YORK®

INSTALL CONFIDENCE

Gas Turbine Inlet Air Cooling

Maximize Power. Optimize Efficiency.

Johnson Controls

The Trend:
Increasing Power Demand

The forecast

Today, energy consumption is rising at an ever increasing rate. Surging populations and rapid urbanization, together with regulation to increase power plant efficiency and reduce carbon emissions mean that the installed gas turbine power plant capacity is forecast to grow at an average Compound Annual Growth Rate (CAGR) of 7.5% across Asia.

The alternatives: add new capacity or optimize output

To meet this accelerated demand for electricity, the industry has turned to gas-turbine generators as a practical and efficient solution, recognizing gas turbine generators are the most environmentally-friendly way to generate electricity using a fossil fuel.

One strategy to meet the growing demand for power is to add more gas turbine generators. Adding new gas turbine capacity is capital intensive and can involve long permitting periods. An alternative strategy involves enhancing the output of existing generators. which allows existing site infrastructure, permits and grid connections to be utilized, maximizing the earning potential of these assets already in place.

The Opportunity:
Optimize Gas Turbine Power Output

The cost-effective optimized solution: Gas Turbine Inlet Air Cooling

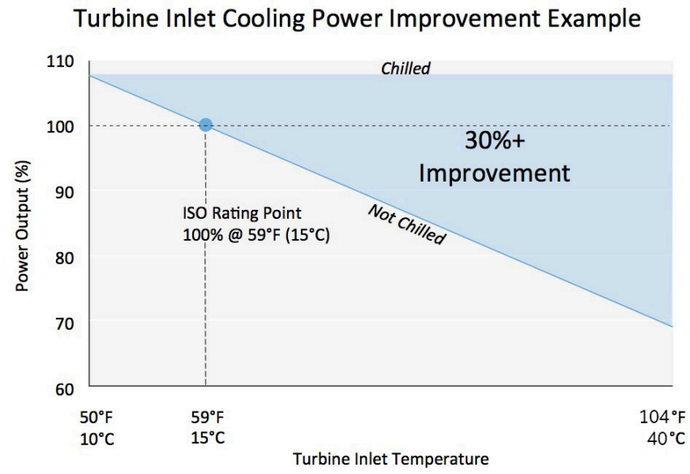
Today, there are various ways to enhance the power output of gas turbines. The most cost-effective means is Gas Turbine Inlet Air Cooling (GTIAC). This technology can increase a gas turbine generator's output to produce 30%+ more electricity at a fraction of the cost of a new gas turbine generator.

Mechanical cooling: a proven method for consistent inlet cooling

The most consistently successful method of GTIAC is mechanical cooling. Based on proven water-chiller and heat-exchanger technologies, this method delivers the cooling capacity, dependably and consistently to obtain optimal output from the gas turbine. Operating the turbine at the relatively constant conditions offered by mechanical cooling can improve turbine life and lower maintenance costs.

Experience: Johnson Controls chillers have been used in GTIAC applications for over 20 years

Johnson Controls chillers were first deployed in a GTIAC application in the early 1990s in the USA. Now, they can be found at the heart of inlet air cooling systems in power plants worldwide.



Inside An Inlet Cooling Solution

System installation strategies

A GTIAC system requires careful coordination in engineering and design, equipment selection and procurement, field installation, commission, and start-up. A typical project can take one of two approaches:

Field-erected approach: Major components are shipped to the job site, then assembled and piped on location.

Packaged approach: Equipment is integrated into a complete system prior to shipment, then site installation is coordinated by project managers.

System configuration

A GTIAC system is comprised of a number of components, including chillers, piping, coils, controls and energy-storage tank units.

Filter housing with cooling-coil module

Responsible for generating the cool air stream entering the turbine inlet

Coil	Provides the heat transfer between the chilled water and the incoming air, reducing the air-inlet temperature
Filter	Removes impurities from the air stream
Housing	Encloses the coil and provides the free area to accommodate air flow for the filter and coil

Modular water chiller plant

Responsible for all cooling operations

Centrifugal Chillers	Use a mechanical cooling technology to cool the water loop that has absorbed heat from the cooling-coil module
Absorption Chillers	Use a chemical process to produce chilled water. YORK® absorption units employ heat sources such as gas, steam or hot water to drive the chemical reaction that produces economical cooling

Pre-packaged

Packaged

Mechanical

Absorption

Thermal energy storage tank

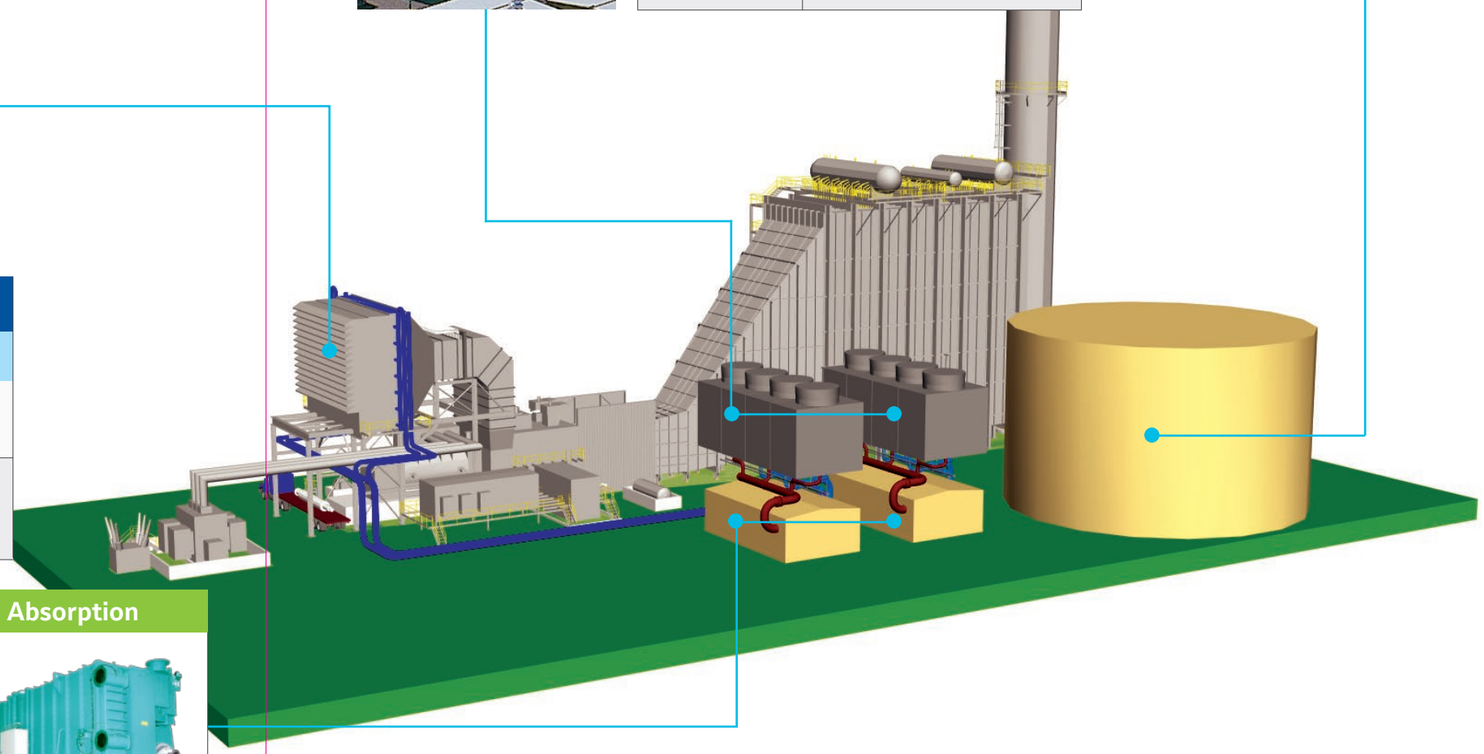
Technology used to create and store thermal energy at off-peak temperature hours. Thermal energy storage (TES) adds to the value proposition of chillers. Tanks can be "charged" at night when electricity demand is lower, and "discharged" when demand is highest to maximize power production and revenue.

Ice Storage	Tank stores ice during low-load conditions, which can then serve as the cooling medium at peak conditions
Cold Water Storage	Same as ice storage, but stores cold water instead of ice

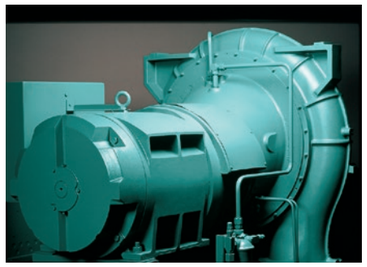
Heat-rejection equipment

Equipment used to remove heat from the chillers

Water-Cooled	Cooling towers use water to reject heat
Air-Cooled	Radiators typically use fan-driven air to reject heat



What Makes YORK® Chillers the Ideal Choice for Gas Turbine Inlet Air Cooling?



An example of a YORK® open-drive compressor

The OptiView control center in-use

At the heart of any Gas Turbine Inlet Air Cooling system is the chiller.
The most demanding 24/7 petrochemical and gas-compression applications on earth rely on YORK® chillers and compressors manufactured by Johnson Controls. The reason? Industrial-grade dependability is built into each and every YORK chiller we deliver.

A GTIAC system can boost the turbine's output, but only if the system operation is reliable under all conditions. YORK chillers have earned a reputation for their simple maintenance and trouble-free operation. Their compressors and control-panel designs are two key reasons YORK chillers provide such unsurpassed performance.

Open-drive compressors

Based on extensive industrial experience, YORK large-tonnage chillers incorporate open-drive compressors, providing significant uptime advantages. First, in the event of an electric motor burnout, the open motor can be simply swapped out for repair in relatively little time. Unfortunately, with burned-out hermetic inductor motors, the entire chiller is contaminated with combustion by-products and must be taken offline for an extensive clean-up period. In addition, open-drive compressors provide improved access for routine maintenance tasks.

OptiView™ control center

For a clear, up-to-the-minute picture of chiller status, YORK chillers incorporate the intuitive and informative OptiView control center. This innovative technology delivers real-time data on all key parameters in a graphical, easy-to-understand format. Powerful logging and trending capabilities let you see how efficiently you are operating while providing early warning of any developing problems.

Options of add-ons, ready access portal & energy essentials, remote monitoring and web-based, real-time dashboards enable you to efficiently measure, verify and manage your plant's performance anywhere and at anytime.

Expert service across Asia

Our Asia-based teams provide technical services at every phase of the system lifecycle.

These services ensure the dependability of your equipment and that your system performs optimally every day. It starts by identifying and preventing problems before they occur, and then delivering exceptional service expertise when you need it most.

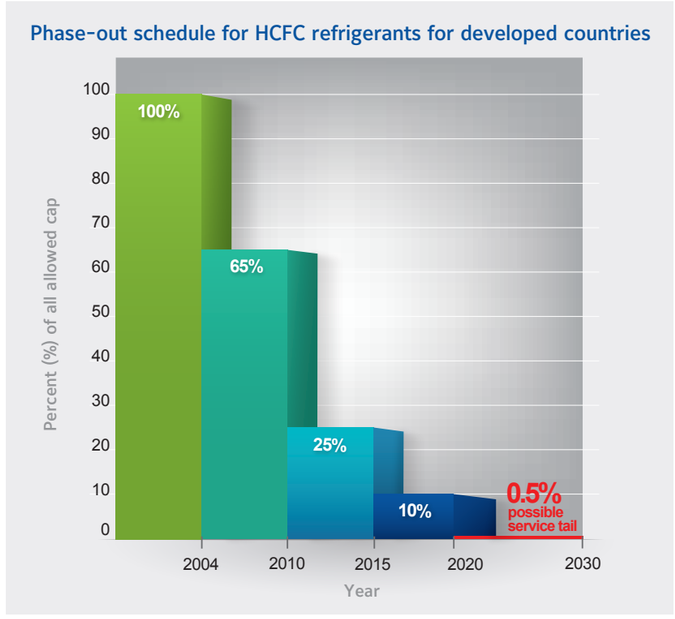
Energy-Efficient and Environmentally Responsible by Design

Environmentally acceptable refrigerants

Power plants are coming under increased scrutiny and regulation in response to concerns on their environmental impact. Johnson Controls helps by offering chillers that have zero ozone depletion and no phase-out date:

- Centrifugal chillers using refrigerant HFC-134a
- Absorption chillers using water as the refrigerant

As an industry leader, Johnson Controls recognizes our responsibility for customer and environmental stewardship. Our design decisions for equipment and refrigerant choice consider safety, efficiency, life cycle cost, availability, and reliability. As the commitments of Montreal Protocol for elimination of CFC and HCFC refrigerants reaches conclusion, attention is now focused on minimizing the effects of climate change by reducing greenhouse gas (GHG) emissions from refrigeration equipment. The Total Environmental Warming Impact (TEWI) or Life-Cycle Climate Performance (LCCP) realized by our choice of HFC-134a refrigerant provides lowest overall impact for the centrifugal chiller operation as well as improving the emission per kW output for the power generation process.



Low parasitic energy consumption

GTIAC provides an energy-efficient and environmentally responsible way to enhance power generation capacity and efficiency. The equation for success begins with energy-efficient YORK® chillers.

To minimize parasitic energy consumption, YORK chillers are designed for real-world energy performance, which is the combined performance at all operating conditions, not just at design conditions of full-load capacity. This is critical to maximizing energy efficiency for inlet cooling because, in the case of thermal storage applications, most of the run-hours are typically spent at off-design conditions. The bottom line: unmatched energy efficiency at all load conditions and more kW's to the grid.

Comprehensive Portfolio of GTIAC Solutions

YD Chiller

YK Chiller

CYK Chiller

YORK® centrifugal chillers: superior performance under real-world conditions

The entire line of YORK® centrifugal chillers is ideal for the high capacity per footprint requirements of GTIAC applications, increasing energy efficiency while delivering reliable, long life performance.

YD chillers

YORK YD water-cooled centrifugal chillers utilize two YORK centrifugal compressors operating in parallel on a common set of heat exchanger shells to obtain large chiller capacities of 1,500-6,000 TR (5,300-21,100 kW) and efficient part load operation. Additional energy savings are available by piping the units in a series-counterflow arrangement. This configuration reduces the compressor work needed on each chiller, lowering system energy use by as much as 8%.

YK chillers

In gas turbine inlet air cooling plants that require chillers of less than 3000 TR (10,550 kW), the YORK YK chiller is an outstanding choice. It offers a capacity range of 250-3000 TR (880-10,550 kW) and provides incomparable energy performance in actual working environments rather than simply in optimal design conditions. This is critical because chillers in the real world operate most of the time in conditions that are off design specifications.

This performance is also important in thermal-storage applications. Although the chiller is often running at full load, the entering condenser water temperature is lower than design, especially at night.

The YK chiller can utilize entering condenser water temperatures (ECWT) as low as 55°F (13°C) to reduce instantaneous energy consumption as much as 50% compared to chillers that can only use 75°F (24°C) ECWT minimum.

CYK chillers

When a GTIAC application entails temperatures that are difficult for a standard centrifugal chiller to handle, the CYK chiller is a smart solution. It incorporates two centrifugal compressors arranged in series to handle air-cooled and brine-chilling applications at conditions outside the performance range of typical centrifugal chillers. Using HFC-134a, CYK chillers are available in a wide range of capacities:

- For air-cooled applications (air-cooled radiators): 700-2,300 TR at 44°F LWT (2,500-8,100 kWR at 7°C LWT)
- For brine-chilling: 700-1,600 TR at 20°F LBT (2,500-5,600 kWR at -7°C LBT)

The combination of standard components and unique performance characteristics like compound-system technology make CYK chillers the right choice for jobs where standard chiller designs simply can't compete.

YST chillers

A derivate of YK, the YST is a steam-turbine-drive chiller designed to provide superior performance at design and off-design conditions with a capacity of 700-2,800 TR (2,460-9,850 kW). Using R-134 as a refrigerant, the YST provides a wide operating envelope that is optimally suited for combined heat and power systems and GTIAC applications. The steam pressure can range from 30-400 PSIG (2-27.5 barg) and the chilled water produced can have temperatures as low as 36°F (2.22°C) without glycol and 22°F (-5.55°C) with glycol.

YK-EP chillers

Through a mechanical compression economizer cycle, which couples a primary compressor with an auxiliary economizer compressor, the YK-EP chiller offers greater efficiency and larger capacities of 2,500-3,500 TR (8,800-12,300 kW) than a single stage chiller. The chiller is able to operate with low entering condenser water temperature (ECWT) down to 55°F (12.7°C) and is efficient even with warm ECWT. The only product available that uses a second single-stage compressor to perform half lift in parallel and the most compact configuration in its class, the YK-EP reduces total cost of ownership and improves control flexibility.

YST Chiller

YK-EP Chiller

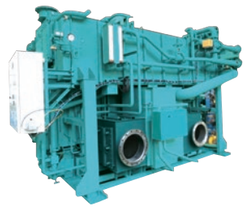
YORK® absorption chillers: maximum cooling with minimal electricity consumption

Absorption chillers are the right choice when suitable waste heat is available. They are thermally-driven and can utilize steam, hot water or exhaust gas. As a result, they can provide GTIAC system cooling while consuming very little electricity. This actually increases the net electrical output from the power plant.

The YORK® YHAU absorption chillers use an innovative two-step evaporator and absorber cycle that splits the absorption process into two steps, similar to how a series-counter-flow arrangement splits the work between two chillers. This, together with the parallel flow cycle, enables lower lithium-bromide solution concentrations, which reduces crystallization risk, reduces the potential for corrosion and improves efficiency. These models have been providing reliable cooling for decades with the same Johnson Controls commitment to quality, reliability and service after the sale.

YHAU-CW Steam Absorption Chiller

YHAU-CL Hot Water Absorption Chiller



YHAU-CE-J Exhaust Gas Absorption Chiller

Packaged YORK® chiller GTIAC solutions

Besides offering a wide range of YORK® chiller units for GTIAC application, Johnson Controls also provides these product solutions as complete packaged systems. These packaged systems are tailored to specific application needs by our expert process engineering team and designed to be as self-contained as our clients require. Pre-built packaged systems incorporate chiller units, pumps, electrical equipment, piping, cabling, auxiliaries and controls, delivered to site as skid mounted modules for fast site erection, commissioning and start-up.

4,000 TR modularized system in build

Electrical and controls module is designed according to project specification complying with the highest power plant standards

Two energy-efficient, reliable YK chillers arranged in series counter flow

Pumps are designed to optimize space and energy efficiency

YCP - 2020

Pre-Packaged YORK chiller GTIAC solutions

As well as tailor-made modular GTIAC systems, Johnson Controls also offers the pre-packaged YCP-2020 system for GTIAC applications. The factory built YCP-2020 combines best-in-class chiller plant technology, process design and intelligent controls to deliver a compact, self-contained and flexible GTIAC system.

Modular Design

The modular system integrates the chilling units, electrical and controls systems, chilled and cooling water circulating pumps in standard 20' shipping container sized modules. This allows for straight-forward site delivery transportation and a flexible system layout, occupying the minimal site footprint.

Intelligent Control System

The YCP-2020 incorporates the proprietary Metasys® control system or PLC to provide overall system control, intelligently adjusting the operation of the chillers and production of chilled water for the optimal level of system performance at any gas turbine operating point.

Efficient Configuration

Designed to achieve optimal results in GTIAC application, the architecture of the system arranges the chillers in series counterflow to reduce system parasitic power consumption.

Two chiller modules as well as one auxiliary module comprising electrical and controls systems and pumps - each module comes in a 20-foot standard shipping container.

YORK® Chillers: the Professional's Choice for High-Performance GTIAC Systems

YORK® chillers by Johnson Controls are ideally suited for today's Gas Turbine Inlet Air Cooling (GTIAC) systems with the broadest array of industrial-grade chillers and the key capabilities that enable you to meet your unique requirements.

Johnson Controls' industrial chillers cool power plants worldwide

Johnson Controls water chillers have been used in GTIAC applications for over 20 years. They now provide the cooling needed to optimize gas turbine performance in power plants across Asia, Africa, the Middle East and the USA.

Talk to the experts today

Let the industrial cooling experts at Johnson Controls Asia help your team create the environment for success. Contact us today.

Johnson Controls YD Chillers provide the cooling capacity to meet the GTIAC requirements of Navanakorn Electric Co. Ltd. CCGT Cogen Plant, Thailand.

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