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Lifetime Prediction OF Process Equipment In Industries Using Labview

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Abstract: Maintenance means "the work of keeping something in apposite condition; upkeep". The purpose of maintenance is to ensure that plant and equipment are available in a satisfactory condition for operation when required. Maintenance is done in equipments by diverse methods like Breakdown, Preventive and Predictive. The former method followed to maintain industrial equipments were visual inspection, but it has more disadvantages that a failure will be known only after greater damage to the machine yet this technique is followed. Predictive maintenance (PDM) techniques help determine the condition of in-service equipment in order to predict when maintenance should be performed, saving the wastage of the resources and avoiding the premature replacement of parts which lead to an increase in failure rate and sometimes "*Infant Mortality*". This approach offers cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted and also be used as a fault prediction system as it can also find out the anomalies in the system and the cause for it. There are many causes for the failure of boiler, the main reason is corrosion. The corrosion takes place in boiler tubes, boiler plates due to presence of solid particles present in the feed water and condensate. This paper is about to show how to control corrosion, as corrosion is the major issue in boiler. Corrosion can be controlled by water treatment method where the feed water and condensate are treated before it is passed in to boiler. The simulation part is done using LabVIEW software. By the use of wide application support and compatibility of LabVIEW, it‟s very easy to execute or integrate other application components with our system and the hardware part is done for controlling corrosion, this achieved by checking the pH value of the feed water to boiler and the value is compared to the pre-set value. The lifetime of the equipment can be improved by predictive maintenance than other maintenance techniques since it is continuously monitored.
Keywords: **Boilers., LabVIEW, lifetime, Maintenance ,Predictive maintenance**

I. INTRODUCTION

To develop a system for predicting the actual lifetime of the process equipment used to carry out major processes in the industries. Since long time maintenance in the industries depending on the time factor based. Assuming that after this period of time these equipment need to be replaced. But case studies shows that this is not the real case. It has been found in those case studies that very identical parts of any machine or equipment when tested under same kind of stressed situations show different working durations. The very identical parts vary in their performance and show different lifetime. This brings out the failure of our assumptions of a time based maintenance technique and need for a system that can predict the right time of replacement of that equipment before they cause any kind of damage to the process.

1.1Types of maintenance:

The major maintenance techniques followed are

- Reactive maintenance
- Preventive maintenance
- Predictive maintenance

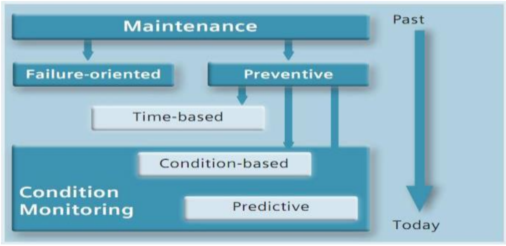


Figure 1 Maintenance levels

II. PREDICTIVE MAINTENANCE (PDM):

The condition of all machinery should be under continual surveillance of operating and maintenance personnel. It is vital that personnel aware of operating conditions of machinery and report accurately. The personnel should develop eye, nose and an ear for the machine condition and it became difficult to analyze deviation from normal condition conditions as their might be human errors. The primary purpose of the predictive system is to provide support to the staff/plant engineers by:

- Diagnosing system conditions such as chemistry excursions or equipment performance issues.
- Prediction of corrosion and scaling conditions in the boiler prior to equipment degradation.
- Prediction of general corrosion concerns in the pre-boiler equipment prior to equipment degradation.
- Detailing proper corrective actions.
- Instructing the user on the consequences of neglecting the abnormal conditions.

Steps in PDM:

PDM can be implemented to any industry to prevent the failure of process equipments. The block diagram of PDM is shown in figure 2.

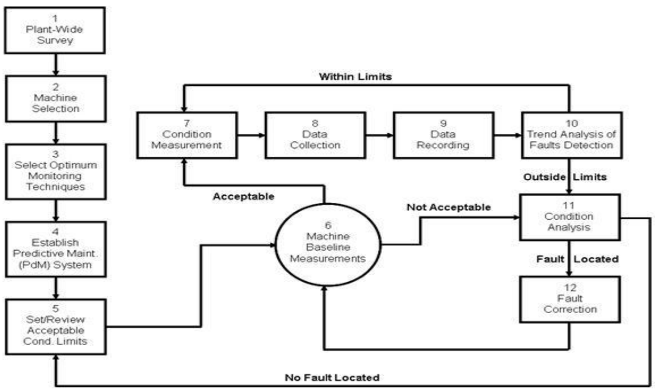


Figure2 Block Diagram of PDM

The Steps involved in PDM**:**

- Select the machine in which PDM is to be implemented.
- Once the machine is selected, select the parameters to be monitored continuously.
- For the selected parameters assign the operating range.
- When the machine is under working the measured values are continuously analyzed.
- When the values are within the operating range means the process will continue.
- When the values are out of range means it will be indicated and corrective analysis are done.

So that the machine will be maintained in good working condition.

III FAILURES IN BOILERS

There are different reasons for the failure of the boiler the primary reasons for the failure if boilers are as follows:

- Stress rupture
- Water-side corrosion
- Fire-side corrosion
- Erosion
- Fatigue
- Lack of quality control

Among various reasons for failure of boiler, this paper is discussed about the water side corrosion as one of the problem in boiler.

3.1 Waterside Problems in Boilers:

Corrosion and Scaling are the major waterside problems in industrial boilers. Calcium, Magnesium, iron, copper and silica predominate in most boiler deposits. These deposits usually form a dense layer that impedes heat transfer and cause costly boiler tube failures

3.1.1 Corrosion:

Most corrosion products that deposit in the boiler originate in the pre-boiler systems. The majority of corrosion products consist of colloidal and particulate metals and their oxides. The compounds are swept into the boiler and deposit on boiler tube surfaces. A major factor contributing to this problem is increased return of condensate containing corrosion products from various processes used throughout the steam plant. Internal corrosion must also be considered. Corrosion not only contributes to deposits, but also results in metal damage.

3.1.2 Scaling:

A flaky oxide film formed on a metal, as on iron, that has been heated to high temperatures. A hard mineral coating that forms on the inside surface of boilers due to the presence of impurities in water which is heated under high temperature forms scales.

3.2 Causes for Corrosion:

The principal problems associated with return condensate systems deal with corrosion by oxygen, carbon dioxide and copper complexing agents. With significant corrosion, fouling of the return piping can also occur. Each of these sources of corrosive attack is discussed below.

3.2.1 pH Variation (Acidic or Caustic Attack).

Previously, a pH of 10.5-11.5 was identified as ideal for boiler operation, excluding high purity systems that could function on other types of treatment programs. Variations from the levels that are considered optimum for maintenance of the magnetite layer can cause general corrosion. Each of these will be discussed below.

Acidic Attack. If boiler water pH has dropped significantly below 8.5, a phenomenon called waterside thinning can occur. The normal manifestation of acidic attack is etching. In areas of higher flow, the surfaces are smooth. In addition, any stressed area would be a principal area for attack.

Caustic Attack. Caustic attack or, as it is more commonly known, caustic corrosion, is often encountered in phosphate treated boilers in which deposits occur in high heat transfer areas. In particular, boiler water can permeate the porous deposit. When it is coupled with significant heat flux, concentration of the boiler water occurs. Caustic soda ($NaOH$) is the only normal boiler water constituent that has high solubility and does not crystallize under these circumstances. This caustic concentration can be as high as 10,000-100,000 ppm. Localized attack due to the extremely high pH

(12.9 +) will occur, as will the formation of caustic-ferritic compounds through the dissolving of the protective magnetite film. Once the process begins, the iron in contact with the boiler water will attempt to restore the protective magnetite film. Caustic corrosion (typically in the form of gouging) continues until the deposit is removed or the caustic concentration is reduced to normal.

Caustic attack typically appears in the form of irregular patterns and gouges. Frequently, the white salts associated with caustic attack remain in the tube samples. In addition, if caustic attack has proceeded for any extended period of time, significant levels of magnetic iron oxide can be found in any low flow area, such as a mud drum. This is essentially "stripping" of the magnetite film.

IV CONTROLLING OF FAILURES:

To control the failures in the boiler due to corrosion and scaling, there are certain situations when these occur. When there is presence of impurities in boiler, due to this failures occurs. There is a recommended value for the presence of solid particles if the solid particle goes above the range corrosion and scaling occurs.

To control the formation of corrosion and scaling the following methods are followed

- Boiler blow down.
- Water treatment.

4.1 Boiler Blow down:

When water is boiled and steam is generated, any dissolved solids contained in the water remain in the boiler. If more solids are put in with the feed water, they will concentrate and may eventually reach a level where their solubility in the water is exceeded and they deposit from the solution. Above a certain level of concentration, these solids encourage foaming and cause carryover of water into the steam. The deposits also lead to scale formation inside the boiler, resulting in localized overheating and finally causing boiler tube failure.

4.2 Water Treatment:

The methods to control scallig effects

by water treatment.Two major types of boiler water treatment are:

- Internal water treatment.
- External water treatment.

4.2.1 Internal Water Treatment:

Internal treatment is carried out by adding chemicals to boiler to prevent the formation of scale by converting the scale-forming compounds to free-flowing sludge‟s, which can be removed by blow down. This method is limited to boilers, where feed water is low in hardness salts, to low pressures- high TDS content in boiler water is tolerated, and when only small quantity of water is required to be treated. If these conditions are not applied, then high rates of blow down are required to dispose off the sludge. They become uneconomical from heat and water loss consideration.

4.2.2 External Water Treatment:

External treatment is used to remove suspended solids, dissolved solids (particularly the calcium and magnesium ions which are major cause of scale formation) and dissolved gases (oxygen and carbon dioxide).

The external treatment processes available are: ion exchange; demineralization; reverse osmosis and de-aeration. Before any of these are used, it is necessary to remove suspended solids and color from the raw water, because these may foul the resins used in the subsequent treatment sections. Methods of pre-treatment include simple sedimentation in settling tanks or settling in clarifiers with aid of coagulants and flocculants. Pressure sand filters, with spray aeration to remove carbon dioxide and iron, may be used to remove metal salts from bore well water.

The first stage of treatment is to remove hardness salt and possibly non-hardness salts. Removal of only hardness salts is called softening, while total removal of salts from solution is called demineralization.

V . IMPLEMENTATION IN LABVIEW

The implementation has two zones. The first zone shows the schematic setup of a power plant and the second zone is the monitoring zone.

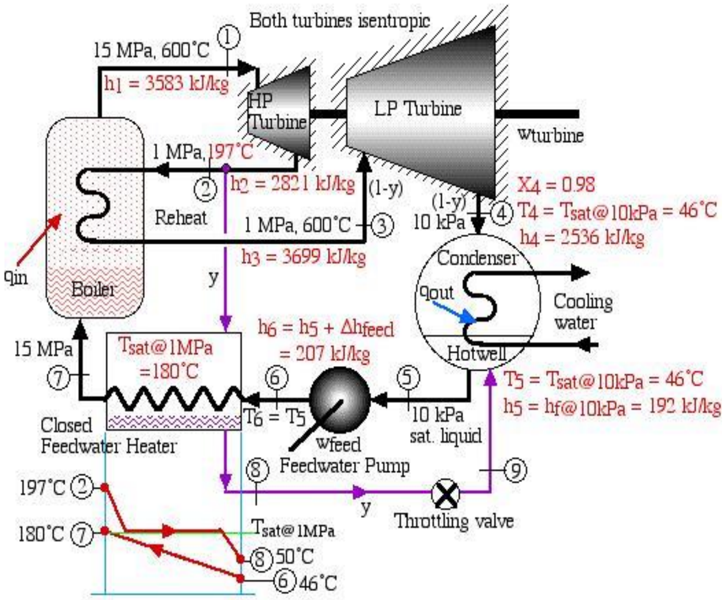


Figure3 Schematic Diagram of Power Plant

Schematic Setup of Power Plant:

The figure 5 depicts the working model of a power plant. The process occurring as per the figure is explained as follows:

1. Initially the feed water is treated. The feed water treatment is done to check the water properties has any deviations from normal levels, necessary actions are taken and stored in the tank. Initial water treatment can be done as per the test we needed to conduct in a separate VI and it is explained in the water treatment process.
2. After the water has stored the pre-heater is ON and its status is indicated. The temperature of the water id increased approximately 174^0C. After reaching the particular values the water flows to boiler at pressure and temperature of 150bar and 1740C. The pressure and temperature values are maintained.
3. After the water filled in the boiler the heater gets ON and the temperature gradually increases and reaches 5000C, steam is produced and the temperature is maintained. After the temperature reaches5000C, steam at pressure of 150bar is sent to the turbine.
4. The high pressure turbine is drived at that pressure and the theoretical calculation of work done by the turbine is shown in appendix.
5. The low pressure steam of 10bar comes out the HPT at 1970C and sent to re-heater. The temperature is increased to 5000C and the pressure is maintained and sent to the low pressure turbine. The work done calculation for LPT is same as the HPT.
6. From the LPT, the output steam is at pressure of 0.1bar and sent to the condenser. In the condenser the steam is condensed to water and the temperature becomes 460C.
7. The condensate pump increases the pressure 10bar and sent to the de-aerator. From there the pressure is increased by the pump to 150bar and condensate water treatment is done and combined with the treated feed water and the process continues.

8. The corrosion is indicated by the change in the water flow in the pipe. Condensate water after treatment allows only till the limited value and if its crosses the limit the valve gets closed indicating the corrosion has occurred in the pipe.

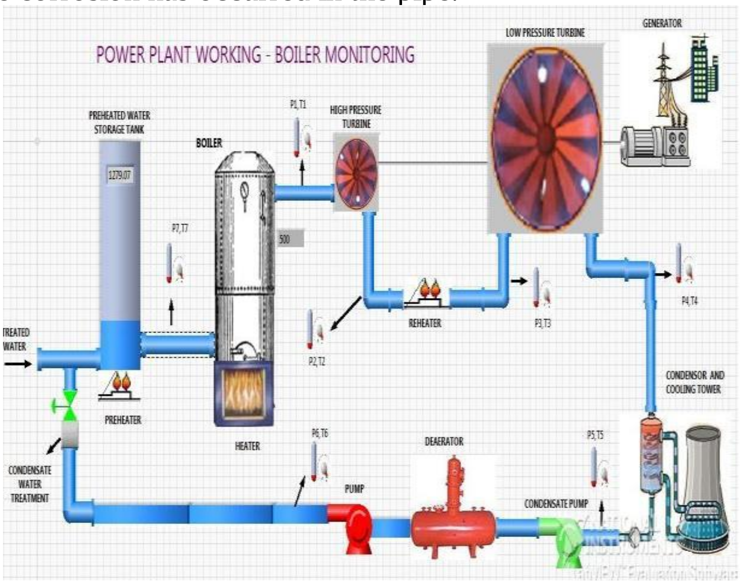


Figure 4 Front Panel of Process

5.1.1 Monitoring Zone:

In this zone the values after the water treatment, temperature and pressure values of the process, status, condensate water treatment and output are shown in below figures.

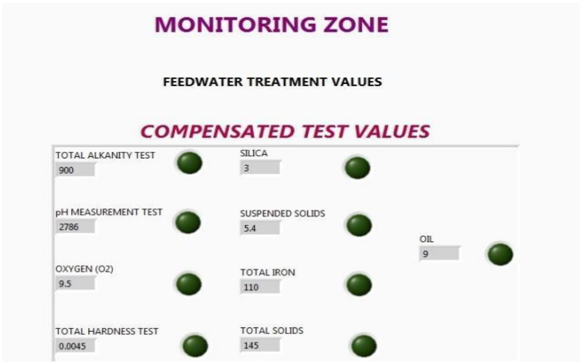


Figure 5 Feed water Treatment Values

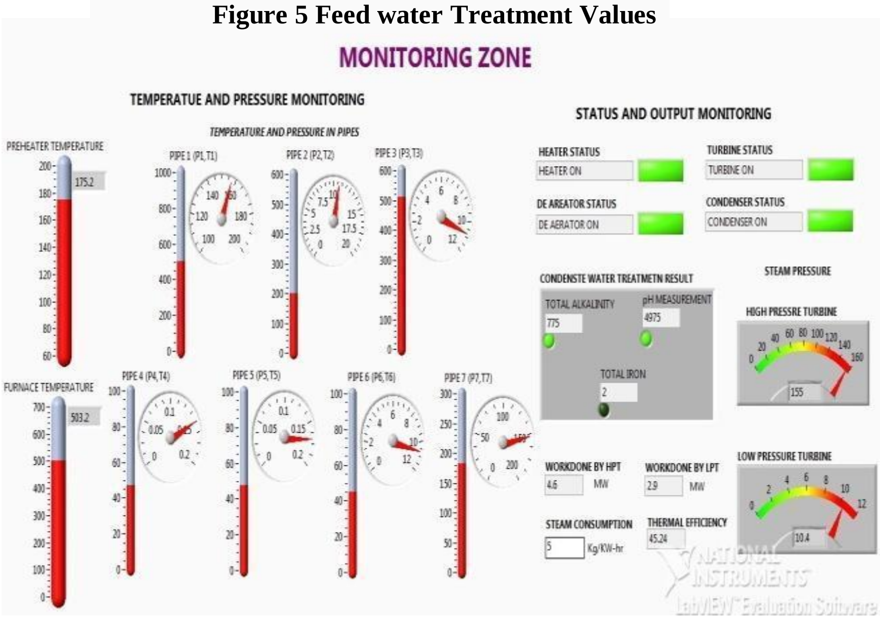
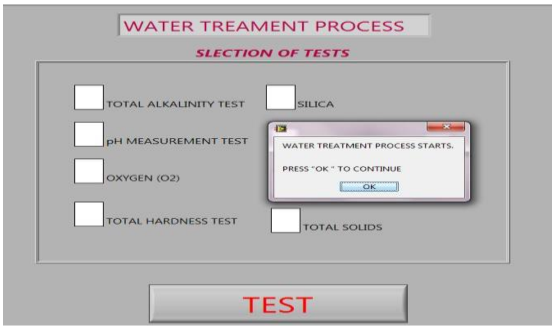


Figure 6 Temperature, Pressure, Status and Output Monitoring Panel

5.1.2 Water Treatment Process:

This is the important process to prevent corrosion occurring in the boiler. This is done by the following steps:

1. The message is displayed to start the process; select the test message will be displayed consecutively and click OK to proceed.



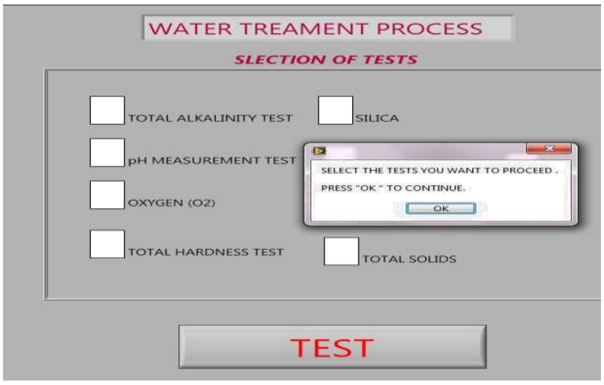


Figure 7.a) Water Treatment Process **Figure7.b) Water Treatment Process step 2**

2. Select the test we wanted to conduct and click test.

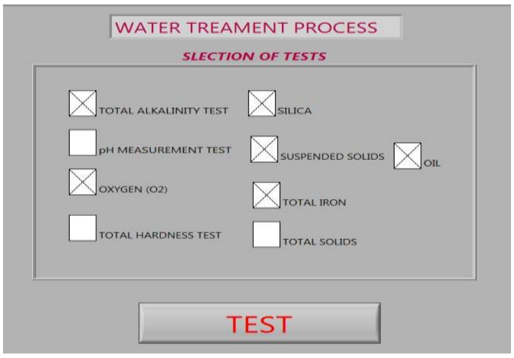


Figure7 c – Selection of Test

3. The values are tests are taken as per the below table and the values will be indicated. If values o beyond the value the indicator will be ON and messages displays to start the compensation test.

Table1 Suggested Boiler Water Qualities

CONSTITUENT	VALUES
Oxygen (O2) pH Total hardness Total alkalinity Silica Oil Suspended solids Total solids Total solids	<0.007 ppm 7.5 to 10 <3 ppm <1200 to 800 ppm <150 ppm <10 ppm <300 ppm <4000 – 2500 ppm <4000 – 2500 ppm

Figure 9.d) Test Values

4. The compensated test values are indicated. The indicator gets OFF

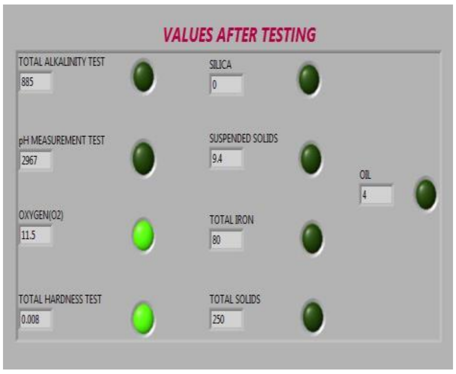


Figure8 e - Compensation Test

VI. HARDWARE SETUP:

Our hardware model shows the method to indicate that corrosion had occurred in the boiler tubes.This can be done by the changes in the chemical properties of water due to corrosion. There are many parameters but we have considered the pH value of the water that has to be maintained in the pre-set value. The block diagram of hardware setup is shown in figure10.

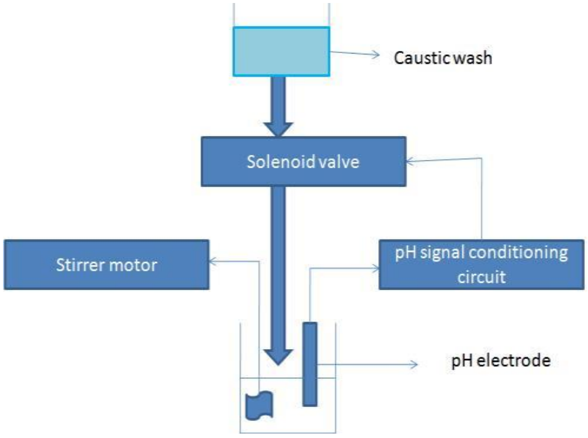


Figure9 Hardware setup

The water flows from top tank to the bottom through the solenoid valve. The solenoid valve is controlled by the signal conditioning circuit. Based on the signal for the pH sensor to the circuit the valve may be opened or closed. If the supply is switched ON the water flows through to solenoid valve to the bottom tank. The pH of the water is detected by the pH sensor. The preset valve is maximum allowable limit if the property of water has changed. If it goes beyond that the valve closes and means that the corrosion has occurred.

6.1 List of Components:

The components that are used in the hardware setup are

- Solenoid valve
- pH sensor
- Signal conditioning circuit

6.1.1 Solenoid Valve:

A solenoid is an electromechanical device which allows for an electrical device to control the flow of a gas or liquid. The electrical device causes a current to flow through a coil located on the solenoid valve. This current flow in turn results in a magnetic field which causes the displacement of a metal actuator. The actuator is mechanically linked to a mechanical valve inside the solenoid valve. The valve then changes the state, either opening or closing to allow a liquid or gas to either flow through or be blocked by the solenoid valve. A spring is used to return the actuator and valve back to their resting state when the current flow is removed.

The solenoid valve used in the setup is 12V and is shown in figure10 Solenoid valves come in various configurations and sizes. Solenoid valves can be normally open, normally closed, or a two way valve. A normally open solenoid valve allows a liquid or gas to flow through unless a current is applied to the solenoid valve. A normally closed valve works in the opposite manner. A two way solenoid valve has three ports; one port is common, one is normally open and the third is normally closed.

Figure 10 Solenoid Valve

Figure 11 pH Sensor

6.1.2 pH Sensor:

pH is a short form for the Power (p) of Hydrogen (H) pH is defined as the negative log of the Hydrogen ion activity, a H+ or the effective hydrogen ion concentration. A pH meter is an electronic instrument used for measuring the pH (acidity or alkalinity) of a liquid (though special probes are sometimes used to measure the pH of semi-solid substances). A typical pH meter consists of a special measuring probe (a glass electrode) connected to an electronic meter that measures and displays the pH reading. The pH probe measures pH as the activity of the hydrogen cations surrounding a thin-walled glass bulb at its tip. The probe produces a small voltage (about 0.06 volt per pH unit) that is measured and displayed as pH units by the meter. For more information about pH probes, see glass electrode. pH meters range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer interfaces and several inputs for indicator and temperature measurements to be entered to adjust for the slight variation in pH caused by temperature. Specialty meters and probes are available for use in special applications, harsh environments, etc.

6.1.3 pH Signal Conditioning Circuit :

The signal conditioning circuit is used to control the solenoid valve position. The input to the circuit is given through the pH sensor. The pre-set value is set in the circuit if the value goes below the pre-set value the circuit send the signal to close the solenoid valve.

VII CONCLUSION

Industrial plants should no longer assume that equipment failures will only occur after some fixed amount of time in service; they should deploy predictive and online maintenance strategies that assume that any failure can occur at any time (randomly). The onset of equipment failure may manifest itself in data generated by the methods used to monitor the equipment, providing clues as to whether the equipment should be repaired, replaced, or left to continue in operation. Development of the proposed system based on the three major types of predictive or online maintenance technologies discussed in this paper promises to deliver technologies that may be applied remotely, passively, and online in industrial processes to improve equipment reliability, predict failures before they occur, and contribute to process safety and efficiency. Integrating the predictive maintenance techniques described in this paper with the latest
sensor technologies will enable plants to avoid unnecessary equipment replacement, save costs, and improve process safety, availability, and efficiency.

Predictive maintenance technique is the best technique to be followed in dangerous working area like boilers. In our project the major reason behind the failure of boiler is corrosion, the cause for corrosion is identified and it is controlled before it totally damages the boiler tubes and boiler plates.

REFERENCES

[1]. F. S. Nowlan and H. F. Heap, "Reliability centered maintenance," Nat.Tech. Inf. Service, Springfield, VA, Rep. A066-J79, 1978.
[2]. G. Hale, "InTech survey: Predictive maintenance top technology challenge in 2007," in *InTech*. Pittsburgh, PA: ISA, Jan. 2007
[3]. H. M. Hashemian *et al.*, "Advanced instrumentation and maintenance technologies for nuclear power plants," U.S. NRC, Rockville, MD, NUREG/CR-5501, 1998.
[4]. H. M. Hashemian, "On-line testing of calibration of process instrumentation channels in nuclear power plants," U.S. Nucl. Regulatory Commission, Rockville, MD, NUREG/CR-6343, Nov. 1995.
[5]. H. M. Hashemian, *Sensor Performance and Reliability*. Research Triangle Park, NC: ISA, 2005.
[6]. J. M. Moubray, *Reliability Centered Maintenance*. New York: Industrial Press, 1992.

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