LETHABO POWER STATION - WATER PURIFICATION AND TREATMENT

In using water for steam generation, it is very important that consideration is given to water treatment for the prevention of corrosion of boiler/turbine steam and water tubing, pipes, blades etc as well as scaling and contamination of steam/water. But the largest portion is used for cooling water which is added directly to the cooing towers.

Lethabo sources its water from the Vaal River and generally, this water is contaminated with organic and inorganic substances, gasses and other impurities. To reduce and eliminate these substances from the raw water, a process of clarification (settling), filtration and demineralisation is used.

Raw water for Lethabo is supplied from the Vaal river, there are two side stream reservoirs with a capacity of 885 000m³ that supply the power station when the river pumps are not running. The river pumps do not running during peak electricity demand periods.

Clarification

At Lethabo two sets of clarifiers are used. The lime softering / cooling water clarifiers which are used to clean the cooling water (up to 10% of the system volume), the recovered drains and treated sewage . The second set, called the raw water clarifiers, is used to clarify water, which will be used for potable water and demineralised water production.

The clarifiers are designed to remove all the solid substances (suspended matter) - such as mud, clay and organic matter from the water.

The water is fed into the clarifier through a centre pipe in the floor. Chemicals are added and mixed into the water to react with the impurities so that the impurities form heavy particle that will settle. The design of the clarifier guides the water flow in an upward direction through the primary section, downward into the secondary section where floc growth continues and eventually into the sedimentation area where the heavy flocculation particles settle down into the bottom of the clarifier basin. This sludge is removed by means of discharge into sumps. The sludge from the raw

The clear water exits the clarifier at the top through launders with “V” notched metal strips and into a main launder located on the periphery of the clarifier.

The cooling water then returns to the cooling towers and the raw water goes on for further processing.

Sand filtration

Clarified water from a holding sump is forced through five horizontal pressurised sand filters.

The bottom of a filter is filled with concrete to form a flat bottom surface area. Nozzles protruding through the concrete are connected to an outlet manifold through which the filtered water leaves the sand filter. On top of the concrete is a layer of gravel (course sand) which filters out remaining particles. Water flows from the top through the sand and then out through the outlet manifold.

The water leaves the sandfiltration plant and splits into two streams. One stream goes through a chlorination precess (to sterilize) and pH adjustment (corrosion control) on the way to a large storage tank (potable head thand) and the balance to the demineralised plant.

When the sand filter unit becomes clogged, the filters are cleaned through backwashing the sand using clean water and compressed air.

Dissolved Solids

These impurities are dissolved in the water and are therefore not visible. There may be a variety of these impurities in the water, the ones which cause the most trouble in the boiler because they form scale, are the compounds of calcium and magnesium such as those listed below:

- Calcium bicarbonate Ca (HCO3) 2
- Magnesium bicarbonate Mg (HCO3) 2
- Calcium sulphate CaSO4
- Magnesium sulphate MgS04

The other group that cause problems are the anions that cause or aid corrosion of the boilers, these are typically:

- Chlorides
- Sulphates

To get a quick indication of soluble solids present in water we determined its electrical conductivity. The greater the amounts of soluble solids present in the water the higher the conductivity of the water will be.

Demineralisation (Ion exchange)

In solution, salts are broken up into positively and negatively charged particles called ions. When all the mineral salts must be removed from the water, a process known as demineralisation or de-ionisation is generally used. A synthetic material called resin, which looks like sand but has a sponge like property and has the ability to exchange these ions, is used in the demineralisation process.

This process of demineralisation involves using a cation exchanger (loaded with positive hydrogen ions) to remove the sodium, magnesium and calcium cations and using an anion exchanger (loaded with negative hydroxide ions) to remove the sulphate, chloride and silica anions. In addition, a degasifier, between the cation and anion units, is used to remove any carbon dioxide present. The outflow from the demineralising process is water that is free from all mineral impurities and is better in quality than distilled water. The water from the anion units flows through the mix-bed (polisher) unit to remove the final traces of cations and anions.

In conclusion, the positive ions are exchanged for hydrogen ions, while the negative ions are exchanged for hydroxide ions. The combination of these two ions, ie hydrogen (H^+) and hydroxide (OH^-), produces pure water H2O.

When the resin becomes saturated, ie when it has absorbed its maximum capacity of ions, sulphuric acid and caustic soda are used to regenerate the cation and anion resins respectively.

In addition to the treatment of water at the water treatment plant, condensate water from the condensers is allowed to pass through 2 of 3 x 50% polishing units, filled with a combination of cation and anion resins. This is to ensure that the feedwater supply to the boiler is up to chemistry specification prior to admitting water into the boiler.

Produced by: Generation Communication
CO 0006 Revision 12 (August 2021)

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