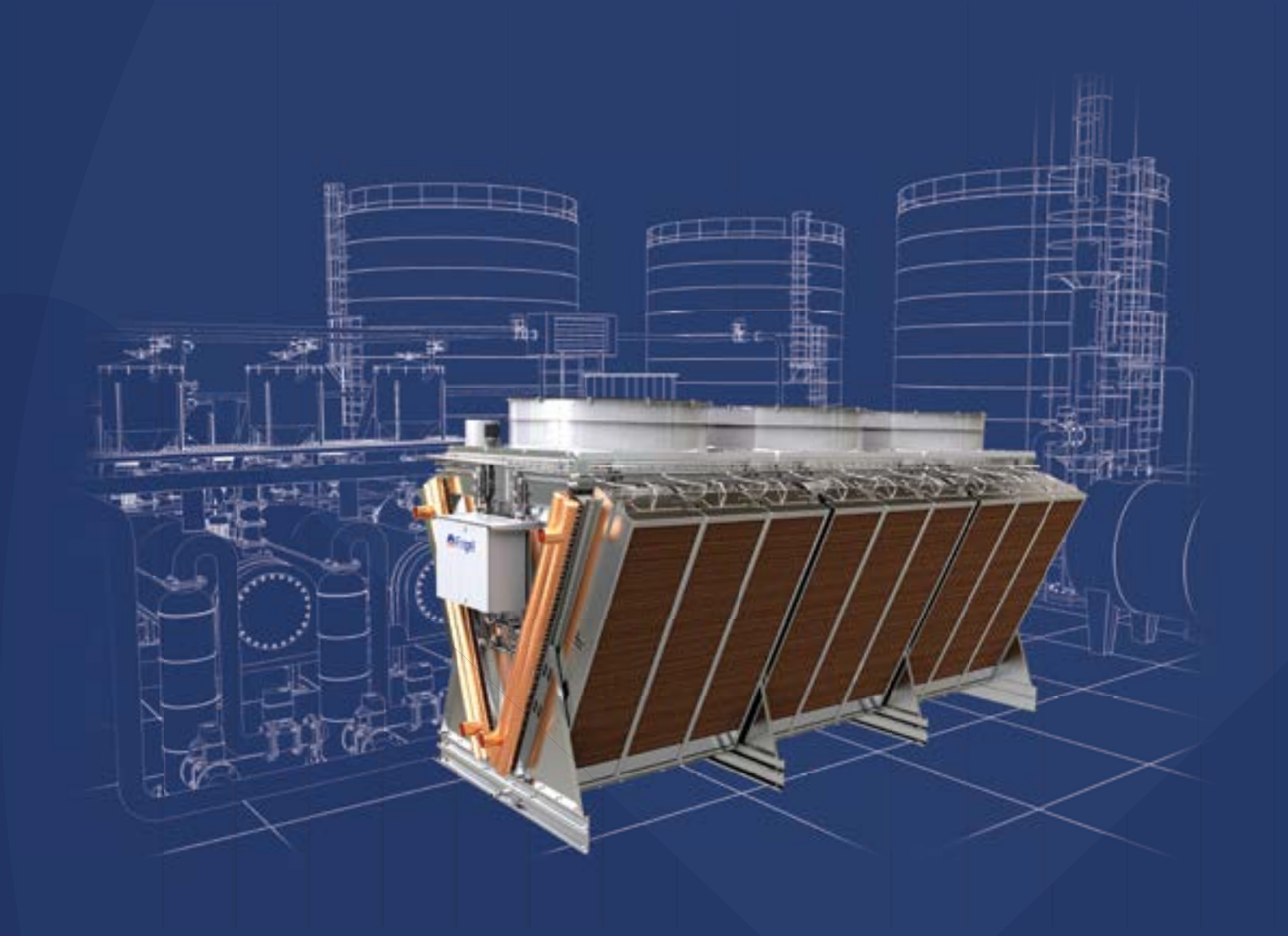
Frigel

Intelligent Process Cooling



ECODRY - LDK

THE MOST EFFICIENT ADIABATIC COOLER

Why is energy efficiency important

There are a number of reasons why you should consider **reducing your energy consumption**... In turn, saving energy produces a better quality of life. **Reducing emissions** translates into cleaner air quality. Plus, it helps create a **healthier planet**, or at least helps sustain the resources we already have.

The most important step in moving away from high energy consumption and towards a better climate balance is to **increase energy efficiency** rather than just saving it.

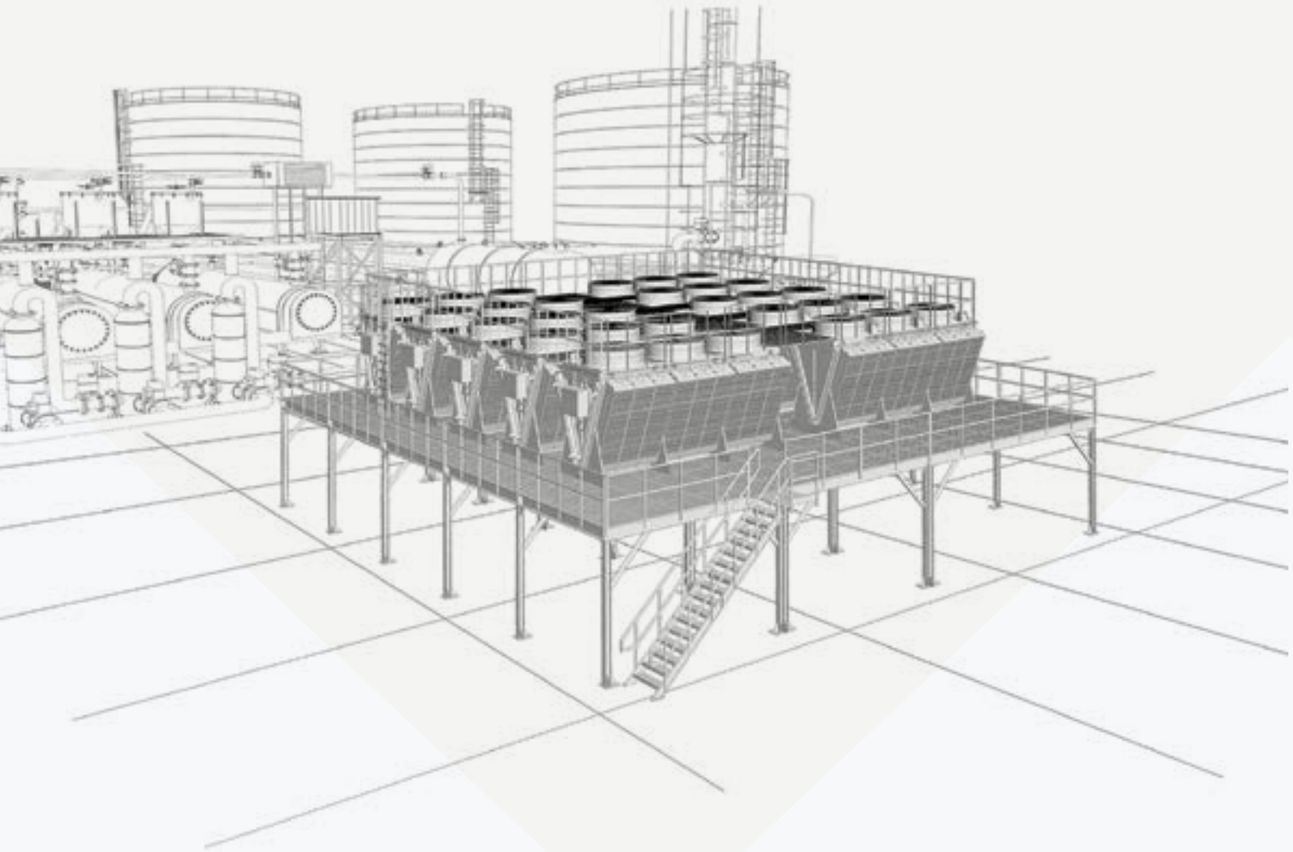
Energy efficiency simply means using less energy to accomplish the same task, which is to **eliminate wasted energy**. While renewable energy technologies also help achieve these goals, improving energy efficiency is the cheapest and often the most immediate way to reduce the use of fossil fuels. There are huge opportunities for efficiency improvements in every sector of the economy, be it power generation, transmission grids, data centres, industrial process cooling.

Frigel has taken up this challenge with the aim of making a concrete contribution by designing a new generation of ECODRY: LDK, the most effective adiabatic coolers available today.

The use of this new technology helps to significantly reduce the consumption of electricity in relation to the cooling capacity required. An extensive list of benefits makes LDK an unbeatable solution to the ecological challenges of the present and future.

The Most Efficient Adiabatic Cooler

Ecodry LDK at glance



- Up to 2,8 MW per unit in adiabatic mode
- Up to 1,8 MW operating in dry mode per unit
- Modular System Design - Wide and Deep
- From Dry - Spray - Adiabatic to Hybrid technology

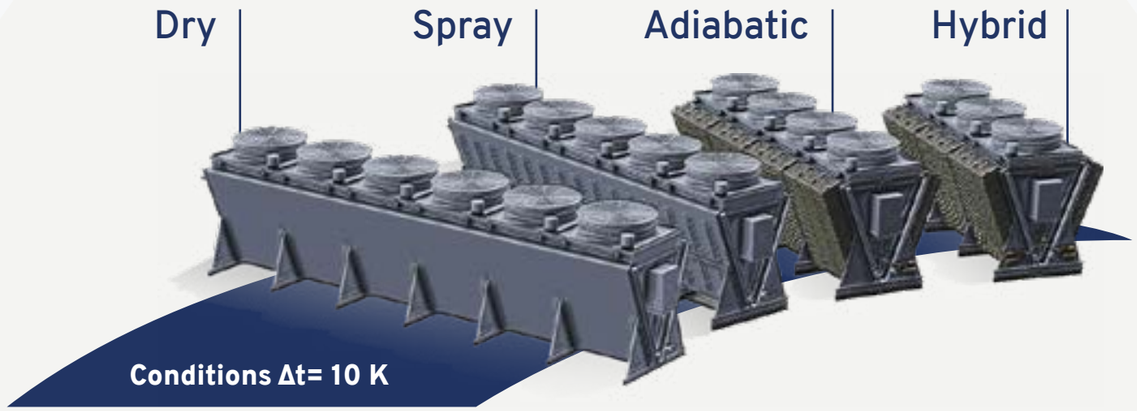
- **> 9000** installations worldwide
- **> Better cooling** performance
- **> Outstanding** operating cost savings
- **> New standards** in terms of environment impact

Power · Process Cooling · Data center · Ind. HVAC · Beverage · Plastic

Toward more efficient Heat Rejection

The natural choice over evaporative cooling towers

Cooling Tower	ECODRY - LDK
High water consumption Uses water evaporation as cooling source throughout the year. Also dumps high volumes of water to reduce salt concentration caused by evaporation.	**Almost no water consumption** Only uses water evaporation at peak ambient conditions. Otherwise, it works completely dry, reducing water consumptionup to 95%.
Contaminated water to process Permanently contaminates water (physically, chemically and biologically) with the pollution taken from the surroundings air.	**Always clean water to process** Close loop circuit and no stagnant water results in pre-treated water that will be kept perfectly clean and uncontaminated.
Causes machine overheating Permanent fouling and scaling dramatically decreases machine heat exchanger efficiencies.	**Constant efficiency heat transfer** Assures always constant heat transfer with no fouling or scaling of surfaces.
Requires permanent chemical treatment Requires specialized ongoing water treatment with chemical additives, permanent filtration and automatic purging, resulting in high consumption of additives.	**No ongoing chemical treatment needed** Process water only needs a chemical pre-treatment and periodic monitoring. No consumption or bleed-off of chemicals.
Expensive maintenance Requires specialized ongoing water treatment with chemical additives, permanent filtration and automatic purging, resulting in high consumption of additives.	**Low maintenance costs** Does not require any periodic maintenance for cleaning of heat exchanger surfaces. Only a periodic monitoring of water quality is suggested. **Reduced costs** Total savings may be estimated in 80 to 95%.
Risk of bacterial diseases It may be the source of dangerous bacterial diseases (Legionella) grown in the water and spread by drift.	**No risk of Legionella** System runs completely dry at least once a day, for several hours. Not enough time to develop any kind of organic growth.



BENEFITS

Advanced software provides the solution for your application and optimizes it for required operation in the plant.

- **Climatic conditions at the site**
- **Yearly ambient temperature profile**
- **Expected process loads**

ADVANTAGES

+ not good ++++ Very good	Cooling tower		Adiabatic	Ecodry LDK
	Open	Closed		
Minimized water consumption	+	+	++	+++
Energy Efficient Fan operation	++	++	+++	++++
No blowdown			++	+++
No areosol and or plumes	+	+	++++	++++
Clean water to process standard	+	+	++++	++++
Stainless Steel 304 STD	+	+	++	++++
Investment costs	++	+++	++	+++
Low maintenance	+	+	++	++++
Operating costs	+	+	+++	++++

ECODRY LDK
the industrial choice

Industrial fans

- Designed for severe Duty and high corriosion resistant
- Airflow And Noise Tested on laboraty and verief on the field
- Unique fan blade design performed trought CFD analsyys

Booster system

- Direct spray cooling for extreme hot ambient temperatures
- Heat dissipated by evaporation
- No scaling on coil surface
- Areosol free operation
- Monitored by intelligent control system

Advanced motor technology (EC)

- The highest efficiency solution
- Zero maintenance
- Integrated ModBus communication
- 0-10V signal
- Safety switch on each fan

Single point power connection

- Drive by wire
- All motors factory wired
- PLC integrated ModBus protocol
- 0-10V signal

V-Coil heat exchangers

- Multiple tube configurations for closed circuit operation
- Self-draining for water systems in freezing climates
- Copper tubes with SS304 or 316 available
- Alu magnesium (Almg 2.5) fins
- Hydrofin, ideal for spray coolers

V-Coil heat exchangers

- Floating system of the array (and pipes!) which reduces mechanical and thermal stresses

Rugged construction

- Stainless steel 304L for increased corrosion resistance and life span
- High corrosion class available as a standard configuration

CoolPad

- Internationally patented adiabatic chamber
- Water drift preventive design
- Flame–retardant material
- Exceptional cooling and humidification rates
- GreenGuard gold certified

LDK – achieves the customer needs by intelligent controls

Stand alone control

Benefits:

- Complete redundancy by machine
- Fully integratable for existing systems

Features:

- 0-10V control
- Modbus RTU control
- Logic driven by integrated electronic boards

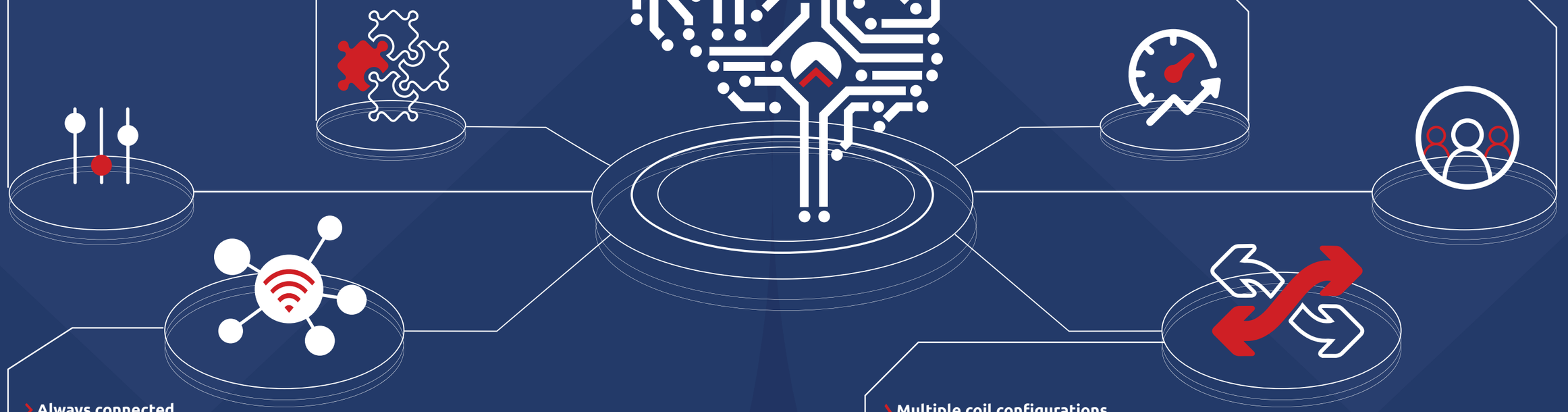
Ready for cooling plant integration

Benefits:

- Complete control of complex cooling systems thanks to 3PR 4.0

Features:

- Main control panel for LDK, Pumping Stations, Chillers and Free Cooling based on logic, tested since ‘90



Always maximum performance and efficiency

Benefits:

- Reduced water and energy consumption
- Achieves the best $/kW cooling possible, second by second

Features:

- Cooling power driven by Ambient and Inlet/Outlet Temps., read second by second

Multiple logics based on customer needs

Benefits:

- Best control based on customer requirements
- All logics have been developed after a deep computational analysis

Features:

- Water saving mode control
- Power saving control mode

Always connected

Benefits:

- Fully supervised by remote
- Online service operations to reduce intervention time

Features:

- Modbus communication
- MiND Frigel supervision

Multiple coil configurations

Benefits:

- Suitable for all the plant configurations
- Suitable for multiple needs

Features:

- C = standard version for glycol and pressurised systems
- D = simplified self-draining
- S = full-self draining system (no glycol even with Ambinet Temps. < 0°C (32°F)

The ultimate cooling solutions

Adiabatic system in hot season. Outside air passes across the **CoolPad**. Here the ultimate design of the patented **CoolPad** gives the best humidification and cooling air: the efficiency boosts overall performance

DRY MODE

Dry operation in cold weather. The external air is conveyed directly to the heat exchanger.

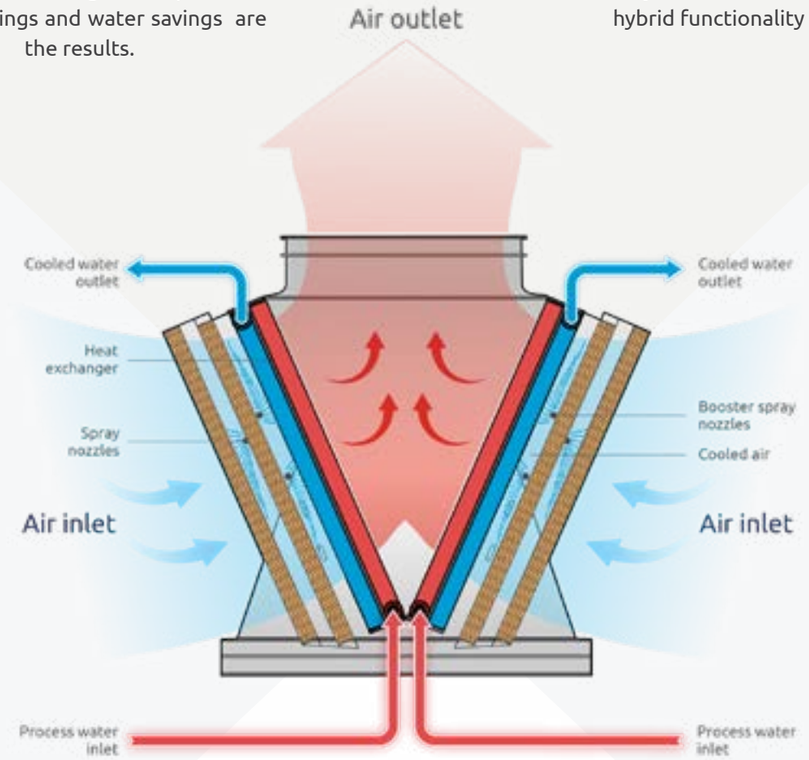
CoolPad system is deactivated in free air intake position. Air flow is modulated according to temperature.

Energy savings and water savings are the results.

ADIABATIC MODE

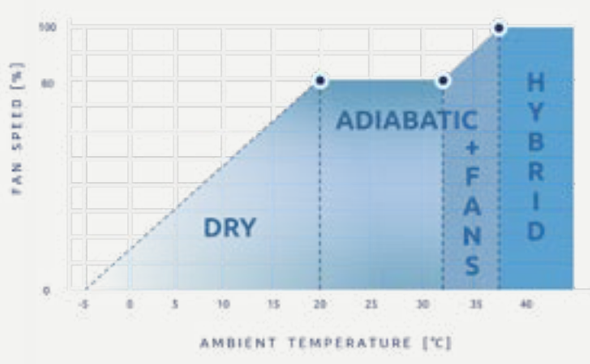
BOOSTER MODE

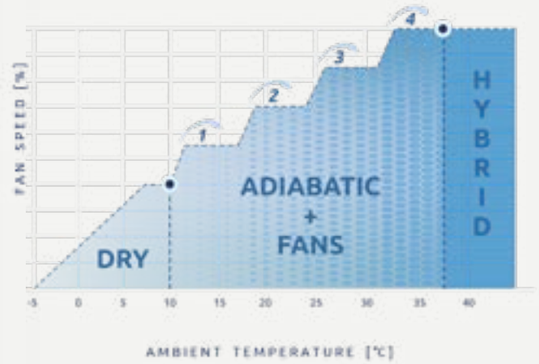
Only in extremely high weather conditions, when ADIABATIC MODE is not enough to keep the leaving water temperature within a predefined setpoint, the booster mode is automatically activated entering into hybrid functionality



Water Saving

Power Saving





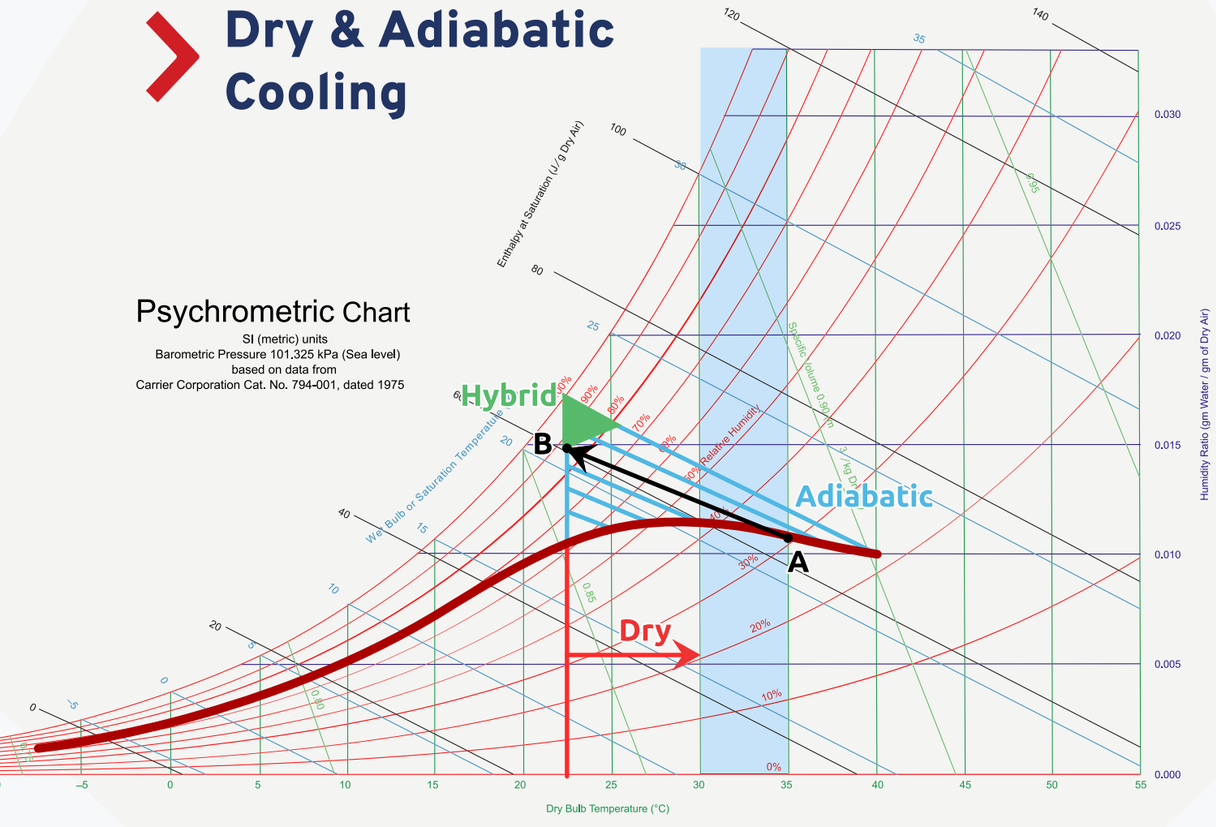
choose for each step how much energy or water you can save

Dry

Adiabatic

Hybrid

Dry & Adiabatic Cooling



How it works

The finned pack heat exchangers can dissipate the heat of the thermal process into the ambient air by convection with a precise **Dry** temperature gradient derived from the design of the machine (exchange surfaces and the air flow of the fans). The parameters involved are the temperatures of the fluid and that of the dry bulb of the ambient air.
The ambient air is a mixture of gas and humidity and has an interesting physical property: by increasing the value of the humidity present in the environment, a variation of the dry bulb temperature value is obtained on the isenthalpic line **A-B** up to the limit of the saturation value. Actually, this property provides for a pre-cooling of the air entering the finned heat exchanger, effectively increasing the heat transfer capacity of the process. The adiabatic chamber, placed before the finned heat exchanger, performs the work of humidifying the air to obtain the desired pre-cooling. The patented Frigel system is not only very efficient in reaching humidification values close to saturation but is able to be very reactive in humidity regulation and in the ability to transfer only the amount of water necessary for pre-cooling without any unnecessary waste.

CoolPad™

EFFICIENT – SUSTAINABLE AND PATENTED

The unique design gives it a high strenght and durability with exceptional cooling and humidification rates.

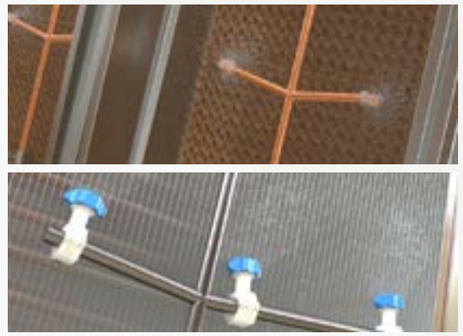
Benefits

- Greater efficiency
- Long lasting performance
- Recyclable at end of life
- Higienic rules compliant
- Minimized operating costs

Performance and reliability

An intelligent system keeps the adiabatic chamber in humidified conditions for long periods, thanks to Frigel's patented pulse cycle system that minimizes water consumption.

- Algae and weather resistant
- Prevents bacterial proliferation
- Scrubbable to extend service life
- Reinforced flame-retardant material
- GreenGuard Gold certified*



Savings
Reduced maintenance

Corrosion, scaling and bacteria concerns are eliminated with the **CoolPad** system. The **ECODRY LDK** series keeps the reduced maintenance by the design with best-in-class materials.

Water consumption

Comparing the traditional evaporative solutions, **ECODRY LDK** series and the new **CoolPad** reduces or eliminates water consumption. Adiabatic mode is activated only when required by ambient conditions. **CoolPad**, managed by the Frigel Netgel control package, maximize water conservation and /or energy consumption thanks to advanced and friendly proprietary control logic.

Engineering made easy

CoolPad is a modular pre-assempled package for easy on-site assembly.
With **NetGel** intelligent control management, all fundmental functions and settings are monitored constanly, thus providing a complete program of yearly maintenance in advance.

GREENGUARD GOLD — PRODUCT CERTIFIED FOR LOW CHEMICAL EMISSIONS UL.COM/GG UL 2818

*__GreenGuard Gold__ means the chemical emissions from the materials are extremely low. This means that **CoolPad** is an environmentally friendly design and safe to use in any application.

Highlights

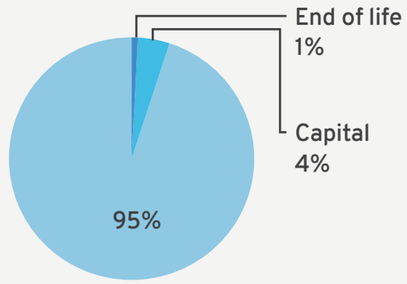
›01
Proven Performance

9000 Installations
GLOBALLY

With more than 9000 systems installed and running in all climate conditions and in a vast range of process applications, Ecodry is, by far, the most proven Adiabatic Cooler worldwide.

›02
Lowest Total Cost of Ownership

Cooling tower TCO average Breakdown



›03
Clean Water to Processes

- Close loop circuit guarantees constant uncontaminated clean water to process
- No surface fouling, constant efficiency of heat exchange with processes
- Minimal ongoing chemical treatment required

›04
Free Cooling Opportunities

The system may have the ability to automatically replace, partially or totally, the thermal loads of existing “mechanical refrigeration systems” operating as a drycooler during winter time.

›Water Savings
Minimized Water Footprint up to -95%

- High humidification efficiency of sprayed mist of water in the “adiabatic chamber”
- Lower approach to WB of pre-cooled air with less water usage
- Proven performance in extreme weather conditions, up to +50°C (+120°F)
- Intelligent Management System adjusts the lowest water consumption according to actual conditions

›Energy Savings
Reduced Operating Costs up to -40%

- Unbeatable efficiency with Electronically Commutated (EC) fans as standard
- Reduced air pressure drops through thin pad design
- Reduced power consumption and noise emissions with exhaust diffusers
- Easy removal of panels during DRY operation (winter)
- Less pumping energy consumption thanks to low coil pressure losses

›Maintenance Cost Savings
Chemicals and water treatment up to -95%

- Minimal ongoing water treatment required
- No risk of coil corrosion and scaling
- Extended life of humidifying pads thanks to water nebulization
- Extended legs to avoid dust intake
- Maintenance-free fan motors
- Easy access for cleaning of coils and adiabatic chamber

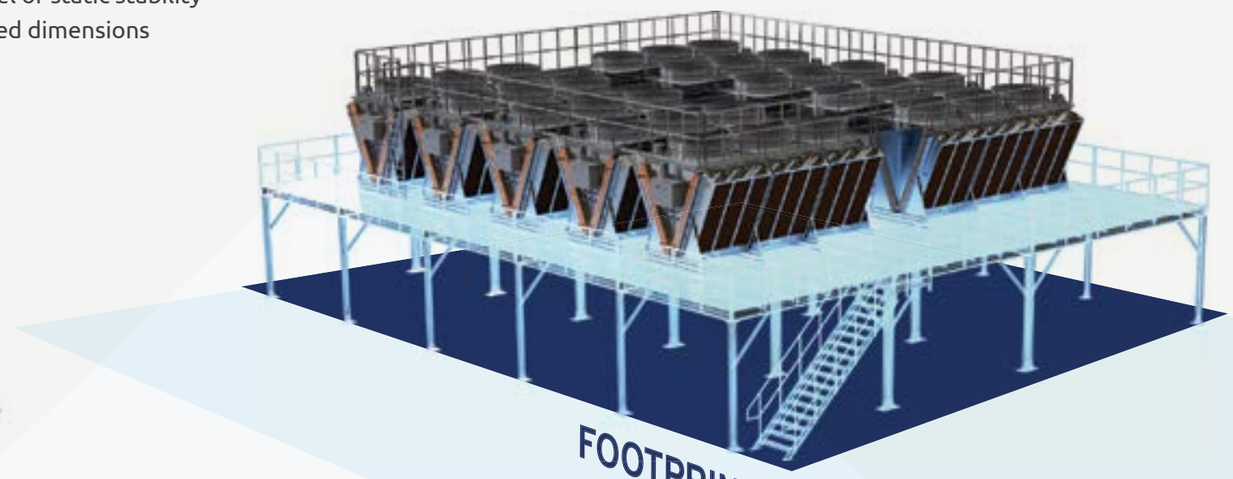
Highlights

05
Total Modularity, High Reliability

- Easy to expand at any time to meet growing needs from Dry - Spray - Adiabatic to Hybrid configuration
- Electrical redundancy with individual fan power plugs
- Modular system design - wide range of options configurable
- Hygienic, safe operation 3 to 7 High efficiency EC fan packages
- Coils with copper or SS tubes
- Multiple coil configurations for any cooling demand
- Safe protective coil system integrated for any duty
- Rigid structure, resistant to deflection

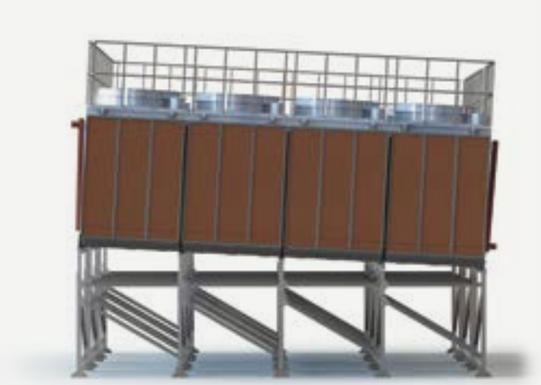
06
High density and compact design

- 45% less footprint requirement thanks best optimized air intake
- Maximized performance and minimized footprint
- Reduced installation costs
- No air flow recirculation between units
- Extra large heat exchanger surfaces
- High level of static stability
- Optimized dimensions



07
Glycol FREE Operation

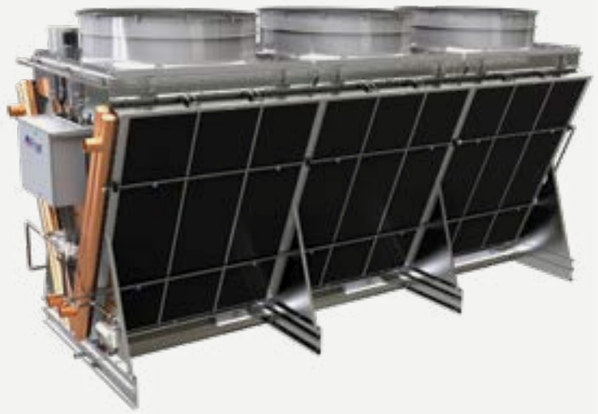
- 100% reliability in extreme climate conditions, down to -40°C (-40°F)
- Unique Frigel self-draining design by gravity
- Complete set of sensors and anti-freezing software
- Special manifolds ensuring fast and full draining



Highlights

›08
Spray System

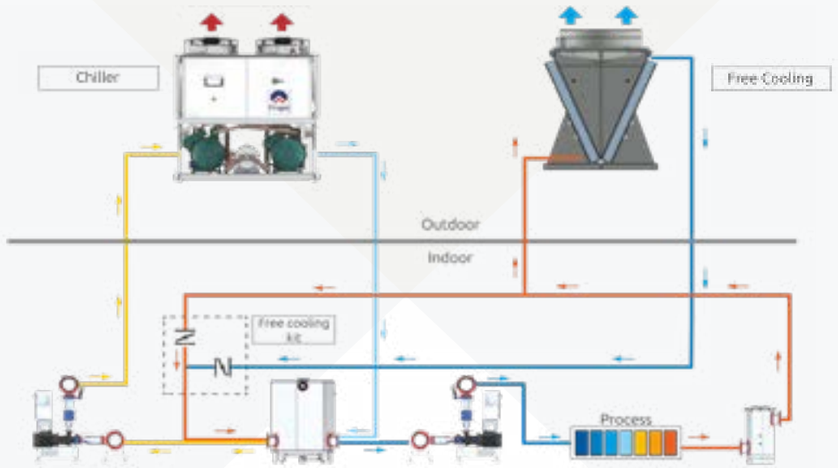
Cooling solution tailored for your process. LDK- SC is a freeze-proof solution that combines dry air cooling during the cooler months of the year with spray cooling during the warmer months.
With the closed-loop system, intelligent controls and rugged design, the LDK SC is an efficient, flexible and sustainable approach to process cooling.



›10
Advanced Optimization

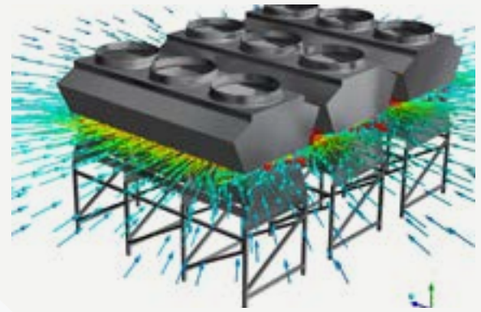
The LDK Hybrid adiabatic cooling system can save up to 80% in energy costs annually by operating as a free-cooler during winter time and mid-season.

Increased coil surface area automatically optimizes heat transfer and replaces, partially or totally, the thermal loads of packaged air-cooled chillers.
This reasults in reduced energy consumption when compared to alternative dry cooling systems.

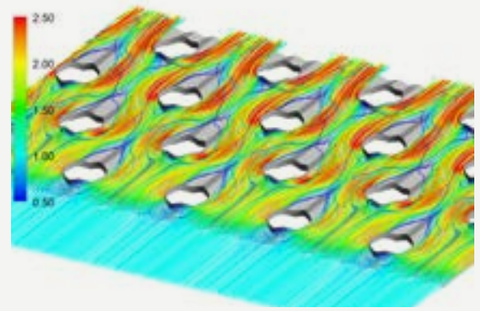


›11
Free-Cooling Opportunities

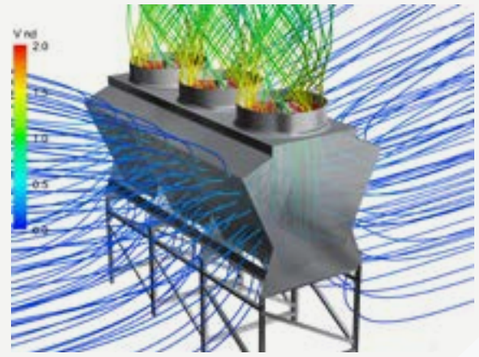
CFD has become a powerful instrument in the hands of design and R&D engineers. With specific expertise in the fields of fluid dynamics and heat transfer, CFD can provide a strong acceleration to the design process of cooling systems and can help to guarantee high production efficiency. This is how Frigel has exploited the benefits of CFD for the design of its LDK adiabatic cooling system.



Study of the effects of side by side units



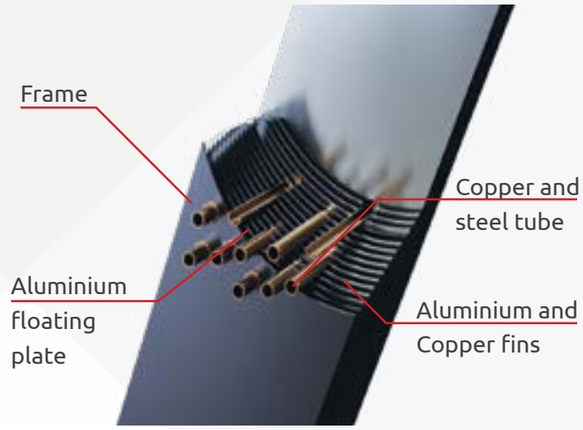
Heat exchanger optimization



Study of optimized V shaped adiabatic cooler

›12
High Operational Reliability and Leak-Safety

LDK safety coil system carrying tubes do not make contact with the casing, increasing heat exchanger service life.



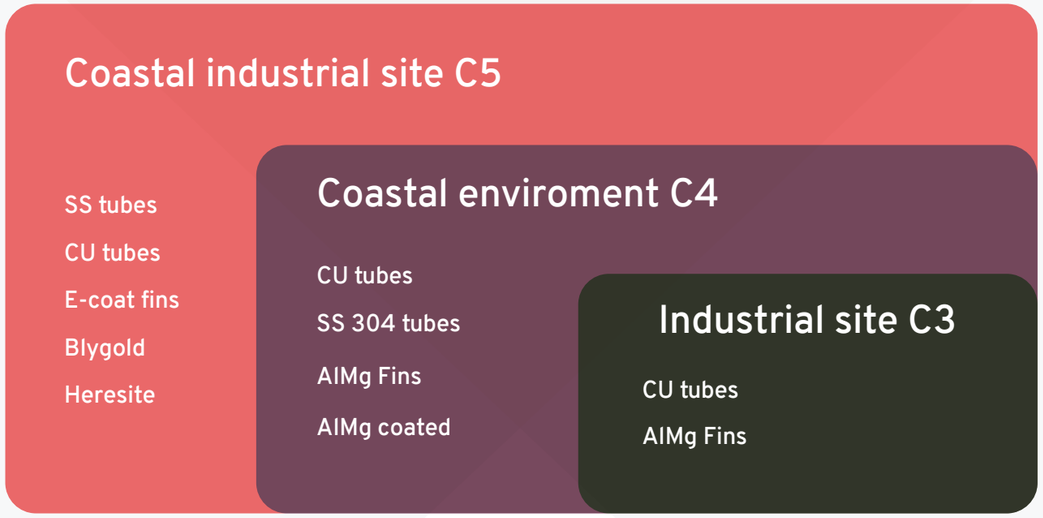
Configurability

Material Options

Value for the money is the key.
Frigel has long been the industry innovator in process cooling and LDK builds on this past success and raises new standards.
LDK is engineered to have low maintenance in mind.
The array of combination allows for making the best choice for heat transfer, as well for construction concerns.

LDK stands for:

- Coil frame is always stainless steel 304L for superior corrosion protection
- Copper tube coils are excellent for most applications
- SS 304 or 316L for corrosive environment or with deionized water
- Fins are always Aluminum magnesium (AlMg) to provide a superior quality for to coastal environments
- HydroFin (Hydrophilic) coatings are the right standard for spray systems due to amenity to wetting
- E-Coat fins (C5) are suitable for very aggressive environments and high corrosion resistance



Handrails, Ladders, Roof Top

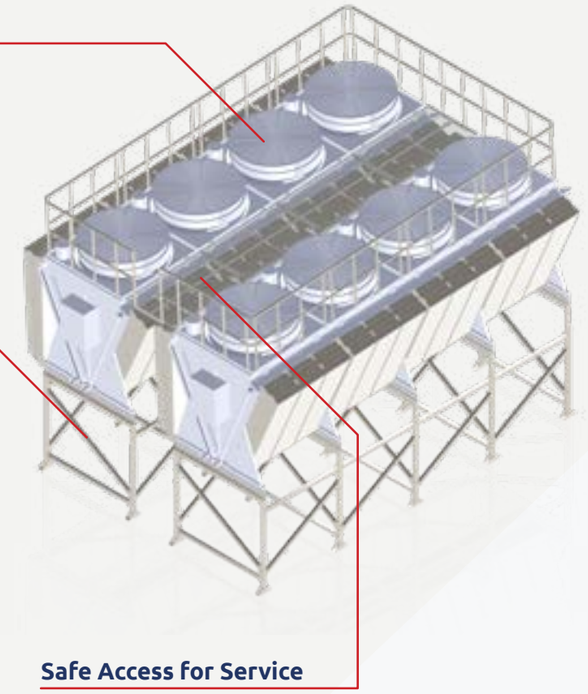
Significantly reduced installation labor.
A complete set of arrangements are available for easy and safe service access when working at heights.

Safe Access for Service

- Anti-slip fan decks
- Ladders and handrails in hot-dipped galvanized steel
- Assembled on site by bolting only
- Crane to lifts and replace fans

Extended Legs

- 2m up to 3 units side-by-side (13m long)
- Steel structure made of hot-deeped galvanized steel
- Mechanical calculation report available on request
- Simplifies pitched installation for “Self-Draining Configuration”



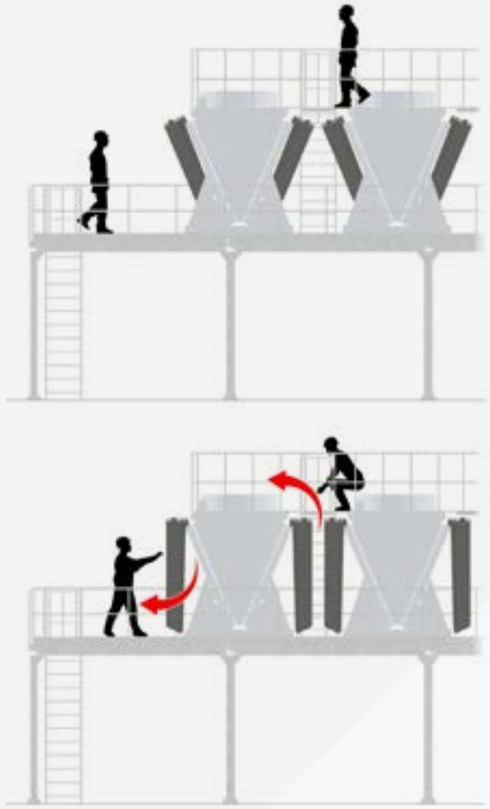
Safe Access for Service

Roof top between units for easy inspection and maintenance of pads and sprays nozzles

Silent

Specific design help to further reduce the noise emissions, up to -4dB per fan

Stay Operational with Service



The most imporant objective using an adiabatic cooling system is, on top of reliable functioning, its long lasting operation.
It starts with the planning, selection and construction of components.
Inspection and maintenance have never been so simple and easy to perform as on the ECODRY LDK.

The unique design of LDK takes into account the rules of hygenic operation, work safely at height and chemical emissions.
Further, to minimize maintenance, all parts are made in SS304L to make it highly corrosion resistant when in contact with water.

Maintenance and inspection are included in a full range of professional service packages, from commissioning, repairs and troubleshooting to expansion.

The Frigel Service includes cleaning, replacement parts and fans updating to the latest energy-saving versions, improving operating costs and reducing the carbon footprint.

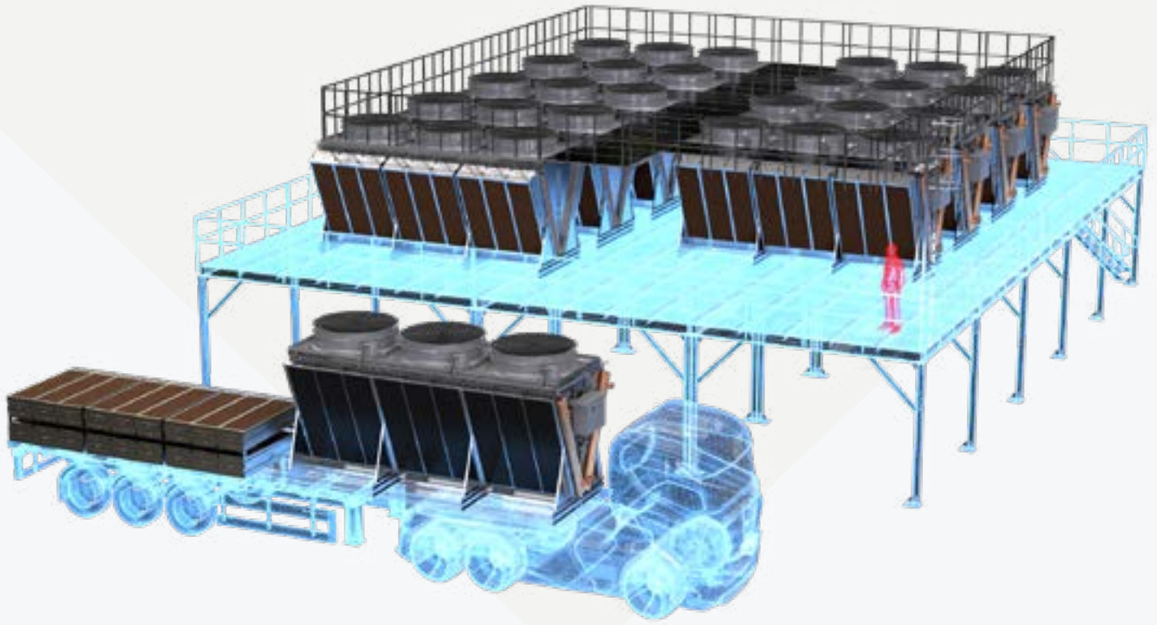
Wide range of spare parts are available for the entire life cycle.

Transport

- Fully assembled version (dry cooler) delivered on low-body trucks
- Pre-assembled with unmounted fan units for container deliveries

Install

- Factory wiring, plug &play control on board
- Trouble-free assembly of adiabatic pads
- Handrails, ladders, rooftops and legs are made for easy made for assembly
- Ready for single crane lift off truck into site position
- The sturdy construction also ensures helicopter lifts

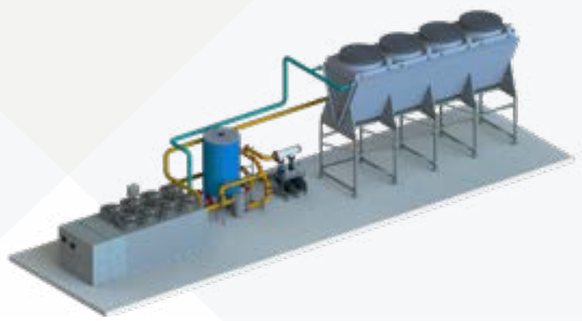


Product range

Aquagel

GPV	Modular pumping station for process with inverter
GPP	Modular pumping station for process
GPR	Modular pumping station for Ecodry recirculation
GPA	Modular pumping station for chiller recirculation
GPE	Simplified pumping station for Ecodry

GPS	Stainless steel tank from 1000 lt to 5000 lt
KTF	Stainless steel filtering system



IndustrialChiller

MRS	Air cooled chiller, small capacity up to 70 kW
MRM	Air cooled chiller, medium capacity up to 580 kW
MRT	Air cooled chiller, medium capacity (air >52°C)
3HL	Air cooled chiller, large capacity (45/52°C air)

ModularChiller

3FR + 3CR	Modular chiller with remote air-cooled condenser
3FX	Modular water-cooled chiller
3FA	Modular air-cooled chiller, same sizes as 3FX

www.frigel.com

INNOVATION | PERFORMANCE | RESPECT