International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE) Vol 2, Issue 7, July 2016

Implementing Water Purification in Large Scale in Power Plants

[1] P.Akilan, [2] S.Ahamed,
[1][2] Third year, Electronics and Instrumentation Engineering, Arunai Engineering College, Tiruvannamalai, Tamil Nadu

***Abstract:* — Global environmental changes and demands for multiple use of increasing population make water management a difficult task, especially in developing countries like India with exploding population, weak economy and several social issues such as disputes over Trans-boundary Rivers, resettlement and rehabilitation issues during project implementation, corruption and vested political and regional interests. With the increase in population, reliable water is becoming a scarce resource. The principal source of water for India is the southwest monsoon that undergoes wide spatial and inter-annual variations associated with global climate anomalies. Any further extremes in rainfall and changes in the frequency and intensity of severe weather systems due to a changing climate will have serious impact on water resources and agriculture, and it will be reflected in all facets of life.**

***Keywords*— Powerplant ,Evaporation,Condensation, Purification,Re-Mineralization.**

I. INTRODUCTION

In our country major of the people are affected by different types of diseases which are caused due to the consumption of impure water. A necessary step has to be taken in purifying the water in large scale but our government hasn't taking those steps. So that around 8.5 lacks of children below the age of 5 has been die. Now our project is about purifying water using distillation method in power plant in large scale. So that impure water can be converted into pure water in large quantity at no cost.

II. OBJECTIVE AND NEED

i. Water problem in India.

Summers are here and the cities in India are already complaining about water shortage not to mention many villages which lack safe drinking water. In the list of 122 countries rated on quality of portable water, India ranks a lowly 120.Although India has 4% of the world's water, studies show average availability is shrinking steadily. It is estimated that by 2020, India will become a water-stressed nation. Nearly 50% of villages still don't have any source of protected drinking water.

According to 2001 census 68.2% households have access to safe drinking water. The department of drinking water supply estimates that 94% of rural habitations and 91% urban households have access to drinking water. But according to experts these figures are misleading simply because coverage refers to installed capacity and not actual supply.
The ground reality is that of the 1.42 million villages in India, 1, 95,813 are affected by chemical contamination of water. The quality of ground water which accounts of more than 85% of domestic supply is a major problem in many areas as none of the rivers have water fit to drink.37.7 million People –over 75% of whom are children are afflicted by waterborne diseases every year. Overdependence on groundwater has brought in contaminants, fluoride being one of them.

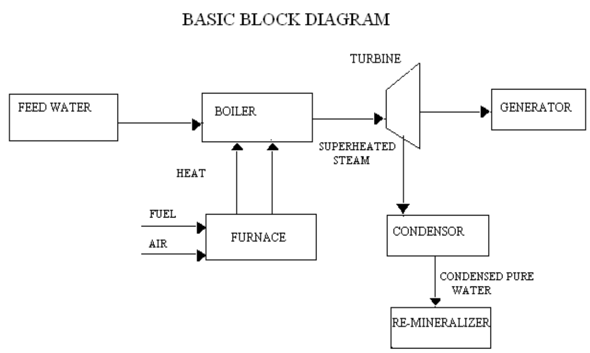
III. IMPORTANCE FOR PURIFICATION

Nearly 66 million people in 20 states are at risk because of the excessive fluoride in water. While the permissible limit of fluoride in water is 1 mg per liter in states like Haryana it is as high as 48 mg in some places. Delhi water too has 32mg. But the worst hits are Rajasthan, Gujarat and Andhra Pradesh. Nearly 6 million children below 14 suffer from dental, skeletal and non-skeletal fluorosis.

Health is not the only issue; impure water is a major burden on the state as well. Till the 10th plan the government had spent Rs 1,105 billion on drinking water schemes. Yet it is the poor who pay a heavier price spending around Rs 6700crore annually on treatment of waterborne diseases. There is an urgent need to look for alternative sources of portable water in places where water quality has deteriorated sharply, Also in places where groundwater has arsenic or fluoride, surface water should be considered as an alternative.

ii. Remedy: Our solution for water treatment

Impurities in water are usually suspended molecules of another substance suspended in a liquid solution. When water evaporates, it turns to vapors. Because of the distance between molecules in vapors it can hold fewer suspended particles. So unless the substance in the water becomes vapors at the same temperature it is left behind. if you could evaporate water, and condense it in a sterile environ mint, the water would be purified.



IV. PRACTICALLY HOW IT COULD BE DONE

1) Evaporation and condensation process in power plant.

I Feed water heating and desecration.

The boiler feed water used in the steam boiler is a means of transferring heat energy from the burning fuel to the mechanical energy of the spinning steam turbine. The total feed water consists of re-circulated condensate water and purified makeup water. Because the metallic materials it contacts are subject to corrosion at high temperatures and pressures, the makeup water is highly purified before use.

A system of water softeners and ion exchange demineralizers produces water so pure that it coincidentally becomes an electrical insulator, with conductivity in the range of 0.3–1.0 micro Siemens per centimeter. The makeup water in a 500MWe plant amounts to perhaps 120 US gallons per minute (7.6 L/s) to replace water drawn off from the boiler drums for water purity management, and to also offset the small losses from steam leaks in the system. The feed water cycle begins with condensate water being pumped out of the condenser after travelling through the steam turbines. The condensate flow rate at full load in a 500 MW plant is about 6,000 US gallons per minute (400 L/s).Diagram of boiler feed water desecrator (with vertical, domed aeration section and horizontal water storage section).The water is pressurized in two stages, and flows through a series of six or seven intermediate feed water heaters, heated up at each point with steam extracted from an appropriate duct on the turbines and gaining temperature at each stage.

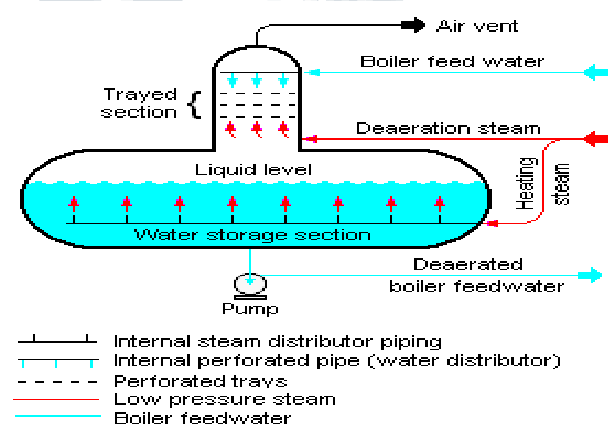
Typically, in the middle of this series of feed water heaters, and before the second stage of pressurization, the condensate plus the makeup water flows through a desecrator[9][10] that removes dissolved air from the water, further purifying and reducing its corrosiveness. The water may be dosed following this point with hydrazine, a chemical that removes the remaining oxygen in the water to below 5 parts per billion (ppb).[vague] It is also dosed with pH control agents such as ammonia or morphine to keep the residual acidity low and thus non-corrosive.

2) *Boiler operation.*

The boiler is a rectangular furnace about 50 feet (15 m) on a side and 130 feet (40 m) tall. Its walls are made of a web of high pressure steel tubes about 2.3 inches (58 mm) in diameter. Pulverized coal is air-blown into the furnace through burners located at the four corners, or along one wall, or two opposite walls, and it is ignited to rapidly burn, forming a large fireball at the center. The thermal radiation of the fireball heats the water that circulates through the boiler tubes near the boiler perimeter. The water circulation rate in the boiler is three to four times the throughput. As the water in the boiler circulates it absorbs heat and changes into steam. It is separated from the water inside a drum at the top of the furnace.

Fig. 1-Operation of boiler

The saturated steam is introduced into superheat pendant tubes that hang in the hottest part of the combustion gases as they exit the furnace. Here the steam is superheated



to 1,000 °F (540 °C) to prepare it for the turbine. Plants designed for lignite (brown coal) are increasingly used in locations as varied as Germany, Victoria, Australia and North Dakota. Lignite is a much younger form of coal than black coal. It has a lower energy density than black coal and requires a much larger furnace for equivalent heat output. Such coals may contain up to 70% water and ash, yielding lower furnace temperatures and requiring larger induced-draft fans.

The firing systems also differ from black coal and typically draw hot gas from the furnace-exit level and mix it with the incoming coal in fan-type mills that inject the pulverized coal and hot gas mixture into the boiler. Plants that use gas turbines to heat the water for conversion into steam use boilers known as heat recovery steam generators (HRSG). The exhaust heat from the gas turbines is used to make superheated steam that is then used in a conventional water-steam generation cycle, as described in gas turbine combined-cycle plants section below.

3) *Boiler furnace and steam drum.*

The water enters the boiler through a section in the convection pass called the economizer. From the economizer it passes to the steam drum and from there it goes through down comers to inlet headers at the bottom of the water walls. From these headers the water rises through the water walls of the furnace where some of it is turned into steam and the mixture of water and steam then re-enters the steam drum. This process may be driven purely by natural circulation (because the water is the down comers is denser than the water/steam mixture in the water walls) or assisted by pumps. In the steam drum, the water is returned to the down comers and the steam is passed through a series of steam separators and dryers that remove water droplets from the steam. The dry steam then flows into the super heater coils. The boiler furnace auxiliary equipment includes coal feed nozzles and ignition guns, soot blowers, water lancing and observation ports (in the furnace walls) for observation of the furnace interior. Furnace explosions due to any accumulation of combustible gases after a trip-out are avoided by flushing out such gases from the combustion zone before igniting the coal. The steam drum (as well as the super heater coils and headers) have air vents and drains needed for initial startup.

***4) Super heater*.**

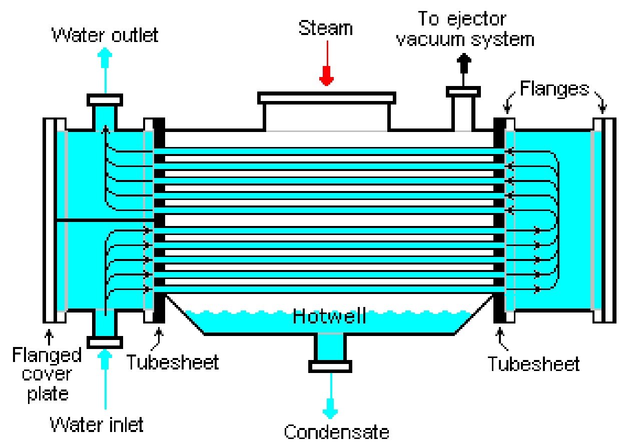
Fossil fuel power plants often have a superheated section in the steam generating furnace.[citation needed] The steam passes through drying equipment inside the steam drum on to the superheated, a set of tubes in the furnace. Here the steam picks up more energy from hot flue gases outside the tubing and its temperature is now superheated above the saturation temperature. The superheated steam is then piped through the main steam lines to the valves before the high pressure turbine. Nuclear-powered steam plants do not have such sections but produce steam at essentially saturated conditions. Experimental nuclear plants were equipped with fossil-fired super heaters in an attempt to improve overall plant operating cost.[citation needed].

5) Steam condensing.

The condenser condenses the steam from the exhaust of the turbine into liquid to allow it to be pumped. If the condenser can be made cooler, the pressure of the exhaust steam is reduced and efficiency of the cycle increases**.**

Fig. 2- Diagram of a typical water-cooled surface condenser

The surface condenser is a shell and tube heat exchanger in which cooling water is circulated through the



tubes. The exhaust steam from the low pressure turbine enters the shell where it is cooled and converted to condensate (water) by flowing over the tubes as shown in the adjacent diagram. Such condensers use steam ejectors or rotary motor-driven exhausts for continuous removal of air and gases from the steam side to maintain vacuum. For best efficiency, the temperature in the condenser must be kept as low as practical in order to achieve the lowest possible pressure in the condensing steam. Since the condenser temperature can almost always be kept significantly below 100 °C where the vapors pressure of water is much less than atmospheric pressure, the condenser generally works under vacuum. Thus leaks of non-condensable air into the closed loop must be prevented. Typically the cooling water causes the steam to condense at a temperature of about 35 °C (95 °F) and that creates an absolute pressure in the condenser of about 2–7kPa (0.59–2.07 in Hg), i.e. a vacuum of about −95kPa (−28 in Hg) relative to atmospheric pressure. The large decrease in volume that occurs when water vapor condenses to liquid creates the low vacuum that helps pull steam through and increase the efficiency of the turbines.

The limiting factor is the temperature of the cooling water and that, in turn, is limited by the prevailing average climatic conditions at the power plant's location (it may be possible to lower the temperature beyond the turbine limits during winter, causing excessive condensation in the turbine). Plants operating in hot climates may have to reduce output if their source of condenser cooling water becomes warmer; unfortunately this usually coincides with periods of high electrical demand for air conditioning. The condenser generally uses either circulating cooling water from a cooling tower to reject waste heat to the atmosphere, or once-through water from a river, lake or ocean.

6)A Marley mechanical induced draft cooling tower.

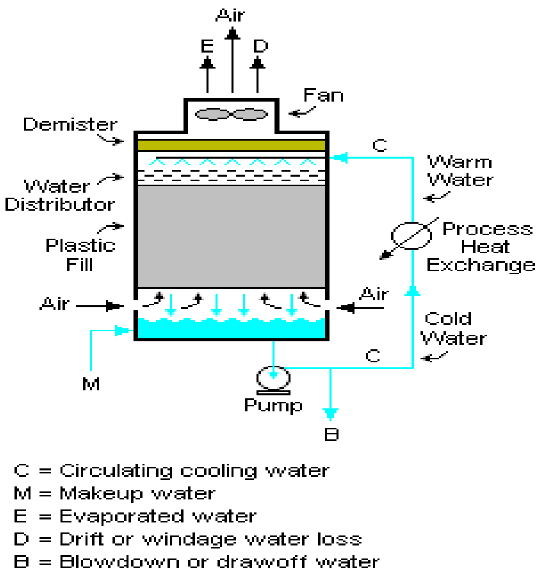


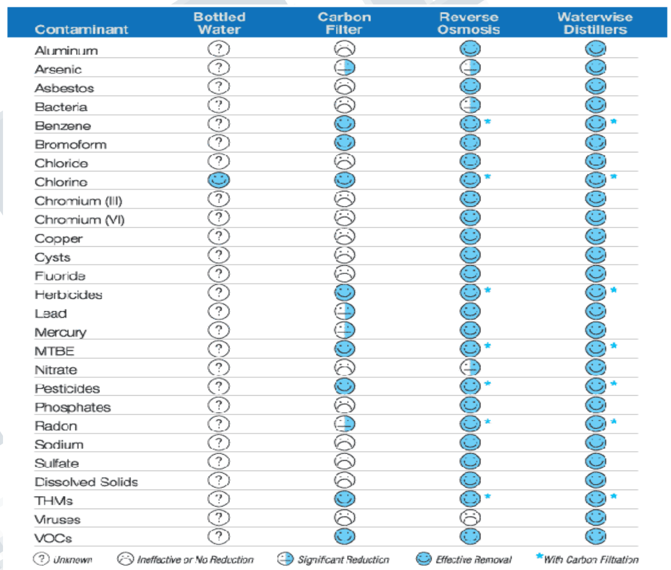
Fig. 3-Cooling tower system

The heat absorbed by the circulating cooling water in the condenser tubes must also be removed to maintain the ability of the water to cool as it circulates. This is done by pumping the warm water from the condenser through either natural draft, forced draft or induced draft cooling towers (as seen in the image to the right) that reduce the temperature of the water by evaporation, by about 11 to 17 °C (20 to 30 °F)—expelling waste heat to the atmosphere. The circulation flow rate of the cooling water in a 500 MW unit is about 14.2 m³/s (500 ft³/s or 225,000 US gal/min) at full load.[14]The condenser tubes are made of brass or stainless steel to resist corrosion from either side. Nevertheless, they may become internally fouled during operation by bacteria or algae in the cooling water or by mineral scaling, all of which inhibit heat transfer and reduce thermodynamic efficiency.

Many plants include an automatic cleaning system that circulates sponge rubber balls through the tubes to scrub them clean without the need to take the system off-line.[citation needed].The cooling water used to condense the steam in the condenser returns to its source without having been changed other than having been warmed. If the water returns to a local water body (rather than a circulating cooling tower), it is often tempered with cool 'raw' water to prevent thermal shock when discharged into that body of water. Another form of condensing system is the air-cooled condenser. The process is similar to that of a radiator and fan. Exhaust heat from the low pressure section of a steam turbine runs through the condensing tubes, the tubes are usually finned and ambient air is pushed through the fins with the help of a large fan. The steam condenses to water to be reused in the water-steam cycle.

Fig. 4-Water Purification Processes Comparison Chart

Air-cooled condensers typically operate at a higher temperature than water-cooled versions. While saving water, the efficiency of the cycle is reduced (resulting in more carbon dioxide per megawatt-hour of electricity).From the bottom of the condenser, powerful condensate pumps recycles the condensed steam (water) back to the water/steam



cycle. Now the exact aim of our project is in most of the power stations where feed water are used for the operation of power plants those feed waters can be replaced by the water to be purified and thus as a result of the evaporation and condensation of the water it gets its suspended impurities lost and thus purified water is obtained.

7) Steam Distilled

Based on Mother Nature's primary purification method, distillation uses evaporation and condensation to separate pure, fresh water from its contaminants. In nature the process is called the hydrologic cycle. It occurs when water evaporates, condenses, and then falls to the earth as precipitation. Distillation, combined with carbon filtration, is the one water treatment technology that most completely reduces the widest range of contaminants, including biological, organic and inorganic elements. In fact, a quality distillation system provides water that is up to 99% free of impurities, including heavy metals and most chemicals. It is the treatment of choice for removing biological contaminants including cysts like Giardia and Cryptosporidium.

The prolonged boiling process of distillation kills virtually all types of microorganisms, including bacteria, viruses and parasites. Microorganisms are not evaporated into the product water but remain in the boiling chamber as part of the residue. Additionally, a distillation system with activated carbon post filtration and venting is effective in removing pesticides and VOCs (volatile organic compounds). Distillation provides consistent purity, gallon after gallon, year in, year out. No other technology can guarantee consistent quality over time. The purity of your drinking and cooking water is guaranteed when you make 100% steam distilled water with a water wise purifier/distiller. Fig.4 shows. What to expect from different water sources and treatment.

8) Re-Mineralization of distilled Water.

Water already has minerals in it, But not after it's been distilled. This process removes most of the impurities – up to 99.5% of them – from the water. The purification process is indiscriminate, though. It removes the "good" minerals along with the bad stuff. Proponents of re-mineralizing water advocate the process for a few different reasons.

1. You need the minerals, especially if you're not eating properly or you've been out in the heat sweating. The primary minerals that your body needs to replenish are calcium, magnesium, potassium and salt, though there are many others, too.

2. Re-mineralized water quenches thirst better and is absorbed by your body faster. This is a point of contention but the argument for faster hydration states that adding minerals back into the water boosts the pH and brings it back to an alkaline state. The water becomes ionized, which makes the water molecules cluster into smaller groups, which makes it easier for your body to absorb.

3. Re-mineralized water tastes better. Though this is subjective, it's true that the human palate is used to the flavor of water with minerals in it. It gives it a fuller flavor (that is to say, it gives it SOME flavor) that many people find preferable to distilled water.

V. CONCLUSION

In every boiler operation tons of feed water is fed into the furnace and is cycled back for producing steam to move the prime mover using closed loop ranking cycle instead we are using open loop ranking cycle in the process so that tones of impure water can be purified .so that diseases caused due to the consumption of impure water may be reduced.

VI. MERITS AND DEMERITS

a. Merits.

1. It is a low cost process up to a purifying operation comparing with other conventional methods.

2. This process may suitable for all the power plants which use steam to move their prime movers.

3. The design of this process is simple.

b. Demerits.

1. Slight changes should be made in the power plant.

2. Pipelines carrying feed water should be replaced.

REFRENCES:

[1] IRJC Asia Pacific Journal of Marketing & Management Review Vol.1 No. 3 , "DEMAND AND SUPPLY OF WATER RESOURCE IN THE STATE OFTAMIL NADU: A DESCRIPTIVE ANALYSIS", November 2012.

[2] EPA United States Environmental Protection Agency Office of Water 4601 EPA 810-F-98-001 June 1998 ENVIRONMENTAL EDUCATION WATER PURIFICATION BY EVAPORATION AND CONDENSATION.

[3] Shang Jingtai, "Condensation". Beijing China, Machinery Industry Press, 1994.

[4] Hu Yinping, "Boiler Manual". Beijing China China Electric Power Press, 2005.

[5] Faye C. McQuiston, Jerald D. Parker and Jeffrey D. Spitler, "Heating, Ventilating, and Air Conditioning Analysis and Design". Beijing China, Machinery Industry Press, 2005.

[6] Wu Afeng, Pan Hao and Tan Canshen: "1000 MW ultra-supercritical coal-fired boiler fan configuration technical and economic analysis". Journal of Generating Equipment, No.2. 2009, pp.136-143.

[7] Esa Vakkilainen, Ralf Holm and Liisa Simonen, Emission performance of large recovery boilers. Andritz-Ahlstrom Corporation. Finland/USA.

[8] Esa Vakkilainen, Jaakko Poyry Oy. Development of recovery boiler technology. Vantaa, Finland.

[9] Anna Lundborg, Simulation of the flue gas flow through the superheated in a recovery boiler. Master of Science Thesis (2005), KTH, Sweden.