual control can be done from this faceplate if controller in manual mode. In manual mode we just increase and decrease the value of manipulated variable and see the position feedback of control valve.

IV. Control Loop Schematics In Graphics

After the graphic page development of feed water circuit next step to develop the three element drum level closed loop control schematics in graphics.it is also part of graphics development.it is made to understand the control loop of drum level without entering in the logic in FBD.It also provide the real values at the time of running control and during the plant operation, so any engineer can find out what values are running in process and what is the value of output generated by PID to control the position of valve to control the flow of feed water. In the given figure 1.3 closed loop control of three element drum level control without cascade and feed forward signal has been shown. In the given figure it is clear that all the real values are coming from transmitters and and going to PID controller to generate the output.

Feed water flow and steam flow are added to each other and the value is scaled from -100 to +100 and scaled value is further added to the LIC output to control the opening and closing of control valve.

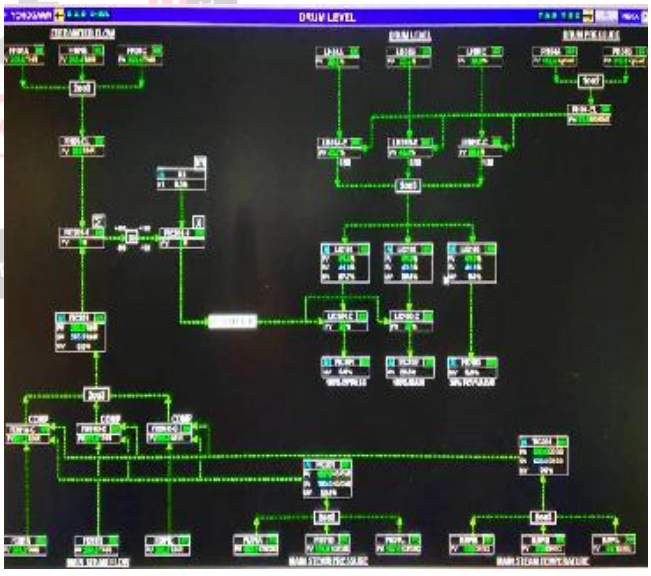

Fig.1.3 Control schematics of drum level control loop

V. Three Element Drum Level Closed Loop Control Logic In Function Block Diagram in DCS

After designing the control schematics in graphic page next step to program the three element drum level closed loop control without cascade and feed forward signal in control builder of DCS.It is programmed using the language called graphical language and name function block diagram. In

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this language we have different type of standard blocks available in the program library. Blocks may be different like PID, Scaling, annunciation, and many other blocks. It can be used depends upon the program requirement. Figure 1.4 shows the FBD logic of the drum level control.

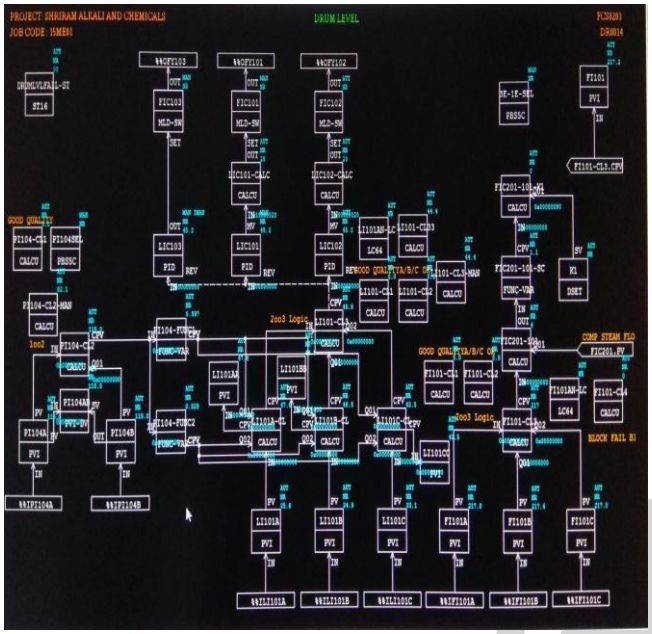

Fig.1.4 Three element drum level control Logic in FBD without cascade and feed forward signal

In figure 1.4 three element control loop is programmed in form of function block diagram. In the control loop we take the drum level transmitter signal and given to level controller. Set point is also given 50% to controller. Output of controller is again summed to the difference of scaled value of feed water flow and main steam flow. This output is again fed to 1E/3E block and selected as per the mode used for control loop. It is used to control the control valve position to control the level of drum.

VI. TUNING OF PID CONTROLLER

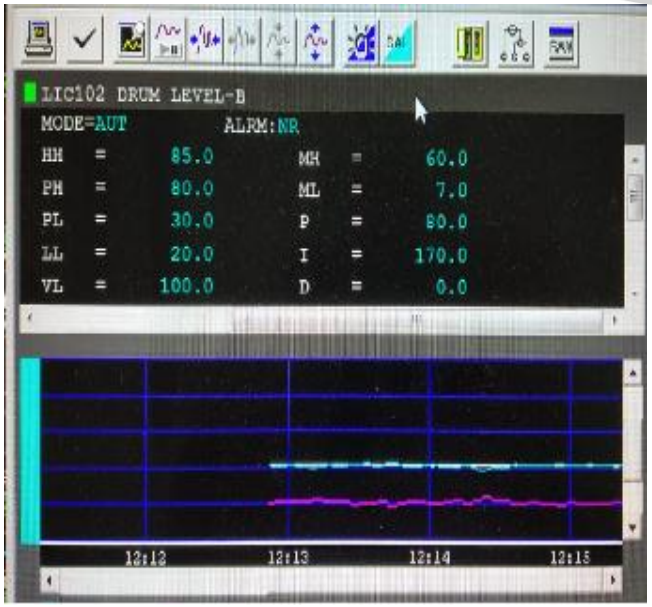

Fig.1.5 Tuning Parameter of Three element Drum Level PID controller without cascade and feed forward signal

In PID tuning process we have to make trail at different values of PID at different time of interval and at different load condition. Initially we have to see the behavior of process before going to tune the PID controller. In drum level control the process variation is very fast during the load swing and very stable during the continuous running load. Hence we have to tune the PID for fast response and as well as continuous control. It is tuned at different value of P, I and Where P is the gain and I is the reset time is used to reset the value of trends of process behavior. In figure 1.5 optimum value of P, I and D is given. It is the value which is used to control the process in real time power plant shown in figure.

VII. TRENDS AT DIFFERENT LOAD

When the three element drum level control strategies without cascade and feed forward signal is implemented in the DCS and the process trends are taken of various parameters at various load is given in figures 1.6, 1.7 and 1.8.It can be analyzed that the trends of steam flow, Drum level and feed water flow is.All the trends are taken after final tuning of PID controller and taken in line for the drum level control of the boiler.

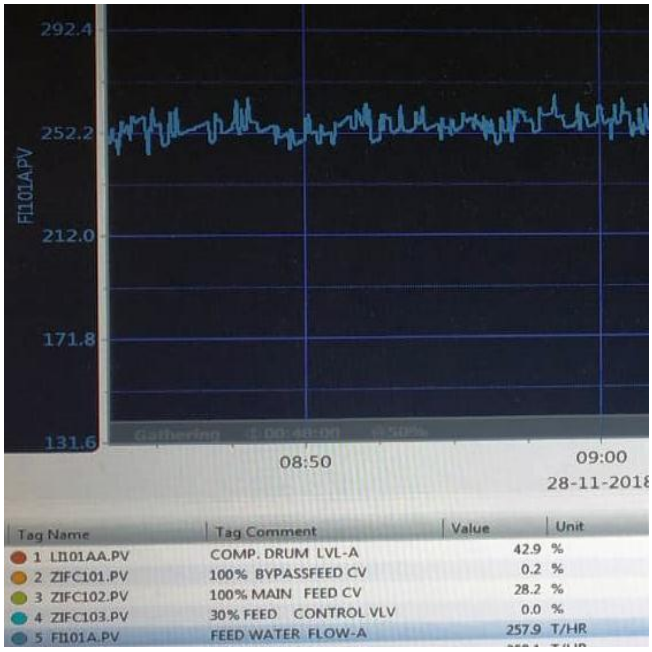

Fig.1.6 Trend of Feed water Flow

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Fig.1.7 Trend of Steam Flow

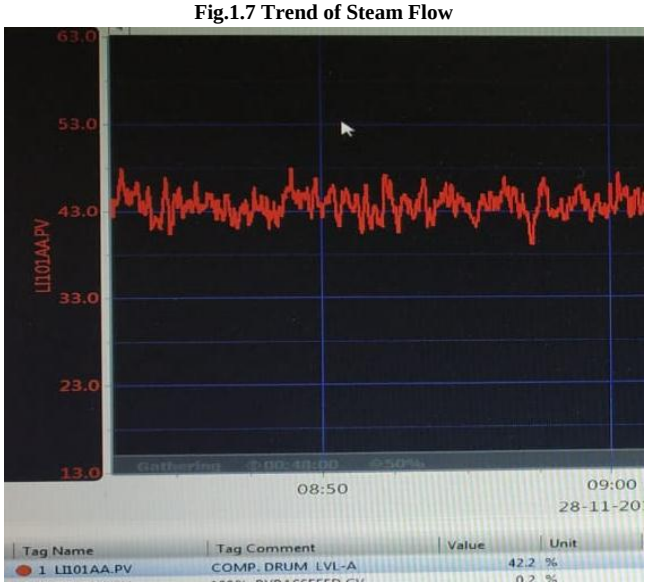

Fig.1.8 Trend of Drum Level

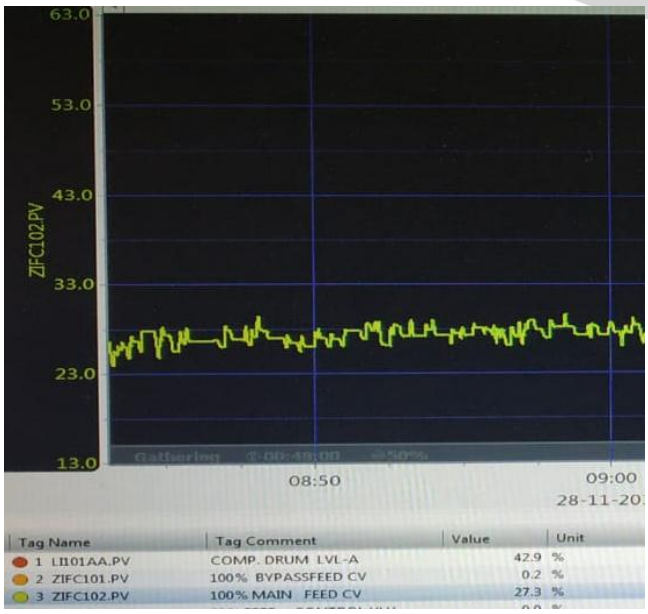

Fig.1.9 Trend of Control Valve Position

VIII. CONCLUSION

In this paper we have discussed about the implementation of three element steam drum level control without cascade and feed forward signal. Implementation of the above scheme has been done after the simulation of the loop. Tuning of PID has been done for the precise control of the process at different load. It has been observed that the hunting of control valve is reduced and opening and closing is also reduced after implementation the above control loop. Process behavior is more stable than the existing one. Tripping due to feed forward signal is eliminated and plant becomes more stable and also efficiency is increased due to minimum breakdown and provides the reliable operation of the boiler in auto mode. It also provides the comforts to operation engineers to control the plant.

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