Donaldson®

Filtration Solutions for Gas Turbines, Generators, and Compressors

Cooling Inlet Air Improves Turbine Output

Choose Evaporative Cooler or Chiller Coils to Create Higher Mass-Flow Rate

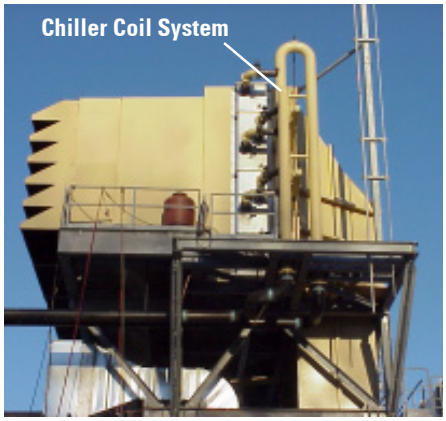
Cooling the turbine inlet air -- even by a few degrees -- can increase power output substantially. This is because cooled air is denser, giving the turbine a higher mass-flow rate and resulting in increased turbine output and efficiency -- even as much as 0.4% per degree Fahrenheit or about 0.7% per degree Celsius. (See graph on p. 4)

Donaldson offers two well-proven inlet air cooling methods: Evaporative cooling and chiller coils. The chart at right contains guidelines for their application.

Donaldson evaporative coolers and chiller coil systems are currently cooling gas turbine engines all over the world, from Southern California to Saudi Arabia -- in hot & arid climates, hot & humid climates, and in places with seasonal heat.

Designs range in size from 25,000 *cfm* to 1,300,000 *cfm*, and are available with choices in media efficiency and materials.

This Donaldson Evaporative Cooler enables this GE Frame 7FA Gas Turbine near Lubbock, Texas, USA, to yield maximum output even during the hot dry summer months.



This Donaldson GDX filter system + Chiller Coil filters and cools the air for an Alstom GTX100 gas turbine in the seasonally hot & humid climate of the upper midwest USA.

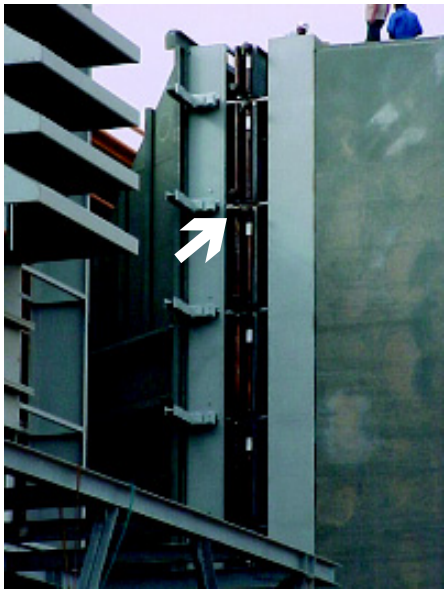
Which Cooling Method Is Best For Your Site?

Evaporative Cooler	*Chiller Coils*
Advantages:	
• Economical operation • Uncomplicated system	• Can cool the inlet air regardless of ambient humidity • Can be sized for small or large systems • Broad range of cooling achievable, down to 45F/7C
Disadvantages:	
• Cooling efficiency depends on relative humidity of ambient intake air....high humidity can inhibit cooling effect • Need source of make-up water	• Need source of chilled water • Causes slightly higher ΔP than an evap cooler does

Chiller Coil Systems

Donaldson designs the chiller coil system as a module that is typically positioned downstream of the air filters. This allows the coils, fins and parts to stay clean enough to function well for many years. On some systems where this positioning is impossible or undesirable for some reason, we recommend using pre-filters to ensure the cleanliness and functionality of the coils.

For maximum turbine performance, the design temperature of the air leaving the cooling system and entering the turbine is typically no less than 45°F / 7°C. The ambient air temp and the altitude at the site are the major factors used in sizing and designing a coil system. Cooling agents are usually either water or a water/glycol mix, depending on local ambient conditions. While Donaldson doesn't supply systems containing ammonia, we will work with your supplier who does.

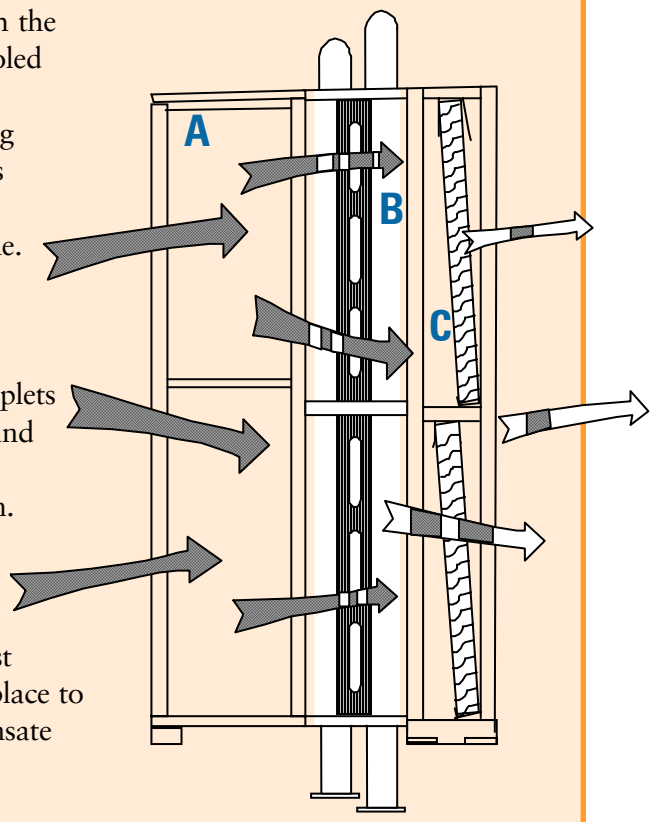


The Donaldson Chiller Coil System typically occupies a space between the filter house and the transition.

How It Works

As airflow passes through the chilled coils, the air is cooled through an indirect heat exchange with the cooling fluid. The air then passes through drift eliminator media and into the turbine.

The coils are cold and therefore condensation is created. Condensate droplets are directed downward and collected in pans, then directed out of the system. Typically, all condensation is eliminated this way, but to ensure air dryness, mist eliminator panels are in place to remove any stray condensate droplets.



Chiller System Components *(letters correspond to drawing above)*

(A) Access Module:
- Provides access so operators can check systems functionality and perform repairs should they be necessary.
- Can be equipped with lights or access hatches or doors.

(B) Chiller Coil Section:
- Chiller coil tubes are typically made of copper and caged with aluminum fins that economically and effectively extend the cooling surface area. Coil casings are stainless steel for long life.
- Supply and return manifolds distribute incoming water evenly to individual coil headers so that all coils cool the airflow to the same temperature.
- When moist air is cooled below the wet bulb temperature, condensation forms. Condensate is collected in stainless steel drip pans and directed out of the system.

(C) Drift Panels:
- A final preventive measure, drift eliminator panels prevent any remaining condensate droplets from going into the ducting.
- Moisture removed by the drift eliminator panels is drained into the sump at the bottom of the unit.

Evaporative Cooling

We generally recommend that the evaporative cooler module be positioned downstream of the filter section. Our new, improved design offers several advantages:

• Easier installation: Because of our exclusive construction design (patent pending), there is almost no field welding necessary during erection. This means faster, simpler, more reliable installation.

• Solid structural design (patent pending) minimizes leak-through.

• Fewer mechanical and more electrical & electronic controls yield a highly reliable water control system that is much more sensitive and responsive to water level needs.

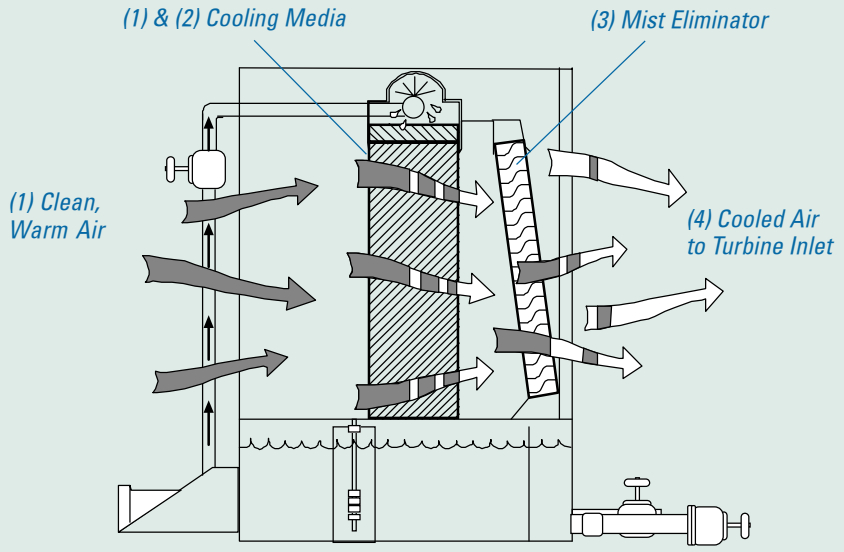
• Low air pressure drop of 0.3-0.4 inches w.g., or 0.5-0.6 inches w.g., depending on your media choice.

• Two coats of epoxy on the carbon steel structural members prevent corrosion. Pans and other components are made of corrosion-resistant materials.

Hazard Protection

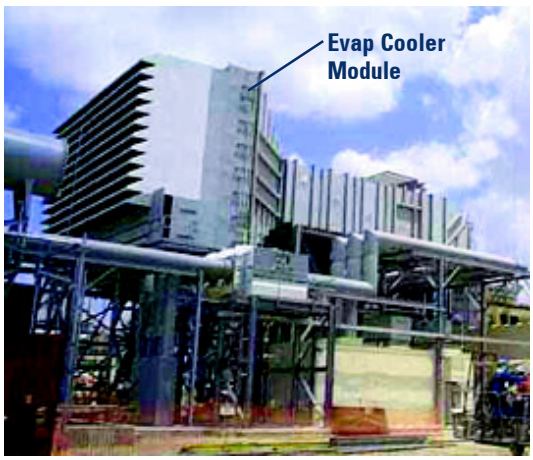
• Little or no water carryover, thanks to integral drift/mist eliminators that prevent droplets from reaching the gas turbine inlet.

• Only captive fasteners are used down-stream of final filtration.

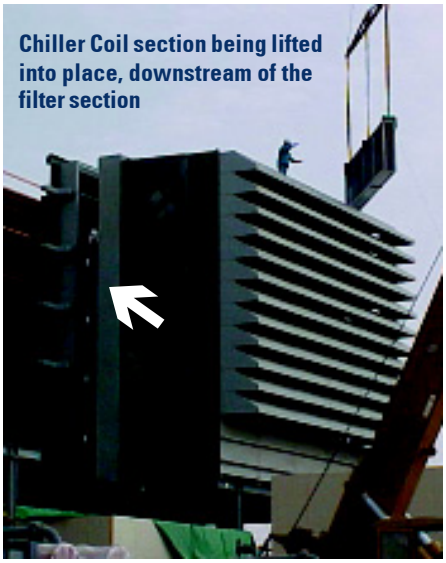


How It Works

(1) When the filtered air passes through the saturated evaporative cooling media, water evaporates off the wet media. This evaporation is the process that reduces the air temperature.
(2) Excess water that does not evaporate is directed downward so as not to be carried along with the cooled air.
(3) Cooled air then passes through the integral mist eliminator, where leftover water droplets are removed.
(4) Clean, cooled air is then directed into the turbine inlet.



Donaldson's Evaporative Cooler fits neatly behind any of the Donaldson air inlet filters -- in this case it's downstream of a GDX self-cleaning filter.



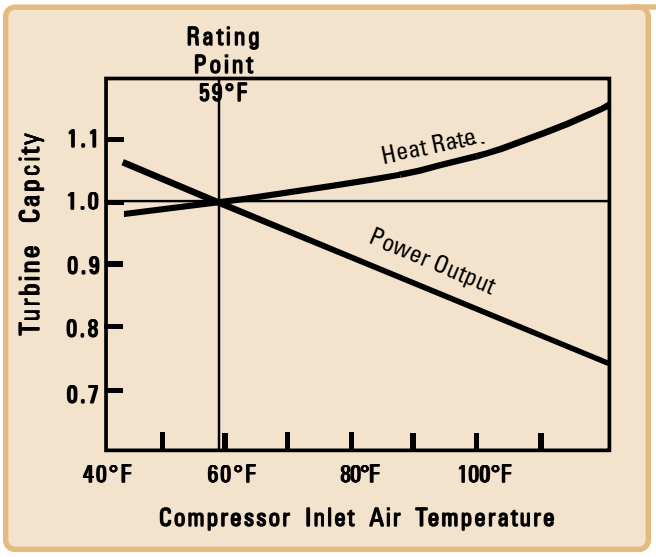
Chiller Coil section being lifted into place, downstream of the filter section

The Donaldson chiller coil system being installed will cool the inlet air for a GE Frame 7EA Gas Turbine in the hot, dry desert environment near Onaizah, Saudi Arabia.

The Donaldson evaporative cooler, positioned behind the GDX self-cleaning air filter, reduces inlet air emperature for a Siemens Westinghouse 501FC Gas Turbine near St.Paul, Minnesota, USA.

Cooler Inlet Air Means Higher Turbine Output

Optimizing inlet air temperature increases power output, as the graph below illustrates.



For example, a gas turbine generator with a Donaldson evaporative cooling system installed at a site having an ambient temperature of 100°F and a relative humidity of 30% could deliver up to 7.6% more power than a gas turbine without an evaporative cooler. Evaporative cooling typically can decrease inlet air temperatures by as much as 20 to 30°F, depending on the ambient humidity.

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