



Water management

Eskom has started using direct and indirect dry cooling systems in its efforts to conserve South Africa's limited water supplies.

Although the expense involved in dry cooling systems is greater than in conventional wet cooling systems, limited available water resources may override economic considerations in determining the choice between the two technologies.

The dry cooling systems used at Matimba, Kendal and Majuba Power Stations are the largest dry cooling power plants currently in operation in the world. All new plant will be equipped with dry cooling systems.

Cooling techniques at Eskom power stations

Three types of cooling systems are employed at Eskom's power plants. Wet cooling is the most common but direct and indirect dry cooling systems are also used.

The turbines at coal-fired power stations are steam driven. Steam is produced using highly purified demineralised water. This water needs to be recovered, both to save water and because of the high costs involved in its production.

Spent steam leaves the turbine at a very low pressure and high volume. The temperature is approximately 40°C. Steam cannot be compressed and the only way to recover the spent steam is through condensation, or changing the vapour into a liquid.

Wet cooling, the conventional system used worldwide, and indirect dry cooling systems both use condensers, cooling water and cooling towers. In both these systems, the cooling water flows through thousands of condenser tubes, with the steam on the outside. Condensation is achieved as a result of the temperature difference between the water and steam. The warmed cooling water flows to a cooling tower where an upward draft of air removes the heat from the water. After cooling, this water returns to the condenser.

Unfortunately, during wet cooling, the upward movement of air means that a substantial amount of water is lost through evaporation, as the water to be cooled is in direct contact with the air. The white plume seen on top of cooling towers at most thermal stations is pure water vapour. 'Make-up' water is added to replace evaporation losses. River water is used for cooling.



The indirect dry cooling system also uses a cooling tower and water. Here, however, the operating principle is similar to that used in car radiators. Heat is conducted from the water by means of A-frame bundles of cooling elements arranged in concentric rings inside the tower. Cooling water (clean water) flowing through these elements cools down as the cold air passes over them and returns to the condenser. This is referred to as a closed system as there is no loss of water due to evaporation.

In the direct dry cooling system, steam from the last stage turbine blades is channelled directly into radiator-type heat exchangers. There are no cooling towers. The heat is conducted from the steam to the metal of the heat exchanger. Air passing through the exchanger is supplied by a number of electrically driven fans. The air removes the heat, thus condensing the steam back into water which will be used once again to produce steam in the boiler.

It is interesting to note that at Koeberg Power Station, Africa's only nuclear power plant, a different cooling system is used. Sea water is used to condense the spent steam, following which the warm sea water is discharged back into the ocean.



Desalination at Lethabo Power Station

Lethabo Power Station uses raw water from the Vaal River, highly concentrated underground water from the New Vaal Coal Mine and treated sewage water to make up for the water that is lost due to evaporation. The mine and river water could introduce approximately 27 tons of salts per day into the cooling water systems. These salts must be removed on a continuous basis to prevent accumulation of salts above acceptable thresholds. If these salts were not removed, corrosion damage would cause premature failure of the condenser and associated plant. The removal of the salts is called desalination and is achieved by a process known as osmosis, where a semi-permeable membrane separates two solutions of different salinity, water flows through the membrane towards the more concentrated solution.

In reverse osmosis, the opposite of natural osmosis, a pump is used to force the liquid through membranes, leaving the salts behind. During this process approximately 80% of the water is forced through the membranes, leaving behind 20% containing most of the salts. The advantage of this process is that

any volume of dirty, unusable water can be reduced by 80% leaving a residual volume, called brine, to be disposed of in an environmentally acceptable manner.

Lethabo Power Station, in Sasolburg in the Free State, uses reversible osmosis units for desalination. The clean water from the reversible osmosis units is of better quality than river water and is therefore reused in the power station to produce water of even greater purity (demineralised water) and for make-up water to the cooling towers.

Approximately 10% of the warmed cooling water en route to the cooling towers is periodically, depending on the chemical condition of the water, taken through to a clarifier. In the clarifier, suspended solids are removed before the water is fed, at a rate of 160m³/h, into the reverse osmosis system. The three Lethabo reversible osmosis units are capable of purifying (desalinating) 480 cubic metres of water an hour, approximately 12 MI/day. The amount of treated sewage sent to the treatment plant is ± 1 MI/day

The brine is disposed of on the dry ash dump by mixing it with ash. The brine is used at the ash conditioners to dampen the ash prior to transporting it to the ash dumps. The cementing, or pozzolanic, properties of the ash are used to encapsulate the salts contained in the brine. This combats dust problems and the salts are also prevented from polluting the environment.

For more information on Eskom related topics see the Eskom website (www.eskom.co.za).

Select the "Knowledge Centre" and "Facts and Figures"