GE
Oil & Gas

Inlet Air Cooling

Benefits

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

Benefits are very site specific and weather dependent:

- Increase in gas turbine output
- Increase in efficiency / Decrease in Heat Rate

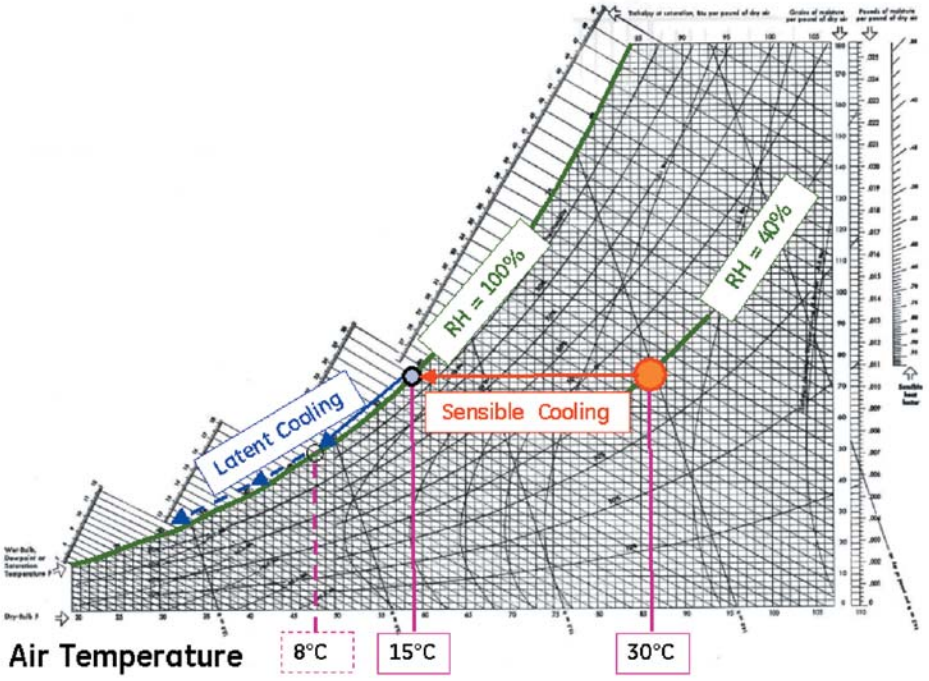
What it is

A chilling system for gas turbine inlet air is a beneficial option for installations where high ambient temperatures are common. With inlet air cooling a gas turbine will have a higher mass flow rate and pressure ratio, yeilding an increase in turbine output power and efficiency.
With a chilling system, a chilling coil is inserted in the filter house downstream of the filtering elements, in the clean air path. Downstream from the coils, a mist eliminator is installed in order to prevent condensed water droplets from entering the gas turbine inlet duct. The chiller coil cooling fluid is usually a mixture of water and glycol to avoid freezing in the coil tubes.
The economic benefit of chilling system is directly related to the potential average increase in annual output, and this in turn is dependent on average ambient conditions. A chilling system can be installed on any gas turbine.

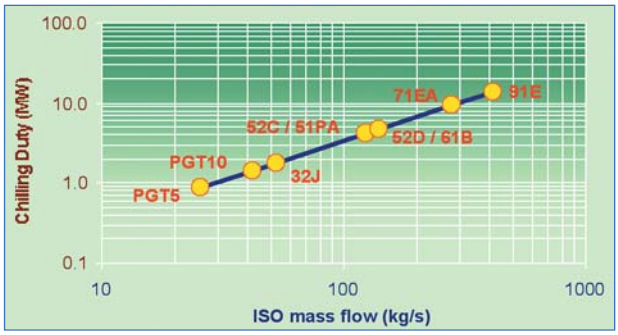
Example of chilling installation

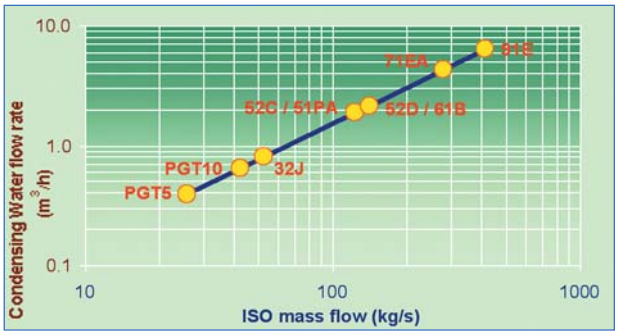
How it works

In a chilling system, heat is removed from the inlet airflow by means of heat exchangers (chilling coils). Cooling is achieved through both sensible cooling (no condensation of water) and latent cooling (with condensation of water), where the former is more energy efficient but the air is only cooled down to the dew point.
For example, given a dry bulb temperature of 30°C and a relative humidity of 40%, air can be cooled down to its dew point (15°C) without water condensing and then further cooled to 8°C by removing latent heat. The cooling should be limited to 8°C due to the risk of ice formation on the Inlet Guide Vanes (IGV). Therefore, a control valve should be installed on the adduction header in order to provide the chilling system with the required turndown capability. The following images show the approximate water condensation rate and the required refrigeration duty on the coolant side.

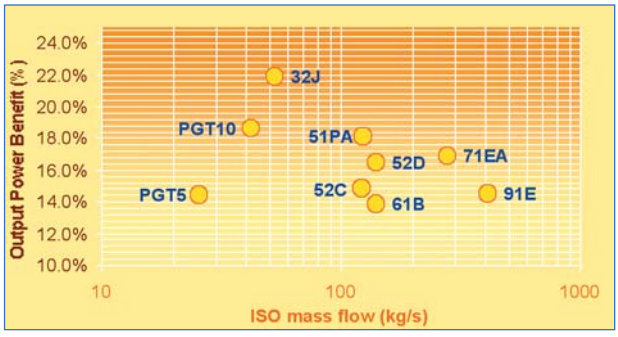


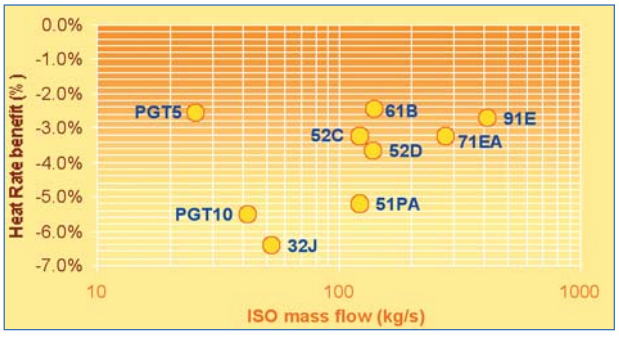
Representation of chilling process on the psychrometric chart





Requirements for chilling inlet air from 30°C & 40% relative humidity down to 8°C 100%





Performance increase by chilling inlet air from 30°C & 40% relative humidity down to 8°C 100%

How it works

The coolant is usually a mixture of water and glycol with the proportions determined to avoid icing (a function of the absolute minimum temperature that the coolant could experience).
The coolant supplied to the heat exchangers can be supplied by several methods, including mechanically actuated refrigeration cycles (e.g., propane cycles), absorption chillers, and ice storage systems.
In the example provided, the cooling would have an effect of up to a 22% increase in power and a reduction in heat rate of as much as 6.5%, even considering the additional 1 inch of H_2O pressure loss introduced by the coils and the mist eliminator. The actual power increase may be limited so as not to exceed the driver and driven equipment ratings. The effect of 1 inch of H_2O permanent inlet pressure loss has to be taken into account when the unit operates with the chiller off.
The chilling coils are normally placed downstream of the filter cartridges in the clean-air path inside the filter house itself. This will result in a zero-fouling factor for the chilling coils and a reduction of maintenance requirements. A mist eliminator is provided downstream of the coils to prevent condensed water droplets from entering the inlet duct and causing erosion or FOD damage to the axial compressor. Moreover, the transition duct between the filter house and the inlet duct is symmetrical in order to ensure flow uniformity over the surface of the coils. This feature, together with the placement of the coils inside the filter house, ensure an airflow speed over the surface of the coils low enough to avoid the risk of water carry-over.
The heat exchangers are usually of the plate-and-fin type. These exchangers are characterized by tubes running through plates that cover the entire height of the coil set. The tube material is usually copper and the plate material is aluminum.
The mist eliminator is of the inertial type and will capture most of the condensed water droplets that may have been carried over by the air stream.
In retrofitting existing units, the filter house must frequently be modified by inserting the chilling module and modifying the supporting structures in order to accommodate the transition duct between the filter house and the inlet duct. In the event that the filter house provides both ventilation and combustion air, splitting the two streams may be required in order to avoid wasting cooling power and feeding saturated ventilation air into the enclosures. Due to the continuous presence of saturated air, a stainless steel inlet duct and plenum are usually needed.

Scope of Supply

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

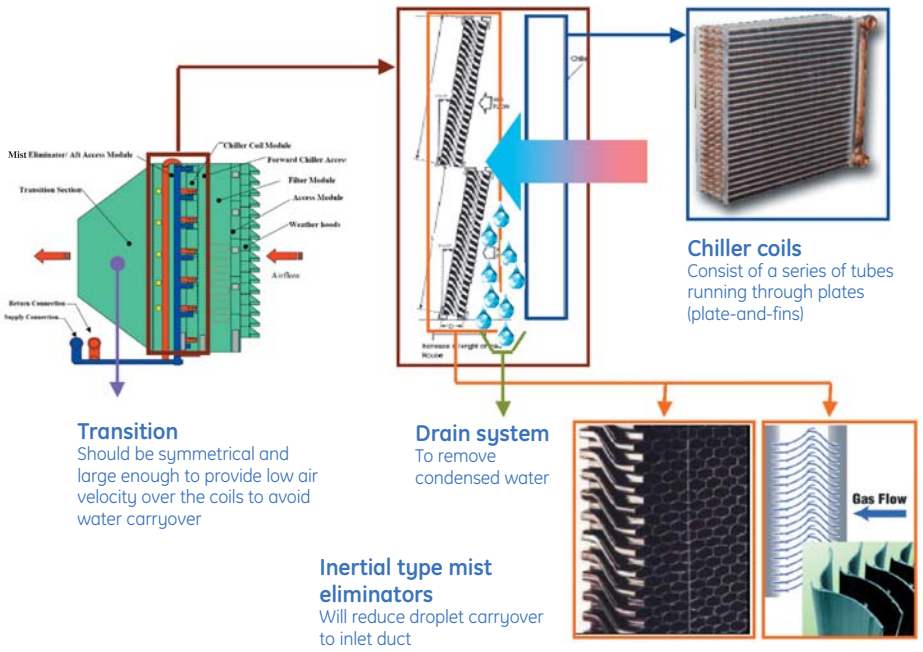
Chilling module consisting of:
- Heat exchangers
- Mist eliminator
- Drain system

Filter House and supporting structure modifications to accommodate:
- Chilling module
- Symmetrical transition

On a case by case basis the following additional scope may be required:
- Stainless steel inlet duct and plenum
- Modifications to ventilation ducting

In order to speed-up field activities a complete new filter house could be supplied.
The system requires a suitably sized refrigeration system to feed the coils with appropriate coolant flow at the correct temperature; therefore a refrigeration system must be installed if not currently available.

Main components of chilling system



Chiller coils
Consist of a series of tubes running through plates (plate-and-fins)

Transition
Should be symmetrical and large enough to provide low air velocity over the coils to avoid water carryover

Drain system
To remove condensed water

Inertial type mist eliminators
Will reduce droplet carryover to inlet duct

GE imagination at work

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