Technical Specifications

Aquaflair™ Air-Cooled and Free-Cooling Chillers
Uniflair™ BREC, BREF

400V/3Ph/50Hz
400-1200kW

Schneider Electric

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AIR-COOLED WATER CHILLERS WITH AXIAL FANS
AIR-COOLED WATER CHILLERS WITH FREE-COOLING SYSTEM

BASIC VERSION

BREC – cooling only series

- Self-supporting galvanized sheet steel framework with panels painted with epoxy powder paints (colour RAL 9022)
- Two semi-hermetic double screw compressors with internal thermal protection, discharge shut-off valve, oil heaters and anti-vibration supports.
- Two refrigerant circuits conforming to EC norms (PED 97/23/EC) in copper tubes including: filter dryer, flow indicator, electronic expansion valve managed by the Uniflair™ control system, valve on the liquid line, pressure switches, transducers and manometers of high and low pressure.
- High efficiency shell & tube single passage evaporator. The heat exchanger is insulated with UV-resistant closed-cell expanded neoprene.
- Air side exchange coil with aluminum fins and internally grooved copper tubes.
- Water flow differential pressure switch.
- Acousti-Composite fans: Sickle-blade axial fans, statically and dynamically balanced, made from composite materials for high efficiency and low acoustic impact, with safety protection grilles.
- Modulating condensation control with fan speed regulation.
- Electrical panel conforming to EC Norms (Directive 2006/95/EC and EMC 2004/108/EC, IP54) with general cut-off switch, electric bars distribution for power supply, acquisition of absorbed current, maximum internal temperature control, magneto-thermal cut-off switch on the fans and auxiliaries, fuses for the compressors.
- Sequence phase, minimum and maximum power supply monitoring
- Microprocessor control system UPC1m including:
  - local user terminal with external accessibility
  - outlet chilled water temperature regulation by means of an exclusive PID algorithm
  - electronic expansion valve managed by the control system
  - advanced control of cooling capacity by automatic set-point sensitivity regulation
  - refrigerant charge monitoring
  - monitoring of the absorbed current and checking of eventual malfunctions
  - advanced anti-freeze protection on evaporator
  - integrated LAN card for local network connection of a group of chillers
  - integrated clock card
  - rotation of pump group setting functioning and start of pump in stand-by in the event of pump breakdown
- Microprocessor control system in addition allows:
  - management of double set-point from remote control
  - limiting of absorbed current on pre-set value or external signal
  - “Quick Start” procedure to reach total cooling capacity within 3 minutes.
  - free-contact for general alarm and 2 for addressable alarms
  - remote ON-OFF switch
  - ability to interface with Modbus protocol directly on RS485 serial card
  - ability to interface with main external communication protocols: Bacnet, Lonworks, Trend Metasys, TCP/IP and SNMP.

BREF – free-cooling series

- Exclusive Uniflair free-cooling system completely managed by the microprocessor control.
- Self-supporting frame in galvanized steel with panels finished in epoxy powders (colour RAL9022).
- Two semi-hermetic double screw compressors with internal thermal protection, discharge shut-off valve, oil heaters and anti-vibration supports.
- Two refrigerant circuits conforming to EC norms (PED 97/23/EC) in copper tubes including: filter dryer, flow indicator, electronic expansion valve managed by the control system, electrovalve on the liquid line, pressure switches, transducers and manometers of high and low pressure.
- Possibility of operation with external temperatures as low as -25°C.
- High efficiency shell & tube single passage evaporator. The heat exchanger is insulated with UV-resistant closed-cell expanded neoprene.
- Air side exchange coil with aluminium fins and internally grooved copper tubes.
- Water flow differential pressure switch.
- Acousti-composite fans: Sickle-blade axial fans, statically and dynamically balanced, made from composite materials for high efficiency and low acoustic impact, with safety protection grilles.
- Modulating condensation control with fan speed regulation.
- Electrical panel conforming to EC Norms (Directive 2006/95/EC and EMC 2004/108/EC, IP54) with general cut-off switch, power supply electric bars distribution, acquisition of absorbed current, minimum and maximum internal temperature control, magneto-thermal cut-off switch on the fans and auxiliaries, fuses for the compressors.
- Sequence phase, minimum and maximum power supply monitoring
- Free-cooling pump regulated by microprocessor control.
- Microprocessor control system UPC1m including:
  - local user terminal with external accessibility
  - outlet chilled water temperature regulation by means of an exclusive PID algorithm
  - electronic expansion valve managed by the control system
  - advanced control of cooling capacity by automatic set-point sensitivity regulation
  - refrigerant charge monitoring
  - monitoring of the absorbed current and checking of eventual malfunctions
  - advanced anti-freeze protection on evaporator
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  - free-contact for general alarm and 2 for addressable alarms
  - ability to interface with Modbus protocol directly on RS485 serial card.
  - ability to interface with main external communication protocols: Bacnet, Lonworks, Trend, Metasys, TCP/IP and SNMP.

AVAILABLE OPTIONS

BREC

Power supply	
	Single power supply
	Double power supply
Control	
	UPC1m with LUT mP20II
	UPC1m with touch screen LUT
Version	
	Low noise
	Ultra low noise
Fans	
	Acousti-Composite fans with asynchronous motor
	Acousti-Composite fans with EC motor
Options	
	Low external temperature
	High external temperature
Heat recovery	
	Partial condensation heat recovery
Pump group	
	Without pump/s
	1 pump
	2 pumps
Anti-freeze heaters	
	Evaporator
	Evaporator and 1 pump group
	Evaporator and 2 pumps group
Compressor options	
	Suction shut-off valves
	Economizer
Protection	
	Coils' metal grilles and filters
	Coils' manifolds protection panel
Options	
	Unit connected in LAN
	Low temperature water production
	Power phase capacitors
Packing	
	Standard packing
	Packing for container transport
Accessories supplied separately	
	Remote user terminal
	0-10V signal Set-point compensation kit
	RS485 card
	LON FTT10 card
	TCP/IP card
	Spring anti-vibration supports
	Flanged connections
	Victaulic pipe joints kit
	Lifting kit
	Remote water sensor

BREF

Power supply	
	Single power supply
	Double power supply
Control	
	UPC1m with LUT mP20II
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Version	
	Low noise
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Fans	
	Acousti-Composite fans with asynchronous motor
	Acousti-Composite fans with EC motor
Options	
	High external temperature
	Intelligent free-cooling
Heat recovery	
	Partial condensation heat recovery
Pump group	
	Without pump/s
	1 pump
	2 pumps
Compressor options	
	Suction shut-off valves
	Economizer
Protection	
	Coils' metal grilles and filters
	Coils' manifolds protection panel
Options	
	Unit connected in LAN
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	Flanged connections
	Victaulic pipe joints kit
	Lifting kit
	Remote water sensor

NOTES FOR THE SELECTION

- All the configuration items must be completed.
- All the versions are equipped with modulating condensation control as standard, but in order to operate with external temperatures lower than 0°C, it is necessary to fit the units with crankcase heaters for the compressors and an anti-condensation heater for the electrical board. These devices are in the “Low ambient temperature” option
- The models 1602A – 1802A – 2202A – 2502A – 2802A can operate with external temperatures up to 50°C without additional accessories, therefore the option “High ambient temperature” is already included in the basic version.

MAIN COMPONENTS

BREC/F units are designed and built to guarantee the production of chilled water 24 hours a day, all year round, with the highest levels of safety and reliability.

For this reason, only the best components are used in its construction and Uniflair constantly strives to improve the products offered to its clients in terms of:

- reliability
- ease of installation and maintenance
- quiet operation
- compactness
- resistance to corrosion
- energy efficiency
- operating precision

Frame

In order to ensure resistance to external environmental corrosion, the structure and panels of the casing are produced entirely in galvanized steel (RAL 7037 colour). The paint conforms to ASTM B117 standard regarding resistance to saline humidity; therefore the units can be installed in even the most testing of atmospheric conditions. All external fastenings are in stainless steel. The closing mechanism on the casing gives IP54 protection.

Refrigerant

As Uniflair is and always has been, an environmentally conscious company, these units have been designed for use with the ecological refrigerant R134a. “Ecological" in that it does not harm the ozone layer and contributes less to global warming (The TEWI* index value is very low, 10% less than R407C).

*TEWI (Total Equivalent Warming Impact): parameter relating to the emission of refrigerant during the unit life-cycle, and the indirect emissions of CO_2 for energy production

Main refrigerant components

The units are equipped with two cooling circuits conforming to EC Directive (PED 97/23/EC) including:
- dehydration filter
- liquid sight glass
- electronic expansion valve managed by the control system
- solenoid valve on the liquid line
- high and low pressure pressure switch
- high and low pressure transducer
- high and low pressure manometer

Compressors

The units are equipped with two double screw compact compressors. These compressors are supplied by the market's leading manufacturers. They are supplied with a temperature sensor fitted in the over-current protection windings, a non-return valve on the delivery line both for preventing screw reverse rotation and to allow equalisation of the pressure values inside the compressor for pressure free starting. Both compressors have partial heat recovery in four steps (0 – 25 – 50 – 75 – 100%) and, therefore, the temperature of discharged water is controlled in 8 steps:

0%	**13%**	**25%**	**38%**	**50%**	**63%**	**75%**	**88%**	**100%**

This ensures high EER values at part loads. To attenuate the transmission of vibrations, and therefore reduce noise levels and possible faults, each compressor is fitted on rubber antivibration supports.

Water side heat exchanger

The evaporator fitted in BREC/F units is a high efficiency shell & tube single passage evaporator.

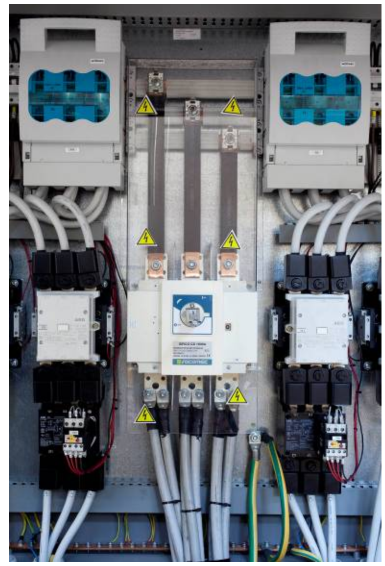
This type of “single passage” evaporator allows for:
- maintaining the flow of water horizontally, guaranteeing a uniform temperature of the volume of water even in partial load conditions or when one of the circuits is not operating
- the flow of refrigerant to be straight, facilitating the drag of oil inside the tubes
- the thermal exchange to always occur “against the current” so ensuring maximum possible efficiency

The heat exchanger is insulated with UV-resistant closed-cell expanded neoprene.

Air side heat exchanger

The condenser (evaporator) is generously proportioned in order to function at high ambient temperatures. It is made from a coil equipped with aluminium fins and mechanically expanded copper tubing in order to obtain optimum metallic contact for maximum exchange efficiency.

Electrical panel



Placed in appropriate areas, conforming to EC Directives (2006/95/EC & EMC 2004/108/EC) with:

- IP54 protection grade
- Lockable general cut-off switch
- Electric bars distribution
- Acquisition of the absorbed current
- Phase sequence control, minimum and maximum power supply
- Maximum internal temperature control
- Anti-condensation resistance (for low ambient temperature option)
- Thermo-magnetic protection for the fans and auxiliaries, fused on the compressors
- Remote control switches for the compressors
- Auxiliary transformer at 24V and 230V
- Motor protector for the pump/s and the free-cooling pump (BREF)

Electrical panel: double electrical supply (Optional)

With the aim of guaranteeing a redundancy even in terms of electrical supply the BREC/F can be provided with the option of double power supply with automatic commutation. The unit, equipped with double port isolator and control room, can be connected to two separate electric lines, generally with one connected to a principal line and the other to a generator or emergency line.

In case the principal line is not defined, the unit autonomously switches over to the other, at the same time verifying an eventual return of supply. When the principal line becomes available again the supply is restored to this line. Thanks to the fact that this solution allows both definition of the priority line and the frequency of checking, the units equipped with double power supply guarantee absolute continuity of service. Activating the “Quick Start” procedure (see Control section) the problems resulting from a lack of power supply can be resolved in less than three minutes.

Electrical panel: separate power supply for control and auxiliaries (Optional)

With the aim of guaranteeing a continuous power supply for the control & the protection devices from an external UPS.

Microprocessor control - UpCO1m control

The UpCO1m control system consists of two sections:

- a Control Board which consists of one (UPC1m) I/O board containing the regulation software and which is fitted in the unit.
- a User Terminal which consists of a user interface and which can be installed locally or remotely.

The control system uses specifically designed sophisticated algorithms in order to control the outlet water temperature within a minimal range and to monitor and protect the various unit components. The user interface provides clear information on the unit status and any current alarms.

Control card

This new advanced control is designed to be highly flexible and can be easily adapted for use with both comfort and technological applications, allowing the management of partialization steps. The control system regulation programme can be found in the FLASH-EPROM on the main board. The programming of the control parameters (set points, differentials, alarm thresholds) and the displaying of data and events (set point readings, monitored values, function events and alarms) is carried out using the User Terminal. The UPC1m control card uses a 16-bit microprocessor and up to 2Mbyte flash memory, ensuring high performance in terms of processing speed and memory space.

Features:

- 14MHz, 16bit microprocessor, 16bit internal registers and operations, 512 byte internal RAM
- FLASH MEMORY up to 2Mbyte for the program
- 128Kbyte static RAM
- RS485 serial connector for LAN (LAN card)
- 24Vac/Vdc power supply
- Telephone connector for user terminals
- Power indication LED

Main functions

The principal control functions are:

- Regulation
  - Chilled water outlet temperature regulation by means of an exclusive PID algorithm
  - Modulating condensation pressure control
  - Management of the electronic thermostatic valve
  - Advanced control of the cooling capacity by means of the self-adjusting set-point sensitivity regulation
  - Double set-point with contact selection
  - Set-point compensation based on the external temperature (settable)
  - Intelligent free-cooling management (BREF)
  - Rapid “Quick Start” procedure to reach total cooling capacity within 3 minutes
  - Unloading to protect unit operation even with temperatures which exceed the maximum
- Operation
  - Remote ON-OFF control
  - Limiting of absorbed current on the pre-set value or external signal
  - Partial heat recovery management with rotation of pump group on a time basis for equal operation and start of the pump in stand-by in the event of malfunction
  - High/low pressure transducer
  - Integrated clock card
  - Advanced anti-freeze protection on evaporator
  - Integrated LAN card for local network connection of a group of chillers
  - Compatibility with BMS via Modbus protocol with RS485 serial card
  - Compatible with the main external BMS: LONworks, BacNET, TCP/IP, Trent
  - Inter-connected management of more than one chiller (up to 10)
- Safety / alarms
  - Refrigerant charge monitoring
  - Monitoring of the absorbed current and checking of eventual malfunctions.
  - Emergency function to ensure continuity of service even in the event of sensor or transducer breakdown.
  - Management of anti-freeze resistance and minimum temperature of the electric board
  - Advanced anti-freeze protection on the evaporator
  - Alarm events history (relating to date and time of event)
  - General alarm contact (addressable)
  - Addressable alarm contacts (2 in total)
  - Compressor function analysis
  - Compressor rotation (FIFO logic)
  - Compressor operation hours run
  - Programmed maintenance threshold signalling

Local user terminal (mP20II)

The local user terminal comes supplied with the standard unit and allows the control parameters to be programmed (set points, differentials, alarm thresholds) and data and events to be displayed (set point readings, monitored values, function events and alarms).

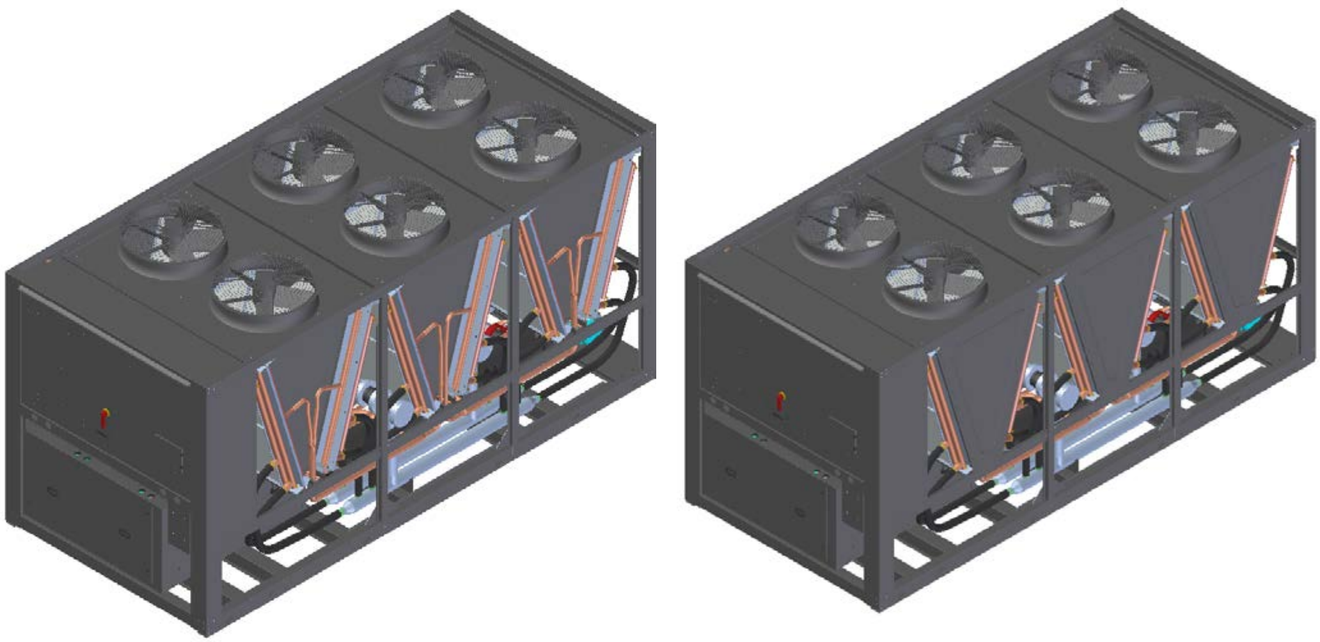
Remote user terminal (mP20II)

It is possible for the unit to be supplied with a remote control which enables commands to be entered directly to the chiller; this can be positioned up to 200metres away (with a shielded cable). With this accessory, the exact same operations are possible as with the local terminal. A wall fixing kit is available for remote fitting.

Protection accessories

The units can be supplied with the following optional protection accessories:

- Condensers or free-cooling coil filters and protection grilles: although naturally protected by the “V” formation, the air side exchangers can be protected by means of metal filters provided with grilles.
- Coil manifold protection panels: protection panels are available for the piping connections to the condensers (see below)



Anti-vibration supports

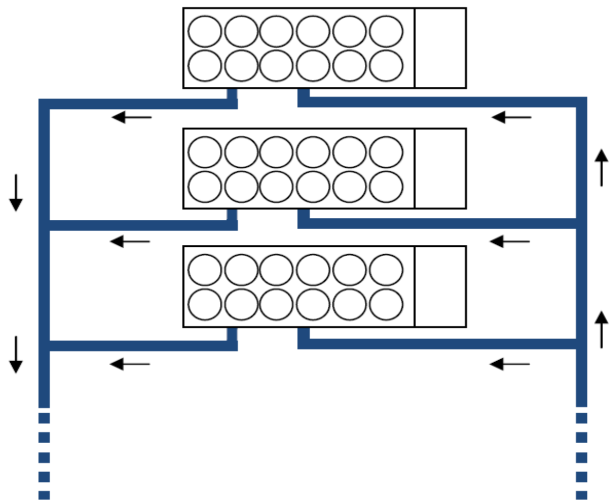
Spring anti-vibration supports are available as an option to insulate the unit from the support slab.

CONNECTION LOGIC FOR UNIFLAIR CHILLERS

Uniflair water chillers equipped with advanced control board (UpCO1m) have the Local Area Network card (LAN) integrated on the mainboard.

Therefore these units can be connected together in order to adapt the logic to the site requirements.
Generally the units are installed in parallel on the hydraulic side and on the control logic point of view, the available operating modes are:

A. Singular
B. Interlaced
C. Cascade



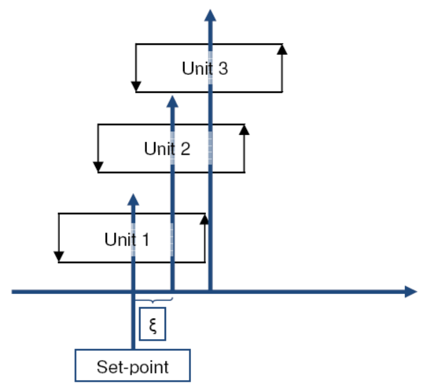
All of the units use an algorithm to control the temperature of the chilled water based on the discharge temperature of the water. Moreover, the algorithm uses the inlet water temperature to minimize the compressor start-ups; in fact, a P.I.D. algorithm controls the discharge temperature of the water proportionally, but also uses an integrated and derivative process on the inlet water temperature to minimize the compressor start-ups.

In this way, the UNIFLAIR control system can be considered an evolution compared to the traditional systems of control which operate "predictably" on the discharge water temperature.
The outlet water temperature value can be taken onboard the chiller (on the discharge side of the evaporator) or, with the optional remote water sensor, along another point for the plan.

Connection logic mode "A"
It permits to the unit to operate in autonomous way, without considering the other units. With this option the LAN signal permits the rotation only in case of failure or time-based rotation.

Connection logic mode "B"
Two or more chillers setted in interlaced mode operate as a single unit.
They acquire the outlet water temperature value introducing with a small gap (offset) between themselves in order to be avoid simultaneous switching on.
The offset is calculated using the LAN address and other parameters.

Considering two units, both operating and fitted with two screw compressor each, the control logic will be the following:



- Unit 1, compressor 1, step 1
- Unit 1, compressor 1, step 2
- Unit 2, compressor 1, step 1
- Unit 2, compressor 1, step 2
- Unit 1, compressor 2, step 1
- Unit 2, compressor 2, step 1
- Unit 1, compressor 2, step 2
- Unit 2, compressor 2, step 2
- Unit 1, compressor 1, step 3
- Unit 2, compressor 1, step 3
- Unit 1, compressor 2, step 3
- Unit 2, compressor 2, step 3
- Unit 1, compressor 1, step 4
- Unit 2, compressor 1, step 4
- Unit 1, compressor 2, step 4
- Unit 2, compressor 2, step 4

Connection logic mode "C"
Two or more chillers disposed in cascade mode operate as two chillers in sequence.
They acquire the outlet water temperatures and operate with the average value calculated with a small gap (offset) calculated using the LAN address and other parameters in order to be avoid simultaneous switching on.

Considering two units, both operating and fitted with two screw compressor each, the control logic will be the following:

- Unit 1, compressor 1, step 1
- Unit 1, compressor 1, step 2
- Unit 1, compressor 2, step 1
- Unit 1, compressor 2, step 2
- Unit 1, compressor 1, step 3
- Unit 1, compressor 2, step 3
- Unit 1, compressor 1, step 4
- Unit 1, compressor 2, step 4
- Unit 2, compressor 1, step 1
- Unit 2, compressor 1, step 2
- Unit 2, compressor 2, step 1
- Unit 2, compressor 2, step 2
- Unit 2, compressor 1, step 3
- Unit 2, compressor 2, step 3
- Unit 2, compressor 1, step 4
- Unit 2, compressor 2, step 4

MAIN COMPONENTS – DETAILS
R134a ENVIRONMENTALLY-FRIENDLY REFRIGERANT

The majority of synthetic refrigerants contribute towards the increase in global warming, the refrigerant R134a however, allows for operation with extremely low values according to the GWP and TEWI parameters concerning environmental impact. The refrigerant R134a however, thanks to its thermodynamic properties and the fact it is a mono-component refrigerant, is characterized by intrinsically high efficiency due to the complete absence of glide and therefore subsequent energy losses during the change of state phases.

Parameters have been established to determine the environmental impact of different kinds of refrigerant:

- **O.D.P.** (Ozone Depletion Potential): can register a value between 0 and 1 (CFC-R12 = 1)
- **G.W.P.** (Global Warming Potential): the relationship between the overall warming caused by a particular substance and the one caused by CO_2 carbon dioxide.
- **T.E.W.I.** (Total Equivalent Warming Impact): parameter relating to the emission of refrigerant during the unit life-cycle, and the indirect emissions of CO_2 for energy production

It is, in fact, important to assess the environmental impact of a given substance, not only intrinsically, that is, considering its chemical-physical features only, but also its application and effects during the entire duration of use. In cooling devices, most of the contribution to the greenhouse effect (approximately 90%, if not more) is caused by energy consumption, or rather, in indirect terms to the amount of CO_2 produced by power plants for supplying the energy necessary for operating the device.

It is thus essential to consider the energy consumption of a unit, and its ability to guarantee and maintain high energy efficiency during the entire product life-cycle. The T.E.W.I. index considers both the direct impact a substance has on the greenhouse effect, and its indirect contribution in terms of CO_2 equivalent.

It takes the following points into account:

- refrigerant losses
- energy efficiency
- refrigerant recycling

Consequently, from the point of view of energy efficiency, the kWh consumed by the unit must be calculated and converted into the CO_2 produced. The higher the unit C.O.P. (or E.E.R.), the lower the environmental impact at the same cooling performance.

This is the addition of the most significant T.E.W.I. when dealing with cooling equipment, which takes into account the indirect contribution to the greenhouse effect. This component of the T.E.W.I. varies from country to country as the kWh –> CO_2 conversion coefficient depends on the power plants considered and the amount of fossil fuel they use.

Refrigerant losses must obviously be kept to a minimum and unit energy efficiency maintained. In the case of non-azeotropic refrigerants, loss of part of the fluid leads to the complete recharging of the cooling circuit, and it will not necessarily maintain the declared efficiency.

T.E.W.I. =	m × L × n × G.W.P.	+	β × E□× n	+	m × (1-α) × G.W.P.
	refrigerant losses		unit efficiency		recycle
	unit related factors				maintenance related factors

Key:

- m: refrigerant charge in kg
- L: % annual loss of refrigerant
- n: product lifespan in years
- GWP: global warming potential in $kgCO_2$/ kg
- β: emission of CO_2 in the power plant for each kWh produced
- E: annual energy consumed in kWh/ year
- α: refrigerant recovery factor at end of life
- (α =0.....no recovery; α=1......total recovery)

REFRIGERANT	TYPE	O.D.P.	G.W.P.	T.E.W.I.(*)
R22	HCFC	0,05	1700	1968
R134	HFC	0	1300	1821
R407C	HFC	0	1600	2032

(*) per year, specific (each kW, each year), with assumed total refrigerant recovery factor at end of life (α=1)

THE COMPACT SCREW COMPRESSOR: A BRIEF DESCRIPTION

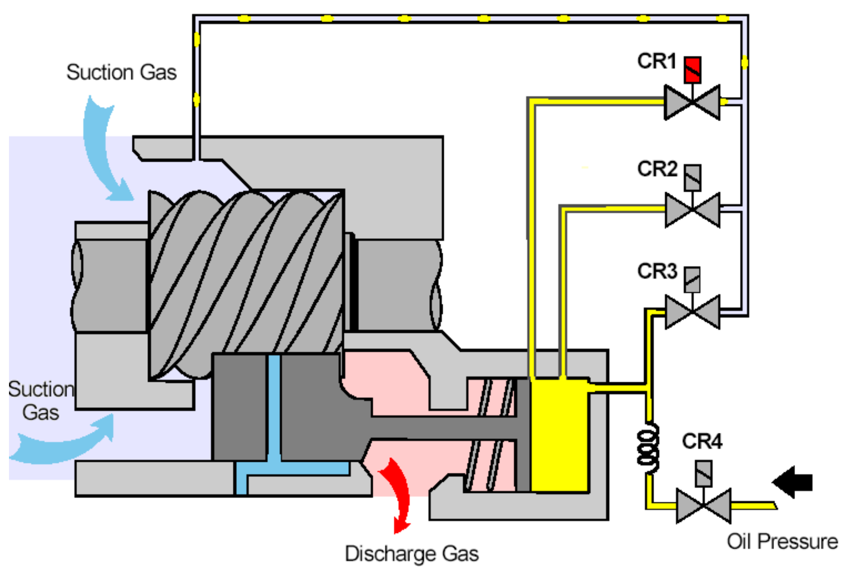
The productivity of a chiller, precision air conditioning unit or heat pump greatly depends on its dynamic behaviour. In particular, when there are great load variations, an elevated quality of regulation with small step power control is necessary. Compact screw compressors offer the best characteristics for these needs. Unlike compressors for large refrigerant systems equipped with externally positioned oil separators (and in some cases, even oil-coolers), compact screw compressors are equipped with an integrated, three stage oil separator with relative oil management system. This design has proved to be particularly advantageous when employed in conditions which don't exceed average pressure values, such as in the case of liquid coolers.

Basic construction design characteristics

- Screw profile: double rotor solution (5:6 profile ratio)
- Semi-airtight constructive design, cooled with intake gas
- Double wall rotor chassis with pressure compensation: guarantees increased strength and prevents, even in conditions of high pressure, rotor chassis deformation which can reduce efficiency. Moreover, the double wall design allows for further noise reduction.
- Long lasting rolling-contact bearings with pressure reduction. This not only reduces stress on the rolling-contact bearings, but it also provokes a degassing process of the bearing chamber (almost reaching intake pressure levels) which is situated on the high pressure side, and, at the same time, provokes a significant increase in oil viscosity.

Power regulation with the sliding valve

Unlike other construction designs where the slide valve is introduced into a cylinder which is positioned parallel to the rotor chassis, the slide valve is in direct contact with the screw profile which clearly provides higher-efficiency levels in full or partial load conditions. This is achieved by adapting the slide valve's shape to the rotor profiles which do not have fissures, interspaces or by-pass apertures which reduce the efficiency. The slide valve is hydraulically shifted along the axis to regulate the power. The motion of the slide valve is controlled by the equilibrium of the involved pressure forces which act upon it. On the left hand side of the slide valve the intake pressure rules, on the right, high pressure.



The pressure in the cylinder (see right hand side of diagram) establishes whether the piston runs left (in the direction of maximum power), runs right (partial load) or remains in the same position. If the pressure is reduced to the intake value by one of the CR1, CR2 or CR3 valves, the slide valve is moved in the direction of partial load. If it occurs by means of the CR4, highly pressurised oil is introduced into the cylinder and there is a movement towards full load. If the cylinder volume is unaltered, the slide valve position is maintained. Through the control of the valves CR1….CR4, power control occurs in a small step mode (100-75-50-25%). The purpose of the integrated spring is to bring the slide valve to a position of minimum power when the compressor is turned off (pressure balance – CR3 open). In this way, baseload start up is guaranteed.

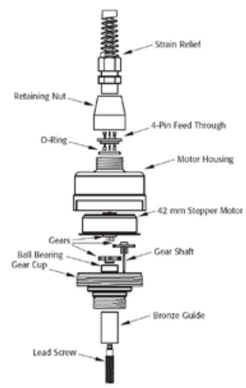
THE ELECTRONIC EXPANSION VALVE

This valve offers important advantages both for air conditioning units and water cooled chillers which are to be used for process applications and cooling systems. An electronic expansion valve consists of two main parts: the valve itself and the step by step motor. The motor is situated in the upper part of the valve and is connected directly to the body of the valve. The body of the valve, including the valve and the motor, is hermetic and welded in order to eliminate the risk of refrigerant leaks. As is the case for the compressors, the valve motor is in contact with the refrigerant and the lubricating oil, the materials for both devices are also substantially the same.

Operating system

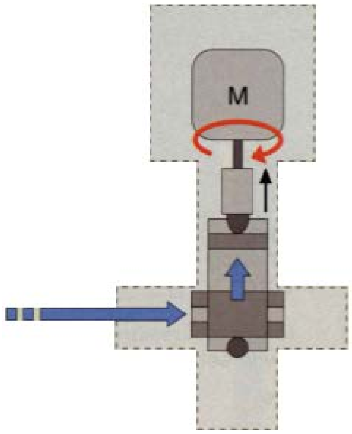
Step by step motor
The electronic expansion valve is equipped with a bipolar, 2-phase motor which has the operating characteristics typical of any step by step motor. It is kept in position until the pulses of current from the driver command it to rotate in one of the two directions. Each impulse commands the rotation of the rotor for one step, and it is rotated for a set degree, while a series of pulses produce continuous rotation of the rotor. The number of steps or levels is extremely high in order to offer a wide and refined regulation field. A mechanical device transforms the rotation movement of the shaft in a linear movement which enables the running of the regulation element of the valve.

The valve
The valve is designed to control the flow of refrigerant which has linear characteristics, in such a way as to allow a wide range of variation in capacity with a linear relationship between the flow and the position of the valve itself. The refrigerant inlet and outlet and the regulation element are made of materials which ensure operating precision over the years as well as an extended operating life.

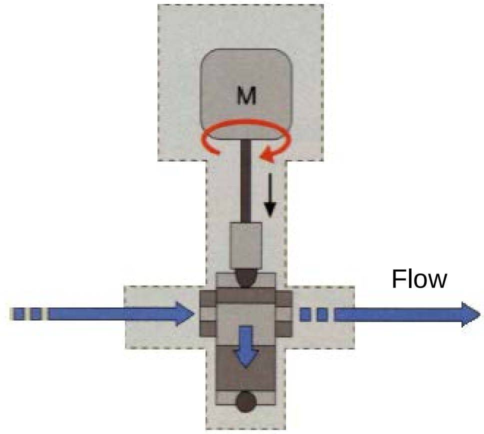


Electronic expansion valve operation
Ordinary thermostatic expansion valves are self-activating, that is, they are activated by the pressure under which they are subjected to with the help of an internal retaining spring. Instead, electronic expansion valves are not self-activating and the step by step motor requires external elements and functions in order to be able to carry out its own action. Two things are essentially necessary: an external driver and an algorithm which establishes the operation of the valve itself.

The Driver
The driver is an electronic control unit which controls the position of the valve by means of digital pulses which open and close the electric contacts in a determined sequence to control the movement of the step by step motor in a clockwise and anti-clockwise direction. The algorithm is written in a determined language to control the operation of the valve according to variations in the parameters and/or variations within the system.
The electronic expansion valve modulates the mass flow of refrigerant into the evaporator according to the sensor signals, the control algorithm and the drivers. The characteristics of the electronic expansion valve enable the integration of additional functions in the refrigerant cycle, like the interception of the refrigerant, the regulation of the suction pressure and the control of the refrigerant load.



Completely closed



Completely open

The drivers are devices which control the opening of the electronic expansion valves according to the superheating required. Therefore, as long as the compressor is not activated, there is no passage of refrigerant through the valve. When there is a request for cooling, and the compressor is activated, the drivers are informed of the action which is taking place and this can happen in two ways: by means of a digital input (stand alone) or by means of a signal from the microprocessor which manages the system. When the information reaches the driver, it starts to control the mass flow of refrigerant, positioning the electronic expansion valve in the operating conditions required according to the operation of the system.

Usually a stand-alone driver is made up as follows:

- hardware which controls the direction of the step by step motor according to the input signal
- algorithm to obtain correct performance of the system depending on the various conditions.
- parameters which allow the “plug & play” operation in different systems
- Alarms output

The Uniflair Control system is connected to the driver of the expansion valve which therefore, in addition to standard functions, allows the acquisition of operating and alarm signals in order to ensure complete control of the refrigerant circuit.

PREDICTIVE MAINTENANCE

Predictive maintenance, also known as PdM, is the technique used to determine the correct equipment performance during operation.Evaluating the correctness, or otherwise, using this technique, one can predict if and when a possible maintenance intervention may be required.

PdM solutions allow for the evaluation of the real operating conditions by means of continuous monitoring of the operating conditions of the elements which make up the equipment. This approach offers a tangible benefit, maintaining the performance unaltered over time, increasing reliability, rendering the ordinary maintenance operation more effective and reducing the possible downtime of the unit.

The components and algorithms which make up the predictive maintenance are based on the direct acquisition of all the operational parameters of the unit, on comparison with the optimum operating conditions, the default of each component and on the evaluation of the future performance of the equipment.

In this way, it is possible to:

- recognize each operational parameter, to identify possible anomalies.
- make each component operate within its own functional parameters
- intervene preventatively for maintenance interventions
- intervene correctly for operations of extraordinary maintenance.

The Uniflair Control software checks the complete operative state of the chiller, not only registering malfunctions or abnormal conditions, but assuming the necessity/type of service requested. In particular, indirect monitoring of the refrigerant load can quickly signal an alarm avoiding any significant loss.

Refrigerant leak detection

In conjunction with the electronic expansion valve and associated sensors, the system continually checks a whole series of operating parameters including condensing and evaporating pressures, superheat and sub-cooling values, as well as the current absorbed, which between them, when evaluated by the Uniflair Control software, give an indirect indication of the refrigerant charge.

Management of the external temperature

The BREC/F units are equipped with modulating condensation control, therefore, influence of the external temperature variations on the condensation pressures are managed by varying the speed of the ventilating section and the cooling capacity of the unit (unloading).The Uniflair Control software monitors the operational parameters allowing for discrimination between the situation in which the increase in condensation pressure is caused by the external temperature or by other causes.In this way, interventions can be limited for high pressure alarms only in the event of a real problem, by a preventative alert.

Advanced antifreeze protection for the evaporator

One of the most critical factors for a chiller is the possible formation of ice inside the evaporator. In fact, if the installation does not use an antifreeze mixture, ice can form even if the registered temperature of the water maintains a value above zero, with disastrous consequences for the exchanger and consequently for the installation. In order to avoid this happening it is necessary to evaluate the refrigerating group as a whole.

The advanced antifreeze function serves to understand if there is or isn’t the formation of ice inside the evaporator, using this technique, and therefore the pressures, the current temperatures and not least the ideal cooling capacities are registered, compared and checked. As soon as ice starts forming the direct consequences on these parameters quickly manifests the phenomenon, presenting the possibility to intervene before any actual damage occurs.

ACOUSTI-COMPOSITE FANS

BREC/F units are equipped with new generation axial fans made from a composite material: aluminium and reinforced plastic material. This solution creates significant advantages in terms of efficiency, reliability and acoustic impact.

Efficiency
These fans feature a “heart” made from aluminium and blades made of plastic. This allows better heat dissipation compared to fans made only from polyurethane. The currents involved are lower thanks to the reduction in weight which leads to lower inertia.

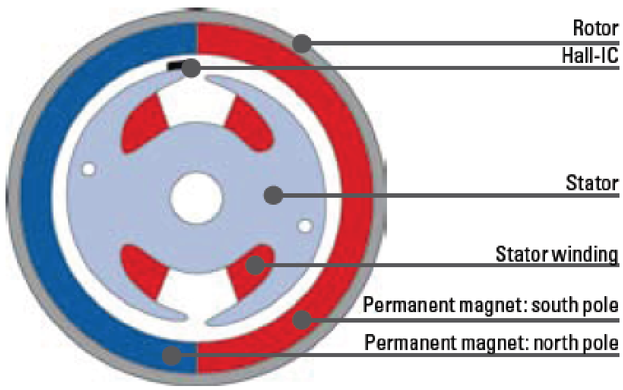
Reliability
The fact that these fans are coupled with a motor by means of a metallic cross section means that there is improved resistance compared to fans made only from polyurethane and a reduction in weight compared to those made completely from metal.

Acoustic impact
Acoustic impact and efficiency are closely linked to the “cleaning” of the air flow through the fans.
The use of fans made from plastic allows forms, and consequently performance, to be achieved which are not possible with aluminium fans, resulting in an improved air flow.

Sustainability – reduced use of resources
The use of a critical raw material such as aluminium is limited to only the internal section of these fans.

ACOUSTI-COMPOSITE FANS WITH ELECTRONICALLY COMMUTATED MOTOR (EC)

The electronically commutated (EC) electric motor is a motor synchronized by permanent electronically commutated magnets.



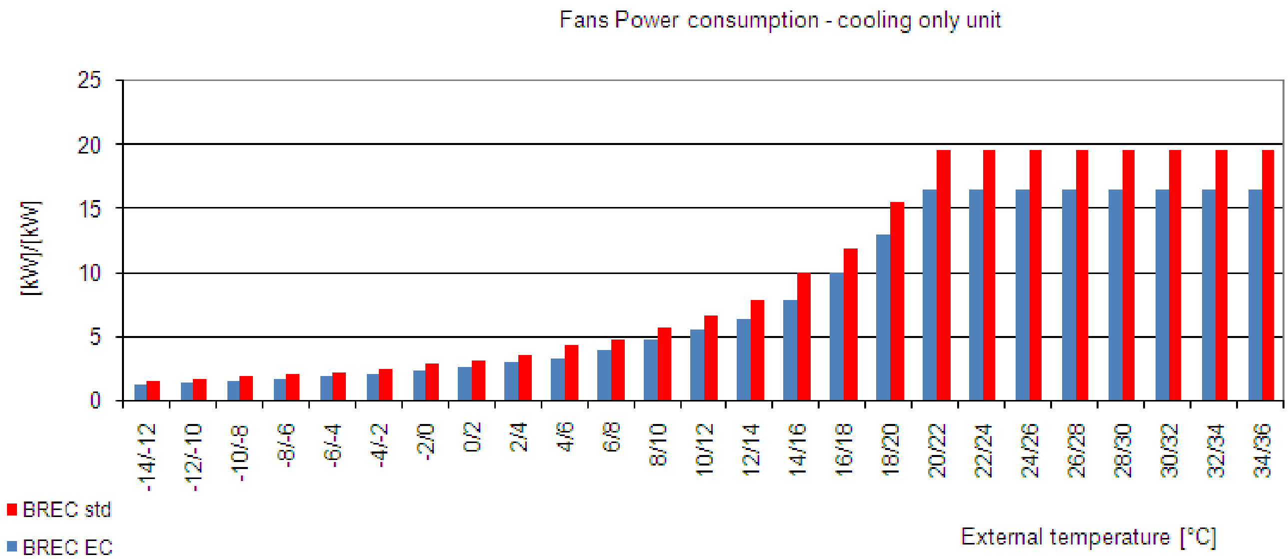
The units with an EC electric motor guarantee:

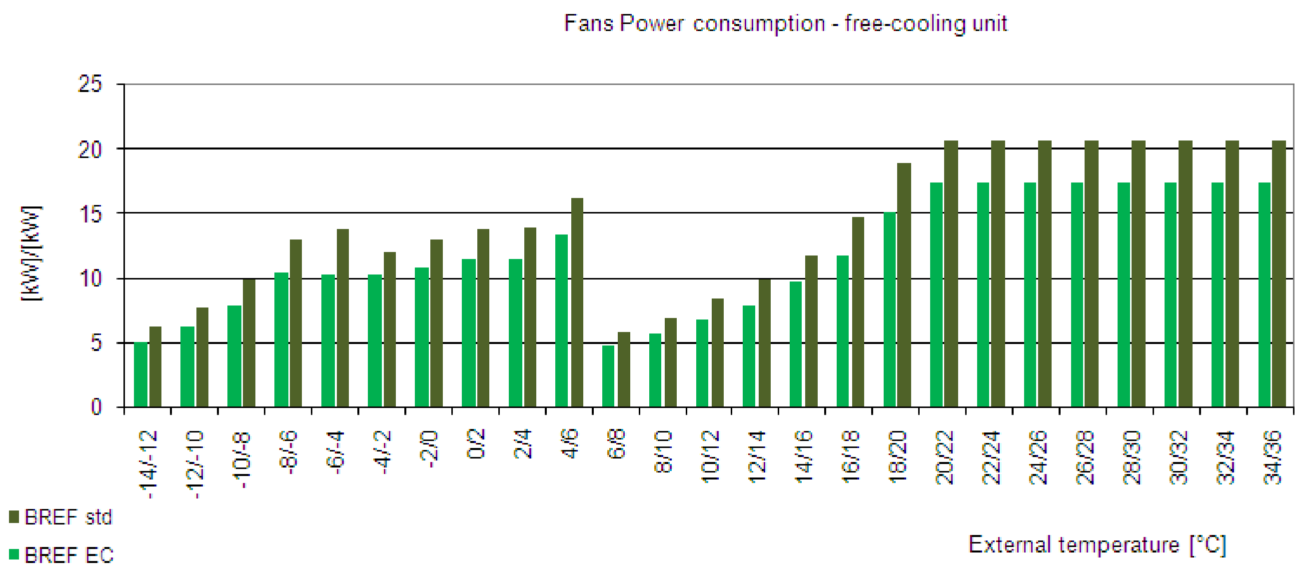
- **High reliability:** the commutation is made by a power transistor, therefore there are no mechanical elements present such as a collector or brushes which limit the working life. In EC motors the magnetic field is generated by the same rotor thanks to the presence of permanent magnets. The commutation of the magnetic field is electronic and consequently free of wear and tear resulting from contact between static and rotating parts.
- **High efficiency:** The operating mode and materials used result in an increased efficiency which can be demonstrated by less absorption with the same performance.
- **Lower in-rush current** thanks to "Soft Start" start-up due to the absence of mechanical elements.
- **Low noise impact,** particularly during regulation. In general, the speed regulation of traditional fans occurs by means of phase cutting.

  This type of regulation is so called as it "cuts" the sinusoid of the power supply.
  In this way, the power supply of the electric motor is reduced, increasing the slip and reducing the speed.
  This "cutting" of the power supply implies that the motor is as if supplied by a series of sinusoids of multiple network frequencies.

  This therefore creates "anomalous" coupling (i.e. forces) between the stators and the rotors which causes more noise in the motor in respect to a power supply with a "clean" sinusoid.
  In fans with an EC motor the speed is altered by varying the magnetic field, so resulting free from the phenomenon described above.

High efficiency
Below are illustrated the results of a comparison of the two units BREC/F 4812A supplied with fans with an asynchronous motor or EC type.





ENERGY EFFICIENCY AT PART LOAD: I.P.L.V., E.M.P.E. AND E.S.E.E.R. PARAMETERS

Tandem units are equipped with two separate compressors on the same circuit. The exchange surfaces are constant and sized for the maximum available power which can be supplied; this means that, when the power is reduced (partialized unit), the thermal differences in the heat exchangers are reduced (due to an increase in the evaporation temperature and a decrease in the condensing temperature of the refrigerant cycle) allowing elevated efficiency even during operation at partial load.

I.P.L.V. and E.S.E.E.R.

Energy indexes define the behaviour of a chiller in particular situations. There are energy indexes which refer to nominal conditions and seasonal energy indexes, which are more reliable and which enable the average energy consumption over a year to be calculated.

The principal indexes are the C.O.P. and the E.E.R., while the following stand out from the remainder:

- **I.P.L.V.**: Integrated Partial Load Value
- **E.S.E.E.R.**: European Seasonal Energy Efficiency Ratio

The criteria used to establish these indexes allow the annual behaviour of a chiller to be analysed using a single figure in the considered operating conditions. These parameters are essentially the average found by the E.E.R. at different loads (100%, 75%, 50% and 25%) and differ from each other regarding the weight given and the conditions in which the different E.E.R. are calculated.

$$\underbrace{PE_{100\%} \cdot EER_{100\%} + PE_{75\%} \cdot EER_{75\%} + PE_{50\%} \cdot EER_{50\%} + PE_{25\%} \cdot EER_{25\%}}_{IPLV-ESSER}$$

Where:

- P.E. is the “weight” given to each operating condition
- E.E.R. represents the energy efficiency at different load conditions

The three parameters are issued from ARI, AiCARR and Eurovent respectively. The I.P.L.V. (Integrated Partial Load Value) was established by the American ARI Standard 550. Thanks to the E.E.C.C.A.C. study the European Union is also equipped with a seasonal energy index which is called E.S.E.E.R (European Seasonal Energy Efficiency Ratio),which is based on experimental tests, and the average European operating conditions.

Note
These indexes are applied to units using the refrigerant circuit throughout the whole year, therefore, it is not possible to include units with free-cooling devices when calculating these indexes.

I.P.L.V.
The American standard ARI (Air Conditioning & Refrigeration Institute) has put forward an energy index called I.P.L.V. which is contained in the 550 - 590 Standard and it’s various updates. The I.P.L.V. calculation is made according to the following formula:

$$\underbrace{0{,}01 \cdot EER_{100\%} + 0{,}42 \cdot EER_{75\%} + 0{,}45 \cdot EER_{50\%} + 0{,}12 \cdot EER_{25\%}}_{IPLV}$$

The calculation conditions are:
Evaporator:

- Outlet temperature: 6,7°C
- Delta T: 5°C (at nominal conditions)
- Constant water flow at partial load
- Fouling factor: 0,018m^2°C/kW

Condenser:

- Fouling factor: 0,044m^2°C/kW

Load	Weight	Tin air condenser	Tout water evaporator
%	%	°C	°C
100	1	35	6,7
75	42	26,7	6,7
50	45	18,3	6,7
25	12	12,8	6,7

E.S.E.E.R.

Through the E.E.C.C.A.C. study (Energy Efficiency and Certification of Central Air Conditioners) carried out by the European Commission, an accurate investigation into the energy efficiency of commercial chillers at nominal and part load operation has been made. Simulations have been carried out in buildings which are representative of the European norm with different climatic conditions, the result is an energy index called E.S.E.E.R. which best represents the real operating conditions of chillers throughout Europe. The formula used to calculate the E.S.E.E.R. is similar to that used for the I.P.L.V. and the E.M.P.E but with different values for the energy weights and the conditions on which the E.E.R values are calculated.

$$\underbrace{0{,}03 \cdot EER_{100\%} + 0{,}33 \cdot EER_{75\%} + 0{,}41 \cdot EER_{50\%} + 0{,}23 \cdot EER_{25\%}}_{ESEER}$$

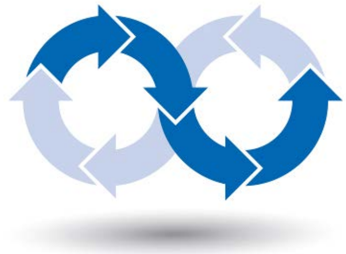
The calculation conditions are:

Evaporator:

- Outlet temperature: 7°C
- Delta T: 5°C (at nominal conditions)
- Constant water flow at partial load

Load	Weight	Tin air condenser	Tout water evaporator
%	%	°C	°C
100	3	35	7
75	33	30	7
50	41	25	7
25	23	19	7

FREE-COOLING SERIES



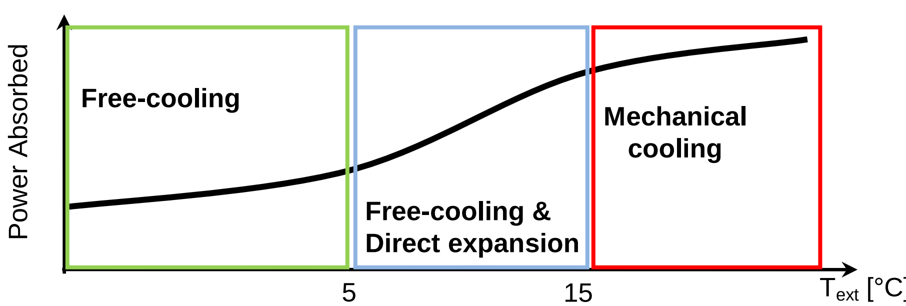
If the system involves technological systems or industrial processes which operate continuously throughout the year, and therefore also with low external temperatures, it is energetically convenient to use systems which have been designed to exploit these conditions; cooling systems with a free-cooling device are a typical solution.

ERAF are free-cooling chillers and in these units, if the external temperature is low enough, it is possible to reduce or even eliminate, depending on the external temperature, the use of the “refrigerant” part of the chiller, i.e. the compressors, which are the components principally responsible for energy consumption by exploiting the air / water exchangers which are integrated in the unit itself. In this way, chilled water is produced using external air and energy consumption is therefore limited to the fans.

Chilled water can therefore be available at absolutely no cost. Since, when the climatic profiles of the main European cities are analysed, the most frequent temperatures are between 0 and 15°C, it is important to design free-cooling methods which maximise performance within this temperature range.

For this reason, Uniflair units which are equipped with free-cooling devices allow operation even when the external temperature is able to guarantee only partial rather than complete dissipation of the thermal load. In these cases, operation is usually called mixed: the refrigerant uses external air to pre-cool the water in the system, allowing the compressors to work less and create energy savings. In fact, the thermal load which needs to be dissipated by the evaporator is less then that of a standard chiller operating in the same conditions.

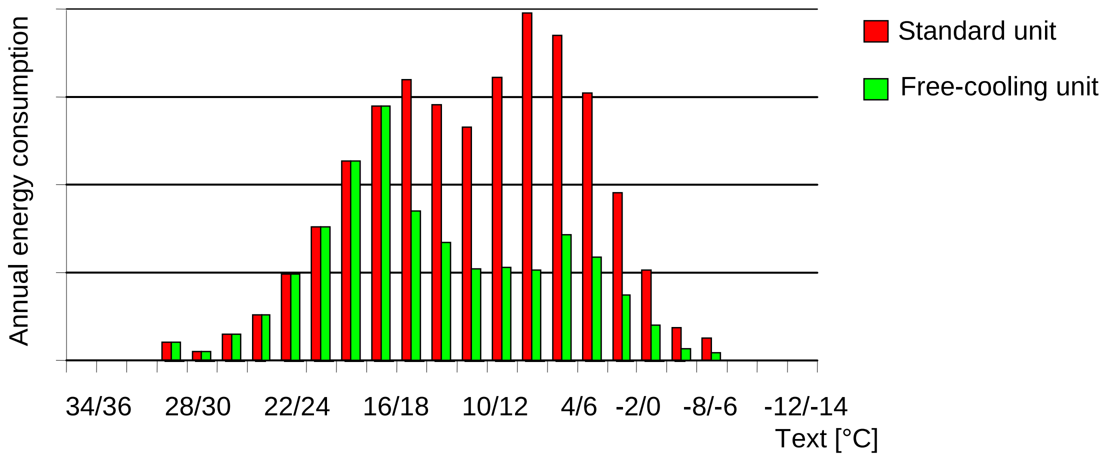
There are, therefore, three operating modes:



- Mechanical cooling: with temperatures higher than 15°C, a free-cooling unit operates as a traditional chiller, dissipating the thermal load of the evaporator with the compressors (fans and compressors operating).

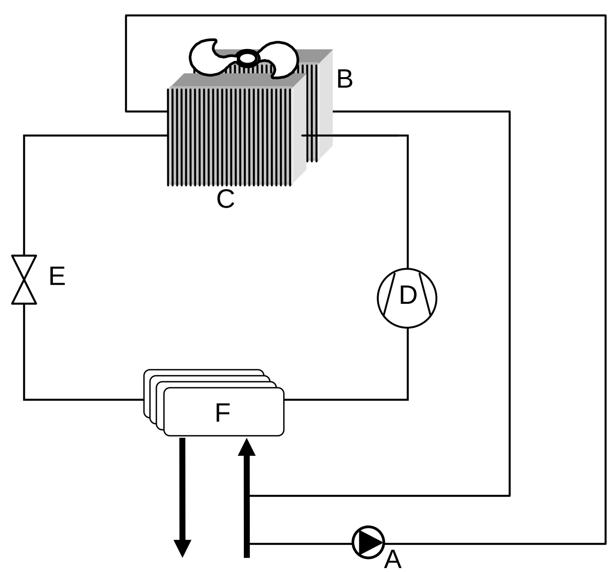
- Mixed: when the external temperature is between 5 and 15°C, the air guarantees only partial, rather than complete, dissipation of the thermal load. At lower temperatures the control system activates the free-cooling pump at 15°C and the water is routed to the air / water exchangers which are placed in series in the evaporator, dissipating at a lower thermal load (fan operation, free-cooling pump and, in part, the compressors).

- Free-cooling: when the external temperature is low enough, the air / water exchangers allow the complete dissipation of the thermal load without needing the compressors (fan operation and free-cooling pump).



OPERATION PRINCIPLE

The idea behind the free-cooling mode is, as mentioned above, that of producing chilled water using external air instead of direct expansion operation. When the external air temperature is low enough, the microprocessor control system activates the free-cooling mode: water is circulated by the free-cooling pump inside special heat exchange coils and cooled by external air forced in by the fans, which, together with the pump, are the only components which absorb energy. The water is then conveyed back into the circuit and supplied to the equipment.



A. Free-cooling pump
B. Free-cooling coil
C. Condenser coil
D. Scroll compressor
E. Expansion valve
F. Evaporator

It is important to bear in mind that an installation's heat load - i.e. the amount of "cold" energy required - depends on both the heat generated inside it (hence machinery, people, lights…) and the external temperature. Generally, therefore, the heat load in summer will be greater than in the winter months. Based on this premise, we can reasonably assume that if the chilled water produced needs to have a temperature of approx. 7°C during the warmer months, during the colder months $T_{outlet\ water}$ = 10°C may be sufficient. Based on these assumptions, the unit can work in full free-cooling mode with a Texternal as high as 5°C.

Nonetheless, there is a temperature range within which, even though production of water at 10°C cannot be assured with free-cooling mode alone, it is still convenient to use the free-cooling coils to pre-cool the water returned from the equipment, therefore making the cooling part "work" less, thus achieving energy savings. The range in question varies depending on the model and load, though we can assume it will be between 5°C and 15°C.

To sum up, operating ranges for BREF units can be split into:

- Free-cooling, with Text < 5°C
- Mixed, with 5°C < Text < 12 to 15°C
- Mechanical cooling (direct expansion) with Text > 12 to 15°C

INTELLIGENT FREE-COOLING SERIES

Redundancy: "N+1"

When designing systems for which uninterrupted service must be guaranteed, reliability is fundamental. Technological environments, i.e. rooms which contain technological equipment and/or particular processes which require guaranteed uninterrupted optimum operating conditions, as well as many industrial processes, very often have higher breakdown costs than the cost of the equipment itself.

Designing a reliable system means choosing both a unit which is intrinsically reliable, and therefore designed and built in such way as to guarantee an extremely low breakdown and inefficiency percentage, as well as creating suitable reserves: the system is equipped with one or more additional units, and for this reason we speak of the "n+1" logic, which ensures that there is always a unit in "stand-by" which guarantees emergency intervention when, for any reason, a system component shows signs of having problems.

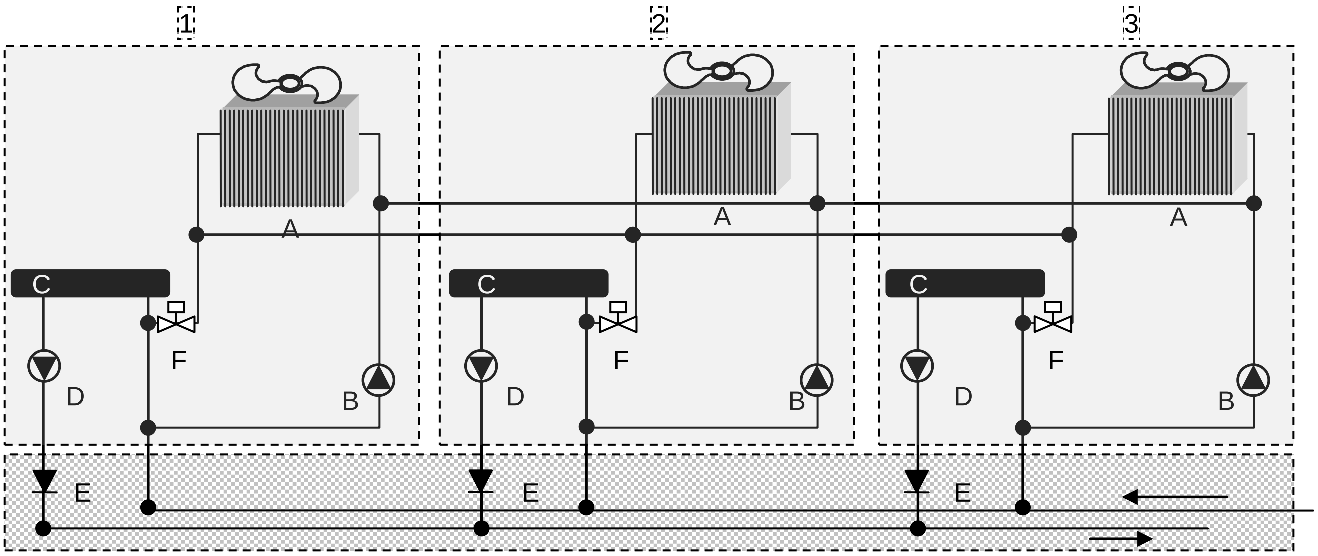
Intelligent free-cooling

By combining the above concepts in applications where uninterrupted operation is required, units equipped with a free-cooling device featuring a redundancy logic can be installed and therefore part of the available cooling capacity is in stand-by. The same consideration can be made regarding the available free-cooling capacity. The principle which forms the basis of intelligent free-cooling is that of also exploiting, when external temperatures allow, the air / water exchangers of the unit/s in stand-by.

By linking all of the air / water exchangers together, it is possible for the water which is to be cooled to flow through all of the free-cooling coils which are available. Thanks to the fact that in Uniflair free-cooling units the water is sent to the free-cooling coils by a pump and not by a simple three-way valve, it is in fact possible, to also use the exchangers of the units in stand-by and therefore increase the free-cooling capacity which is available and therefore its application, with evident advantages in terms of energy saving.

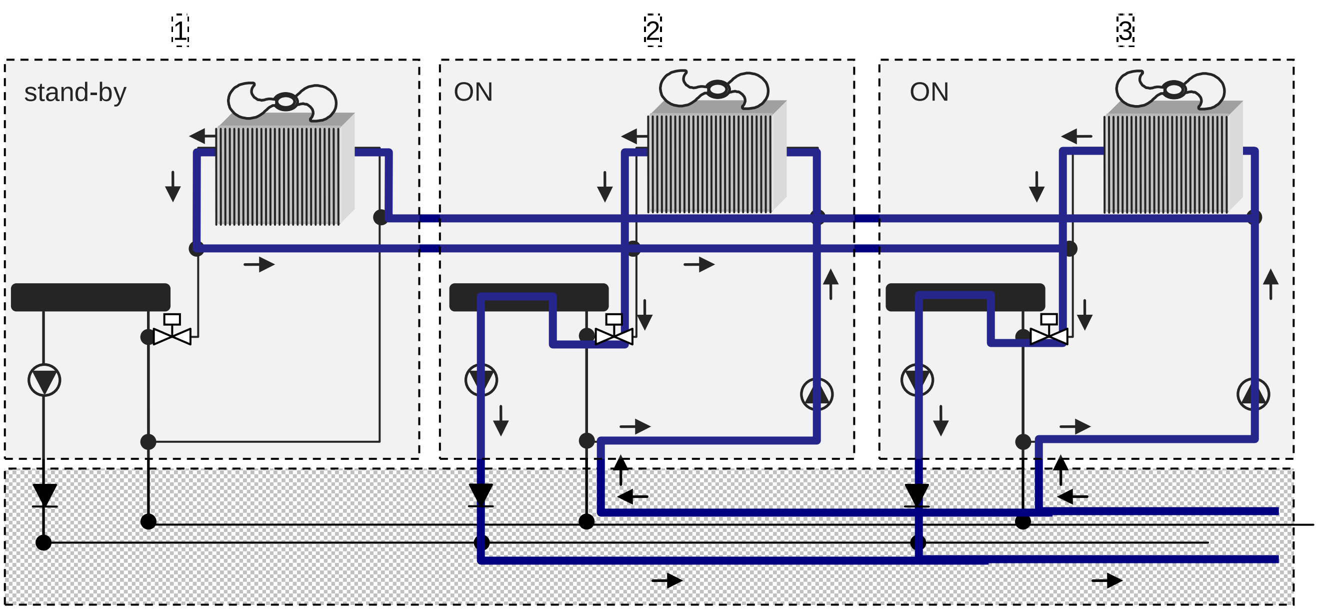
Installation with units equipped with an onboard pump

In the event of a unit operating with an onboard pump for the primary circuit, the installation is usually as illustrated below.

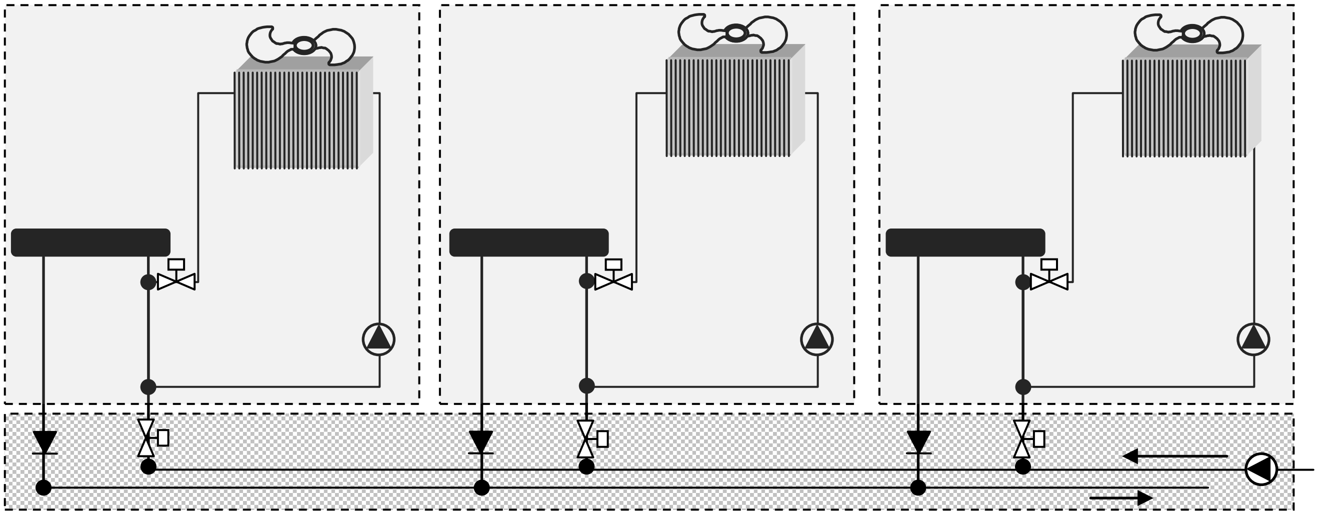


A	Free-cooling coil	E	Check valve
B	Free-cooling pump	F	Motorized valve
C	Evaporator		Supplied by Uniflair
D	Main pump (onboard the unit)		Not supplied by Uniflair

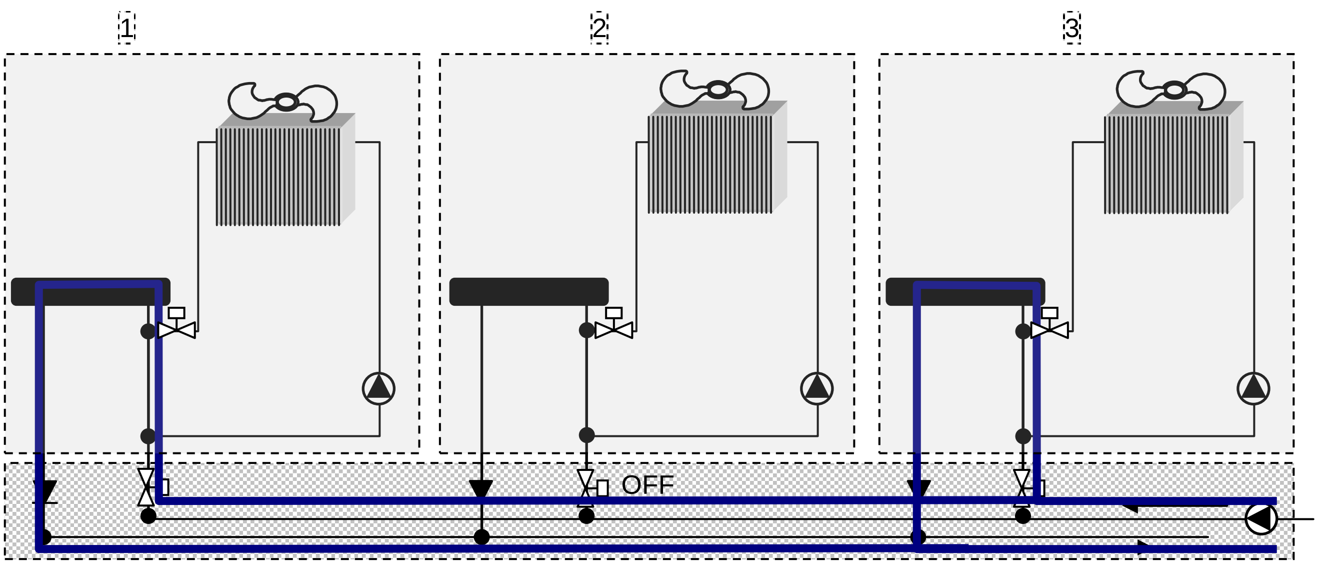
By analyzing a situation such as the following, where unit 1 is in stand-by, units 2 and 3 are operating and the three units are connected together with an intelligent free-cooling solution and when the external temperature is low enough for free-cooling to be activated, the control of the two units which are operating activates the fans in the stand-by unit (1) and the free-cooling pump (B) of the units themselves (2 and 3); this happens in such a way that the water arriving from the system is sent to all of the available free-cooling coils. In fact, since the stand-by unit is also linked, the water also flows through its air / water exchangers (see the following diagram).

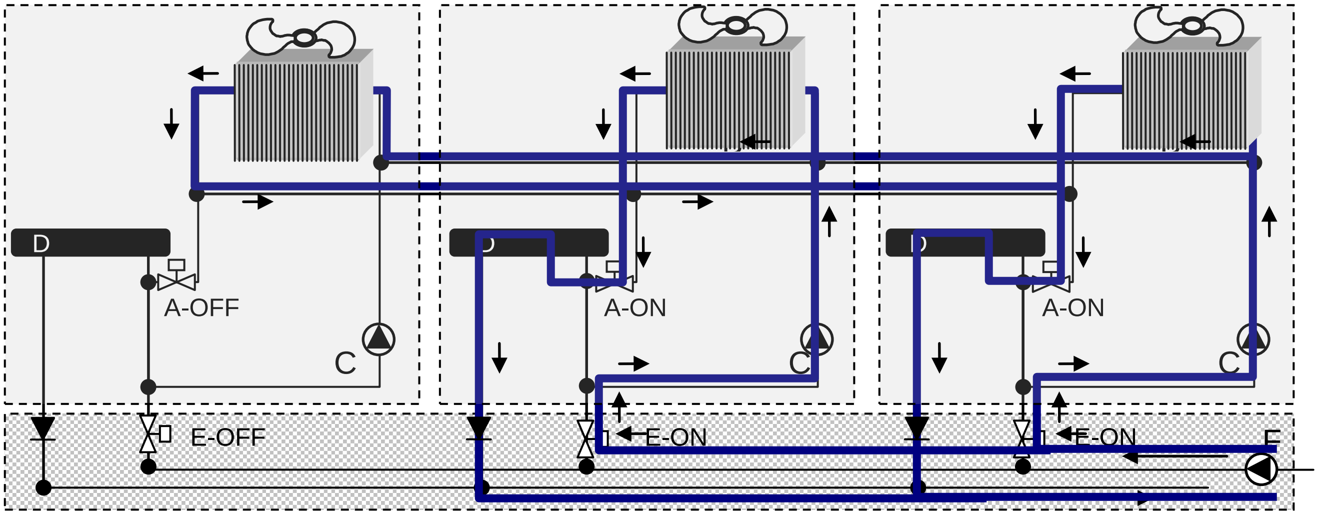


System equipped with a pump for the primary circuit outside the unit
If there isn't an onboard pump, but one has been mounted up or downstream from the chillers, it is necessary to equip the unit with devices which isolate the stand-by unit.



During operation, the stand-by unit is isolated by the motorized valve which is placed on the aspiration line and the non return valve which is placed on the discharge line. In the following diagram, operation with units 1 and 3 operating and unit 2 in stand-by is shown.



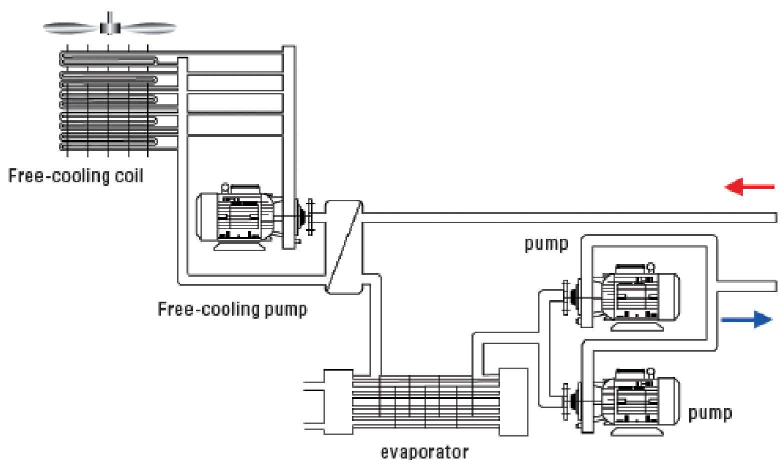


A	Free-cooling coil	E	Check valve
B	Free-cooling pump	F	Motorized valves
C	Evaporator		Supplied by Uniflair
D	Main pump (onboard the unit)		Not supplied by Uniflair

GLYCOL-FREE FREE-COOLING SERIES

Created for applications where the use of anti-freeze solutions are not permitted, the glycol free solution allow the possibility to fill up with glycoled water the free-cooling circuit only, leaving pure water on all the other part of the circuit. The unit is fitted with an onboard intermediate heat exchanger which isolates the principal hydraulic circuit and the free-cooling circuit as per the following drawing.

Of course correct anti-freeze method must be chosen for the hydraulic section which uses pure water.



The careful selection and the position of the intermediate heat exchanger permits to install main pump onboard of the unit as per traditional Uniflair free-cooling chillers and it allows to minimize the reduction in the efficiency which is normally introduced by an additional heat exchange between the fluids which are chilled by the unit.

GENERAL TECHNICAL DATA

BREC – F		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Power supply	V/ph/Hz	400 / 3 / 50								
Refrigerant		R134a								
Fans	Nr	6	6	8	8	8	10	10	12	12
Standard model	Type	Axial with asynchronous motor								
	poles	6	6	6	6	6	6	6	6	6
EC model	Nr	Axial with electronically commutated motor								
Circuits	Nr	2	2	2	2	2	2	2	2	2
Compressors	Nr	2	2	2	2	2	2	2	2	2
Compressor	Type	Double Screw								
Evaporator	Type	Shell & Tube								
Partial heat recovery heat exchanger	Type	Plate					Shell & Tube			

TECHNICAL DATA: NOMINAL CONDITIONS

The technical data shown in the following pages refer to nominal conditions and tolerances which are as follows:

Nominal conditions		BREC	BREF	
Operation mode		Cooling	Cooling	Free-cooling
Inlet / outlet water temperature	°C	12 / 7	15 / 10	15
External air temperature	°C	35	35	5
Ethylene glycol	%	0	20	20
Nominal power supply tolerance	R_0	400V +/- 10%		
Storage conditions	C_0	between – 20°C e + 45°C for all models		

Note

A general design guideline for data centres, where reducing energy consumption and optimising available resources is becoming increasingly more significant, is to adopt solutions featuring chilled water air conditioning units linked to chillers with a free-cooling system, sized in order to optimize operation. This system is based on a chilled water temperature which is higher than the "classic" 7°C, with the aim of increasing the free-cooling capacity and lowering the electrical absorption of the chiller.

This trend can be seen above all in applications used in data centres featuring high density servers, using air conditioning units with temperature control on the discharge where the return temperature is higher than that of standard consolidated units which consequently increases the performance of the close Control units. Since optimising resources is the best solution to reduce consumption, Schneider-Electric™ fully supports this trend, promoting it first hand as well as encouraging it and facilitating the sizing of sites which are designed in this way.

For this reason, the technical data regarding chillers equipped with free-cooling are based on inlet and outlet water temperatures of 15/10°C rather than 12/7°C.

TECHNICAL DATA: CORRECTION FACTORS

If antifreeze mixtures are being used, some of the unit's specifications given in the table (capacity, water delivery, load loss) will change.

Correction factors are given below for calculating the data based on different percentages of ethylene glycol.

Minimum fluid temperature with unit operating	5,0 °C	3,0 °C	-5,0 °C	-10,0 °C	-18,0 °C	-28,0°C
Freezing temperature	0 °C	-4,4 °C	-9,6 °C	-16,1 °C	-24,5 °C	-35,5 °C
Percentage of ethylene glycol by weight	0%	10%	20%	30%	40%	50%

Correction factors	%	0%	10%	20%	30%	40%	50%
Cooling capacity	R_0	1	0,985	0,98	0,97	0,96	0,95
Compressor power consumption	P_0	1	0,995	0,99	0,98	0,98	0,97
Volumetric flow rate	L_0	1	1,02	1,05	1,08	1,10	1,14
Evaporator / condenser pressure drop	C_0	1	1,10	1,25	1,40	1,60	1,7

Corrected cooling capacity (**) = Nominal cooling capacity x R_0.
Corrected compressor power consumption (**): Nominal absorbed power x P_0.
Corrected volumetric flow rate (**):Nominal volumetric flow rate x L0.
Corrected evaporator pressure drop, water side (**): Evaporator pressure drop x C_o.
(**) with the same evaporator inlet and outlet temperatures 12/7

NOMINAL TECHNICAL DATA

BREC Cooling only unit		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Cooling capacity (1)	kW	359	448	503	534	635	704	819	920	1039
Absorbed power (2)	kW	109,3	141,9	158,3	171,0	206,4	226,6	265,9	290,1	329,9
E.E.R. (2)		3,39	3,25	3,34	3,27	3,23	3,25	3,22	3,27	3,3
E.S.E.E.R. (3)		4,11	4,24	4,19	4,21	4,29	4,48	4,77	4,37	4,64
I.P.L.V. (4)		4,68	4,83	4,78	4,82	4,94	5,20	5,50	5,00	5,35
Water flow (1)	l/h	62865	78825	89447	94237	114733	124560	144720	162720	185400
Evaporator pressure drop (1)	kPa	29	48	51	56	55	42,2	63,8	51,4	34,9
Air flow (1)	m^3/h	121875	116813	162500	162500	155750	203125	194688	233625	233625

BREC Cooling only unit with economizer		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Cooling capacity (1)	kW	384	486	549	582	709	776	891	1005	1126
Absorbed power (2)	kW	119,3	157,4	180,5	190,5	248,9	264,7	302,6	333,3	277,2
E.E.R. (2)		3,29	3,13	3,23	3,14	3,05	3,07	3,09	3,16	3,21
E.S.E.E.R. (3)		4,23	4,31	4,28	4,26	4,38	4,60	4,72	4,40	4,59
I.P.L.V. (4)		4,78	4,91	4,85	4,89	5,00	5,20	5,55	5,05	5,40
Water flow (1)	l/h	67610	85348	96427	101963	124180	136646	156647	175872	200369
Evaporator pressure drop (1)	kPa	33	55	58	64	64	49,7	73,6	62,8	40
Air flow (1)	m^3/h	121875	116813	162500	162500	155750	203125	194688	233625	233625

(1) Data refer to nominal conditions: Inlet / outlet water temperature: 12 / 7 °C; External air temperature 35 °C; glycol 0%
(2) Data refer to total input power.(compressors and fans)
(3) European Seasonal Energy Efficiency Ratio
(4) Integrated Partial Load Value

BREF Free-cooling unit		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Cooling capacity (1)	kW	386	474	541	575	685	764	683	980	1099
Absorbed power (2)	kW	115,2	151,8	167,1	181,2	220,5	240,2	285,1	311,6	361,5
E.E.R. (2)		3,47	3,20	3,37	3,31	3,19	3,32	3,17	3,25	3,26
Water flow (1)	l/h	73493	89422	102413	108402	117823	143698	162360	183600	209880
Evaporator pressure drop (1)	kPa	44	66	73	81	77	62	88,8	72	49
Airflow (1)	m^3/h	112500	105000	150000	150000	140000	187500	175000	210000	200379
Free-cooling capacity (3)	kW	256	308	347	351	417	510	602	711	726
Absorbed power in free-cooling (3-4)	kW	16,7	17,6	23,9	24,1	25,4	28,5	29,4	38,2	38,6
E.E.R. in free-cooling (3-4)		15,34	17,52	14,50	14,53	16,43	17,9	20,5	18,6	18,8

BREF Free-cooling unit with economizer		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Cooling capacity (1)	kW	386	503	584	611	745	835	940	1065	1183
Absorbed power (2)	kW	116,2	166,8	188,6	197,6	255,0	280,7	331,7	357,5	425,1
E.E.R. (2)		3,35	3,12	3,21	3,19	3,04	3,12	3,04	3,1	3,08
Water flow (1)	l/h	76394	95000	108531	115387	140382	157680	175680	199440	220424
Evaporator pressure drop (1)	kPa	47	76	81	90	90	73	103	83,7	56,4
Airflow (1)	m^3/h	112500	105000	150000	150000	140000	187500	175000	210000	226267
Free-cooling capacity (3)	kW	260	312	352	356	423	510	602	711	726
Absorbed power in free-cooling (3-4)	kW	16,9	17,7	24,2	24,5	25,8	28,5	29,4	38,2	38,6
E.E.R. in free-cooling (3-4)		15,42	17,63	14,54	14,56	16,44	17,9	20,5	18,6	18,8

(1) Data refer to nominal conditions: Inlet / outlet water temperature: 15 / 10 °C; External air temperature 35 °C; glycol 20%
(2) Data refer to total input power.(compressors and fans)
(3) Data refer to nominal conditions: Inlet water temperature: 15 °C; External air temperature 5 °C; glycol 20%
(4) Data refer to (fans and free-cooling pump) input power

DIMENSIONS and WEIGHTS

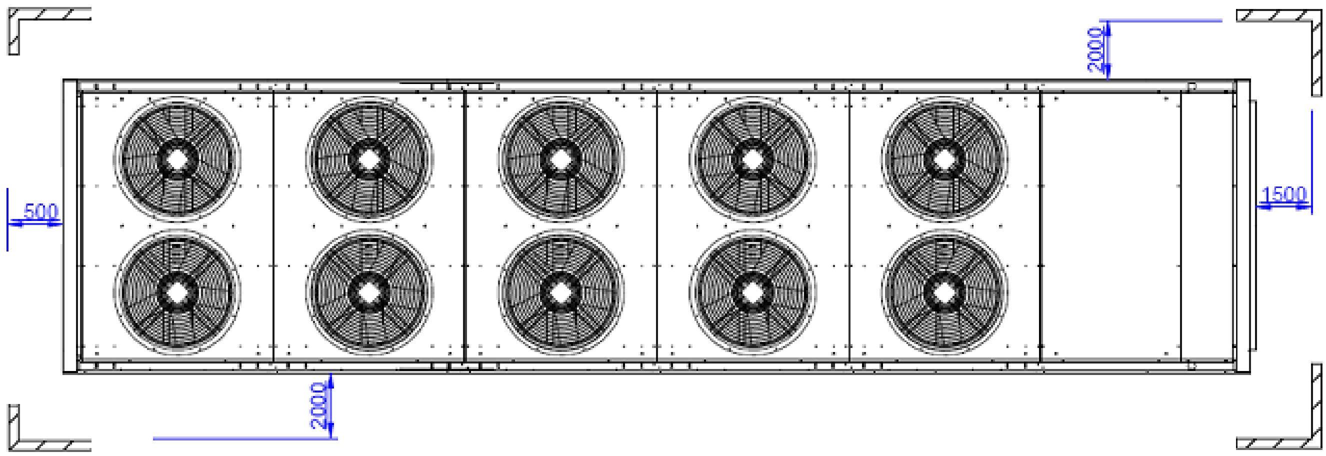
Models		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Height (**)	mm	2510	2510	2510	2510	2510	2510	2510	2510	2510
Depth	mm	4985	4985	6415	6415	6415	8890	8890	10320	10320
Width	mm	2200	2200	2200	2200	2200	2200	2200	2200	2200
Weights (BREC)										
Weight (basic version, without hydraulic kit) (*)	Kg	4196	4552	4828	4856	5340	6889	7189	7956	7995
Weight (basic version with 1 pump) (*)	Kg	4396	4752	5054	5086	5568	7200	7500	8332	8368
Weight (version with 2 pumps) (*)	Kg	4506	4862	5174	5206	5688	7320	7620	8527	8563
Weights (BREF)										
Weight (basic version, without hydraulic kit) (*)	Kg	4912	5356	5791	5819	6423	7987	8287	9478	9517
Weight (basic version with 1 pump) (*)	Kg	5112	5558	6019	6049	6651	8298	8598	9854	9893
Weight (version with 2 pumps) (*)	Kg	5222	5668	6139	6169	6771	8418	8718	10049	10088
Options										
Partial heat recovery	Kg	54	54	92	92	110	322	322	330	330
Ultra low noise version	Kg	200	200	200	200	200	505	505	550	550
Economizer	Kg	35	35	45	45	45	80	80	85	85

(*) with empty hydraulic circuit
(**) without vibration supports

WORKING SPACE

The diagram below shows the minimum recommended distance to be left clear for correct unit operation and to allow access to the unit for maintenance.

WARNING:
prevent air recirculation between the air discharged and taken in by the condenser.

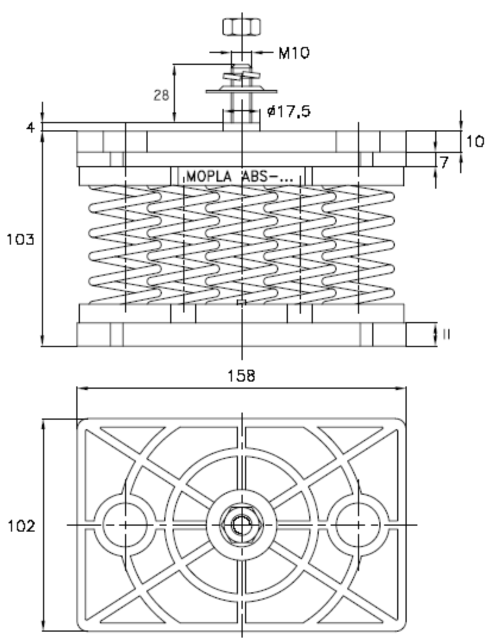


Note: The dimensions are in mm.

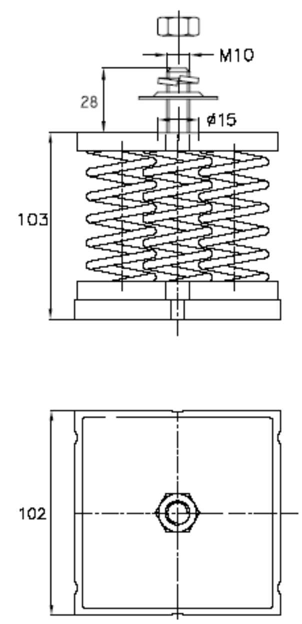
ANTI-VIBRATION SUPPORTS

Type		1450/C	910/C
Spring number		8	5
Height	mm	103	100
Materials	Springs	Steel C72 with epoxy paint	Steel C72 with epoxy paint.
	Bases	Elastomer with metal insert.	Elastomer with metal insert.
	Base	Lexan with metal insert	Lexan with metal insert
Deflection	mm	27	27
Natural frequency	Hz	3	3
Load	Kg	1450	910
Elastic constant	Kg/mm	54	33.5

1450/C



910/C



REFRIGERANT CONTENT

The table below shows the refrigerant content for the basic version. These values are indicative and the quantities may vary slightly due to adjustments made during end of line testing.

The above data refer to the basic version of each unit, i.e. it goes without saying that the amount may vary depending on the configuration of the unit itself.

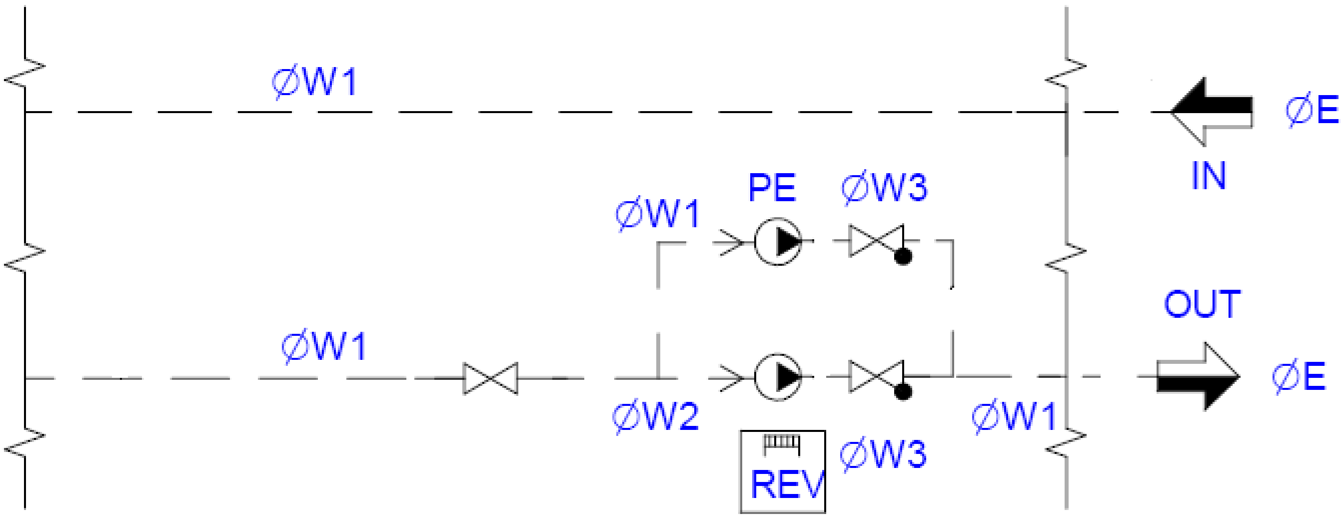
BREC - F		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Circuit 1	Kg	47	48	63	64	65	78	80	95	96
Circuit 2	Kg	47	48	63	64	65	78	80	95	96

HYDRAULIC CIRCUIT

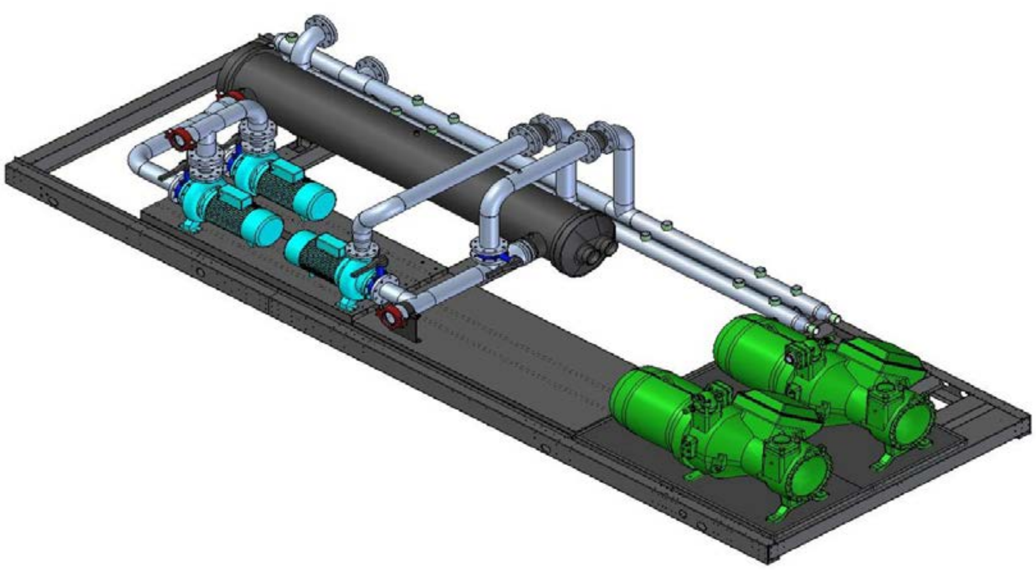
BREC/F units are available with the following hydraulic configurations:

- Without pump
- Units equipped with 1 pump
- Units equipped with 2 pumps

Unit equipped with 1 or 2 pumps

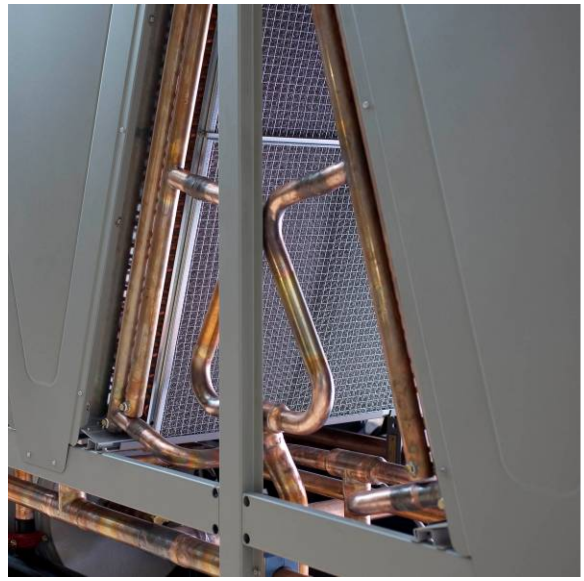


- REV: anti-freeze heater
- TUA: outlet water temperature sensor
- VS: safety valve



HYDRAULIC CONNECTIONS

The pipework connections are produced in steel. The free-cooling circuit is produced in steel with flexible connections to the air/water exchangers in order to eliminate the generation of vibrations and to render the complete structure flexible during the stages of movement. These connections are also available in copper on request.



HYDRAULIC CONNECTIONS

The units are supplied with Victaulic type hydraulic connections. Pipework of this type is composed of two parts: the pipework predisposed for a Victaulic clamp and the Victaulic clamp itself.

The units are only supplied with the pipework.

Available as options are:

- Victaulic pipe joints: this option includes the fixing clamp and rolled stub pipe for soldering to the installation.
- Flanged attachments: this option includes the fixing clamp and reduction of the rolled/flanged tube.

Victaulic/flanged pipe reduction

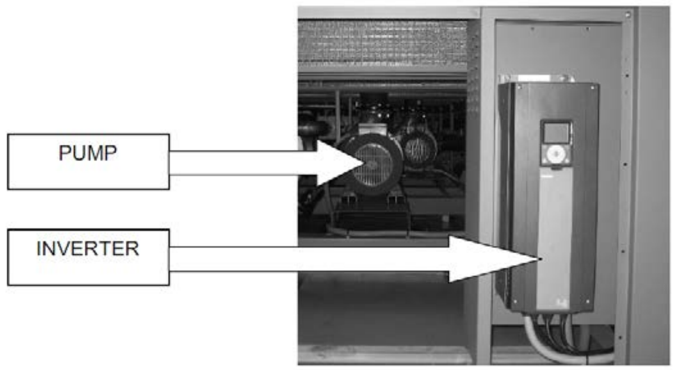
Victaulic fixing clamp

Table of correspondence between the different types of hydraulic connections			
Threaded connections GAS (BSP)		Flexible (Victaulic) joints est. Ø pipe to be welded [mm]	Flanged connections
Male	Female		
G 1" M	G 1" F	OD 33.7	DN 25
G 1"1/4 M	G 1"1/4 F	OD 42.4	DN 32
G 1"1/2 M	G 1"1/2 F	OD 48.3	DN 40
G 2" M	G 2" F	OD 60.3	DN 50
G 2"1/2 M	G 2"1/2 F	OD 76.1	DN 65
G 3" M	G 3" F	OD 88.9	DN 80
G 4" M	G 4" F	OD 114.3	DN 100
G 5" M	G 5" F	OD 139.7	DN 125
G 6" M	G 6" F	OD 168.3	DN 150
G 8" M	G 8" F	OD 219.1	DN 200

INVERTER DRIVEN PUMPS (optional)

The BREC/F large chiller range can be fitted with onboard primary circulation pump/s. When the pressure drop and the water flow do not remain constant, either during the chiller operation or during the evolution of the installation, it is possible to install a completely integrated inverter-driven circulation pump/s.

This solution allows to modify the water flow rate by varying the pump rotation speed. Choosing for this option, the unit is equipped with a pump (one or two, with 1+1 logic) which is connected to an VSD (inverter) driven by the chiller control board. In the event of units fitted with two pumps, the inverter is usually shared between the pumps. It is installed onboard into a protected box (IP54) and it is completely connected to the main power supply and driven by the mainboard.



The inverter, which is located at the rear of the unit, is controlled by the mainboard and the water flow can be modified according to two different logics, i.e.

A. Flexible operation: unit operation with constant speed pump
B. Autoadaptive operation: Unit operation with variable speed pump and constant available head pressure

Flexible operation
With the logic (a), the control board permits to set a value for the inverter speed. The unit operates with this settings until it is modified. Modifications can be done directly on the local user terminal or on the remote user terminal of the unit or from the Building Management System. This solution is necessary when the pressure drop of the system is not completely known or an extension is scheduled, expected or simply possible. Once the chiller is installed the pressure drop / water flow is setted on the control board according the site features and the required deltaT on the inlet / water temperatures. In the event of any modifications on the site the operating parameters can be changed in order to adjust the correct operation of the unit/s.

Autoadaptive operation
With logic (b) the unit is equipped with additional pressure transducers on the chiller water circuit. Once the chiller is installed the required available pressure can be defined on the unit. The information from the sensors[1] permits to the control board to maintain this setting in all the different pressure drop conditions, and therefore constant deltaP through the unit. This solution is useful when the pressure drop of the system can vary during the chiller operation like installations where the CRACs are fitted with 2-way valves or there are separate water circuits. The control board monitors the pressure drop through the unit and it modify the inverter speed and, consequently, the available head pressure of the pump. The settings for the required available head pressure can be done directly on the local user terminal or on the remote user terminal of the unit or from the Building Management System

[1] If the transducer and/or expansion card fails, the pump operates at full speed.

HYDRAULIC CONNECTIONS

BREC - F	1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Main hydraulic connections	4" - OD 114.3					5" - OD 139.7		6" - OD 168.3	
Type	Victaulic								
Main hydraulic connections (optional)	DN 100	DN 100	DN 100	DN 100	DN 100	DN 125	DN 125	DN 150	DN 150
Type	Flanged								
Partial heat recovery hydraulic connections	2"M	2"M	2"M	2"M	2"M	1" 1/2F	1" 1/2F	1" 1/2F	1" 1/2F
Type	BSP								
Intelligent free-cooling connections	DN100	DN100	DN100	DN100	DN100	DN100	DN100	DN125	DN125
Type	Flanged								

WATER CIRCUIT CAPACITY

The table below shows the capacity (liters) of the water circuit in basic units

BREC		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Evaporator	liters	140	140	160	160	256	250	250	420	420

The table below shows the capacity (liters) of the water circuit in basic units ("free-cooling")

BREF		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Evaporator	liters	140	140	160	160	256	250	250	420	420
Free-cooling coils	liters	150	186	200	200	250	300	300	360	360

RECOMMENDED MINIMUM PLANT CAPACITY

The table below shows the recommended minimum plant capacity

BREC/BREF		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Recommended minimum plant capacity	liters	1000	1150	1300	1400	1600	1800	2000	2400	2600

MAXIMUM WORKING PRESSURE OF HYDRAULIC CIRCUIT

Maximum working pressure of hydraulic circuit	P_0	**10**

HEAT EXCHANGERS CORROSION RESISTANCE TABLE

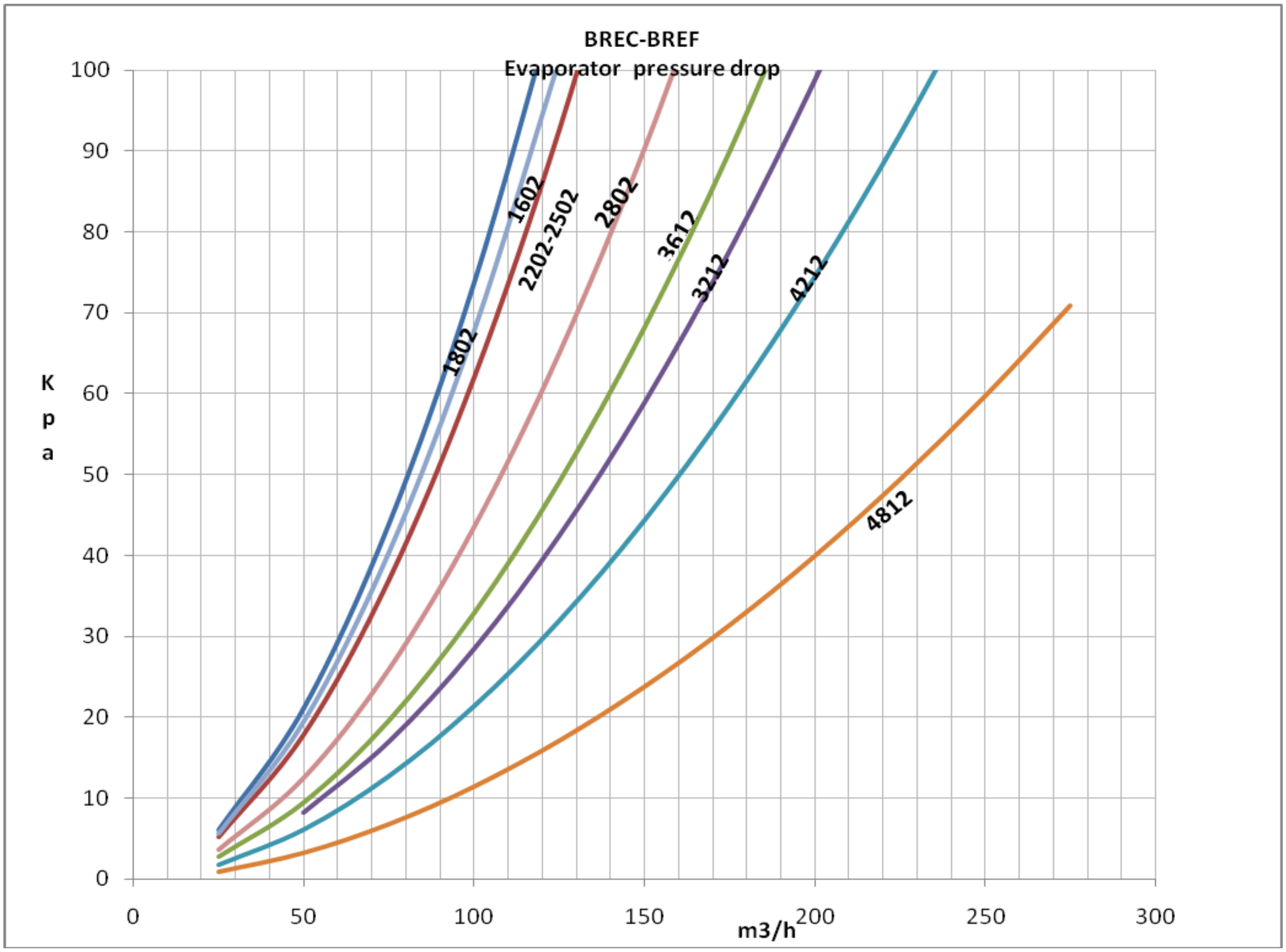
The tables shown below provides a summary evaluation of the substances which could create problems linked to corrosion. No guarantees can however be deduced from this table due to the complex and carious chemical reactions involved in each particular situation

BREC-F	Approximate concentration area [mg/l]	Compatibility with Standard heat exchanger
pH-value	7 ÷ 9 (Value)	OK
Chloride Cl^-	< 3 3 ÷ 50	OK
Free Chlorine Cl_2	<0, 5	OK
Sulphate SO_4^{--}	< 50 50 ÷ 100	OK
Free Carbon Dioxide CO_2	< 5 5 ÷ 50	OK *
HCO_3^- / SO_4^{--}	> 1 (Value)	OK
Nitrate	< 100	OK
Hydrogen Sulphide H_2S	< 0,05	OK
Oxygen O_2	< 0,1 0,1 ÷ 2	OK *
Ammonium NH_4^+	<2 2 ÷ 20	OK
Phosphate PO_4^{3-}	< 2	OK
Iron and Manganese Fe^{3+} / Mn^{++}	< 0,5	OK
Depositable (organic) substances	0 (Value)	**
Hardness	4 ÷ 8.5dH	OK

Note:

- These data do not consider the effects of any bio-pollution present in the water
- Nominal performance data calculated with a fouling factor of 0.043m2°C/kW
- * Corrosion problems could arise, especially when several factors are evaluated together
- ** Corrosion problems could arise when they are present in certain situations

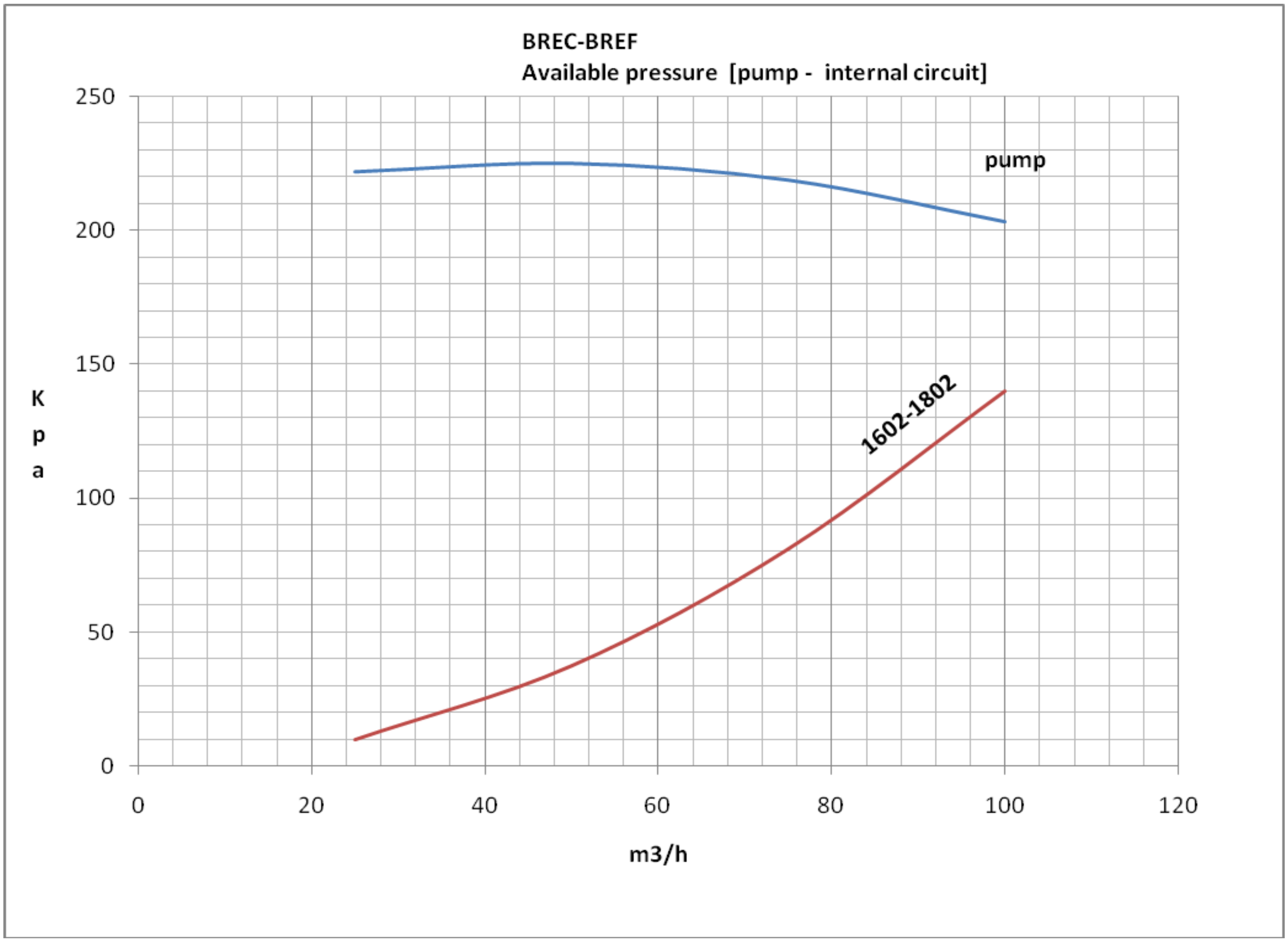
EVAPORATOR PRESSURE DROP



Data refer to 0% glycol.

PUMP HEAD PRESSURE AND UNIT PRESSURE DROPS

The available head pressure is the difference between the “pump head pressure” curve and the curve for load losses.



Data refer to 0% glycol.

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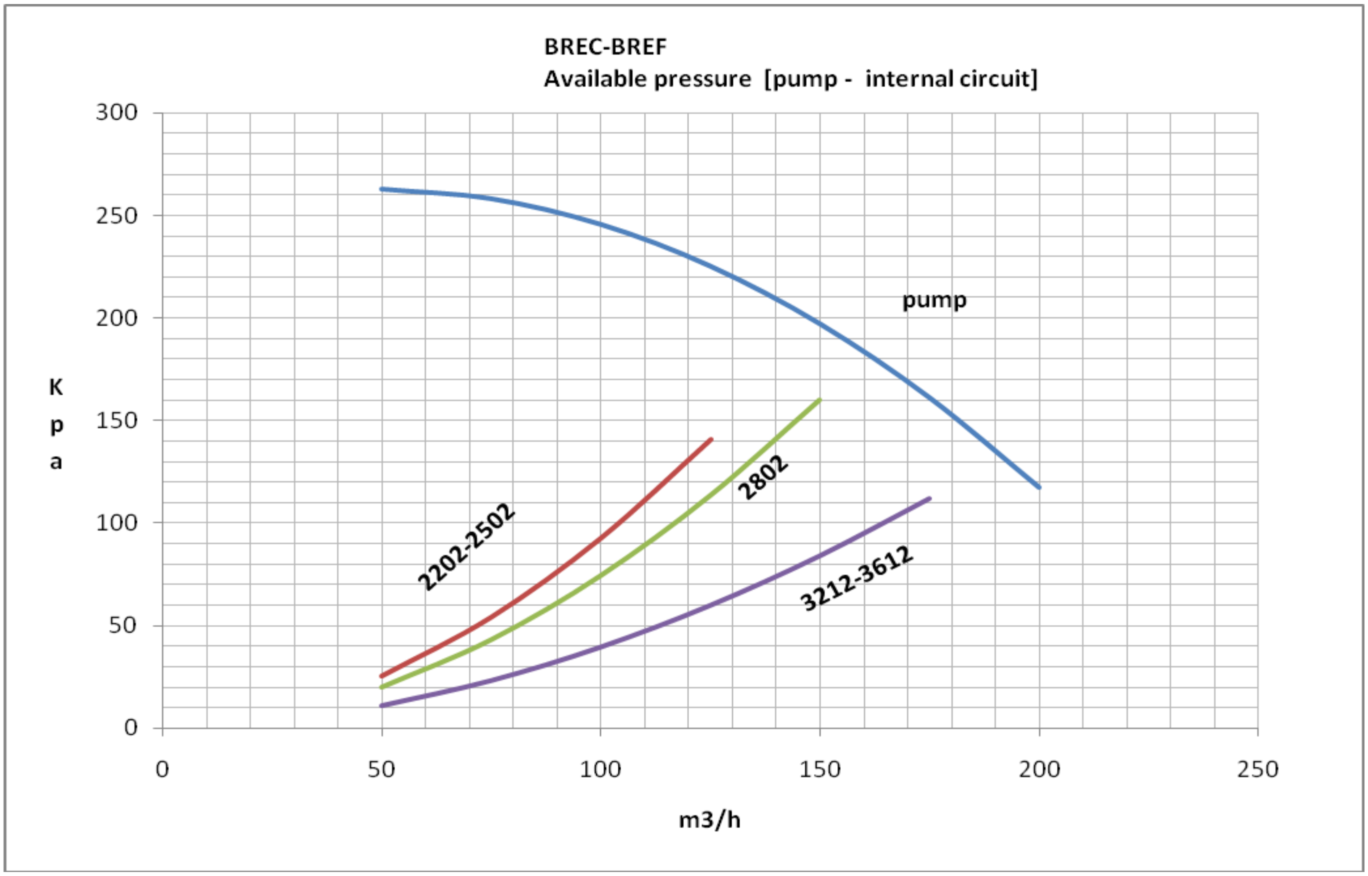

Data refer to 0% glycol.

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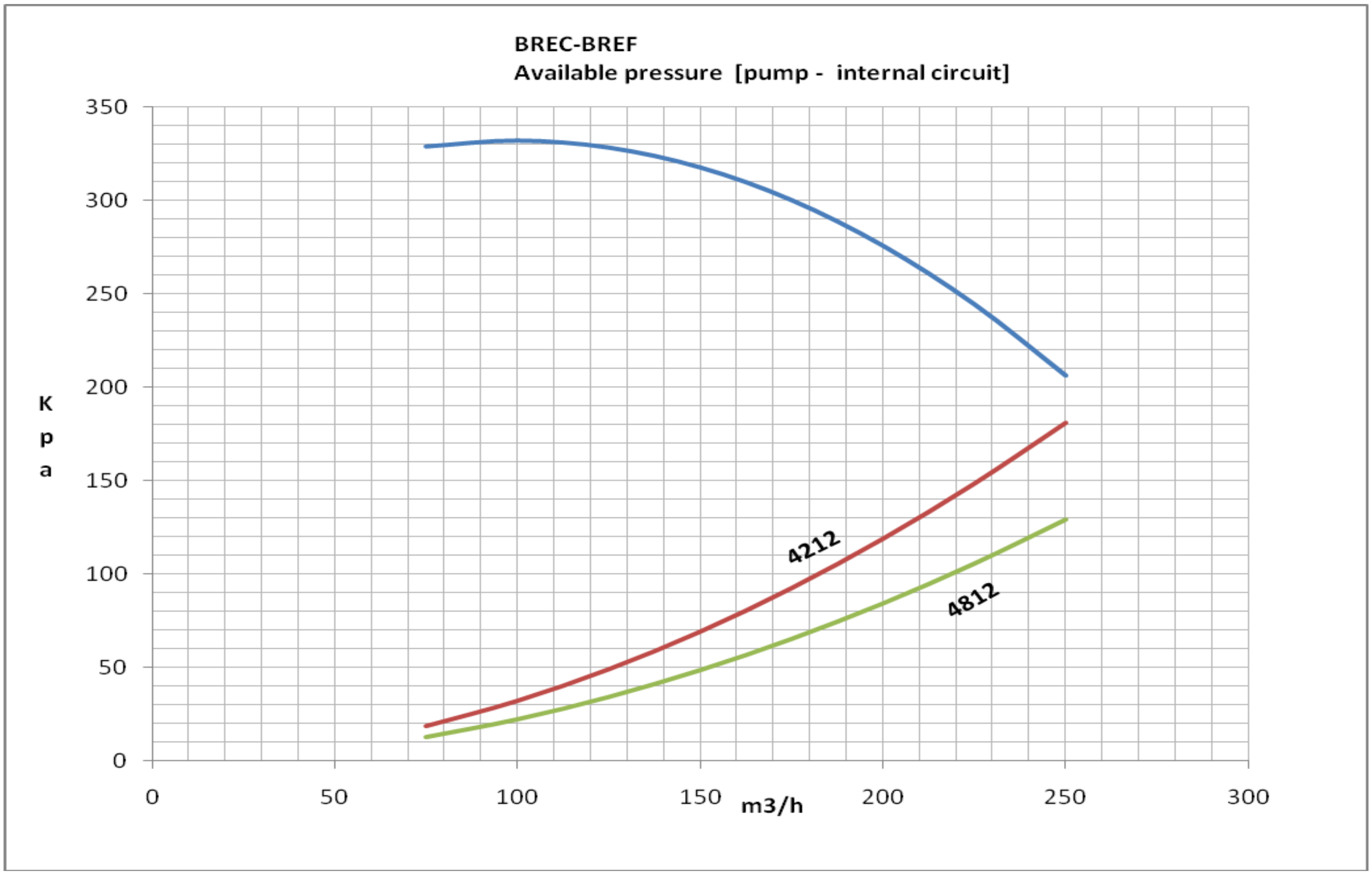


Data refer to 0% glycol.

A GUIDE TO THE SIZING OF THE EXPANSION VESSEL

The project elements to consider when selecting the dimensions of the expansion vessel for a system are:

- C The quantity of water in the system in liters
- e The expansion coefficient of the water, calculated as the maximum temperature difference between when the system is off and when the system is running (the values are given in the table below)
- pi The absolute initial pressure, equivalent to the pre-charge pressure of the expansion vessel (normally 2.5 bar, i.e. 1.5 bar-r)
- pf The absolute tolerated pressure, must be less than the pressure at which the safety valve is set, taking into account of any difference in height between the valve and the expansion vessel.

The total capacity of the expansion vessel is expressed as:

$$V_t = \frac{C \cdot e}{1 - \frac{p_i}{p_f}}$$

using the expansion coefficient values in the following table.

WATER EXPANSION COEFFICIENT

Water temp. [°C]	Density [kg/m^3]	e (at 10°C)
60	983.2	0.0167
70	977.8	0.0223
80	971.8	0.0286
90	965.3	0.0355
100	958.4	0.0430

It is also possible to calculate the average value of ‘e’ between the initial water temperature (generally assumed to be 10°C) and the operating temperature, using:

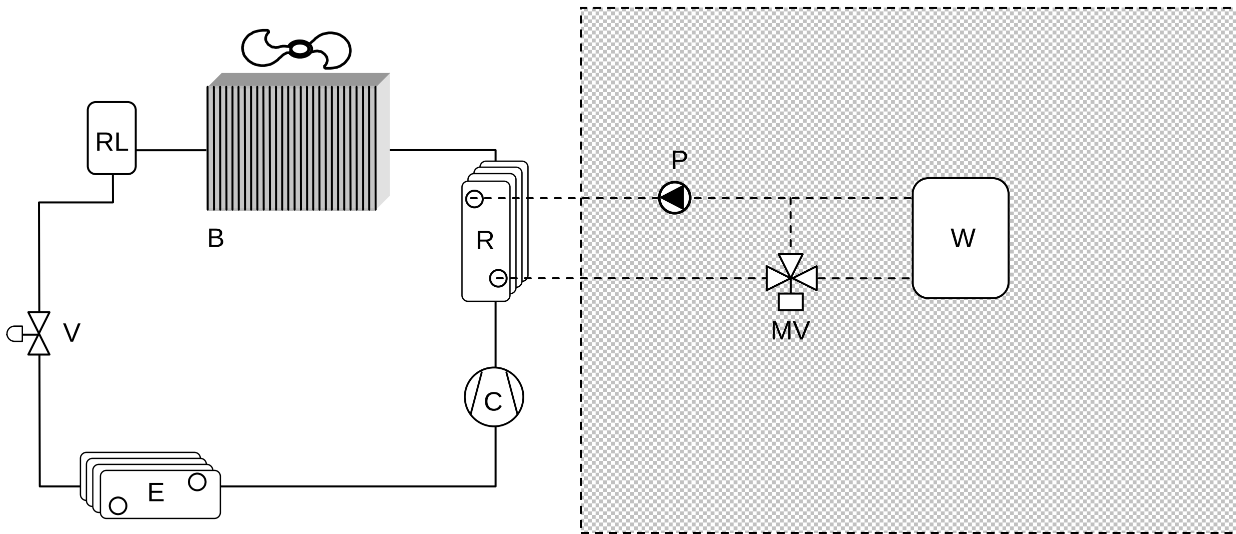
$$e = 7{,}5 \cdot 10^{-6} \cdot (T - 4)^2 \qquad T\ [°C]$$

PARTIAL HEAT RECOVERY

In the BREC/F range, partial heat recovery is carried out by plate/tubular heat exchangers placed between the discharge section of the compressor and the air condenser; the following diagram shows the recovery circuit within the unit and the circuit used.

For correct operation of the chiller it is necessary to avoid supplying the recovery exchanger (R) with water which is too cold (temperatures lower than 30°C).

For this reason, it is advisable to install a 3-way valve (MV) as shown in the diagram.



B	Condensing coils
C	Scroll compressors
V	Expansion valve
E	Evaporator
R	Recuperator
RL	Liquid receiver (only for ERAH)
P	Circulation pump
W	Water tank
MV	3-way valve

Partial condensation heat recovery		1602A	1802A	2202A	2502A	2802A	3212A	3612A	4212A	4812A
Cooling capacity	kW	365	458	519	547	661	710	842	932	1040
Absorbed power	kW	108	141	156	169	206	217	256	282	318
Heat recovery heating capacity	kW	68	91	100	107	135	146	170	188	209
Heat recovery water flow	l/h	11850	15652	17430	18559	23500	25112	31000	32336	35950
Heat recovery pressure drop	kPa	13	23	11,5	13	20	45	57	52	63

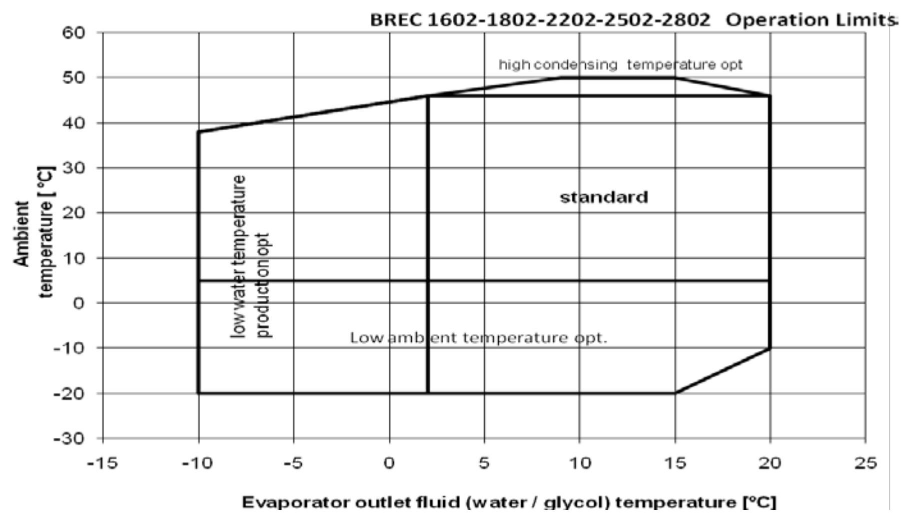
Data refer to nominal conditions for both heat recovery: inlet / outlet water temperature 12 / 7 °C; external temperature: 35 °C; Heat recovery water temperature: 40/45°C; glycol 0%

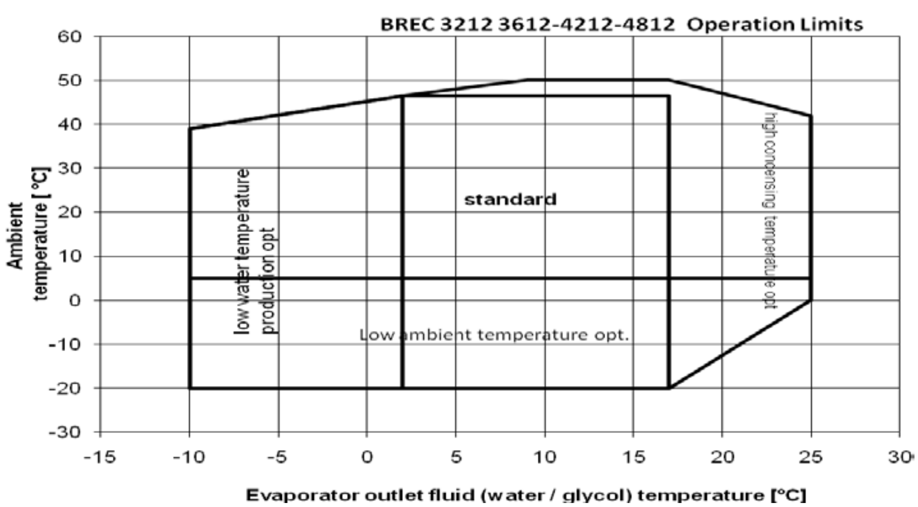
OPERATING LIMITS

BREC
The BREC units are equipped with modulation control and oil heaters for the mass produced compressors, still, depending on requirements, it is necessary to select the different options.

The available options are:
- Low ambient temperature: the unit will be equipped with anti-condensation resistance for the circuit board.
- High ambient temperature: the unit will be equipped with compressors provided with motors capable of operating with high condensation temperatures. These motors are standard for the models 1602A – 1802A – 2202A – 2502A – 2802A.
- Low water temperature production: the units are predisposed for the production of glycoled water at low temperature.

Note: for units with economizer consider a reduction in max ambient temperature of 2°C





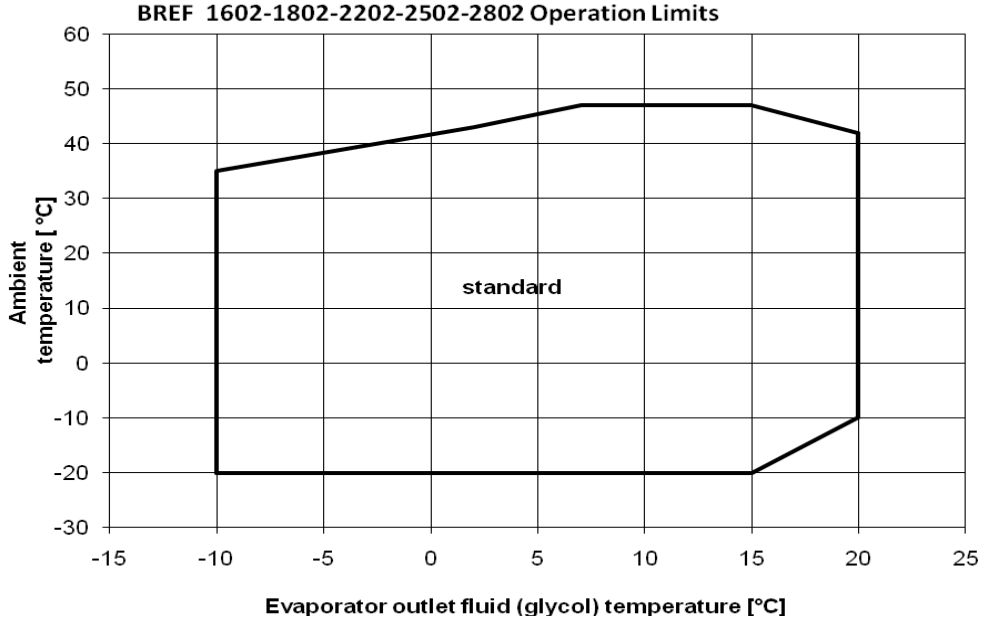
Glycol water mixtures can be cooled down to -10°C as long as the water in the circuit contains enough antifreeze to prevent freezing inside the evaporator

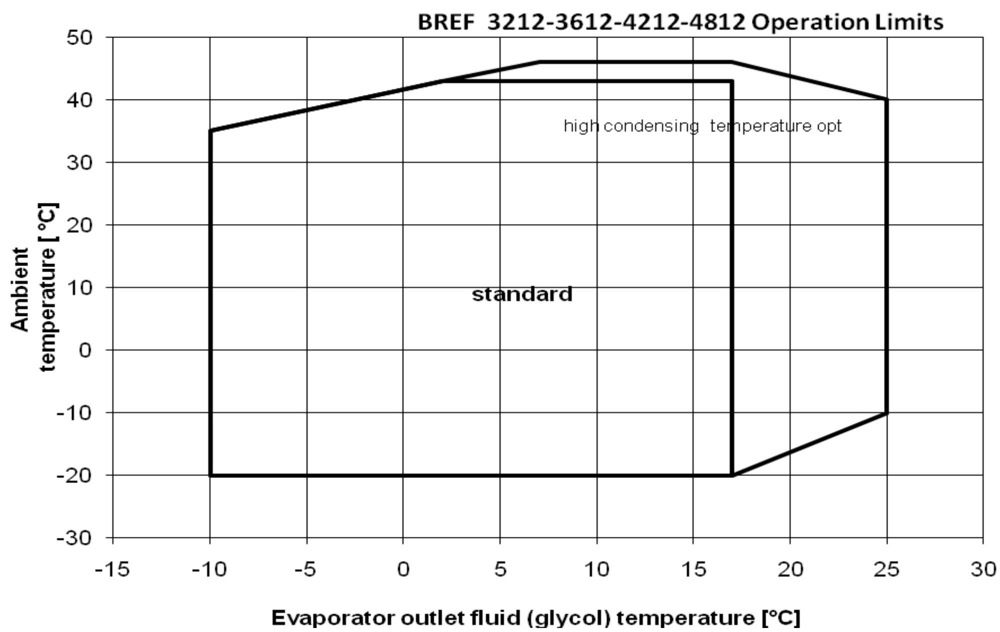
Minimum fluid temperature with unit operating		5,0 °C	3,0 °C	-5,0 °C	-10,0 °C	-18,0 °C	-28,0°C
Freezing temperature		0 °C	-4,4 °C	-9,6 °C	-16,1 °C	-24,5 °C	-35,5 °C
Percentage of ethylene glycol by weight		0%	10%	20%	30%	40%	50%

BREF

The BREF units can be predisposed to operate in high ambient temperatures: the unit will be provided with compressors equipped with motors capable of operating in high condensation temperatures. These motors are standard for the models 1602A – 1802A – 2202A – 2502A – 2802A.

Note: for units with economizer consider a reduction in max ambient temperature of 2°C





External temperature management

The BREC/F units are provided with modulating condensation control, therefore the influence of the external temperature variations on the condensation pressures are managed by varying the speed of the ventilating sections. In the event the external temperatures are such that the maximum condensation pressure is reached even with the fans at maximum speed, the control software automatically reduces the capacity of the compressors, consequently reducing the condensation pressure and maintaining the unit in operation, even if with a lower capacity (unloading).

Note: The maximum external temperature values declared refer to the unit without this procedure activated.

Therefore, if the unit has a maximum operating temperature of T_{MAX} (45 or 50°C) it will have the following operational states:

- $T < T_{MAX}$ normal operation, the condensation pressure is regulated by means of the fan speed.
- $T > T_{MAX}$ Activation of the unloading procedure the condensation pressure is reduced.
- $T > T_{MAX}$ Despite unloading, the condensation pressure is close to the maximum limit, the unit enters in stand-by with the aim of avoiding the necessity for manual resetting of the unit (high pressure alarm).

WATER TEMPERATURE: PRECISION ON SET-POINT

BREC/F chillers are fitted with two double screw compressors, which perform eight steps each. The control system regulates the temperature of the chilled water by switching the compressors on and off and regulating the slide valve of each single compressor. By changing the position of the slide valve according to the heat load, 4 steps are available; in this way it is possible to change the cooling capacity from 25% to 100%; overall, each unit may be controlled by means of 8 partialization steps.

All of the units use an algorithm to control the temperature of the chilled water based on the discharge temperature of the water. Moreover, the algorithm uses the inlet water temperature to minimise the compressor start-ups; in fact, a PID algorithm controls the discharge temperature of the water proportionally, but also uses an integrated and derivative process on the inlet water temperature to minimise the compressor start-ups. In this way, the Uniflair control system can be considered an evolution compared to the traditional systems of control which operate “predictably” on the discharge water temperature.

Thanks to this software it is possible to obtain an increased level of precision regarding the required temperature (between +/-0,6°C on the set-point) even without a water tank, protecting the compressors and their minimum start up times at the same time.

The following tables show data referring to a system with a minimum water rate of 2.5 l/kW.

Outlet water ΔT	Thermal load
±1,6°C	< 16% of nominal load
±1°C	Between 16% and 25% of nominal load
±0,3°C	> 25% of nominal load

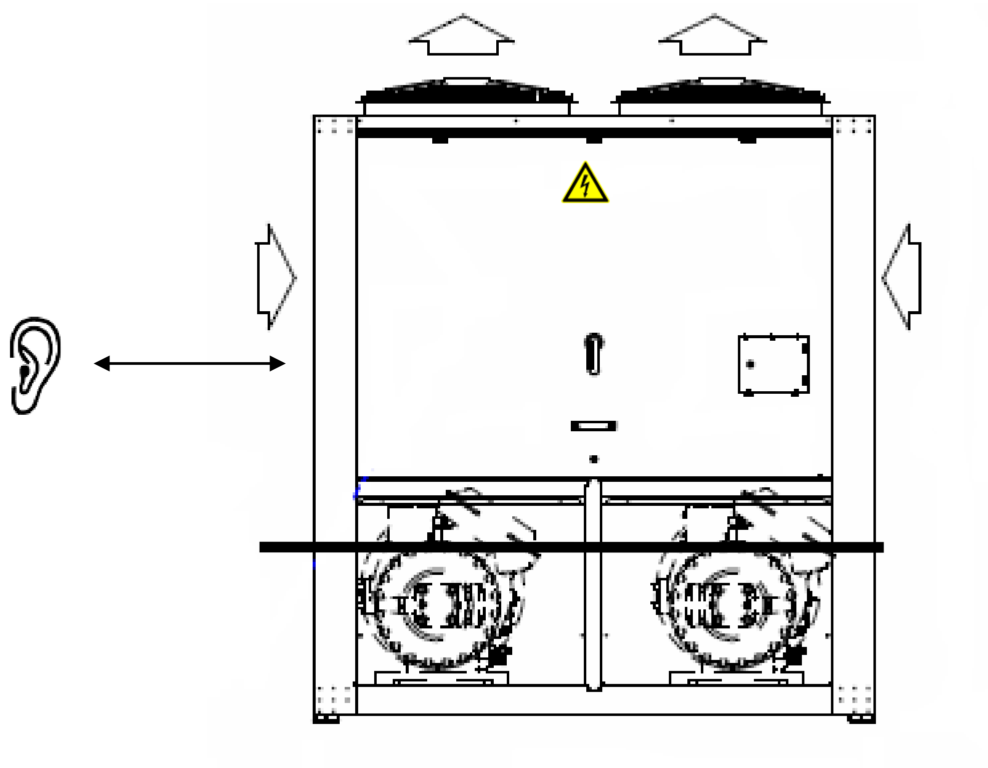
NOISE PRESSURE LEVEL

The **SOUND PRESSURE** levels (measured with BRÜEL & KJǼR class 1 sound-level meter mod. 2260) for each octave band frequency, measured with units working at full load, free-field conditions with **Q=2**, 10m away from the unit condensing coil according to ISO3744-3746.

SOUND POWER level for each octave band frequency supplied in compliance with standard ISO3744-ISO3746.

The tolerance on the data is equivalent to +/- 2 dB (A).

Note: the data supplied refers to units working based on factory settings and units without onboard pumps.



NOISE PRESSURE LEVEL TAKEN AT DIFFERENT POSITIONS AND DISTANCES

The attenuation of the noise pressure level is calculated according to the following:

$$A = 10 \cdot \log\left(L^{(3 \cdot L+1)/D} + H^{(3 \cdot H+1)/D} + D\right) - 10 \cdot \log\left[\left(D_{rif}/D\right) \cdot \left(L^{(3 \cdot L+1)/D} + H^{(3 \cdot H+1)/D} + D_{rif}\right)\right]$$

Where
A: Noise attenuation [dB(A)]
L: Length of the unit [m]
H: Height of the unit [m]
D: Distance [m]

Distance	m	1	2	3	4	5	6	7	8	9	10
Variation	dBA	+14	+11	+9	+7	+6	+5	+3	+2	+1	0

It is possible to calculate the noise pressure level at the desired distance or unit side: electrical board side or on the sides. The delta which need to be added to the data contained in the following pages are indicated in the following table.

Low noise unit			
Position		Electrical board side	Rear side
Attenuation	dBA	-2	-4

Ultra-low noise unit			
Position		Electrical board side	Rear side
Attenuation	dBA	-3	-4

NOISE LEVEL
Low noise version

NOISE PRESSURE LEVEL

Model	63Hz [dB(A)]	125Hz [dB(A)]	250Hz [dB(A)]	500Hz [dB(A)]	1000Hz [dB(A)]	2000Hz [dB(A)]	4000Hz [dB(A)]	8000Hz [dB(A)]	Lp [dB(A)]
1602A	23,9	23,9	27,1	42,7	47,3	59,9	52,3	43,9	61,0
1802A	24,6	30,2	47,0	53,6	59,7	48,6	40,9	28,1	61,1
2202A	25,3	30,8	52,6	52,6	59,2	50,0	41,9	34,5	61,2
2502A	25,1	30,2	50,6	52,8	57,8	49,8	42,5	35,2	60,1
2802A	24,5	26,8	48,1	52,4	57,0	56,2	47,4	36,2	60,9
3212A	27,6	37,8	51,3	54,7	60,1	53,4	48,3	38,6	62,4
3612A	27,4	28,6	41,9	54,0	56,6	59,2	53,5	44,7	62,6
4212A	27,8	34,1	56,3	57,1	58,5	55,4	44,4	38,0	63,1
4812A	27,6	34,4	54,8	56,1	60,8	55,2	46,7	38,4	63,6

NOISE POWER LEVEL

Model	63Hz [dB(A)]	125Hz [dB(A)]	250Hz [dB(A)]	500Hz [dB(A)]	1000Hz [dB(A)]	2000Hz [dB(A)]	4000Hz [dB(A)]	8000Hz [dB(A)]	Lw [dB(A)]
1602A	54,9	54,9	58,2	73,8	78,4	91,0	83,4	75,0	92,0
1802A	55,7	61,3	78,0	84,7	90,8	79,7	72,0	59,8	92,2
2202A	56,3	61,9	83,7	83,7	90,3	81,1	73,0	65,6	92,3
2502A	56,1	61,3	81,6	83,9	88,9	80,9	73,5	66,3	91,2
2802A	56,1	58,5	79,8	84,1	88,7	87,9	79,0	67,9	92,5
3212A	59,4	69,6	83,1	86,5	91,9	85,2	80,1	70,4	94,3
3612A	59,2	60,4	73,7	85,8	88,4	91,0	85,3	76,5	94,4
4212A	60,1	66,4	88,6	89,4	90,7	87,7	76,7	70,2	95,3
4812A	60,1	66,8	87,2	88,5	93,2	87,6	79,1	70,9	96,0

NOISE LEVEL
Ultra low noise version

Ultra-low noise version - Equipment
Ultra-low noise units are equipped with sound-proofing for compressors and mufflers on the discharge side of the compressors.

NOISE PRESSURE LEVEL

Model	63Hz [dB(A)]	125Hz [dB(A)]	250Hz [dB(A)]	500Hz [dB(A)]	1000Hz [dB(A)]	2000Hz [dB(A)]	4000Hz [dB(A)]	8000Hz [dB(A)]	Lp [dB(A)]
1602A	23,3	23,3	25,5	38,6	43,9	53,6	46,6	40,2	55,0
1802A	23,7	27,5	41,3	47,7	53,4	44,8	39,3	26,1	55,2
2202A	24,6	28,3	46,1	47,4	53,2	46,1	40,5	34,2	55,6
2502A	24,5	27,9	44,4	47,5	52,2	46,0	40,6	34,4	54,8
2802A	23,9	25,6	42,3	47,1	51,5	49,4	42,1	34,1	55,0
3212A	26,7	29,2	41,4	51,4	54,4	50,1	42,9	36,7	57,5
3612A	27,4	34,5	45,7	49,9	54,8	49,4	44,7	37,6	57,6
4212A	27,4	32,7	47,2	50,6	54,4	49,7	44,1	37,6	58,0
4812A	27,4	32,7	47,2	50,6	54,4	49,7	44,1	37,6	58,4

NOISE POWER LEVEL

Model	63Hz [dB(A)]	125Hz [dB(A)]	250Hz [dB(A)]	500Hz [dB(A)]	1000Hz [dB(A)]	2000Hz [dB(A)]	4000Hz [dB(A)]	8000Hz [dB(A)]	Lw [dB(A)]
1602A	54,4	54,4	56,6	69,7	75,0	84,7	77,7	71,3	86,1
1802A	54,8	58,6	72,4	78,8	84,5	75,9	70,4	57,8	86,3
2202A	55,7	59,4	77,2	78,5	84,3	77,2	71,6	65,3	86,7
2502A	55,6	59,0	75,5	78,6	83,3	77,1	71,7	65,4	85,9
2802A	55,6	57,3	74,0	78,7	83,2	81,1	73,8	65,8	86,7
3212A	59,3	66,3	77,5	81,7	86,6	81,2	76,5	69,4	89,3
3612A	59,2	64,5	79,0	82,4	86,2	81,5	75,9	69,4	89,4
4212A	60,0	64,0	82,1	83,9	86,1	82,7	76,1	70,1	90,2
4812A	60,0	64,3	80,9	83,3	87,7	82,7	76,7	70,2	90,7

BREC – BREF
Air cooled chillers and free-cooling chillers

Main Electrical Data

Good practices and recommendations for electrical design
The correct design for the electrical section depends on many factors, partially covered by the unit data, which must be considered and matched.
In particular protection sizing depends on cable size and lengths, as well as local standards.

Main electrical data provided for the units are Full Load Amperage, Full Load Input power and Locked Rotor Amperage. Those values are necessary for designing the site electrical circuit/s as per the explanation below, while Operative values for Current and Power are not to be used for sizing cabling, safety devices and other devices since different values may happen according to the different operating conditions.

Electrical data for components

- **ST**: it is the starting mode for compressors. It can be Part-Winding (PW) or Star/Delta(Y/Δ) according to the model (see below the specific note)
- **FLA**: Full Load Amperage. These are the absorbed current values of components [A] at max operating parameters over an extended period of time
- **FLI**: Full Load Input Power. These are the absorbed power values of components [kW] at max operating parameters over an extended period of time
- **LRA**: Locked Rotor Amperage. This is the max current peak of components [A]. Regarding the LRA for compressors refer to the note below.

Electrical data for the unit

- **Voltage:** The power supply for all of the units is 400V / 3ph / 50Hz, with tolerance in voltage of 380V-5% and 420+5%. Therefore the min voltage is 360V while the max is 440V, the unit is self-protected in voltage conditions which are out of this limits and it is automatically switched off by means of the min/max voltage relay. Versions with different power supplies (voltage and/or frequencies) can be provided on request
- **SB**: Stand-by current: this is the current absorption [A] of the auxiliaries devices. When the unit is in stand-by mode it refers to current absorption without compressors, fans and pump (if fitted) operating
- **OA**: Operative Amperage. This is the absorbed current calculated by simulation software at a specific operative conditions over an extended period of time, i.e. compressor/s specific operative absorbed current + specific operative fans absorbed current + specific operative main pump absorbed current (if present, typically considered separately in the simulation software datasheets). This is the operative steady current value at specific conditions. Since, according to the different operating conditions, different current values may happen, this value is NOT to be used for sizing cabling, safety devices, etc.
- **OP**: Operative Power input. This is the absorbed power calculated by simulation software at a specific operative conditions over an extended period of time, i.e. compressor/s specific operative absorbed power + specific operative fans absorbed power + specific operative main pump absorbed power (if present, typically considered separately in the simulation software datasheets). This is the operative steady power value at specific conditions. Since, according to the different operating conditions, different power values may happen, this value is NOT to be used for sizing cabling, safety devices, etc.
- **FLA**: Full Load Amperage, the maximum absorbed current of the unit [A]. This is the absorbed current of the unit at max operating parameters over an extended period of time, i.e. compressor/s max absorbed current + max fans absorbed current + max main pump absorbed current (if present) + the auxiliaries devices current (SB). This is the maximum steady current value actually necessary to size cabling, safety devices, etc.
  Data for units fitted with power phase capacitors refer to the worst case, i.e. without power phase capacitors active.
- **FLI**: Full Load Input Power, the maximum absorbed power of the unit [kW]. This is the absorbed power at max operating parameters over an extended period of time, i.e. compressor/s max absorbed power + fans

absorbed power + max main pump absorbed power (if present). This is the maximum steady power value actually necessary to size cabling, safety devices, etc. In combination with the FLA value.

- **LRA**: Locked Rotor Amperage, the maximum absorbed pick in current of the unit [A]. This is the max current peak of the unit, i.e. compressor nr 1 locked rotor amperage + other compressor/s max absorbed current + max fans absorbed current + max operating current for pump (if fitted) + the auxiliaries devices current (SB). This is necessary to define the delay in external safety devices and the genset sizing (if fitted).
  Data for units fitted with power phase capacitors refer to the worst case, i.e. without power phase capacitors active.
  NOTE on LRA values
  The star/delta transition increases the absorbed current value for an instantaneous timeframe. This peak can be calculated as: compressor nr 1 LRA (Δ) + the max compressor nr 2 absorbed current (FLA) + the fans absorbed current (and pump if fitted) + the auxiliaries devices current (SB). This transition is usually shorter than the protection tripping min time and therefore it is possible to evaluate if not considering in the protection design (at designer responsibility).
- **COSφ**: it is the cosine of the φ angle of displacement between the current and the voltage in an electrical system with alternate current.
  Values in the table below are provided at nominal conditions, i.e. Inlet/Outlet water temperature: 12/7°C, Ambient temperature: 35°C, glycol: 0%, fouling factor: 0 m^2°C/kW and full load conditions
  NOTE on COSφ values
  - **Cosphi at different load conditions**
    Standard power phase capacitors (fixed) cannot maintain a value in every condition. As the capacity for standard power phase capacitors is fixed, they cannot adapt to the load and the cosphi cannot be the same in all conditions.
  - **Power phase capacitors on chillers with screw compressors**
    Regarding power phase capacitors on chillers with screw compressors it is very important to underline the following points. It is not possible to use power phase capacitors for the fans, as they are connected to a phase cutting regulator; consequently the only way to achieve a cosphi target value for the entire unit is to apply a higher value to the compressors (for instance to achieve 0.90, it is necessary to use 0.92 on the compressors).
    Regarding 0.95, this is the max acceptable cosphi value for screw compressors. It is absolutely not permitted to have a value higher than 0.95, this means that it is not possible to grant 0.95 for the entire unit, but only a value close to and below 0.95. The gap depends on the size of the unit which can fall within the measurement tolerances.
  - **Cosphi on units equipped with fans with EC motors**
    Electronically commuted (EC) motors, which are applied on EC fans, do not have the same effect as asynchronous motors with relation to the phase displacement between current and voltage.
    These types of motors do not introduce a phase displacement, but modify the shape of the wave as a phase displacement. However this effect is different and it cannot be corrected with the traditional power phase capacitors.

Compressor starting procedures

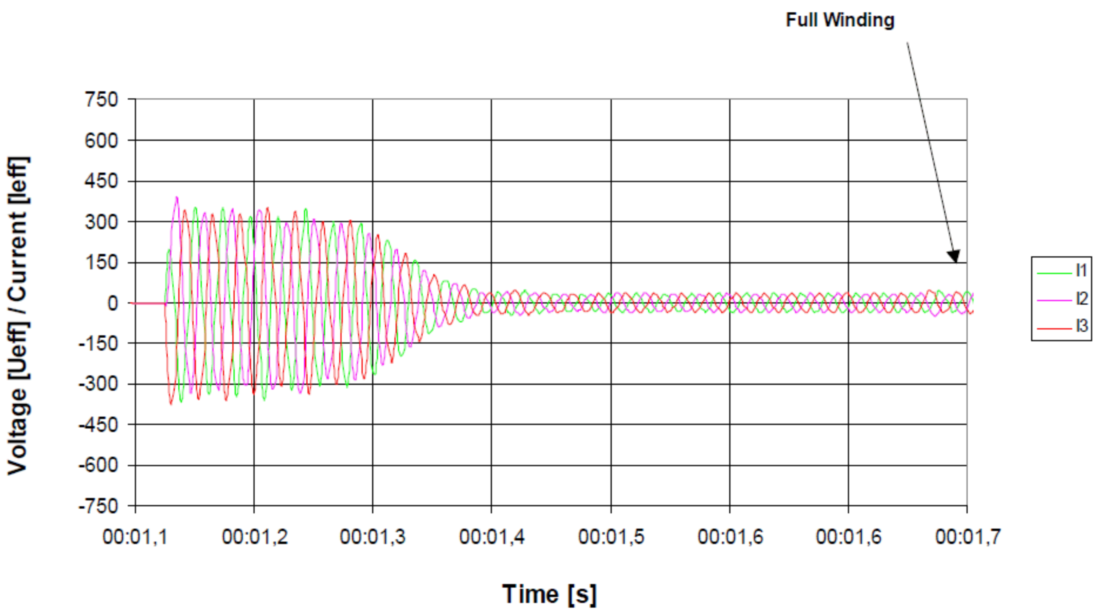
According to the compressor model/type, the starting mode on BREC/F units can be the following.

- Part-winding, for BREC/F1612A-2812A (indicated as “PW” in the tables below)
- Star delta, for BREC/F1602A-2802A and BREC/F3212A-4812A (indicated as “Y/Δ” in the tables below)

Part-winding

Part-winding: on motors with this system the windings of the motor are divided in two sections and therefore these motors are powered in 2 steps, 60% of the windings first, then 100%. A typical amperage profile for this configuration is shown in the following image.

NOTE: The intent of the picture is descriptive only, values for amperage and timing may change a lot according to the compressor size, model or manufacturer)



Is this case the starting current for a compressor is slightly higher than the LRA, which is measured according to relative standards, i.e. Tout at 32°C, with rotor locked, and 4 seconds after the compressor has been powered and therefore these values could be slightly different in different conditions.

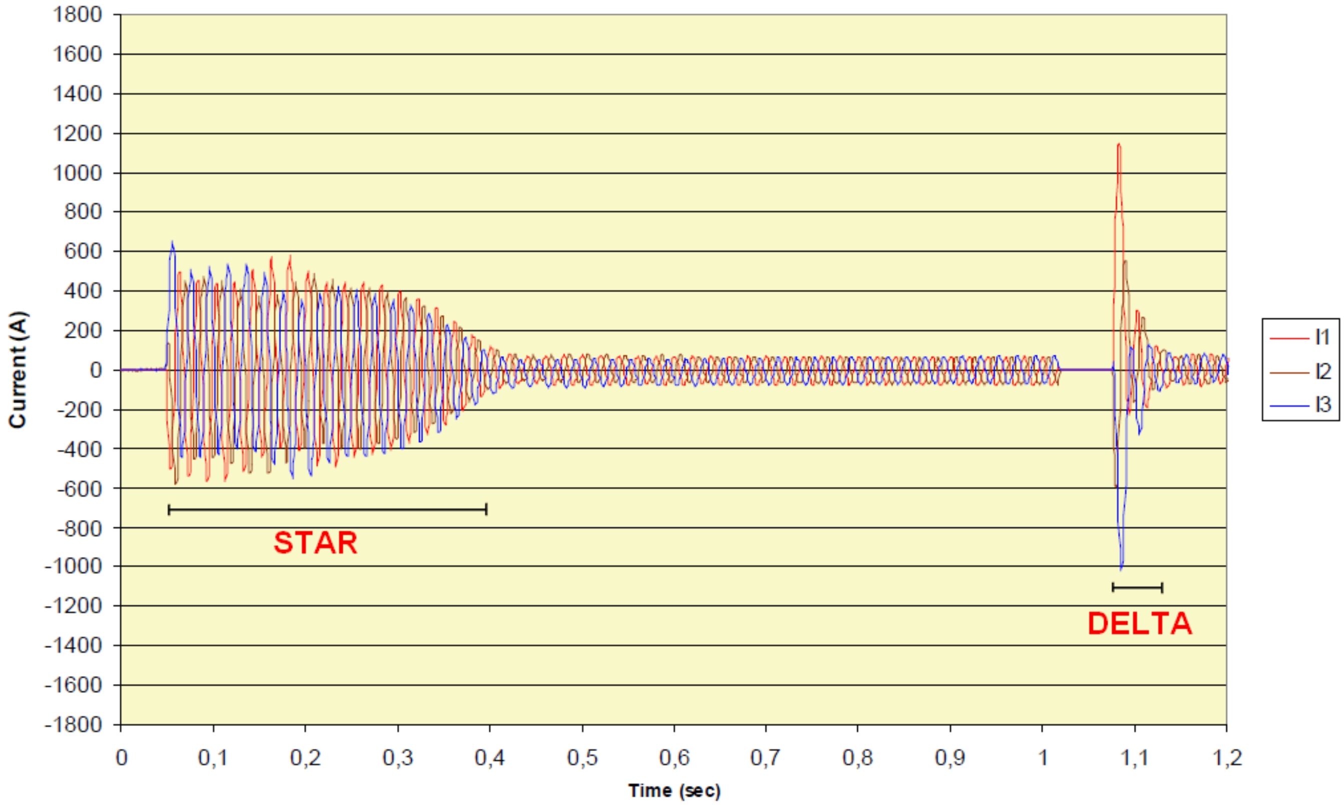
NOTE: All the values in the datasheets refer to RMS (root mean square) value.

In the following tables this value is identified with the “D”, while with “DD” is usually identified the Direct On Line starting method (DOL), usually not applied on screw compressors.

Star-Delta

The motor is started in 2 configurations, star and then delta: The first one in a Star layout, the second one in a Delta layout. A typical amperage profile for this configuration is shown in the following picture.

NOTE: The intent of the picture is descriptive only, values for amperage and timing may change a lot according to the compressor size, model or manufacturer).



The first peak is typically lower (in current) and longer (in time) than the second one which is higher and very short.
This is the reason why the star value is usually considered for sizing and design, while the delta value is necessary for a double check. Moreover, this is the reason why declared data refer to star mode.
In the following tables the star value is identified with the "Y", while with delta with "Δ".

Since it is really short, the Delta (Δ) peak is practically transparent from a current absorption prospective, but it could influence the operation of some critical devices, as for example generators, and it should be consequently considered in the general electrical design (at designer responsibility).

Electrical data for components

BREC units – chiller series

	Compressor (Basic version)					Compressor (High temperature version)				
	Nr	FLI	FLA	LRA	ST	Nr	FLI	FLA	LRA	ST
1602A	2	78	128	177 (Y) / 563 (Δ)	Y / Δ	2	78	128	177 (Y) / 563 (Δ)	Y / Δ
1802A	2	103	165	224 (Y) / 717 (Δ)	Y / Δ	2	103	165	224 (Y) / 717 (Δ)	Y / Δ
2202A	2	114	183	279 (Y) / 888 (Δ)	Y / Δ	2	114	183	279 (Y) / 888 (Δ)	Y / Δ
2502A	2	122	207	279 (Y) / 888 (Δ)	Y / Δ	2	122	207	279 (Y) / 888 (Δ)	Y / Δ
2802A	2	146	243	276 (Y) / 861 (Δ)	Y / Δ	2	146	243	276 (Y) / 861 (Δ)	Y / Δ
1612A	2	88	144	350 (D) / 585 (DD)	PW	2	102	170	479 (D) / 790 (DD)	PW
1812A	2	96	162	423 (D) / 686 (DD)	PW	2	112	180	516 (D) / 887 (DD)	PW
2212A	2	110	182	520 (D) / 801 (DD)	PW	2	150	246	665 (D) / 1023 (DD)	PW
2512A	2	120	196	612 (D) / 943 (DD)	PW	2	160	260	729 (D) / 1114 (DD)	PW
2812A	2	131	214	665 (D) / 1023 (DD)	PW	2	186	310	757 (D) / 1181 (DD)	PW
3212A	2	155	280	436 (Y) / 1364 (Δ)	Y / Δ	2	246	370	586 (Y) / 1853 (Δ)	Y / Δ
3612A	2	175	310	465 (Y) / 1442 (Δ)	Y / Δ	2	255	420	650 (Y) / 2029 (Δ)	Y / Δ
4212A	2	204	320	586 (Y) / 1853 (Δ)	Y / Δ	2	280	450	805 (Y) / 2520 (Δ)	Y / Δ
4812A	2	222	360	650 (Y) / 2029 (Δ)	Y / Δ	2	280	450	805 (Y) / 2520 (Δ)	Y / Δ

	Standard Fan			EC fan		
	Nr	FLI	FLA	Nr	FLI	FLA
1602A	6	1,9	3,9	6	2,86	4,5
1802A	6	1,9	3,9	6	2,86	4,5
2202A	8	1,9	3,9	8	2,86	4,5
2502A	8	1,9	3,9	8	2,86	4,5
2802A	8	1,9	3,9	8	2,86	4,5
1612A	6	1,9	3,9	6	2,86	4,5
1812A	6	1,9	3,9	6	2,86	4,5
2212A	8	1,9	3,9	8	2,86	4,5
2512A	8	1,9	3,9	8	2,86	4,5
2812A	8	1,9	3,9	8	2,86	4,5
3212A	10	1,9	3,9	10	2,86	4,5
3612A	10	1,9	3,9	10	2,86	4,5
4212A	12	1,9	3,9	12	2,86	4,5
4812A	12	1,9	3,9	12	2,86	4,5

	Main Pump		
	FLI	FLA	LRA
1602A	9,2	18,5	152
1802A	9,2	18,5	152
2202A	11,0	21,5	183
2502A	11,0	21,5	183
2802A	11,0	21,5	183
1612A	9,2	18,5	152
1812A	9,2	18,5	152
2212A	11,0	21,5	183
2512A	11,0	21,5	183
2812A	11,0	21,5	183
3212A	11,0	21,5	183
3612A	11,0	21,5	183
4212A	22,0	41,0	439
4812A	22,0	41,0	439

Electrical data for components

BREF units – free-cooling chiller series

	Compressor (Basic version)					Compressor (High temperature version)				
	Nr	FLI	FLA	LRA	ST	Nr	FLI	FLA	LRA	ST
1602A	2	78	128	177 (Y) / 563 (Δ)	Y / Δ	2	78	128	177 (Y) / 563 (Δ)	Y / Δ
1802A	2	103	165	224 (Y) / 717 (Δ)	Y / Δ	2	103	165	224 (Y) / 717 (Δ)	Y / Δ
2202A	2	114	183	279 (Y) / 888 (Δ)	Y / Δ	2	114	183	279 (Y) / 888 (Δ)	Y / Δ
2502A	2	122	207	279 (Y) / 888 (Δ)	Y / Δ	2	122	207	279 (Y) / 888 (Δ)	Y / Δ
2802A	2	146	243	276 (Y) / 861 (Δ)	Y / Δ	2	146	243	276 (Y) / 861 (Δ)	Y / Δ
1612A	2	88	144	350 (D) / 585 (DD)	PW	2	102	170	479 (D) / 790 (DD)	PW
1812A	2	96	162	423 (D) / 686 (DD)	PW	2	112	180	516 (D) / 887 (DD)	PW
2212A	2	110	182	520 (D) / 801 (DD)	PW	2	150	246	665 (D) / 1023 (DD)	PW
2512A	2	120	196	612 (D) / 943 (DD)	PW	2	160	260	729 (D) / 1114 (DD)	PW
2812A	2	131	214	665 (D) / 1023 (DD)	PW	2	186	310	757 (D) / 1181 (DD)	PW
3212A	2	155	280	436 (Y) / 1364 (Δ)	Y / Δ	2	246	370	586 (Y) / 1853 (Δ)	Y / Δ
3612A	2	175	310	465 (Y) / 1442 (Δ)	Y / Δ	2	255	420	650 (Y) / 2029 (Δ)	Y / Δ
4212A	2	204	320	586 (Y) / 1853 (Δ)	Y / Δ	2	280	450	805 (Y) / 2520 (Δ)	Y / Δ
4812A	2	222	360	650 (Y) / 2029 (Δ)	Y / Δ	2	280	450	805 (Y) / 2520 (Δ)	Y / Δ

	Standard Fan			EC fan		
	Nr	FLI	FLA	Nr	FLI	FLA
1602A	6	1,9	3,9	6	2,86	4,5
1802A	6	1,9	3,9	6	2,86	4,5
2202A	8	1,9	3,9	8	2,86	4,5
2502A	8	1,9	3,9	8	2,86	4,5
2802A	8	1,9	3,9	8	2,86	4,5
1612A	6	1,9	3,9	6	2,86	4,5
1812A	6	1,9	3,9	6	2,86	4,5
2212A	8	1,9	3,9	8	2,86	4,5
2512A	8	1,9	3,9	8	2,86	4,5
2812A	8	1,9	3,9	8	2,86	4,5
3212A	10	1,9	3,9	10	2,86	4,5
3612A	10	1,9	3,9	10	2,86	4,5
4212A	12	1,9	3,9	12	2,86	4,5
4812A	12	1,9	3,9	12	2,86	4,5

	Main pump			Free-cooling pump		
	FLI	FLA	LRA	FLI	FLA	LRA
1602A	10,9	18,5	152	8,5	14,3	130
1802A	10,9	18,5	152	8,5	14,3	130
2202A	12,6	21,5	183	10,9	18,5	152
2502A	12,6	21,5	183	10,9	18,5	152
2802A	12,6	21,5	183	10,9	18,5	152
1612A	10,9	18,5	152	8,5	14,3	130
1812A	10,9	18,5	152	8,5	14,3	130
2212A	12,6	21,5	183	10,9	18,5	152
2512A	12,6	21,5	183	10,9	18,5	152
2812A	12,6	21,5	183	10,9	18,5	152
3212A	12,6	21,5	183	12,6	21,5	183
3612A	12,6	21,5	183	12,6	21,5	183
4212A	25,2	41,0	439	21	34	320
4812A	25,2	41,0	439	21	34	320

Electrical Data for complete unit

BREC/F units – units without pumps and with EC fans

	Units without power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	175	289	338	0,87	0,85	5,8
1802A	225	363	422	0,87	0,85	5,8
2202A	253	408	504	0,86	0,84	5,8
2502A	269	456	528	0,87	0,85	5,8
2802A	317	528	561	0,86	0,84	5,8
1612A	195	321	527	0,85	0,82	5,8
1812A	211	357	618	0,87	0,85	5,8
2212A	245	406	744	0,86	0,83	5,8
2512A	265	434	850	0,85	0,83	5,8
2812A	287	470	921	0,85	0,83	5,8
3212A	341	611	767	0,88	0,86	5,8
3612A	381	671	826	0,89	0,87	5,8
4212A	445	700	966	0,87	0,85	5,8
4812A	481	780	1070	0,88	0,86	5,8

	Units with power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	175	289	338	0,92	0,89	5,8
1802A	225	363	422	0,91	0,89	5,8
2202A	253	408	504	0,90	0,87	5,8
2502A	269	456	528	0,92	0,89	5,8
2802A	317	528	561	0,90	0,88	5,8
1612A	195	321	527	0,94	0,91	5,8
1812A	211	357	618	0,93	0,91	5,8
2212A	245	406	744	0,92	0,90	5,8
2512A	265	434	850	0,92	0,90	5,8
2812A	287	470	921	0,92	0,90	5,8
3212A	341	611	767	0,93	0,91	5,8
3612A	381	671	826	0,94	0,92	5,8
4212A	445	700	966	0,92	0,90	5,8
4812A	481	780	1070	0,92	0,91	5,8

Electrical data for complete unit

BREC/F units – units with high ambient temperature option, with EC fans, and without pumps

	Units without power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	175	289	338	0,87	0,85	5,8
1802A	225	363	422	0,87	0,85	5,8
2202A	253	408	504	0,86	0,84	5,8
2502A	269	456	528	0,87	0,85	5,8
2802A	317	528	561	0,86	0,84	5,8
1612A	223	373	682	0,85	0,83	5,8
1812A	243	393	729	0,85	0,82	5,8
2212A	325	534	953	0,83	0,80	5,8
2512A	345	562	1031	0,85	0,83	5,8
2812A	397	662	1109	0,80	0,78	5,8
3212A	523	791	1007	0,84	0,82	5,8
3612A	541	891	1121	0,85	0,83	5,8
4212A	597	960	1315	0,85	0,83	5,8
4812A	597	960	1315	0,86	0,85	5,8

	Units with power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	175	289	338	0,92	0,89	5,8
1802A	225	363	422	0,91	0,89	5,8
2202A	253	408	504	0,90	0,87	5,8
2502A	269	456	528	0,92	0,89	5,8
2802A	317	528	561	0,90	0,88	5,8
1612A	223	373	682	0,94	0,91	5,8
1812A	243	393	729	0,91	0,89	5,8
2212A	325	534	953	0,90	0,87	5,8
2512A	345	562	1031	0,93	0,90	5,8
2812A	397	662	1109	0,87	0,85	5,8
3212A	523	791	1007	0,90	0,88	5,8
3612A	541	891	1121	0,90	0,88	5,8
4212A	597	960	1315	0,91	0,88	5,8
4812A	597	960	1315	0,91	0,89	5,8

Electrical data for complete unit

BREC/F units – units with onboard pumps and EC fans

	Units without power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	186	307	356	0,87	0,85	5,8
1802A	236	381	440	0,87	0,85	5,8
2202A	266	429	525	0,86	0,84	5,8
2502A	282	477	549	0,87	0,85	5,8
2802A	330	549	582	0,86	0,84	5,8
1612A	206	339	545	0,85	0,82	5,8
1812A	222	375	636	0,87	0,85	5,8
2212A	258	427	765	0,86	0,83	5,8
2512A	278	455	871	0,85	0,83	5,8
2812A	300	491	942	0,85	0,84	5,8
3212A	353	632	788	0,88	0,86	5,8
3612A	393	692	847	0,89	0,87	5,8
4212A	470	741	1007	0,87	0,85	5,8
4812A	506	821	1111	0,88	0,86	5,8

	Units with power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	186	307	356	0,92	0,90	5,8
1802A	236	381	440	0,91	0,89	5,8
2202A	266	429	525	0,90	0,88	5,8
2502A	282	477	549	0,92	0,89	5,8
2802A	330	549	582	0,90	0,89	5,8
1612A	206	339	545	0,94	0,91	5,8
1812A	222	375	636	0,93	0,91	5,8
2212A	258	427	765	0,92	0,90	5,8
2512A	278	455	871	0,93	0,90	5,8
2812A	300	491	942	0,92	0,90	5,8
3212A	353	632	788	0,93	0,91	5,8
3612A	393	692	847	0,94	0,92	5,8
4212A	470	741	1007	0,92	0,91	5,8
4812A	506	821	1111	0,92	0,91	5,8

Electrical Data for complete unit

BREC/F units – units with high ambient temperature, EC fans, and onboard pumps

	Units without power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	186	307	356	0,87	0,85	5,8
1802A	236	381	440	0,87	0,85	5,8
2202A	266	429	525	0,86	0,84	5,8
2502A	282	477	549	0,87	0,85	5,8
2802A	330	549	582	0,86	0,84	5,8
1612A	234	391	700	0,85	0,83	5,8
1812A	254	411	747	0,85	0,83	5,8
2212A	338	555	974	0,83	0,81	5,8
2512A	358	583	1052	0,85	0,83	5,8
2812A	410	683	1130	0,80	0,78	5,8
3212A	535	812	1028	0,84	0,82	5,8
3612A	553	912	1142	0,85	0,83	5,8
4212A	622	1001	1356	0,85	0,83	5,8
4812A	622	1001	1356	0,86	0,85	5,8

	Units with power phase capacitors					
	FLI	FLA	LRA	COSφ at nominal conditions		SB
				EC fans	AC fans	
1602A	186	307	356	0,92	0,89	5,8
1802A	236	381	440	0,91	0,89	5,8
2202A	266	429	525	0,90	0,87	5,8
2502A	282	477	549	0,92	0,89	5,8
2802A	330	549	582	0,90	0,88	5,8
1612A	234	391	700	0,94	0,91	5,8
1812A	254	411	747	0,91	0,89	5,8
2212A	338	555	974	0,90	0,87	5,8
2512A	358	583	1052	0,93	0,90	5,8
2812A	410	683	1130	0,88	0,86	5,8
3212A	535	812	1028	0,90	0,88	5,8
3612A	553	912	1142	0,91	0,89	5,8
4212A	622	1001	1356	0,91	0,89	5,8
4812A	622	1001	1356	0,91	0,90	5,8

Worldwide Customer Support

Customer support is available at no charge via e-mail or telephone. Contact information is available at **www.apc.com/support/contact**.