Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 51 (2013) 141 – 150

Procedia Engineering

www.elsevier.com/locate/procedia

Non-Circuit Branches of the 3rd Nirma University International Conference on Engineering (NUiCONE 2012)

Structural Engineering Challenges in Structures for Cooling Water System in Thermal Power Plant

Dipal P Trivedi[a], Raja I Bagga[a], Jignesh V Chokshi[a,*]

[a]*L&T-Sargent & Lundy Limited, L&T Knowledge City,SEZ Unit NH-8, Ajwa-Waghodia Crossing, Vadodara – 390019, Gujarat., INDIA*

Abstract

Water is one of the most important resource requirements in thermal power plant for process cooling in the condenser, ash disposal, cooling of plant auxiliaries and various other plant consumptive uses. Cooling water requirement in a thermal power plant is a major water resource issue for project feasibility as it has tremendous effect on the surrounding environment, population, animal and aquatic life. In a thermal power plant, Cooling Water system is one of the most important power plant systems which ensure continuous supply of cooling water for steam condensation in condenser and other plant equipment. Power plants are key elements of national infrastructure and eco-friendly solutions are required for commitment to the society. With a thrust on use of non-agricultural land as well as potential for importing coal through sea, the power plants are now being developed along the coastal lines, where water is available in abundance. The cooling process can be done either through air or with use of water and both have its merits and demerits. With increased power demand, the sizes of power plant units have increased substantially as compared with previous decades. This has further called for large structures and has imposed many engineering challenges for a power plant engineer. From civil and structural engineering perspective, the CW system involves very large water conveying and retaining structures namely cooling towers, intake and discharge channels, forebay, large underground sump, pump station for housing of large cooling water pumps, large piping between cooling tower and condenser, etc. In order to reduce the capital and running cost of the plant, thrust on economical design is emphasized. This imposes an additional constraint for engineer and it demands meticulous analysis and design to provide optimum techno-commercial solution. The present study describes various types of CW systems, structures and associated engineering challenges faced by structural engineer.

Selection and peer-review under responsibility of Institute of Technology, Nirma University, Ahmedabad.

Keywords: CW, CW System, Cooling Water, Challenges, System.

Nomenclature

CW	Cooling Water
ESP	Electrostatic Precipitator
FEM	Finite Element Method
FRP	Fibre Reinforced Plastic
GRP	Glass Reinforced Plastic
HRSG	Heat Recovery Steam Generator
IDCT	Induced Draft Cooling Tower
NDCT	Natural Draft Cooling Tower
RC	Reinforced Concrete

* Dipal P Trivedi Tel.: +91-265-245-6240; fax: +91-265-245-6300, *E-mail address:*dipal.trivedi@lntsnl.com, *Web:* www.lntsnl.com

Selection and peer-review under responsibility of Institute of Technology, Nirma University, Ahmedabad.
doi:10.1016/j.proeng.2013.01.021

1. Introduction to Cooling Water System

In a typical thermal power plant, power is generated through steam turbine generator. The thermal energy of high pressure steam is converted in to mechanical energy in the steam turbine where in steam is supplied to turbine blades and as a result rotor is rotates at high speed. The turbine rotor is connected with generator rotor and hence rotation of turbine rotor results in rotation of generator rotor. Ultimately power is generated in the generator due to rotation of rotor against static components of generator.

In power plant, fuel is burned to generate high pressure steam. The steam, exhausted from turbine is condensed in condenser. For condensation of steam, either air or water is supplied through the condenser so as to exchange heat from steam. The cooling water system ensures continuous flow of water or air through condenser for steam condensation. The general classification of types of cooling system is furnished in fig 1.

After condensation, the steam is condensed back to liquid (i.e. water). In case of water cooled system, the water which comes out from condenser is comparatively hot. This hot water is supplied back to cooling tower where the heat is extracted and water is cooled again for recirculating to condenser again. See fig 2 for schematic representation of a typical power plant system including cooling water system.

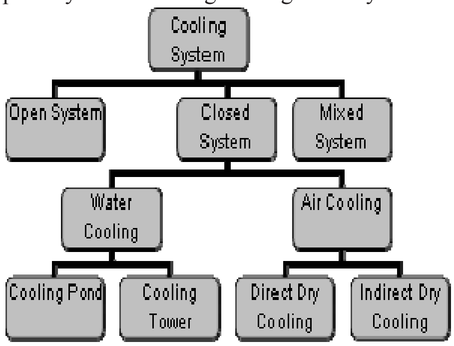
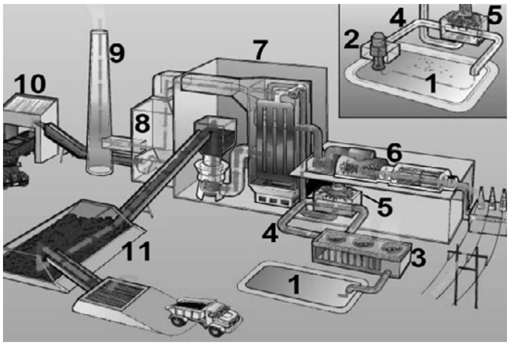


Fig 1 Types of cooling system



1. Cooling water
2. CW Pump
3. Cooling tower
4. CW Pipe
5. Condenser
6. Steam Turbine Generator
7. Boiler/HRSG
8. ESP
9. Chimney
10. Ash system
11. Coal system

Fig 2 Typical Power Plant Schematic with CW system

The function of cooling water system is to circulate cooling water through condenser by pumping. Hence, a typical CW system includes structures like cooling towers, underground channels, sump & pump station, CW piping. Cooling water is taken from a body of water such as a river, lake or ocean.

1.1. Open Cooling System

In open or once through CW system, cooling water is drawn from the source water body (sea/river/pond etc.) through underground CW Channel, CW forebay and collected in CW sump below CW pump station. From here the water is pumped to condenser through CW pipes. The hot water from condenser outlet is ultimately discharged to source water body through underground RC box culvert and channel. The heat is gradually transferred to the atmosphere by evaporation, convection and radiation. It shall be noted here that there is no cooling tower required in this system and also water is not re-circulated and hence this system is called as open cooling system. This system is most appropriate for power plants located near to the water body having large volume of water, generally near sea.

1.2. Closed Cooling System (Water cooling)

In closed cooling system, the hot water from condenser discharge is diverted to cooling tower basin through CW return pipe. In the cooling tower heat is dissipated to atmosphere and cold water is stored in cold water basin. The cold water is circulated by gravity flow from cooling tower basin to CW sump through CW channel and forebay. From Sump, water is collected in CW sump and pumped back to condenser through CW supply pipes. Thus in a closed cooling system, the circulating water serves as an intermediate heat transfer medium from which the waste heat is directly rejected to the atmosphere. Cooling towers have been used at power plants where large volume of water is not available. There are generally two types of cooling towers, Natural Draught Cooling Tower (NDCT) and Induced Draft Cooling Tower (IDCT). In case of NDCT, no mechanical device is utilized to create air flow through the tower and the air flow is derived from