Krishna Prasad Dasari, Dr.A.M.Prasad, V.Sai Krishna Prasad / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue4, July-August 2012, pp.2198-2202

Water Temperature and Flow control Measurement for Thermal Discharge Model using PID controller

Krishna Prasad Dasari[1] Dr.A.M.Prasad ME,Ph.D[2] V.Sai Krishna Prasad[3]

Department of ECE, University College of Engineering
Jawaharlal Nehru Technological University Kakinada (JNTUK), Kakinada, India

1. ABSTRACT:

This main aim of this paper is evaluate the method of environmental impact of power plant discharge by reducing the temperature difference between effluent and costal water and flow control. Water temperature control and flow control measurement have been designed in advance technology of industrial control area for thermal discharge model test. Digital temperature sensors, level sensors, Flow meters, different modulated circuits, dedicated interface are used in the test and controlling of the system is adopted in software designing and programming. Measurement procedure, data processing and controlling are done by Proportional – Integral – Derivative (PID) controller. The numerous analyses of these applications it is shown that measurement is satisfactory, precise and reliable meeting the requirement of test. This technology can be implemented where the thermal effluent are discharged in coastal areas.

KEYWORDS: Thermal discharge, Temperature measurement, Flow Control, level measurement, Temperature/Flow control System

2. INTRODUCTION:

A lot of electricity is produced by the thermal power plants constructed along the coast. Every day they are pumping the hundred thousand tonnage of sea water as heat sink from thermal power plant. Through in this process more number of heat wastes is emitted to the environment of sea or river. Various human living and industrial activity also cause for this thermal discharge. This is not so sever to aquatic ecological system but also not negligible. Thermal discharge from many factories and plants along coasts results environmental impact especially huge power plants has been big issue in the socio-economic viewpoints of coastal eco-system.

Water temperature is an important factor to water quality and ecology, which almost affects the entire physical, chemical and biochemical properties of water. Large number of thermal pollution is caused by heat regression effect due to emission of thermal discharge from power plants to surrounding water, so the physical model test on the warm water temperature region prediction is very necessary.

Water temperature is not only an important parameter for the test, but is also important for the process control. For this experiment, we generally require sensors to measure temperature, flow rate and this automatic synchronized signal is displayed at remote place and recorder is also necessary in the test. Besides, model discharge needs to get temperature, flow and level in control and not just be measured. Obviously, mercury thermometers cannot be competent, but electronic thermometer is suitable. The general temperature sensors include IC LM35, thermistor, resistance temperature detector (RTD) and thermocouples, etc. However, electronic thermometers (including IC shunt sensor) need separate signal cable transmission, separate amplification, shaping circuit, A/D converters and multichannel analog switch, this will make hardware system complex. Let analog circuits and digital circuits coexist in one system and the assembly and commissioning is troublesome and with higher cost and magnetic level sensors are used in order to measure the level of the liquid at regular intervals.

3. SYSTEM STRUCTURE AND OPERATION

The system design has been adopted with digital temperature sensors, Flow Meters, level sensors with the latest extreme fast control technology several modules computers and dedicated interface is shown in the below figure 3.1

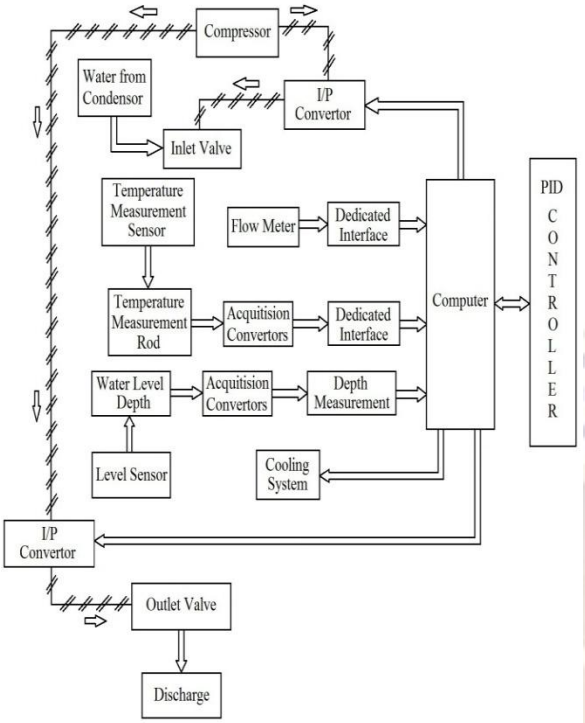


Figure 3.1

A.WATER TEMPERATURE MEASUREMENT AND CONTROL

The digital temperature sensor is a thermal transistor of temperature measurement. when the water temperature changes then the sensor detect and the physical quantity of temperature is converted in to digital quantity in computer through temperature sensitive devices and corresponding circuits such as analog to digital convertor, controller, data acquistion. Herewe undergo with a Resistance Temperature detector(RTD) sensor for temperature measurement which has a range of -202°C to 855°C and accuracy of 0.1 °C and resolution 0.0625.

The system mainly consists of heating pool (hot water) The water temperature of the pool showed by temperature sensor and this signal will be compared with the experimental reading with was given computer as a set point, based on the water temperature the cooling system is switched ON to reduce the temperature to the required set point. The controlling action is been processed by the controller and the final temperature is displayed in the computer. The Cooling system is been powered with the solar panels instead of electric power. The power can be stored in Battery and can be utilized when the solar power is interrupted.

Data aquistion is intergrates ETRX2(W-PAN) transreciver module to transmit the data to remote place through wireless communication this module is equiped with power supply.

Digital temperature sensors, data acquisition converter, dedicated communication interface, and computer composed, the temperature measurement system realized the simultaneous multi-point temperature values detected of synchronous by the specific software to complete data sampling, transfer, display and output of graphics and tables.

B. FLOW MEASUREMENT AND CONTROL

The Flow rate of the inlet and the discharge can be measured by venturimeter or Orifice meter and the differential pressure is calculated and it is been transmitted to the computer for the comparison with the set point with is already fed to the computer. The flow rate and the valve opening/closing depends upon the level of the heating pool and it is continuously monitored by the set point given and been operated by PID Controller.

C. LEVEL MEASUREMENT AND CONTROL

The level of the system is monitored by using the magnetic level sensor. The level is processed by using controller and based on the level the cooling system is activated and the temperature of the pool is controlled to the required set point. The level of the system is displayed on the personal computer and the controlling action takes place. The cooling system has to work in a condition that it should satisfy the pool temperature with the given set point in between the inlet and outlet valves of the pool.

4. SOFTWARE DESIGN

The programming of control system is completed in object oriented program it includes two operations for temperature control and level control, MATLAB is used in measurement procedure and data processing to communicate between two modules this interface is friendly and easy to operate.

Display of measurement shows each temperature value measured and all data will be automatically saves in the form of document for easy access, the MATLAB code is used for data processing procedures based on the display temperature the temperature is controlled to allowable range, the measured signals are then calculated in computer for data integration after processing to keep the consistency results.PID control method is applied to system, this PID is suitable for nonlinear problem with large delay and difference to be simulated in mathematical model.

Temperature measurement and control: In this control it has two modules those are manual and automatic. In manual cooling system, the set point has to be given to the personal computer, so according to the input value the cooling system comes into the action. In automatic cooling system, it operates continuously depending up on the discharge rate.

Level measurement: In this it consists of two modules those are manual and automatic. In manual operation cooling system, the set point has to be given to the personal computer, so according to the input value the cooling system comes into the action. In automatic cooling system, it operates continuously depends up on the discharge rate.

Flow measurement and control: In this it consists of two modules those are manual and automatic. In manual operation cooling system, the set point has to be given to the personal computer, so according to the input value the cooling system comes into the action. In automatic cooling system, it operates continuously depends up on the Temperature and level.

5. FEATURE OF THE SYSTEM

The system is digitally programmed with multi functional circuit module high integration, light simple structure and high precision in temperature measurement.

The way of transmission with data is highly reliable because it can transmit the data through large distance without loss of data by using the ETRX2 module.

Using this XFC (extreme fast control) technology provides a real time control and fast accurate response. Using XFC technology, I/O response time ≤ 100μs, XFC components achieves the cycle time of 50μs in the Windows system, I/O distributed processing time is 30μs, time stamp and the over-sampling ensure high precision timing (up to 10ns). These greatly meet the process control requirements of real time. Meanwhile, we can improve the precision and resolution by optimizing the system cycle, and we can also reduce the response time and improves the function of the system. Standard tasks, measurement tasks and fast control tasks can be executed parallel in hardware and software platform because XFC are compatible with the system.

6. DATA ANALYSIS

The power plant has to sign a protocol with local government to reduce influences on marine environment by thermal discharge. The thermal discharge standard of MKS Power Plant in America points, temperature-rise of power plant should be less than 5°C, dissolved oxygen concentration must be more than 5mg/L, and temperature should be less than 28.33°C in summer. Internationally, main marine countries all made some management regulations about thermal discharge. Table I shows limited value of water temperature by some European countries regulations. Belgium highest temperature is 30-35°C, Holland highest temperature rise is 3°C and highest temperature out fall is 30°C.

For France highest Temperature rise is 3°C and for Italy highest temperature rise is 3°C, highest temperature is 30°C and highest temperature of out fall is 35°C.

India published more perfect standard on the power plants thermal discharge. There are also concentration limit about other pollutants in the thermal discharge. Table II shows Indian power plant discharge standard of water cooling. Table III shows Egyptian power plant standard of thermal discharge.

TABLE I. SOME EUROPEAN COUNTRIES' LIMIT VALUE OF DISCHARGED WATER

Country	Highest Temperature-rise(℃)	Highest Temperature(℃)	Highest Temperature of Outfall (℃)
Belgium	—	30-35	—
Holland	3	—	30
France	3	—	—
Italy	3(Ocean)	30(River)	35(Ocean)

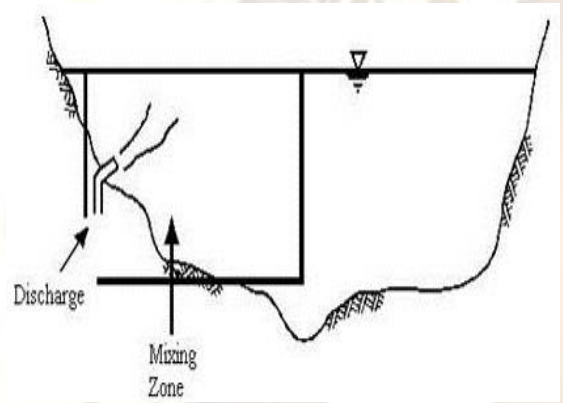
TABLE II. INDIAN POWER PLANT'S DISCHARGE STANDARD OF WATER FOR COOLING

Parameter	Up Limit of Concentration	Parameter	Up Limit of Concentration
pH	6.5~8.5	Total Iron	1.0mg/L
Residual Chlorine	0.5mg/L	Zinc	1.0mg/L
SS	100.0mg/L	Total Chrome	0.2mg/L
Oil	20.0mg/L	Phosphate	5.0mg/L
TCu	1.0mg/L		

There are some regulations for temperature monitored at bay shore plants for intake and discharge process, in summer months the maximum intake of plant must be 28.9°C and maximum discharge must be 34.3°C and in winter months maximum intake must be 13.8°C and maximum discharge must be 18.1°C, for summer months minimum intake must be 17.9°C and minimum discharge is 21.4°C and in winter months minimum intake must is 1.1°C and minimum discharge is 3.4°C.

TABLE III. EGYPTIAN POWER PLANT'S STANDARD OF THERMAL DISCHARGE

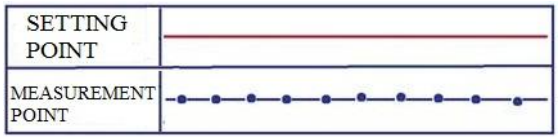
Parameter	Egyptian Standard	Guiding Standard of World Bank
pH	6~9	6~9
BOD	<30mg/L	—
Chrome	0.05mg/L	0.5mg/L
Copper	1mg/L	0.5mg/L
Iron	1mg/L	1.0mg/L
Zinc	1mg/L	1.0mg/L
Oil	5mg/L	10mg/L
TSP	30mg/L	50mg/L
Residual Chlorine	—	0.2mg/L
Temperature-rise(℃)	HighestAbsolute temperature of Outfall is 35℃	Temperature-risealongMixed ZoneBoundary≤3℃



The mixing of the discharge to the river or sea is not a physical process. But it must be regulatory designed to discharge the effluent before all the required standards are met. Reasonable amount of dilution of thermal water results in minimizing the environmental effect by mixing zone size. The 'mixing zone' is simply the region within which a contaminant plume is legally allowed to interact with the surrounding water. The contaminant may cause impact to the environment due to presence of heat of any other chemical effluent.

China hasn't special standard aiming at cooling water, but only has clear clauses about water temperature-rise in some environment regulations. For example, in "Standard of Surface Water Environment Quality the Water temperature term points, "Artificial environmental water temperature change should be limited under an average of 1°C per week in summer and 2°C in winter. And in "Sea Water Quality Standard it is said that Artificial Temperature-rise should be no more than 4°C higher than that place at that time." However, compared to foreign related standards, China's regulations about water temperature is very general, and has no clear regulation on neither aspects such as discharge intensity and range of mixed zone, nor temperature rise limit related to regional or ecological features.

7. EXPERIMENTAL RESULTS



Temperature control using PID at 35°C

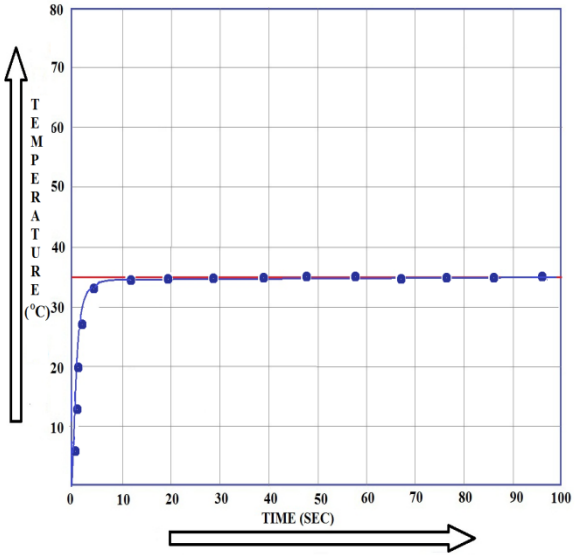


Figure 7.1

Flow Control Using PID at 50% Opening

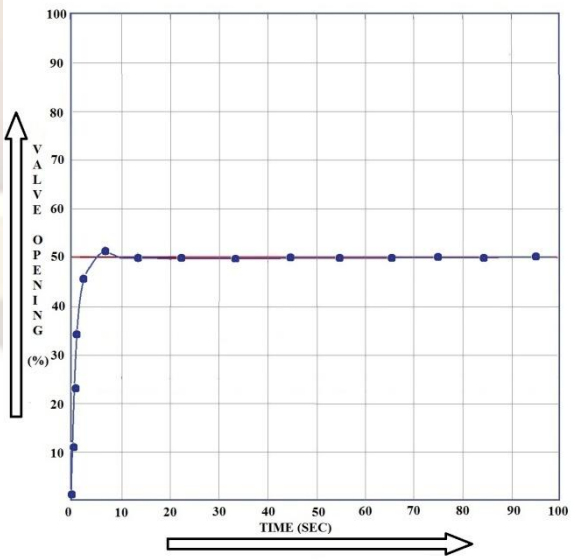


Figure 7.2

Flow Vs Level

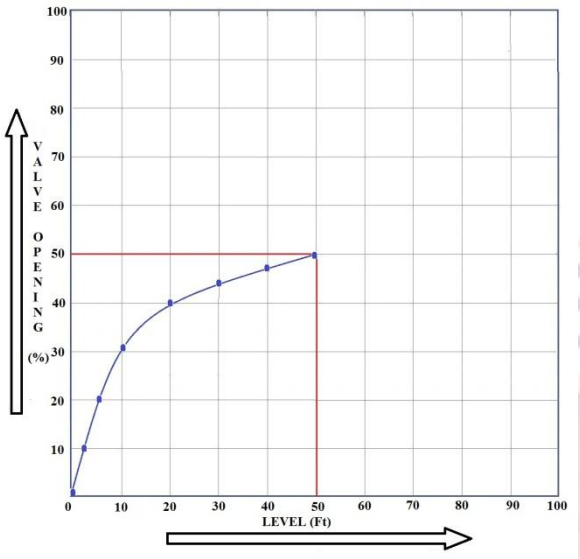


Figure 7.3

8. CONCLUSION:

By using this proposed method we can reduce the temperature of the thermal discharge from power plant up to desired set point by controlling the desired flow rate and we can also measure the level of the system and get displayed on the computer.

Selection of the higher grade of sensors can add advantage to the project and gives the better performance. This method have multiple effect of reducing the carbon dioxide emissions from hot water which cause thermal pollution and the effects would be proportionally magnified if plants are added and expanded.

The system will have a wide range of application where water temperature monitoring is needed and such as, industries, lakes, rivers etc.

9. REFERENCES:

[1] Wu Xinsheng, Lin Musong, Yao Shiming, Liao xiaoyong, Huang weidong "Design and application of multi-point water temperature measurement and control system for thermal discharge model" 2010 International Conference on Digital Manufacturing & Automation

[2] G.C. Nihous, M.G. Brown, D.Levrat, M. Gauthier, J. Ruer, "Ocean Thermal Energy Conversion (OTEC): Principles, problems and prospects", 2nd International Conference on Ocean Energy (ICOE 2008), October 2008, 1-9.

[3] H.Z. Li. Evaluation of Influences on Environment by Japanese Nuclear Power Plant's Thermal Discharge [J] Research & Design of Nuclear Engineering,2007,1:14-16.

[4] Clean Water Act NPDES Permitting Determinations for Thermal Discharge and Cooling Water Intake from Mirant Kendall Station in Cambridge,MA 2004.8.8.

[5]. Wu Xinsheng, Zhou Zhen, Yu Lianqing, and Chen Fengyu, "Development and application of control facility of warm-water discharge in river model test", Journal of Yangtze River Scientific Research Institute, Wuhan, vol. 20, pp. 58–60, Oct. 2003. (in Chinese)

[6]. He Xicai, Sensor and Its Application Circuit. Beijing: Electronics Industry Press, 2001. (in Chinese)

[7] Notification, Ministry of Environment and Forests, New Delhi,the 22nd December,1998.

[8] Cheikh I. Fall, Egypt:EL Kureimat Combined Cycle Power Plant Project(ModuleII), Environmental And Social Management Plan Summary,2005,Feb 4th .

[9] T. Toyota, T. Nakashima and T. Ikeda, "Overview of research activities on the utilization of deep seawater in Japan", International OTEC/DOWA Association, May 1997, pp.109-118.

[10] Y. H. Kim, "Power plant discharge and its affect to marine ecological system", Electric signal science technology press center, Seoul, June 2000, p.259. (in Korean).

[11] Vega L.A., "Ocean Thermal Energy version". In Encyclopedia of Energy Technology and the Environment, Vol. 3 (A. Bisio and S. Boots eds.), John Wiley & Sons, New York, 1995. pp.2104-2119.

[12] J.R. Adams, "Ecological investigations related to thermal discharges, Pacific Electrical Association, Engineering Operations Section, Annual Meeting, Los Angeles.

[13] Penney T.R., Daniel T.H, "Energy from the ocean: a resource for the future", Year Book for 1989, Encyclopedia Britannica, 1989, pp.98-115.

[14] J.R. Vadus, "A strategy for OTEC Commercialization", International OTEC/DOWA Association, May 1997, pp.235-247.

[15] H.J. Kim, D.H. Jung, D.S. Moon and W.Y.. Oh, "Development and Application Direction of Ocean Thermal Energy Conversion", Proc. Of Korean Society