MUELLER® AVALANCHE® ICE HARVESTER SYSTEM

For Gas Turbine Inlet Air Cooling

MUELLER®

THERMAL ENERGY STORAGE

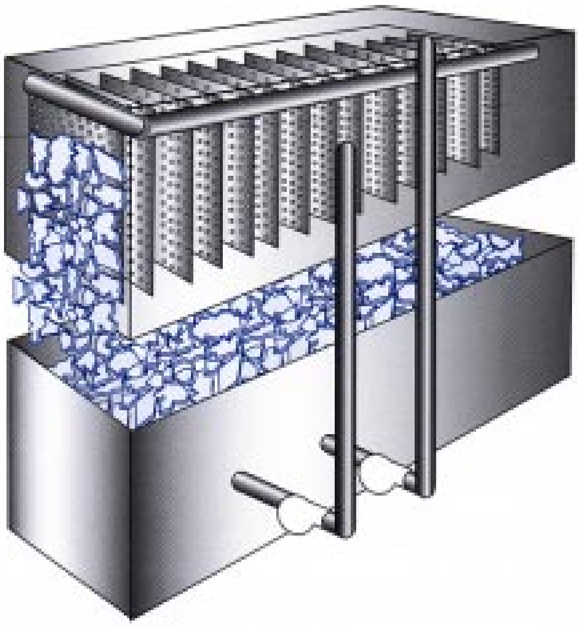
Mueller® Avalanche® Thermal Energy Storage Systems for Gas Turbine Inlet Air Cooling

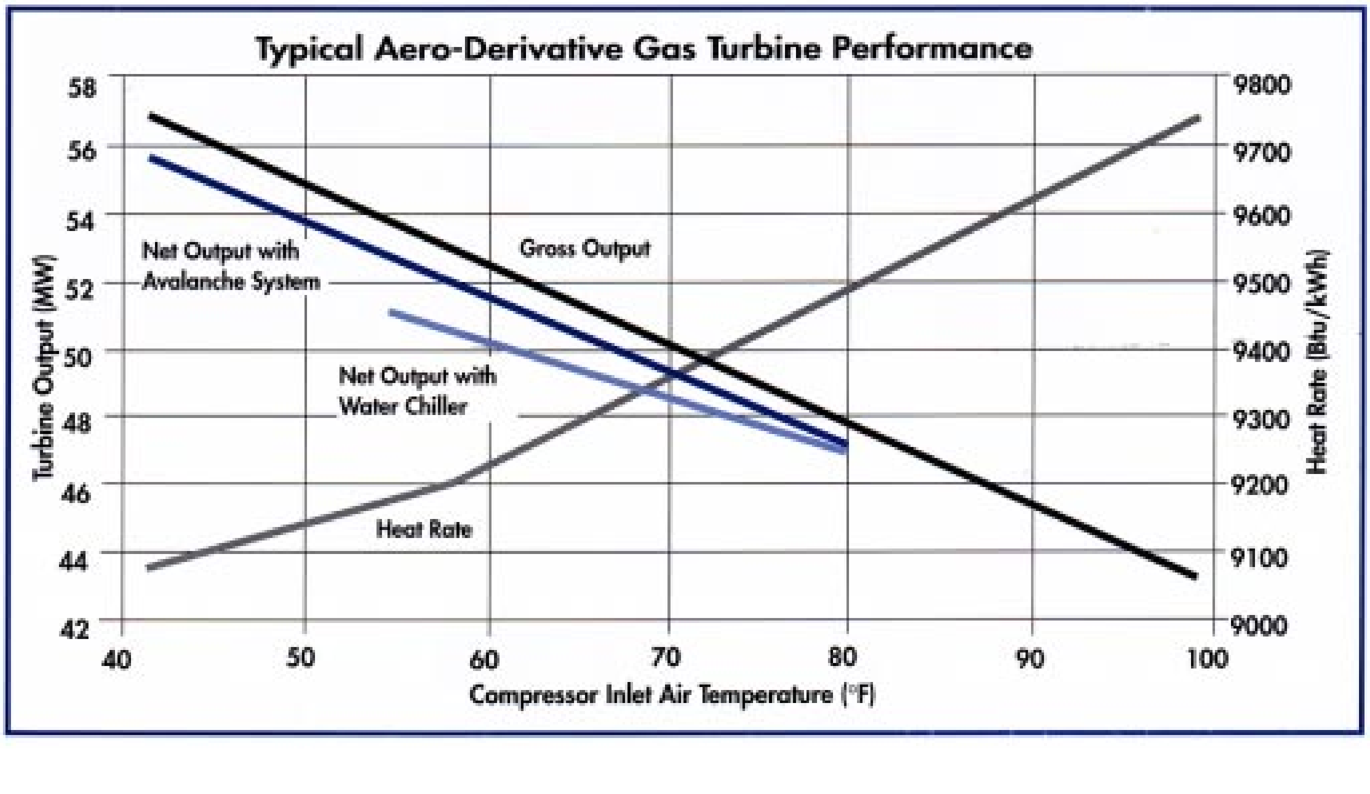
Gas Turbine Inlet Air Cooling

Degradation of gas turbine output power with the rise in ambient air temperature poses a serious problem during the summer when demand for turbine output is at its highest. Additionally, gas turbines lose capacity over their lifetime due to degradation. These factors are a major concern for electrical utilities.

Gas turbines are constant volume machines and their output depends on the mass flow of air through the turbine. As ambient air temperature rises, air density decreases, which in turn reduces the mass flow through the turbine and decreases the generating capacity and efficiency of the turbine. Cooling inlet air increases the air mass flow through the turbine, increasing turbine output, reducing heat rate, and improving efficiency.

The Mueller Avalanche thermal energy storage system cools inlet air and enhances turbine capacity. Typically, the Avalanche system is operated during off-peak hours and the stored ice is used to cool inlet air during on-peak hours. It is easy to install an Avalanche system since it is not an integral part of the gas turbine, making it ideal for use either with new turbines or for retrofitting existing installations. The Avalanche system is especially beneficial for peaking gas turbine plants that have short on-peak periods.





Advantages of Avalanche Gas Turbine Inlet Air Cooling System

Increased Turbine Capacity

Avalanche gas turbine inlet air-cooling systems can cool inlet air to 42°F and increase turbine capacity by up to 30%.

Reduced Cost and Quick Installation

Avalanche gas turbine inlet air-cooling systems not only cost less than new gas turbines—they can also be implemented quicker than new turbines, typically within 6 to 12 months.

Reduced Refrigeration Capacity

Avalanche TES systems require reduced refrigeration capacity compared to direct refrigeration systems that are matched to the instantaneous load.

Reduced Auxiliary Power Consumption

Unlike direct refrigeration systems that operate during on-peak hours, Avalanche TES systems operate during off-peak hours and avoid auxiliary power penalty on plant output during on-peak hours.

Eliminates Refrigerant Leakage into Turbine Inlet

Unlike direct refrigeration systems that use refrigerant coils for cooling turbine inlet air, the Avalanche system uses water coils. This eliminates the risk of refrigerant leaking into the gas turbine.

Lower Inlet Air Temperatures

Ice TES systems provide 33°F-35°F water to the inlet air-cooling coils, resulting in 42°F air temperature off the cooling coils.

For chilled water storage systems, water supply temperature to the inlet coils is higher, resulting in higher turbine inlet air temperatures and lower power output.

For evaporative cooled systems the inlet air temperature is limited to within 2°F-4°F of the wet bulb temperature. This results in higher inlet air temperatures and a smaller enhancement of turbine output.

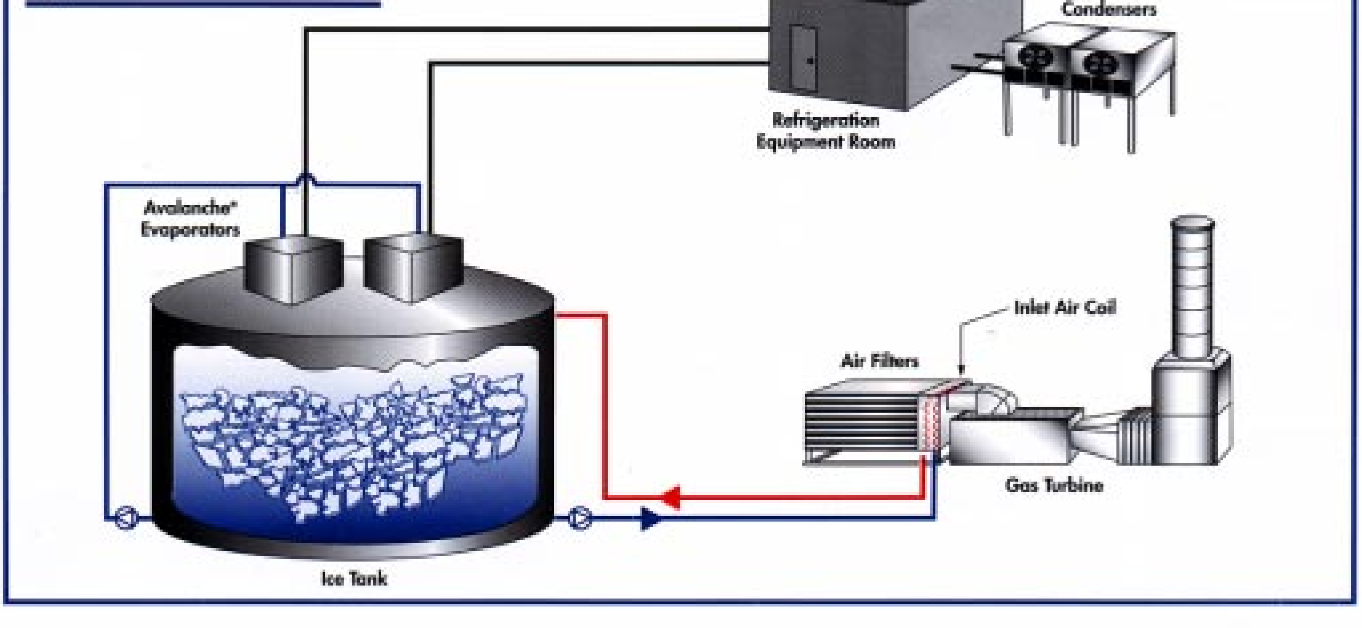
Smaller Tank Size

Compared to chilled water storage systems, Avalanche TES systems require one-fifth the storage volume due to the higher latent heat capacity of ice.

Avalanche Gas Turbine Inlet Air Cooling System Description

- ▲ The Avalanche evaporator is mounted on top of the ice storage tank and produces ice during off-peak hours by freezing water pumped from the storage tank to the Avalanche evaporator.
- ▲ Ice is discharged from the evaporator and stored in the storage tank.
- ▲ Chilled water is pumped from the storage tank to cooling coils located at the inlet to the turbine providing desired cooling of the turbine inlet air.
- ▲ Warm water is returned from the cooling coils to the tank via spray nozzles located at the top of the tank and is sprayed evenly on the ice to assure an even ice melt.

System Schematic



MUELLER® AVALANCHE® GAS TURBINE INLET AIR COOLING APPLICATIONS

LINCOLN ELECTRIC SYSTEMS

Lincoln, Nebraska

Project Description:

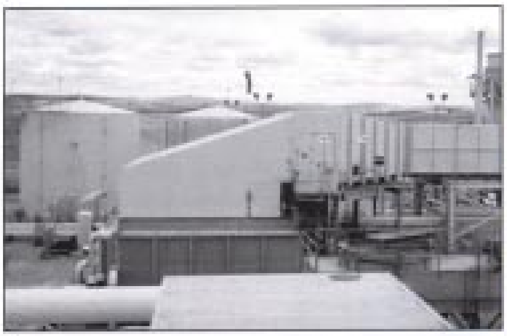
Six Mueller Avalanche evaporators for gas turbine inlet cooling application serving two 67 MW turbines (at 92°F inlet air).

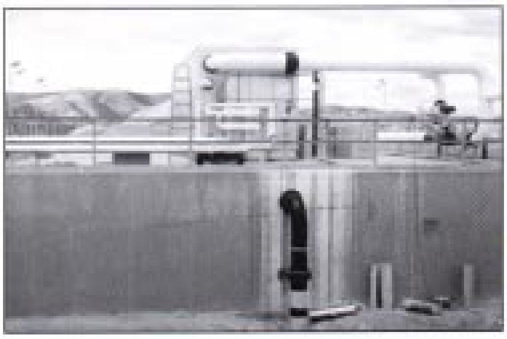
Project Scope:

- Installed six Mueller Avalanche evaporators for inlet cooling
- 3-million gallon ice storage tank
- 165,000 RT-HR capacity
- 10,000 RT GTIC air cooling coil load (two turbines)
- Net ice-making capacity 128,000 lbs. per hour
- Weekly cycle total load shift strategy
- Refrigerant: ammonia (R-717)
- Fully automated, unmanned TES installation

Project Benefits:

- Increased gas turbine capacity by 14 MW (each turbine) using inlet air cooling at 42°F.





TEXACO COGENERATION COMPANY

San Ramon, California

Project Description:

One Mueller Avalanche evaporator for gas turbine inlet cooling application on a 31 MW turbine (at 95°F inlet air).

Project Scope:

- Installed one Mueller Avalanche evaporator for inlet cooling
- 333,000 gallon ice storage tank
- 14,800 RT-HR capacity
- 1,345 RT GTIC air cooling coil load
- Net ice-making capacity 31,500 lbs. per hour
- Weekly cycle total load shift strategy
- Refrigerant: ammonia (R-717)
- Fully automated, unmanned TES installation

Project Benefits:

- Increased the gas turbine capacity by 7 MW using inlet air cooling at 42°F.

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