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Removal of Metal Oxide and Monitoring of Parameters in Feed Water Using Microcontroller in Thermal Power Plant

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Abstract:

This project depicts the removal of metal oxides from feed water using superconducting magnetic separation and monitoring of parameters using microcontroller. In case of puncture in stir tank or outlet line of stir tank, causes a huge loss for the plant and take a week to restart the routine process.It focuses on the metal deposits on the feed water piping system which decreases the heat efficiency of the thermal plant. It concentrates to remove metal scales to maintain power generation efficiency, to reduce the water losses with the help of superconducting magnetic separator that operates in high temperature and monitoring of parameters like electrical conductivity, temperature, scale formation, etc.

Keywords-- **Superconducting magnetic filter,Metal oxides, conductivity, Temperature, scale formation.**

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I. INTRODUCTION

Recently, reduction of carbon-dioxide(Co_2) from feedwater and waste water is the main requirement to prevent global warmingand it is necessary to maintain the efficiency ofThermal power plant. We focused on the blockage in the feed water pipe, the metal oxide scales deposit on the piping system. Normally, In Thermal power plant the feed water has been treated by All Volatile Treatment (AVT) using the chemical solution(ammonia and hydrazine) to remove metal oxides and scales in the feed water and the flow of water in the feed water pipe is continuous unless there is a breakage, leakage or blockage(can be referred as faults) in the feed water pipe [1][2]. It causes a severe downfall in the generation of power and need of huge money in the reorganisation of the pipe in the Thermal powerplant;also incase of puncture in stir tank it takes more time in complete removal of water and reloading it again to start the routine process. In order to prevent the Thermal power plant from this problem, superconducting magnetic filteris incorporated in the feed water pipe line.The used Superconductingmagnetic filter operates in high temperature for effective removal of oxides. In addition, parameters are monitoredby Microcontroller (MSP430) interfaced with sensorsto sense temperature, determine electrical conductivity and maintain water flow of the feed water.For increasing the efficiency of Thermal power plant, the following conditions are to be followed:[1][2]

- Reduce the emission of Co_2
- Remove the Metal oxide scales fromfeed water pipe line.
- Eliminate the residual oxygen.

This proposed idea ensures the removal of metal oxide from feed water that improves the thermodynamic efficiency of thermal power plant.

II.MATERIALS AND METHODS

A)Water Treatment

Water treatment is important to get rid of the impurities that are contained in water as found in nature. Controlling and elimination ofimpurities is required to combat corrosion, scale formation and fouling of heat transfer surfaces throughout the support systems. The iron oxide or metal oxide deposits or scales in the inner wall of the pipe to be removed in the water treatment as it decreases the efficiency and increases the emission of Co_2 in the thermal power plant. Thermal power plant focus on water treatment mainly for aging plants to improve its operational efficiency and better environmental conservation [4]. Normally, in Mettur Thermal power plant, the plant is completely checked only during the annual maintenance.To prevent from the mentioned problem All Volatile Treatment (AVT) is carried out in the Deaerator. All Volatile Treatment uses only volatile chemicals for condensate return pH control, feed water, and boiler water. Gases such as oxygen and carbon dioxide can be extremely corrosive to boiler equipment and pipes, on reaction it forms oxides and cause rust in the inner wall of the pipe. Therefore, removing these gases to acceptable limits (nearly 100%) can be imperative to the service life and safety of the boiler system[4]. The commonly used additives are ammonium hydroxide, cyclohexylamine, and morpholine in the Deaerator for feed water treatment process[8]. The dissolved oxygen in

the feed water is typically removed in the AVT with the help of oxygen scavenger hydrazine. Higher concentrations of hydrazine aregenerally used during startup and shutdown operations due to less efficient deaeration periods. This deaeration is also processed by using a tablet named free Co_2 that removes the oxide forming gases that cause rust.On using this considerably helps in maintaining pH level in the range of 9.0-9.2, the specific electrical conductivity (Ability to conduct electricity) is in the range less than 10.0 µs/cm. The cation conductivity is in the range less than 3.0 µs/cm. Silica less than 20 ppb, hydrazine is in the range less than 10-13 ppb, Iron is in the range less than 20 ppb and the dissolved oxygen is in the range less than 7ppb is maintained in the feed water. The pH value is monitored regularly using pH meter.

B)Temperature Sensor

LM35 is a temperature sensor that senses the instantaneous temperature that outputs in the form of analog signal. The output is easily read in terms of Celsius.It is shown in the figure 1.1. It does not require any external calibration. The coating provided in it protects from self-heating. It operates from 4V to 30Vin the range, rated for full -55℃ to 150℃ with 0.5℃ of ensuredaccuracy with low impedance output 0.1Ω for 1mA load.In this configuration, on simply powering temperature sensor(LM35) and connect the output directly to analog to µdigital converters and recommended to convert 80K to 100K resistor between V_{out} and GND pin to remove fluctuations.

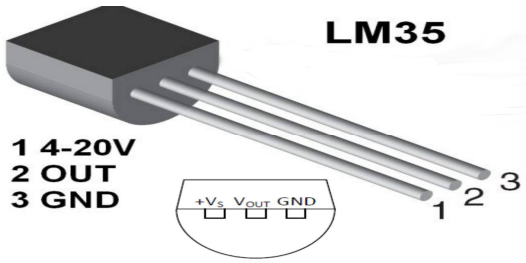

Fig 1.1 Temperature sensor

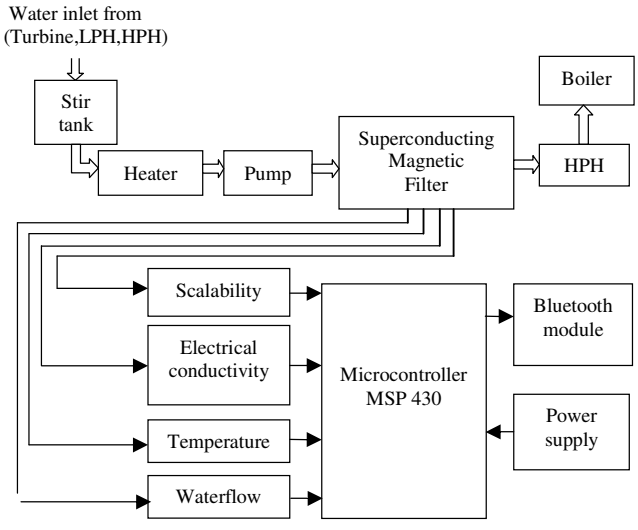

Fig 1.2 Block diagram of removal of metal oxide from feed water

C)Water flow Sensor

In Thermal power plant,it requires large amount of water supply for cooling and for boiler feed water requirements. Water flow sensor is to monitor the rate of flow of water and the supplied amount of water been used to be measured. It calculates the amount of water flowing through the pipe measured in liters per hour or cubic meters. YFS201 water flow sensor consists of a plastic value from which water can flow and it also consists of water rotor along with Hall Effect sensor that helps to measure the flow. The water flow sensor can be used with hot, cold, warm, clean and dirty water also. It has three wires. Red wire to connect with supply voltage. Black wire to connect the ground and yellow wire to collect output from Hall Effect sensor. It requires supply voltage 5V to 18V of DC. It has the working flow rate of 1-30liters per minute.

D) Electrical Conductivity

Conductivity is the ability to pass an electric current through a solution or material. In metals, it is carried by electrons. Conductivity is based on: Salinity, total dissolve solid, mobility& Valence of ions.The conductivity varies from the low conductivity of ultra-pure water to the high conductivity of some chemical solution. The measurement of electrical conductivity gives detail about the purification of water or solution. The probes of conductivity measurer are used to measure the conductivity by the concentration of ions. Here, a 2-pole cellused. In this type of probe, an alternating current is given between 2 probes and resulting voltage is measured.

E)Voltage Regulator

Unregulated voltage sources in a circuit may have fluctuation resulting in not providing fixed voltage outputs. A voltage regulator is used to get desired voltage levels.A steady, reliable voltage, then the voltage regulator is the preferred device. Voltage regulator maintains desired voltage at a constant value. Positive unregulated voltage is given in regulation. Then that voltage is converted into regulated voltage. Regulated power supply that provides a convenient power source for most TTL components.

F)Step down Transformer

For requiring minimum voltage than input, Step down Transformer is used. It is a static apparatus. By electromagnetic induction principle this step down transformer is working. Step down transformer is converting high voltage, low current into low voltage, high current.

G) Bluetooth

Bluetooth module(HC-05) isdesigned and used for wireless communication.It is operated based on master or slave configuration. It is a wireless technology for transmitting and receiving data between fixed and mobile devices in limited distance, uses short wavelength UHF radio waves. It is managed by Bluetooth Special Interest Group(SIG) in the areas of telecommunication. Bluetooth uses the band from 2.400 to 2.485 GHz for industrial, scientific medical radio and also to building personal area networks.

H)MSP430

MSP430 Microcontroller uses ultra-low power, it is 20pin plastic small outline wide bodypackage also consist of analog and digital devices for sewing and measurement as shown in the figure 1.3. In different applications, it is used in receiving

analog signal and convert them to digital values to host devices. MSP430XIIX series has 16-bit timer and 14 Input & output pinouts, it also has fine power modes to enhance battery life in portable measurement.Generally, it is provided with the feature of 16-bit register, 16-bit RISC CPU and constant generators also the module changes its state from low power mode to active mode within bus, by a Digitally Controlled Oscillator (DCO). The operating voltage range is 2.5V to 5.5V. Its active mode is 330µA at 1MHz, 3V for standby mode are 1.5µA. During off mode (RAM retention) is 0.1µA. It has serial on board programming.

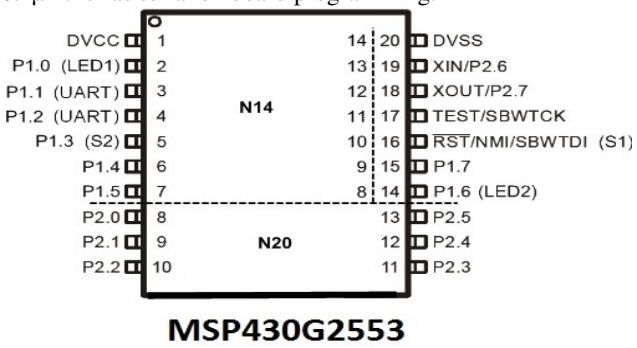

Fig 1.3 MSP 430

I)Superconducting Magnetic Filter

The magnetic filtration technique gives a high speed, efficient, solid - liquid separation process with a simple operation that needs a very small working space compared to other filtering processes.The developments in superconducting magnets, which provides us high gradient magnetic fields much easier and convenient ways than before. By imposing a very high gradient magnetic field with the given supply of 24V using Step down transformer, there is a possibility to separate a wide range of fine particles, from the suspended water. A magnetic filtration process contains an effluent of liquid polluted with Small suspended solids at low concentrations, which is flowed through a porous media i.e., magnetic filter[3][4][5]. The filter is usually packed with spheres, coils and plates or wires, located inside for the induce of magnetic field that separates the solid and liquid. Once the Effluents are eliminated; the fluid leaves the filter as a purified stream of liquid can be called as treated water. It is shown in the fig 1.4. Superconducting magnets can generate magnetic flux densities more than 10 T and the magnetic force density can be of the order N/m^3[3].

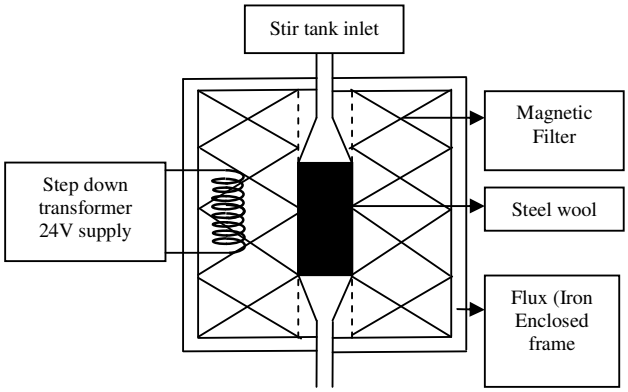

Fig 1.4 Superconducting magnetic filter

The induced magnetic flux by superconducting magnet produces heat and also that increase of temperature in enclosed frame removes the scales and metal oxides.The Magnetic separator, using solenoid magnet to exhibit the separation of micro particles. The presented magnetic filter helps to resolve the Blockage due to the accumulation of the particles which is an important in large industries and workplaces. The filtration process using the magnetic separation filter uses ferromagnetic wool as high porous media that are alternately inserted to remove the oxides.

III. WORKING METHODOLOGY

Water treatment is vital in keeping boilers properly functioning, which makes boiler feed water treatment a mandatory process. On using untreated water under extreme temperature and pressurized environment causes failure in the system. These problems include blockage, overheating, high maintenance costs, lower heat transfer efficiency, etc. Thus, feed water should undergo the proper treatment before being distributed to other parts of the system. During the treatment of feed water, corrosive compounds and effluents are eradicated, typically with the aid of a deaerator[4][6]. Such treatments are regularly carried out by various chemicals like Ammonia and Hydrazine and some other chemical tablets to maintain its specific electrical conductivity and pH level. Water treatment is the closed loop process. Oxygen scavengers are also used because boiler corrosion is mainly due to the presence of dissolved oxygen. In alternate to the above method with use of super conducting magnetic separation filter with high temperature helps in removing the effluents and metal oxides from feed water. On reaction of dissolved oxygen with feed water forms metal oxide in the system. On using two parallelly connected superconducting magnetic filter, has the pipe with iron enclosed surface frame, where inside placed with an electromagnetic coil that operates in 12V for the given supply voltage(here 12V is regulated by voltage regulator). In two parallelly connected superconducting magnetic filter, only one filter operates and the other filter remains unoperated. The unoperated filter steps into operation if the operating filter fails. A superconducting magnetic filter (as shown in fig 1.4) connected with supply voltage, induces a magnetic flux which further induces magnetic flux and produce heatin the steel wool which is made up of steel that absorbs the metal oxides from the feed water and let out the stream of water (treated water) to High Pressure Heater (HPH) and to the boiler for cyclic routine process[7].It is shown in fig 1.2. Bluetooth HC-05 module is connected via mobile phone using an app named Bluetooth terminal for displaying values. To maintain and monitor the value of specific electrical conductivity, temperature, oxide deposits, the BluetoothHC-05 module interfaced with MSP430 microcontroller (operates in 5V) used where the desired output can be viewed in LCD or mobile phone.

A)Existing Method

In Regular method, thermal power plant feed water contains Metals, scales, dust, etc. Meanwhile it forms metal scales that blocks the water flow of the system. This can be removed in stir tank by mixture of chemical solution (Ammonia and hydrazine) i.e. AVT (All Volatile Treatment). In addition, the

treated make up water, pH level is maintained in the limited levels in the closed loop lines by using pH tablets that helps in specific conductivity of the feed water.

B)Proposed Method

The proposed method uses the Super conducting magnetic separation filter, where a filter connected with supply voltage induces a magnetic flux which further induces magnetic flux and produce heat in the steel wool which is made up of steel that absorbs the metal oxides from the feed water and let out the stream of water (treated water) to the system operation.The induced magnetic field attracts the metal oxides and the filter filtrates the solid contaminants during the water flow through the filter.

IV.CONCLUSION

The Superconducting magnetic separation filter with solenoid magnet is demonstrated that our HGMS (High Gradient Magnetic Separation) system can achieve scale and oxide removal. The Temperature, Electrical conductivity and water flow are continuously monitored using mobile app (Bluetooth terminal) or with the help of LCD interfaced with MSP430. An important procedure is to maintain these parameter values at the set point level (limits) else there exists an occurrence of fault in the system. The parameter valuesis monitored and values are displayed in LCD and mobile app via Bluetooth (HC-05 module).Among many processes of filtration this super conducting magnetic separation process is simple way with reduced size, maintenance cost, reduced losses. Because of the fine refining porous media used in the filtration, a detailed microscopic analysis for the deposition of the oxides in the filter is difficult. For instance, the high gradient magnetic filter is a new idea in this area to filtrate the oxides. However, more novel designs and innovations are expected soon to be applied in industrial developments using HGMS (High Gradient Magnetic Separation).

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