GE
Oil & Gas

Evaporative Cooler

Benefits

■■■ **Increased production**
■■□ **Higher efficiency**
■□□ **Compliance with environmental regulations**
□□□ Availability and Reliability
□□□ Life extension

Customer benefits include the following:

- Increase in turbine output
- Increase in turbine efficiency/decrease in heat rate
- No modifications to the gas turbine

The evaporative cooler system installation depends primarily on the plant where it is to be installed. It must be noted that adding an evaporative cooler causes an additional pressure drop in the inlet ducts. This increase is limited however, to approximately 15 mmH_2O. This system requires a supply of suitably treated water, therefore, a water treatment system must be installed if one is not already available. At low temperatures, the system must be deactivated and drained to avoid the risk of icing.

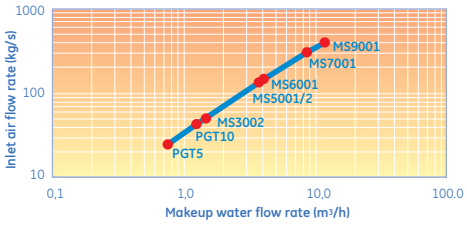
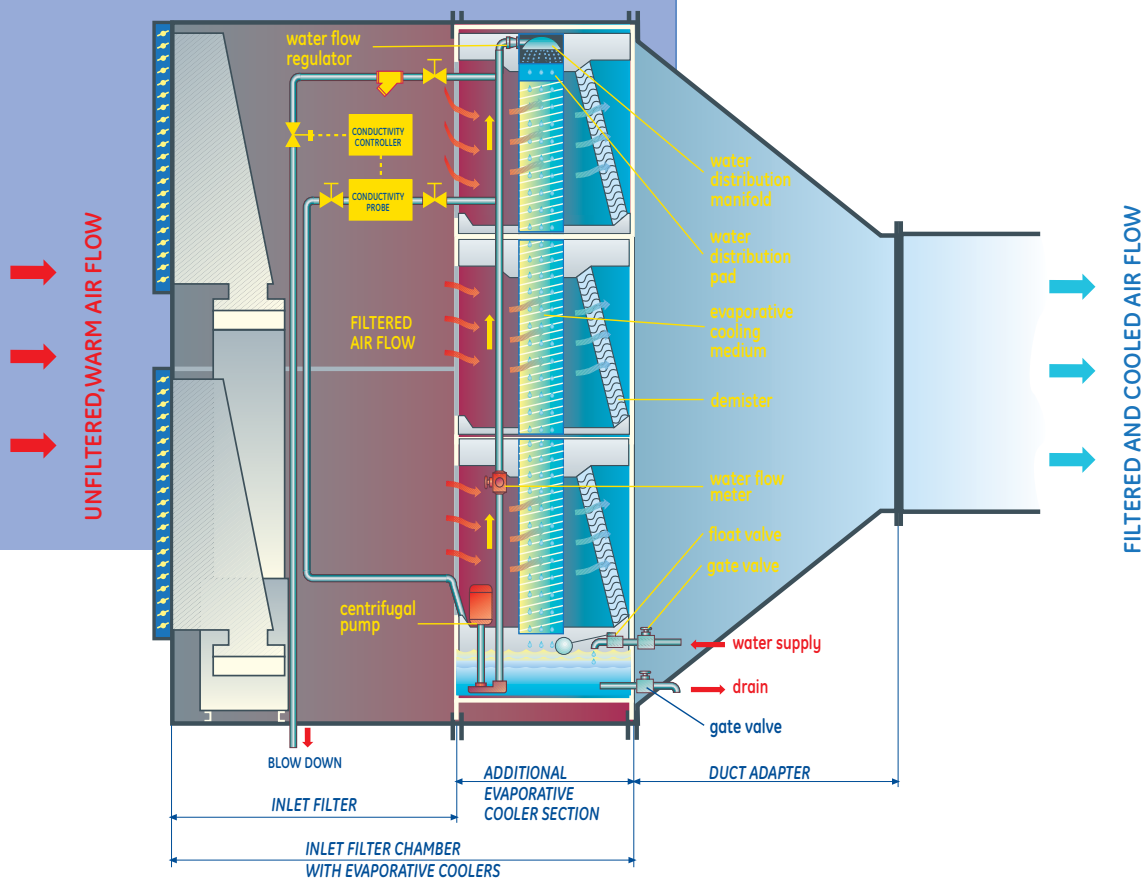
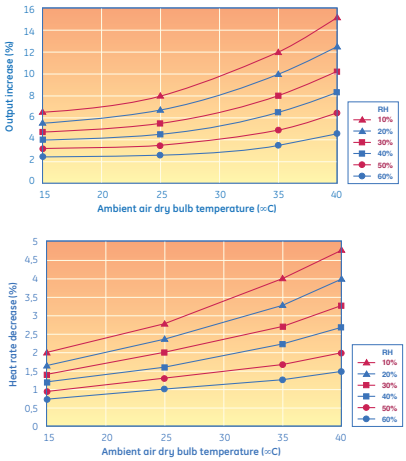


Figure 1



What it is

An evaporative cooling system for turbine inlet air is a useful option for installations where high ambient temperatures and low relative humidity are common. With an evaporative cooler, water is added to the inlet air of a gas turbine. Part of the water evaporates absorbing latent heat from the air. As a result, the air, which gives up sensible heat, cools and increases in density. This gives the machine a higher mass flow rate and pressure ratio resulting in an increase in turbine output and efficiency.
For example, considering a dry-bulb temperature of 40°C with 20% relative humidity, the output power can be increased by about 12% if an 80% effective evaporative cooler is used. Correspondingly, the heat rate decreases by about 4%. The benefit of an evaporative cooler system from an economic point of view is strictly related to the potential average annual increase in output. The Evaporative Cooler can be applied to all Heavy Duty gas turbines.



How it works

The amount of water required for evaporative cooling depends on the inlet air flow, the temperature, pressure and humidity of the ambient air, and the hardness of the water. The increase in power available from a turbine with an evaporative cooler depends on the turbine model and ambient conditions (pressure, temperature and humidity). As previously mentioned, the greatest advantages are obtained in hot, dry climates. Clearly, the temperature drop realized by the cooler is not only a function of atmospheric conditions, but is also related to the cooler design, and particularly the cooler's effectiveness, which is defined as follows:

- Evaporative cooling has the advantage that it can be installed without modification of the gas turbine
- The components it requires and the control system are also easy to install

Cooler Operation

Water is pumped from a tank at the bottom of the module to a header above the heat exchange medium. A spray system wets the top of the medium and the water flows through the channels of the medium, which are made of corrugated layers of fibrous material. The layers of channels in the medium alternately contain water and air. The water flows down through the channels by gravity, wetting the material of the walls where some of it evaporates into the air.
Excess water is collected in the tank below together with makeup water. The level is maintained by a valve that admits makeup water when the water drops below a pre-defined level.

Water System

The amount of water which must be provided as makeup is the sum of evaporation, carryover and blowdown. The rate at which the water is evaporated into the air stream depends on the ambient temperature, humidity and pressure, cooler effectiveness, and turbine airflow.
A certain amount of water is entrained in the form of droplets by the air stream entering the turbine.
It may either have escaped from the channels or have dripped from the medium retainers. To reduce carryover, mist eliminators are installed on the downstream side of the medium. These capture the droplets by impingement of the air flow and drain the liquid to the cooler tank. Since the cooling water recirculates, part of it must be drained periodically (termed blowdown) and be made up with new water. This makes it possible to control the concentration of substances present in the water supply that could cause scaling and corrosion if allowed to reach excessive concentrations.
Figure 1 shows the makeup water requirement for different turbine models, referring to an 80% effective evaporative cooler operating at 35°C and 20% R.H.
The amount of makeup is calculated by taking into considering the replacement of enough raw water (high $CaCO_3$ hardness) with treated water (low $CaCO_3$ hardness) to maintain a level of 140 PPM of water hardness as $CaCO_3$.

Scope of Supply

This uprate is very customer/site specific and must be engineered on an individual basis.
The scope of supply includes:

- Header
- Medium retainers
- Mist eliminator
- Instrumentation
- Evaporative cooler arrangement
- Control system
- Modification and installation drawings

A demineralized water supply system can be also supplied upon request.

GE imagination at work

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