Desuperheater Temperature Control System Using Distributed Control System (DCS)

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***Abstract* --- The Control System for Desuperheater Temperature of Boiled water is a critical task in industry. In this Paper reviews the study and collection of measurement data's from in TNPL (Tamil Nadu Newsprint and Papers Limited) Power Plant, there are three sections namely Deaerator tank, Boiler and Turbine. I have done this work in the turbine section. The steam from the Boiler is at very High Temperature. The temperature of this high temperature steam is lowered by spraying the oxygen dissolved water using Desuperheater. The spraying water is controlled by Distributed Control System (DCS). The Input to the turbine is at High Temperature and High Pressure steam. The output of the turbine is mentioned in Mega Watts. When the superheated steam is given to the turbine then the Temperature and Pressure output steam condition is Low. The Low level steam is fed to the Desuperheater depends upon requirements in the various units. It is supplied to each section in TNPL.**

Keywords -- Boiler, Steam, Temperature, Pressure, Desuperheater, DCS.

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I. INTRODUCTION

The present study involves the separation of water at various different temperatures depending on the needs. In all the industries, water is an in-dispensable major requirement and it is consumed in different steps. In some industries, the water is obtained along with the final product but at high temperature, which is of no use. This high temperature water cannot be discharged directly to the soil, as it will make the soil sterile. Hence, this water should be changed to normal conditions before discharged out. The water can also be used when it is normal physical and chemical properties. The Desuperheater Temperature Control System, temperature measurement method is used to measure the temperature of water at various points and to collect the water at different temperatures, which can be used for several purposes.

II. DESUPERHEATER TEMPERATURE CONTROL SYSTEM

A. Power plant

It is a specialised section, which produces electricity. The energy produced in this section is used for almost all the other sections in **TNPL**. Altogether, we have more than 22 sections in **TNPL.** In order to produce electric current, we have three important sections in power plant. That is **Deaerator Tank, Boiler** and **Turbine.**

B. Deaerator Tank

Deaerated tank is used to de oxidation in the de-mineralized water. Deaerated tank is used to eliminate the oxygen content in water, the size and shape of the Deaerated tank is noted below. The Deaerated tank has the arrangement of the cylindrical shaped Deaerator is kept on the cylindrical shaped storage tank. The Deaerator tank has the height of 3000mm, and of its diameter is 1800mm. The storage tank has the length of 10.5M, and of its diameter is 3M. This Deaerated tank's level is controlled by **DCS (**distributed control system**).**

C. Water Tank Plant

Take some mineralised water from a well and insert it in the RO plant. Here RO plant changes the fresh water into demineralised water. Then fill the demineralised water in feed water tank and by using feed transit pump suck the entire demineralised from the feed water tank and insert if into Deaerator tank.

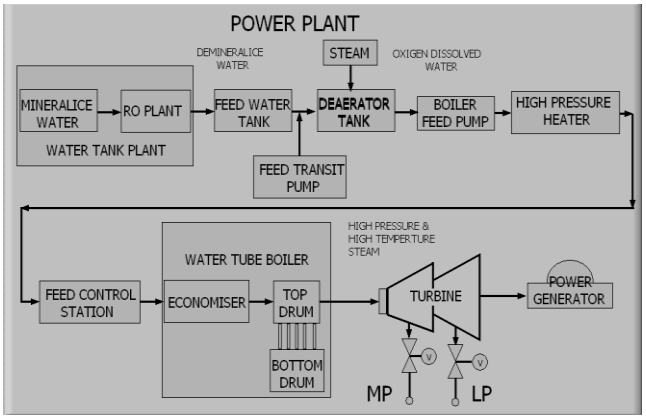


Figure 1.1. Power Plant Diagram

D. Function of Deaerator tank

We have two tanks in Deaerator tank (Deaerator tank). One is at the top and the other one is at the bottom (storage tank). By giving low steam pressure up to

4kg/cm², Oxygen is removed from the demineralised water and thereby we get oxygen-dissolved water. This process is done by adding hydrogen (chemical name), product name Yellow card.
The oxygen-dissolved water is separated to the bottom tank where it has been given constant inlet, outlet pressure; temperature and level are maintained perfectly.

E. Specification of Deaerator tank

- Diameter - 1800mm
- Height -3000mm
- Deaerator capacity – 245 T/H
- Steam pressure – 4kg/cm²

F. Specification of Storage tank

- Volume – 85 m^3
- Diameter - 3M
- Cylinder length – 10.5 M
- Water inlet – 50°C
- Water outlet –105°C
- Steam temperature – 185°C

G. Boiler

We have two different types of boilers. They are water tube boiler and fire tube boiler. In most cases, we use water tube boiler because if we use fire tube boiler, we may have to face some serious consequences.

H. Water tube boiler

By using feed pump, take the oxygen-dissolved water and heat with high pressure. This heated water is sent to water tube boiler by the help of feed control station and by doing so the water is again heated with high pressure and temperature by using coal, wood and wood powder. In the water tube boiler, we have two arrangements, internally i.e., top and bottom drums. Again the high pressure is sent back to bottom drum in order to increase the steam pressure and finally it is sent back to turbine by the help of top drum which is inside the water tube boiler. The water tube boiler output is at about the pressure of 44kg/cm² and the temperature is up to 440°C.

In the power plant, we have five water tube boilers. The process, which happens in the water tube boiler, is one at the same when we come across or when we analyze the systems in the water tube boilers. The readings from the water tube boiler is given below.

I. Specification of water tube boiler

- Capacity = 60 t/hr
- Steam High Pressure = 44 kg/cm²
- Steam High Temperature = 440°C
- Design Pressure = 55 kg/cm²
- Heating Surface = 2874 Sq.m

J. Turbine

The main power system is generated in turbine output. Let us see how electric power is generated in turbine. High pressure and high temperature steam from the water tube boiler is sent to turbine. What happens here is, we all know that the turbine opens its account by means of safts its rotation.

Here the pressurised steam is directly passed through the turbine and by doing, so the turbine in safts are moves at its extreme speed, there occurs EMF (Electro Magnetic Force), and from here, we get MW (Mega Watts) power.

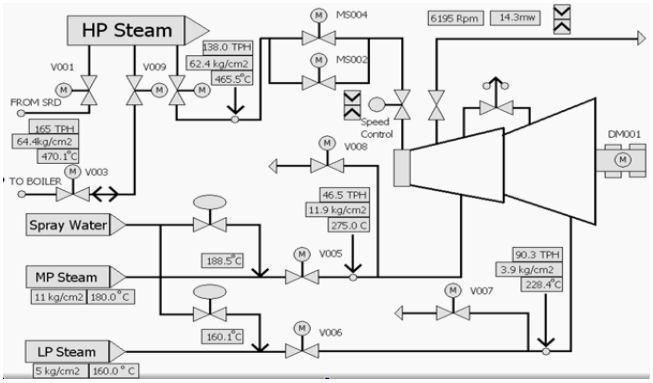


Figure 1.2. Power Plant Diagram

In the power plant system, we have altogether five turbines. Each turbines produce different types of MW power. Siemens Company manufactures turbine 1 and 2, BHEL Company manufactures turbine 3, 4 and 5. Let us see how many MW powers are produced in each turbine.

K. Manufacturing details

- Turbine 1 = Siemens Company
- Turbine 2 = Siemens Company
- Turbine 3 = BHEL Company
- Turbine 4 = BHEL Company
- Turbine 5 = BHEL Company
- BHEL = Bharat Heavy Electrical Ltd

L. Number of Turbines

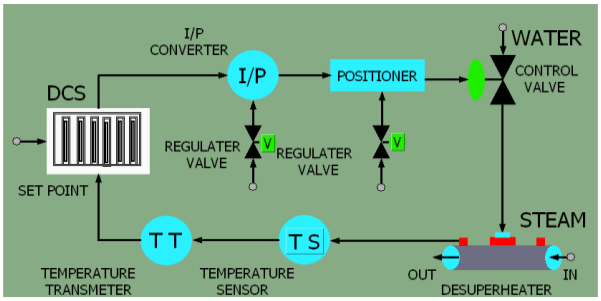
- Turbine (TG1) = 8MW
- Turbine (TG2) = 18MW
- Turbine (TG3) = 10.5MW
- Turbine (TG4) = 24.6MW
- Turbine (TG5) = 20MW

III. DESUPERHEATER TEMPERATURE CONTROL BLOCK DIAGRAM

High Pressure [44kg/cm²(440ºC)] steam comes from the water tube boiler and it is sent to turbine by the help of control valves. In turbine, we have two different sections i.e., one starts its shaft movement from the initial stage and the other gets its movement from the final stage. Five different plants activate this constant

Low Pressure and Medium Pressure steam by adding or reducing its strength. For instance we have in paper machine I and II [Paper Dry Purpose] ,Pulp Mill [Old and New], SRP[Soda Recovery pant], Deaerator tank etc.,.

(a) Block Diagram



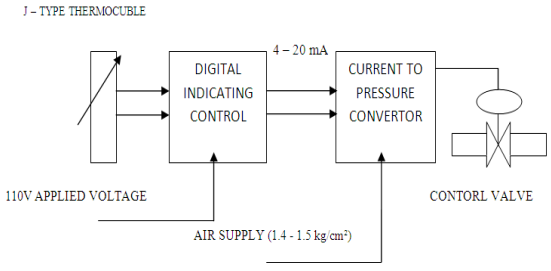
(b) Valve Acual Image

Figure 1.3. Desuperheater Temperature Control

Desuperheater is used to reduce the steam temperature. In order to reduce the steam temperature they use water high-pressured water spray and the temperature sensor calculates the further readings. Temperature sensor means Thermocouples, Thermistors, RTD (Resistive Temperature Detector), Thermopile, etc., .The temperature output is DC mV. Again, this DC mV is shifted to DCS (Distributed Control System) by the help of temperature transmitter.

If we want to activate DCS, we have to apply more than 110DC voltage. The output here in DCS is (4-20 mA). Finally, the DCS output changes its account in accordance to the calculation given by the temperature transmitter.

(a)Control System Method



(b) Control Valve Diagram

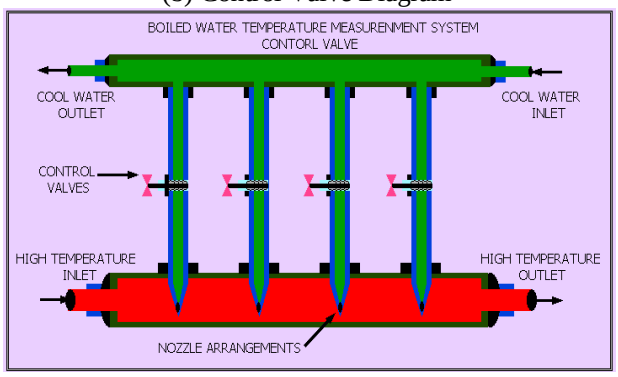


Figure 1.4. (a)Control System Method and (b) Control Valve Diagram

Again the current which is produced here in DCS changes into current pressure in order to activate valve. In order to active the target level i.e., the fixed set point, the control valve controls the DCS system until it gets its accurate set point.

A. Steam Types

- High Pressure (Temperature) = 44kg/cm²(440ºC)
- Medium Pressure (Temperature)= 11kg/cm²(180ºC)
- Low Pressure (Temperature)= 4kg/cm²(160C)

TABLE 1.1
DESUPERHEATER CONTROL VALVE OPERATIONS

Sl. No.	PID	Process Variable	Set Point	Output Process
1	Automatic	Field	Variable	Cannot be Varied
2	Manual	Field	Variable	Variable
3	CAS	Field	Cannot be Varied	Cannot be Varied

IV. DESUPERHEATER STEAM FLOW DIAGRAM

The control valve at Desuperheater temperature control valve by giving corresponding values for I /P **converter** at DCS. If we have to decide the steam, flow temperature of the corresponding current **(4 - 20mA)** has to be given to I/P by setting at DCS.

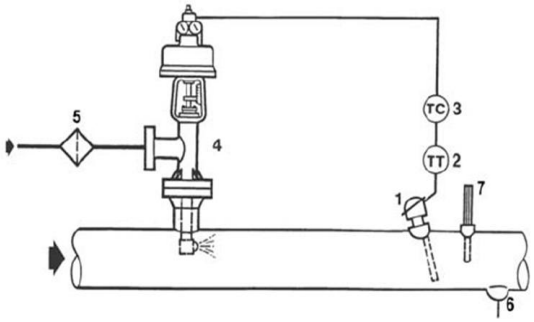


Figure 1.5 Steam Flow Diagrams

1. Temperature Sensor
2. Temperature Transmitter
3. PID Controller
4. DA – 90 Desuperheater
5. Strainer for cooling water
6. Condensate trap
7. Indication Thermometer

TABLE 1.2
CURRENT TO PRESSURE CONVERSION

Sl.No.	Current(mA)	Pressure(psi)
1	4mA	3 psi
2	5mA	3.75 psi
3	6mA	4.5 psi
4	7mA	5.25 psi
5	8mA	6 psi
6	9mA	6.75 psi
7	10mA	7.50 psi
8	11mA	8.25 psi
9	12mA	9 psi
10	13mA	9.75 psi
11	14mA	10.50 psi
12	15mA	11.25 psi
13	16mA	12 psi
14	17mA	12.75 psi
15	18mA	13.50 psi
16	19mA	14.25 psi
17	20mA	15 psi

There is a regulator to give 1.2 Kg/cm^2 pressure of air and corresponding pressure for me at I/P mingled and tends to positioner. The positioner has the regulator of 2 Kg/cm^2 pressure of air to control valve. This control valve constructed as the type of **air to open.** So that air from positioner passing to control valve, and control valve can be opened for the corresponding air from positioner.

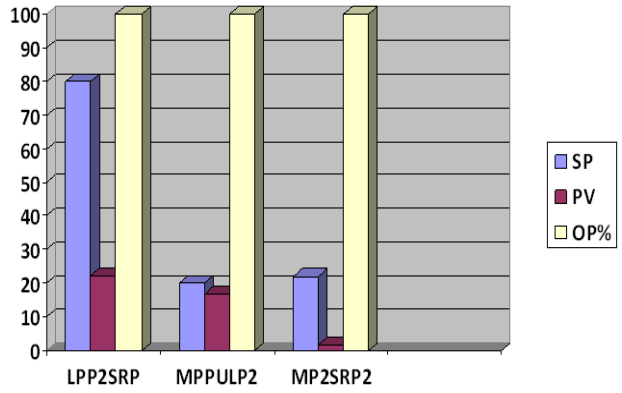
The set point for I/P converter is set at the **HIS** (Human Interface System). The values, which all are going to set by **DCS**, are set at **HIS** only, and the corresponding output values are able to see here. **HIS** goes to **FCS** (Field Control Station). It connected with **Marshalling cabinet,** which is having two cards named **Analog i/p card, Analog o/p card.** Results of the process are taken into the line of Analog i/p card and the set points to control the process variable are taken out through Analog o/p card. Marshalling cabinet is connected with **Junction Box**.

TABLE 1.3
PLANTS AND SET POINTS

Sl. No	Plants	Set Points	Process Variable
1	**Paper Machine I**	**LP-160°C, 4kg/cm²**	**155°C - 175°C**
2	**Paper Machine II**	**LP-160°C, 4kg/cm²**	**155°C - 175°C**
3	**Old Pulp Mill**	**MP-180°C, 11kg/cm²**	**175°C - 185°C**
4	**New Pulp Mill**	**LP-160°C, 4kg/cm²**	**155°C - 175°C**
5	**Soda Regavery**	**MP-180°C, 11kg/cm²**	**175°C - 185°C**
6	**Hooking**	**MP-180°C, 4kg/cm²**	**175°C - 185°C**
7	**Deaerator Tank**	**LP-160°C, 4kg/cm²**	**155°C - 175°C**

A. PLANT RESULTS ARE SHOWN IN THE FOLLOWING BAR CHART

(i) SRP, SRP2 & PULP MILL



(ii) New Paper Machine, PM1 & PM2

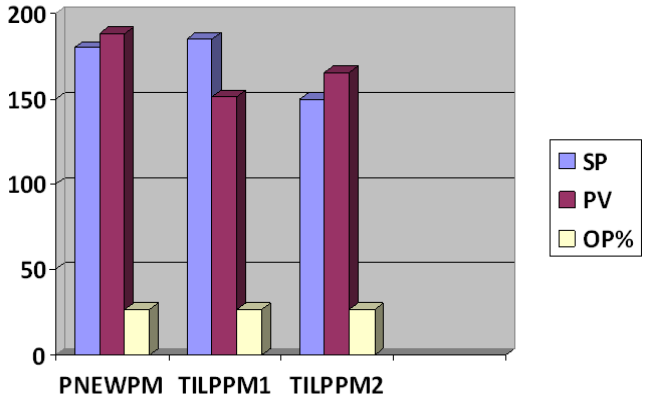


Figure 1.5 Bar Chart

V. CONCLUSION

The project on Desuperheater Temperature Control System is implemented in TamilNadu News Print and Papers Limited. In Industries we cannot control the high temperature manually. This project provides simple way to measure the low temperature parameters. This project is designed using Distributed Control System. The temperature of steam flow in high temperature is measured using thermocouple temperature sensor. In this system, the control valve is automatically controlled and temperature is reduced up to preset valve defined by programmer. In future this DCS system can be updated for more process with the same **DCS** programs.

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