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Hydro-Aerodynamic, Thermal and Technological Processes to Reduce Circular Technical Water Waste in the Heating Power Plant

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ABSTRACT Today, combined cycle power plants provide the bulk of electricity production. This type of thermal power plant has a number of advantages and disadvantages compared to others. The fact that the natural gas supplied to the plant is first burned in the combustion chamber of the gas turbine to obtain primary energy, and the combustion products are used to evaporate water, leads to a more efficient use of fuel energy [1]. Of course, it is theoretically impossible to fully utilize the fuel energy, but its rational use is the main requirement today. The production capacity of such plants is higher than that of other thermal power plants. At the same time, water consumption is also slightly higher, since more water is required to cool the unit and condense steam in the condenser, which provides greater power [2]. At modern combined cycle power plants

1. To produce steam in the boiler and feed it to the steam turbine, water is used for two main purposes.
2. To cool the system and convert the resulting steam into condensate.

In both cases, if the water parameters do not meet the required ones, the system will not work fully or at all. The water supplied to the boiler room at the station is called "working water", and the water cooling the system is called "technical water". Both types of water differ in their purpose and chemical composition [3]. That is, in a chemical water treatment plant, working water undergoes purification several stages more than technical water, and enters the reserve in a closed cycle. Technical water is purified less than working water, and its reserve operates in an open cycle. When technical water circulates in the system and returns after work in the condenser, its temperature rises and cooling is required. This work is performed in a cooling tower.

I. INTRODUCTION

If we look at the world experience, it can be seen that there are various methods of technical water cooling systems; open pool, spray pool and cooling tower. Among these methods, the most optimal choice from an economic and ecological point of view is the cooling tower method, because it does not require a large area like other methods, and the cooling capacity and volume of water are large, and the efficiency is high. Therefore, in recent years, countries around the world have been using only the cooling tower method. Now let's consider the technical characteristics of the air-cooled cooling tower from the beginning. We can see this again in the example of the cooling tower (cooling tower) built at the Turakurgan TPP (Figure 1).

II. COOLING TOWER TECHNICAL SPECIFICATION

The technical water-cooling system starts with hot water pipes returning to the tower from the general system. At the top of the cooling block there are circular air intake fins that draw hot air from below upwards. Of these, 11 serve 2 450 MW steam-gas units, for a total of 22 holes.

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Fig. 1 Water Cooling Tower.

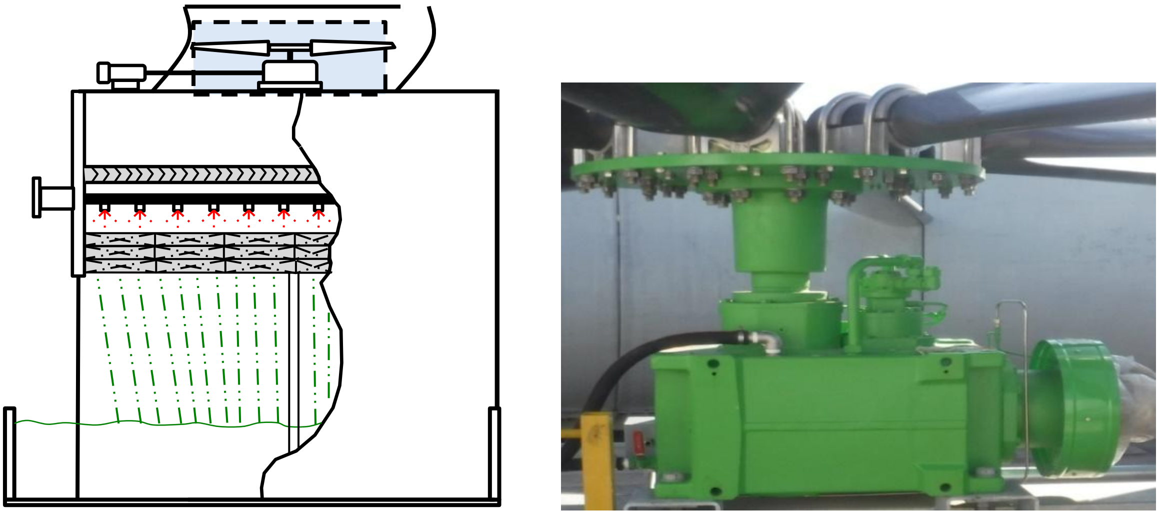

Fig. 2 Air vents.

Cooling tower model - ASTM E 84
Number of fan blades - 8
Fan rotation speed - 1485 times/min
Hole diameter - 9.7 meters
The air blades of the Turakurgan TPP cooling tower perform the function of pulling air from the internal environment of the cooling tower to the outside (Figure 2.5-a). Fans are the main element responsible for creating air flow in the cooling tower. It consists of the following components: Working ring - creates air flow when rotating[8].
Diffuser - controls the flow and protects the equipment from damage.

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Confuser - smoothly narrows the air flow, reduces resistance.
Electric drive - causes the fan shaft to rotate (Figure -3).

Fig. 3: Motor and drive shaft that rotates the blades.

Motor power for rotating the blades – 199 kW/h
Voltage- 400 V
Diameter of the shaft transmitting the rotational motion from the motor – 159 mm

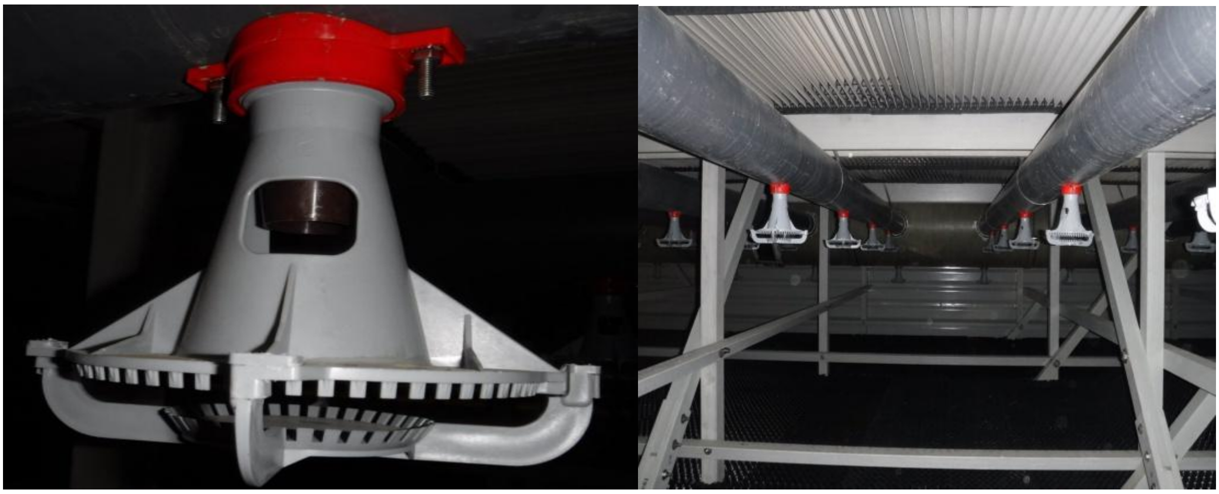

Fig. 4 Water spray nozzles.

III. THEORETICAL STUDY OF THE HEAT EXCHANGE PROCESS

Hot water from the general system is distributed through pipes to the sprinklers in the upper part of the cooling tower (below the fins). The sprinklers spray hot water onto the surface (Figure 2.7). The sprayed hot water droplets hit the apacumel and spread out and flow towards the surface. There is a water basin at the bottom of the cooling tower where the cooled water reserve is stored. Cold water is transferred back to the system through supply pumps and the circulation continues. Water from the external pipe is distributed to each distribution pipe and then to the sprinklers. The material of the distribution pipes is FRP (fiberglass). The figure below shows a typical water circulation around a cooling tower[1]. The heat source comes mainly from condensers and a closed water cooling system, which receive circulating water cooled by these heat exchangers.

During this process, heat is absorbed by the circulating water and returned to the cooling tower for cooling. This process is continuous while the plant is operating. To compensate for evaporation losses, displacement losses, etc., make-up water is supplied to the cooling tower pool. In winter conditions, a bypass line is used.

Heat exchange process and technical water loss in a water cooling tower

Before we start talking about the heat exchange process in a water cooling tower, let's recall a little about heat and heat transfer.

Heat is a form of matter motion; an energetic expression of the heat exchange process between bodies. The amount of sufficient motion of microparticles (molecules, atoms, electrons, etc.) that make up matter represents Heat. The terms heat and heat quantity mean the same thing[2].

Information about heat has been known for a very long time. In ancient times, heat was considered a kind of basis, a basis, depending on the various states of bodies. Until the 16th century, the degree of heating of bodies was determined using the senses. In the 16th century, G. Galileo first made a thermometer and determined the degree of heating (temperature) of bodies. Starting from the 17th century, the state of heat began to be explained by linking it to the movement of particles in the composition of matter (F. Bacon and R. Descartes). In the first half of the 18th century, D. Bernoulli and M. F. Voltaire further developed this doctrine. In the 18th century, metallurgy and steam-powered technology made great progress. This required even more accurate investigation of heat phenomena. In particular, temperature (thermometry) and methods for measuring the amount of heat (calorimetry) developed. In the middle of the 18th century, M. V. Lomonosov experimentally investigated the combustion of substances in a closed vessel and discovered the theory of molecular heat. The German naturalist Yu. After R. Mayer proved the equivalence of heat and mechanical work (1850-60), the molecular kinetic theory was revived by J. Joule and the French scientist Girny and developed by R. Clausius and J. Maxwell. According to this theory, heat depends on the random motion of atoms and molecules in bodies. When the temperature of a body increases, the random motion of molecules or atoms in its composition accelerates. If two systems of different temperatures are brought closer together (brought into thermal contact), their internal energy changes; heat is exchanged without macroscopic (visible) work being done in the two systems. When a system exchanges heat with the external environment without macroscopic work being done, the change in the internal energy of the external environment is called heat received by the system, and this heat leads to an increase in the amount of thermal motion of the system. In heat exchange, if macroscopic work is not performed, microscopic (invisible) work is performed, that is, the molecules and atoms of the external environment act on the molecules and atoms of the system through molecular forces. When a heated gas is brought into thermal contact with a solid object, the transfer of energy from the gas to the object occurs through direct collisions of gas molecules with the molecules of the object (microscopic work is performed)[3].

The operation of a water cooling tower is also based on the basic laws of the heat exchange process. As the air entering the tower from the external environment is sucked upward by a fan, it collides with hot water sprayed from a sprayer and flowing over the surfaces of the apacumel, and absorbs the heat of the water and leaves. It is here that the heat exchange process between air and hot water occurs. That is, work is performed.

When all of the respective big kind data is stored basically in a single type data centre, the Map type Reduce schema is considered simple, kind of flexible and considered efficient [7]. In new kind scenario, a type data as part of cloud type data is actually stored in the respective cloudlets and are geographically known as isolation from those of data basically with the cloud type which actually causes much delay to the considering users. Parallel type data in process can be expected with this schema[4].

IV. RESEARCH RESULTS

In this way, as heat is absorbed into the air and released into the atmosphere, a certain amount of water droplets are also absorbed and released along with the air due to the air flow velocity, and in addition, the evaporation coefficient is also high due to the high water temperature. To replace this lost technical water, clean technical water is supplied to the cooling water reserve in the amount of water lost from the chemical water treatment plant. Turakurgan TPP consumes 474 kW of electricity for every 1000 $m^3$of water[5].

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Table 1 is a comparative table of the amount of technical water lost in the cooling tower of the Turakurgan TPP on hot and cold days of the year.

Season	Amount of new water added to the cooling tower per hour (m^3/h)	Amount of water discharged from the cooling tower per hour (m^3/hour)	Amount of water evaporated into the air per hour through cooling tower fans (m^3/hour)
In the summer season	1051	400	651
In the winter season	843	500	343
per day (summer)	25224	9600	15624
per day (winter)	20232	12000	8232

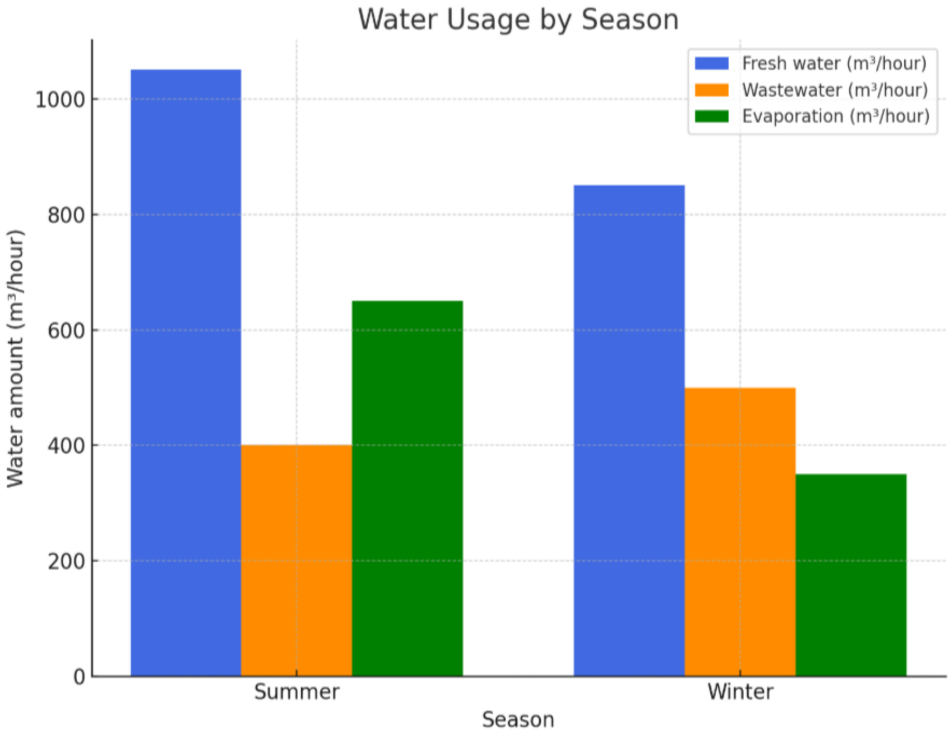

Fig. 5 Seasonal distribution of water loss in Cooling tower.

V. CONCLUSION

In conclusion, the role of water in industry, especially in the energy sector, is very important. The operation of a thermal power plant cannot be imagined without water. Because we have partially examined above what consequences even a slight change in the amount or composition of water can lead to[6]. While the importance of water is so important, saving it and using it rationally is also of great importance. It is no secret that the amount of fresh water in our nature is decreasing and the importance of the water problem is increasing. Therefore, rational use of water and the introduction of waste-saving technologies remain an important requirement of today.

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