International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 06 | June - 2021 ISSN: 2582-3930

Boiler Automation and Parameter Controls

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ABSTRACT

Today's industrial environment is changing from manual to semi- automation and semi-automation to fully automation. In all these feasibility's process control plays a vital role. Also most probably upon the process control are via analog, digital circuitry The designer selects the appropriate system, depending upon the usefulness & cost to performance ratio. Boiler automation & control is our proposed project. Here the steam pressure & temperature are sensed, indicated and controlled separately. The boiler system will be working only when temperature and pressure are within safe limits.Boilers are available in two basic designs:

1)FIRE TUBE BOILER
2] WATER TUBE BOILER

Our aim is to prove the automation in boilers; hence source of heat is not so importance. After excessive heat exit valve should be open or heat sourcing element should be stop. In boiler automation following process parameters are to control.

a) TEMPERATURE OF STEAM
b) WATER LEVEL IN TANK

The main abstract of the proposed system is to automate the boiler with the microcontroller. This paper focuses on the system that will control the flow of coa part in thermal power station so it requires frequent inspection with regular time interval. Earlier days these analyses and monitoring was done manually. There are number of chances for occurrence of errors with workers while measuring particular values in boiler operation process. So a reliable monitoring system is required to overcome these errors and maximize profit. Thus the automation of boiler is safe, fast and reliable, it must have variable tool for the operator to control various operation in the boiler. The software and hardware controls are made of modularity is taken in account. Prone of error is reduced because of reduced workers. With the help of automation the complexity of Control system is reduced by using Microcontroller-Based Temperature Monitoring. This automation operation is developed using ARDUINO ATMEGA 168 controller.

Keywords:-Analog, Boiler Automation, Digital Security, Pressure, Semi Automation, Temperature

INTRODUCTION

The objective for the automation in boiler is to ensure boiler is safe and prevent the boiler from dangerous conditions. The automation in boiler must be safe, less time consumption and informative should give an alert to the operator for his attention so that he can control the parameters in the boiler.The automation software and hardware. components are made easier so the modularity is taken into account. Thus the whole automation operation is easier to handle they can be expanded if needed.

The main conditions for the automation in boiler are to increase in performance, safe, reliable and easier to operate with improved integration degree.The boiler automation unit is the one which warps the entire thermal power plant. The entire power produced is guarded from control section, likewise there are some identical

workstations, for an example, in the power plant, coal handling and at maintenance room. As the entire plant is operated by one system, the control room can be designed to be consistent and ergonomic. Thus the man power can be reduced so that the plant can be designed to run at one person per shift. Prone of error is reduced because of automation and the complete plant is operated easily with high efficiency and safety. The Thermal Power plant can be controlled in a single mode of operation without any disturbance which makes the system to be efficient. The automation makes it easy to find someone to help debugging the project. A boiler is a self-sufficient combustion system which is mainly used for heating of water or other fluids. It generally consists of a closed metal container or a vessel in which the pressurized water is subjected to heat and then converted into steam or vapors. This conversion of liquid into gaseous state or vapors is known as evaporation process .This heated water or steam generated inside the boiler can then be used for variety of purposes like Home heating systems.
Steam turbines + Oil refining Paper drying etc.
"In the boiler furnace, the chemical energy in the fuel is converted into heat, and it is the function of the boiler to transfer this heat to the contained water in the most efficient manner. A good boiler system design should be such that, It produces superior class steam for use in plants and industrial applications. It results in maximum absorption of heat energy produced by the combustion reaction. There are three means by which heat can be transferred to the water inside the boiler, i.e. via radiation process, conduction process and convection process. The relative percentage of each is dependent upon the type of boiler, the designed heat transfer surface and the fuels."The heating surface of a boiler can be defined as the section of boiler which tends to contain hot combustion or flue gases at its one end and liquid on the other. In other words, any metallic component of the boiler which helps steam generation would be regarded as its heating surface.

BODY OF PAPER

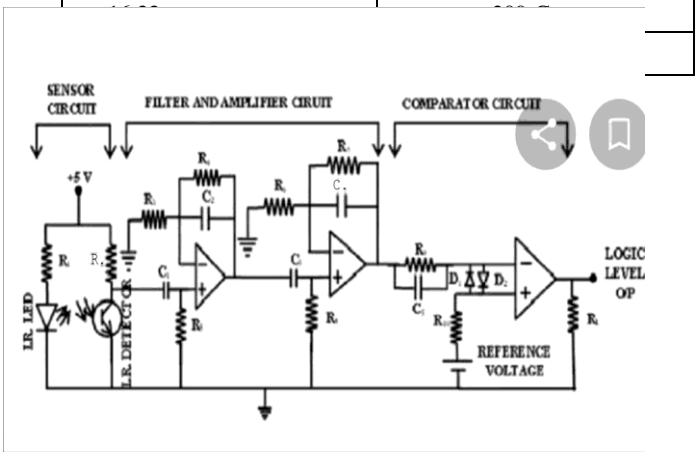
MATERIALS AND METHODS

1) MANUFACTURING:

1.1-Introduction of manufacturing:

The word manufacturing is derived from the Latino manufactures, meaning made by hand. Manufacturing involves making products from raw materials by various processes or operations. Manufacturing is generally a complex activity, involving people who have a board range of disciplines and skills and wide verity of Machinery, equipment, tooling and process with various levels of automation, including computers, robots and material handling equipment or devices. Manufacturing is the process of converting the raw material, components or parts into the finished product that meet a customer's expectations or specifications, Manufacturing process are the steps through which the raw materials are transformed into which the design is made. There materials are then modified through manufacturing process to become the required part Manufacturing processes can include treating (such as heat treating or coating) Machine or reshaping the material. The manufacturing process can also include tests and checks for quality assurance during or after the manufacturing and planning the production process prior to manufacturing. Manufacturing is the production of merchandise for use or sale using labor, Machine, tools, chemical & biological processing or formulation. The term may refer to a tunge of human activity from handicraft high tech, but it most commonly applied to the industrial production, in which The raw material are transformed into finished goods on a large or small scale. Such finished goods may be used for manufacturing other, more complex products, such

Volt	*Temperature*
0 mV	0° C
1.28mV	Ambient temperature
5.23mV	at 100 C
10.77mV	at 200 C



as chemicals, fertilizers, paint and fuels or sold to wholesaler, who in turn sells them to retailers.

1.2-TEMPERSATURE CONTROLLER:

1.2.1-DESCRIPTION: Transducer converts one form of energy into another form. In our case the physical energy is to be converted in to an electrical signal. For temperature we use thermocouple as a transducer and for humidity we use Ds-20 a resistive transducer. (The thermocouple theory is already provided). The DS-20 is a resistive transducer, its resistance varies depending upon the atmosphere moisture contains increases its resistance also increases and vice-versa. The variation in resistance depending upon the variation in moisture is converted into humidity in terms of de milli volts in signal conditioning block. Thermocouple works of see back effect principle i.e. when two dis-similar n are fused together and heated mill volts are generated at another end. We use J type thermocouple, which use and constants, two dis-similar metals and boiler.

The milli volts generated at perpendicular temperature are as bellow:

Table 1.2.1 Milli volts

- **Analog signal conditioning:** In Analog signal conditioning operational amplifiers are used.The electrical signal received from the transducer is conveyed to a proper range.
- **Thermocouple conditioning:** operational amplifier configurations are here. For thermocouple on, cold junction compensation is to be done. We are adding the mill volts signal corresponding to ambient temperature here one ambient sensor is used, 2N2222 is transistor having two diodes connected together inside. We use one of the diodes among the two. As shown this eje diode sensor is connected in series with conducting transistor. This transistor is made ON by providing should be above 0.7V. A potential divider with two different resistors is used hare this divider has resistance R1-12k & R2-7k5,
  imput 5Vdc;
  V Volt 7k5/12k +7.5k During calibration, this sensor is allowed to sense atmosphere temperature. In such situation the output from the transistor emitter is fed to the non-inveding terminal of the operational amplifier. The inveding terminal is provided with a variable signal. This variable signal is provided using a variable divider as below. The total voltage drop (-5V-0V-5v)-10V Thus, the voltage signal at the variable terminal of the variable potentiometer be varied as per the requirement. As this signal is fed as an input to the inveding input of the amplifier, the output of amplifier changes depending upon any of the input either inveding or non-inverting.Initially 300my are adjusted at the central point i.e. wiper

of potentiometer. The op-amp being in unity gain fashion,generates-300mv at the output. This signal is equivalent to 30°c. Thus, if no signal from Thermocouple section, output should be equal to 30°c. Once this is set, the atmospheric changes are sensed by the amp. Sensor and are shown on LCD module. This cold junction compensation section. Thermocouple sensor is connected at the input of difference amplifier. Refer The my generation table of the sensor as given earlier. Suppose we calibrate the unit up to 100 c We require 2000my as an input to ADC. As 20 mv-1 unit on LCD. Thus, 5.23 my is to convert into 2000 mv. Wedo the amplifications in two steps. At initial diff. Amplfier S my conveyed to 100mv i.e. means a gain of 20 is required here. For difference amplifier.

Vout- RF/R1(V2-V1)
Thus,Vout-RF/10K(5mv say)—
Let R1=10k
100mV-RF/10K(5mv)
Therefore RF- 200K,
But, 2000K being not available we use 220K here.Also, a multi-tern trim pot is provided for getting a flexible gain. Thus, the signal available at the output of different amplifier and the signal available at CJC output are added together in adder amplifier
R1 =10k,volt=2600volt.
Here also we requires the gain =20 henceRI=10K and RF=220K Again.

Thus, we get the appropriate output, which goes to ADC. If we connect thermocouple the output varies linearly from ambient to maximum as per the change in temperature. Temperature Calibration - Before using any digital process instrument it should be calibrated properly. Standard Calibrators are required for this purpose. These Calibrates are also cedified by the National Committee such as NABL, ETDC

The Steps are givens as under The steps involved in callibration:
Initially,short the thermocouple input and adjust ambient temperature equal to 30 c, with the help of multi-turn potentiometer. Then connect mill volt source at thermocouple input and set the kilovolt input 5.23 mV and set the output equal to 100 c+ 30 c ambient i.e. total 130°c with "span potentiometer. Repeat above 1 & 2 steps sequentially till we get output ambient-30°c and maximum span-130 c .After calibration, we can connect thermocouple sensor and observe the result. This signal is in analog form. It is connected No-1 i.e. Pin f3 of ADC 4051.

1.3-LEVEL CONTROLLER

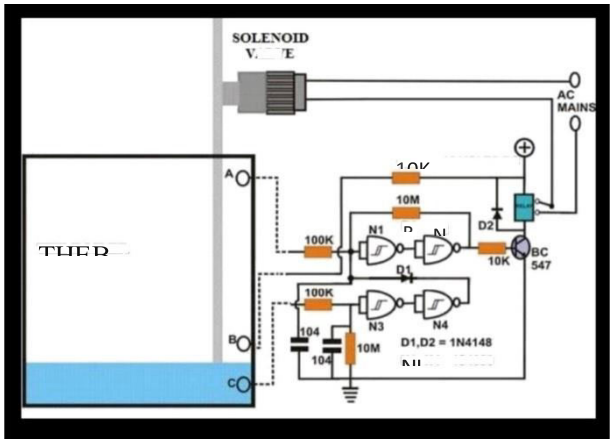


Fig.-Circuit diagram of level controller

DESCRIPTION:

1.3.1-Digital display circuit:

This circuit comprises of a quad 2-input XOR gate ICI (CD4030) for sum; outputs decimal to BCD code converter using diode matrix of diodes D3 through D7 a BCD to 7 segment

decoder/driver IC2 (74LS47) a common anode type 7-segment display LTS542R.When only the tip of sensor probe (cathode) no.1 is in touch with the water the voltage at pins 3 of the 3 of the IC 1 becomes logic high (i.e. +5V).And hence voltage at line no (L-1) also becomes high. Now due to conduction of diode D3, the BCD code 0001 (Q3 Q2 Q1 Q0) is generated and converted to equivalent seven- segment code byIC2 (74LS47) to display the decimal digital. Similarly, when the pins of both the sensors 1 and 2 are in touch with water the voltage at pins becomes logic low 1 (OV) while lathe voltages at pies 4 and line 2(1- 2) become logic high (t. e+5). Now due to conduction of diode D6, the corresponding BCD code0010 is generated and decimal digit 2 is displayed on the seven-segment display.When the tank is completely empty, the outputs of all X or gates; of ICI are low and the display shows decimal digit 0. In this way the display circuit unit works to show digits 0 through 4, corresponding to the level of water, as defined by the position of the sensors at different heights. Here the resistors R9 through R12 and R19 through R21 have been used for passive pull-down.

1.3.2-Controller circuit:

The controller circuit is built neither around three quad 2-input NOR les (IC3) through ICS) to switch the pump motor on or off when certain condition is fulfilled.

The condition to be met for switching-on/running of the pump are:

The mains supply should be within certain low and high cut off limits (say between 200 AC and 250V AC)

The water level I'm the sump (ground tank) is above certain optimum level (2 in fig) 3 Water in the overhead tank (OHT) is below the minimum level.

Once all the above-mentioned condition is satisfied, the pump motor would above start running The corresponding logic level at point A will be low (point B will also be low automatically not being in touch with the liquid). Point C will also be low and pointD will be high.

Once running the pump will continue to run even when the water rises above the minimum level in the OHT. (1.e. level at point A subsequently goes high) provided the first condition is still sully satisfied and the water level in the sump has not fallen below that of sensors 1. it will stop only when either the maximum specified level in the OHT has been reached or the water level in the sump has fallen below sensors I position. Here the NOR gate pairs of N2 and N3 and N6 and N7 form NOR latches. When the ground tank water level is above the defined level 2 the voltage at pin II of gate N6 is low. So diode D12 cannot conduct. Also if voltage at output pin3; of gate N12 is high and the voltage at collector of transistor T2 is low. Diodes D8 and D11 are thus cut- off So the voltage at input pin of gate N4 is pulled down to logic low level by passive pull down resistor R18 (56 k Ohms).Now if the over head tank is empty i.e. water level is below level 1 the voltage statesat input pins I gate N2 and pins 12 and 13 of gate N1 are pulled down to logic low by passive pull down resistors R13, R14 respectively. Hence voltages at output pin 11 ofgate NI and input pin 5 o gate N3 become logic high to force the output at pin4 of N3 are inchod low. This logic level will not change until voltages at input pins 5 and 6 of gate N3 become low (Ov) and voltage at pin 1 of gate N2 goes high (+5v) since both inputs of gate N4 are low, hence its output at pin 10 goes logic to drive transistor TI into conduction. Relay RU is thus energizedand the pump motor is switched on.The water level of the OHT starts rising. When the water level reaches the topmost sensor 5, voltage at input pin I of gate N2 goes high. Already the voltage levels at pin 11 of gate N1 and the input pin 5 of gate N3 are low. So the voltages at output pin 4 of gate N3 and input pin 9 of gate N4 become logic high to turn the output to turn the output pin 10 of gate N4 of logic low level. Thus relay RU is de-energized toswitch the pump off When line voltage within the specified limits and ground water level goes below the

defined level 1, the voltage at output pin 11 of gate N6 becomes logic high to make diode high to make its output pin 10 to go low. Transistor T1 is cut-off and the relay iskept disabled, even though the OHT is fully empty. The relay will be enabled only when the water level in the sump tank is above level 2.When the ground tank water level is above level 2 but the line voltage is out of range, gate N12 output pin3 goes low to cut-off transistor T2. making diode D11 conduct. In this state the output of gate N6 and the output of gate N2 becomes logic low. Although diode D12 does not conduct, diode DII conducts and the output of gate N4 to cut-off transistors TI. This disables relay RLI and the pump remains off, even though the OHT is completely empty.

Here two cathode sensors for sensing ground tank water level have been used instead of one, to provide some hysteresis in the becomes in the system. When ground water level is below levels, the output of gate N6 becomes logic high (+5v). When water level is above level 2, the output of gate N6 is logic low (Ov). if the water level 1&2. state. there is no change of state at output of gate N6, i.e. output remains at the previous state.

1.4-Power supply:

The power supply circuit consist of step down transformer XI (having two secondary with ratings of 12v, 100mA and 15v, 750mA), a bridge rectifier (using four IN4001 diodes), a capacitor of 2200 micro farad for filtering purpose, regulator IC 7812 for feeding the code probes as well as relay RLI, and regulator IC7805 for feeding regulated +5v supply to all digital.ICS, LED's, seven segment displays. The twelve-volt secondary is used for sampling the mains. One of its terminal is grounded, while its other terminal marked "G'. is connected to point 'G' of high/low, cutout circuit in fig. the marked secondary rated at 15v, 750mA are used for deriving the regulated D.C supplies required for operation of the circuit

1.4.1-Construction of sensors:

The highlights of the circuit are its electrodes used for mineral/conductive water, which are made of stainless steel rods. These electrodes have a life of more than 5 yr. Anode is a rod of 5-mm Dis, and each of the cathodes of 3-mm diameter.The cathodes and the anodes should be long enough so that the soldered terminals are not in contact with water, even when the tank is full. The joints should be covered with insulation in such a way that rain water does contact with the soldered joints. One has to use orthophosphoric acid or zinc chloride to make a soldered joint between stainless steel and conducting part of the flexible feed wire.The distance between the anodes and the cathodes should not be more than 60 cm Arrangement should be made in such a way that no electrode touches the other.

1.4.2-About microcontroller IC89c51:

The AT89C51 is a low power, high performance 8 bit microcontroller with 4K bytes of flash programmable and erasable read only memory.The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51 instruction set and pin configuration The on chip flash allows the programmed memory to be re- programmed in a system or by a conventicle nonvolatile memory programmer By combining a versatile 8 bit CPU with flash on a monolithic chip the Atmel AT89C51 is a powerful micro-computer which provides a highly flexible and cost effective solution to many embedded control applications.The AT89C51 is designed with a static logic for operation down to zero frequency and supports two software selectable power saving mode. The idle mode stops the CPU while allowing the RAM timer/counter serial port and interrupt system to continue functioning. The power down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

Features:

Following are the features of microcontroller AT89C51 as per the data sheet given by Atmel

1) Compatible with MCS-51 products.
2) Kbytes of system reprogrammable flash memory.
3) Endurance 1000 write/erase cycles.
4) Fully static operation 0Hz to 24MHz.
5) Three level programmed memory lock.
6) 128*8 bits internal RAM.
7) 32 programmable I/O lines.
8) Two 16 bit timer or counters.
9) Six interrupt sources.
10) Low power idle and power down mode.
11) Programmable serial channel.
12) Integrated Boolean processor for control operation.

POWER SUPPLY:

Power supply is the first and most important part of our project. For our project we require +5V regulated power supply with maximum current rating 500mA.

Following basic building blocks are required to generated power supply:

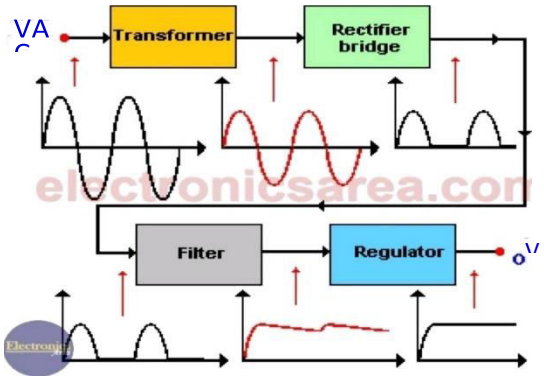


Fig.-Block diagram of power supply

1.4.3-STEP DOWN TRANSFORMER:

Step down transformer is the first part of regulated power supply. To step down the mains 230V AC. we require step down transformer.Following are the main characteristics of electronic transformer.Power transformers are usually designed to operate from source of low impedance at a single freq. It is required to construct with sufficient insulation of necessary dielectric strength. Transformer ratings are expressed in volt-amp. The volt-amp of each secondary winding or winding is added for the total secondary VA. To this are added the load losses Temperature rise of a transformer is deciding on two well known factors i.e. losses on transformer and beat dissipating or cooling facility provided unit.

2. PCBDESIGN

Many electronic systems impossible to package without designing printed circuit boards printed circuit are metal foil conducting patterns usually copper, handled to a substrate for support. The metal conduction pattern serves as a connecting support . The metal conducting pattern served as a connection medium for electronic components.

2.1-Advantages of PCB over conventional wiring methods are:

1)Easy adaptability to minimization and moduler dsign.

2)Uniformity in production.

3)Virtual elimination of wiring error.

4)Lower cost.

2.2-ATWORK:

Perfect artwork is the most important in the production of PCB. There are some real methods of producing quality artwork. Skills and patience are the basic assets of at work designers.

2.3-DRILLING:-

Drilling can be done with the electronic drilling machine specially designed for drilling the PCB. To drill a hole for resistor, capacitors lead & for IC pins a specific drill this Before going for etching of PCB we have done drilling prior that because if aching is done before drilling the PCB we would have a problem which can be explained a follows while performing work a lot more skill is required if somebody drills a hole just besides a place where actual hole should be drilled. At that time nobody can correct & drilling is done before etching we can extend the copper area by marker pen. So at the respective places drilling is done. For mounting of PCB four holes are made at the mer. One extra hole is drilled just be side the twenty-six pin connector. So that while coition the connector on the PCB pressure on the PCB is minimized in this way willing is completed.

2.4-ETCHING:-

Etching is process by which unnecessary copper clad is chemically washed out. A copper clad with ready artwork or screen printing is ready for etching process a Chemical solution of FeC13 is the commonly used chemical for etching process because it a short etching time this means copper dissolve in this solution by producing the pate of copper is chloride and ferrous chloride. The chemical reaction is as,

13-Cu-CucI2+2FeC12

Ferric chloride (FeC13) is a cheap chemical and least dangerous and easily available. For etching a PCB allowed to move freely in to the solution of ferric chlorides that etching process would be faster. For this a thread is tied to a PCB and it is resolved in to ferric chloride solution. When the copper is fully dissolved into the solution the PCB IS washed with the help of water.

2.5-HANDSOLDERING:-

In this soldering technique every point is soldered at a time. The components to be soldered are taken and the flux is supplied to its lead for prominent solder or avoids dry solder due to oxides on the leads. In this type of techniques considering each point solders every point.The advantage of this technique is that individual attention and disadvantage is that it is time consuming and not economical.

FoIIowing are the steps in handsoldering:-

1.Making the iron ready.
2.Apply flux to two surfaces.
3.Heat both the surfaces by iron bit positioned properly.
4.When both the surfaces are not heated then apply solder wire at135c.
5.Let the solder be met and wetting of both the surfaces will take place.
6.Lift the iron tip along the component (after the cutting process is complex).
7.Remove their on rubit against the pad and restore it.
8.Cut the extra leads.

ADVANTAGES

1.Due to auto control of boiler risk of accident is minimized.

2.ManuaI operation is not requiring. So man power is reduced.

3.Due to accurate measurement & control saving of eIectricity which helps

4.Microcontroller based system provides many flexibilities & access for future development.

5.System is multi purpose & can be utilized in various industries

.6.Prototype boiler model is provided in order to check.

APPLICATIONS

Today's industrial environments are changing from manual to automation. Boiler automation is very important in some industries to sense the steam and temperature and controlled separately. Mostly in sugar industry the boiler is used in great amount, with the help of boiler also produces light and provides to other and uses them also. It also used by some other industries also.

These are some Industries where BOILER AUTOMATION is used in great amount these are follows:

1.Sugar Industry
2.Paper Industry
3.Pharmaceutical
4.Chemical Industry

LITERATURE SURVEY

- Fire-Tube boiler
- Superheated steam boiler
-

Fire-Tube boiler:-

This boiler has a water tank, boiler shell, it is permeated with water and the tubes are aligned in horizontal position. Water is partly filled in the tank and the water level is maintained in such a way that it is suffcient for the accommodation of steam. The horizontal tubes are known as flue sand they carry the combusted gas over water tank which make the water hot. The hot gas pass through the furnace located at one end of the Fire- Tube. The pressure in the boiler is approximately 360 psig of steam pressure.

The Water tube boiler tubes are arranged vertically in firebox when the flow of water is carried out over the tube it gets heated, the vertical pipes are known as risers and they extend from the bottom of the boiler where the water drum is kept it passes the steam to the top of the boiler. Water tubes are used because it can withstand high pressure. The water or steam is passed over the small diameter pipe so that they can tolerate high pressure.

Superheated steam boiler:-

This boiler reheats the steam which is produced from the boiler and makes it as the superheated steam. The produced steam varies from the initial steam produced this varied steam is known as saturated steam it has vapor molecules which condenses slowly compared to the saturated steam. The temperature increases in the super heater part up to 370degree Celsius but the pressure remains constant. This superheated steam are mostly used to rotate the turbine as it removes droplets at initial stage.

Future scope and expansion:

- **PC Interface:-** We can use this system with the PC interfacing; such as we can operate the boiler on the PC by using some other software. By using PC we can add many other functions additionally.
- **PLC Interface:-**
  The PLC interfacing also can be useful to control the water level of the tank, we can use PLC for opening or closing of valves we can give the programmed to it by which itcan control the system.
- **Scada Application:-**
  We can also use SCADA application to control the system, the SCADA application also used combined with PLC to terminate the program.
- **Data Loging:-**
  The PLC interfacing also can be useful to control the water level of the tank, we can use PLC for opening or closing of valves

we can give the programmed to it by which itcan control the system.

CONCLUSION

In this way after completion of project we can conclude that the automation of boiler is necessary in all industries because boiler is heart of industries, which drive the turbines, & penetrates the electricity. Implementation of such type automation system for all boilers we improve the output of system . Boiler Automation using Micro-controller was designed and implemented. Sources used for measuring the temperature in the boiler and maintaining at the determined value. If the temperature exceeds predefined value then the entire coal adding process will slow down and decreases the rotation of exhaust fan. If the temperature goes below predefined value then the entire coal loading setup will gets pended up, to maintain the output steam pressure constant in boiler to get the constant required

ACKNOIHLEDGEMENT

With deep sense of gratitude we would like to thanks all the people who have lighted our path with their kind guidance. We are very grateful to these intellectuals who did their best to help during our project work.It is our proud privilege to express deep sense of gratitude to, Prof. Magar sir. Principal of Padmashri Dr.Vitthalrao Vikhe Patil Polytechnic, Loni, for his comments and kind permission to complete this project. We remain Indebted to Prof. N.M. Garad, H.0.D Chemical Engineering Department for their time suggestion and valuable guidance. The special gratitude goes to Prof. A. S. Shirsath. Prof. S. C. Dighe, Prof. P.S. Kale, Prof. P. R. Gulve, Prof. Mrs. A. G. Kharde staff members, technical staff members, of Chemical Department for their expensive, excellent and precious guidance in completion of this work.

We thanks to all the colleagues for their appreciable help for our working project.We are also thankful to our parents who have provided their wishful support for completion of our project work successfully. And lastly we thanks to all our friends and thepeople who are directly or indirectly related to our project work

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