



# OPEN CYCLE SYSTEM

MIRAI INTEX | SAVE THE PLANET WITH US



About us

## Welcome to Mirai

Mirai Intex is an engineering and manufacturing company founded in Switzerland in 2015, with the main mission to reshape the Ultra-Low Temperature (ULT) refrigeration industry, for the benefit of the environment, human health and safety.

Refrigeration machines developed and produced by MIRAI Intex are made of high-grade components and materials, to ensure long-term, efficient and reliable operation. Our commitment to climate protection is visible through our manufacturing practices and our environmentally friendly product design.

The implementation of air-cycle cooling technology helps to eliminate the use of harmful fluorinated gases, as well as prevent ozone layer depletion and global warming. With our innovative refrigeration technology, we contribute to reducing greenhouse gas emissions as well as increasing the safety of refrigeration equipment operating at ultra-low temperatures.

Our portfolio covers a wide range of applications starting from Biomedical and Food Storage to Freeze-drying and liquefaction of gases.

Save the planet with us. Just being mindful of the area you work in can have a huge impact on the whole environment.

Our technical support team provides installation, commissioning and service assistance. Troubleshooting support for our machines is available 24/7. Any support request can be also submitted online on our website. Urgent service requests are processed within 24h.

Montreal Protocol on Substances That Deplete the Ozone Layer, 1989

Framework Convention on Climate Change, 1992

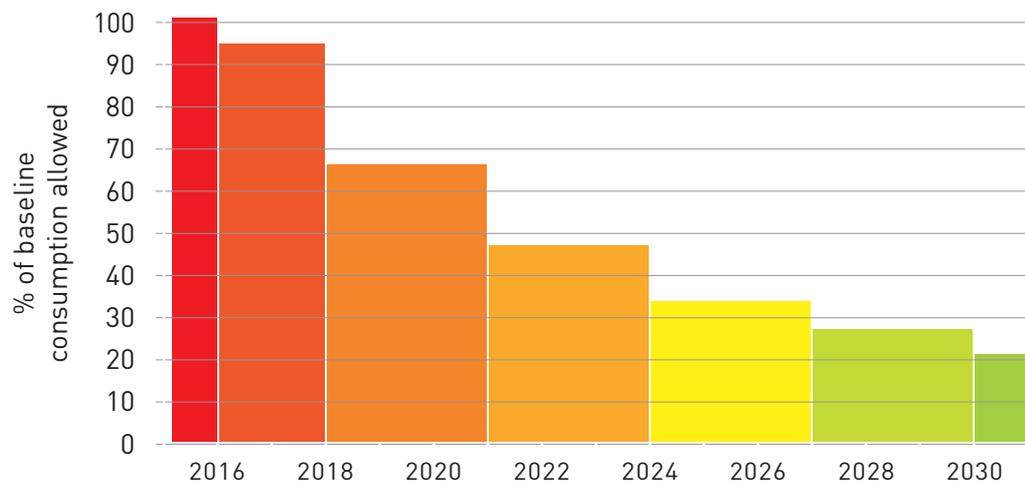
Kyoto Protocol, 1997

Paris Agreement, 2015

European Commission F-gas regulation, 2015

Kigali Amendment, 2019

## EUROPEAN UNION F-GAS PHASE DOWN



Baseline = the average HFC consumption between 2009 and 2012

The aim of the phased reduction of F-gas emissions is to reduce the usage of HFCs by 79 % between 2015 and 2030. And not without reason: F-gases amplify the greenhouse effect and contribute to climate change, with some common gases being thousands times more devastating than carbon dioxide.

Reducing usage levels is thus an important building block for achieving the European Union's climate goals.

We at Mirai support our customers with alternative refrigeration solutions, with a GWP ZERO.

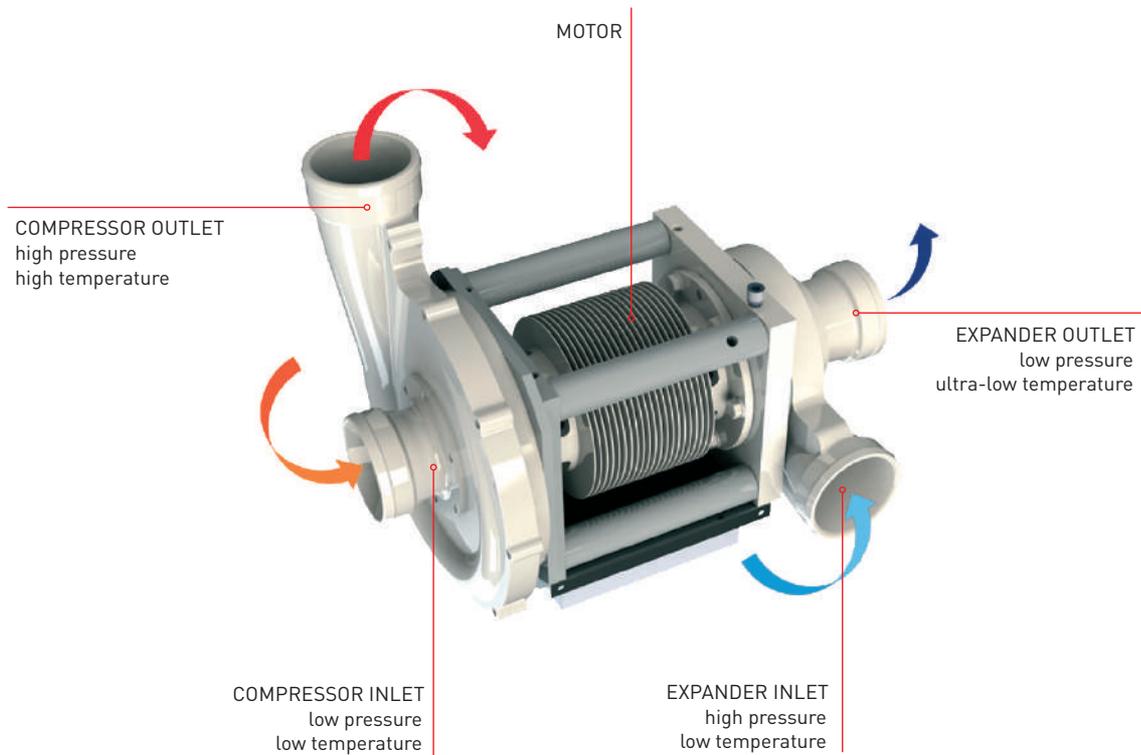
Air is not a subject of F-gas regulation and is the best substitute to existing refrigerants and offers full refrigeration, capacity and safety.



F-gas regulation video



# Technology

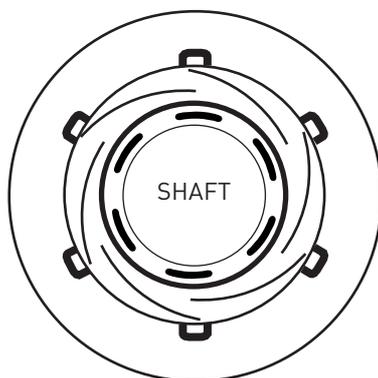


## Air Cycle Technology

The air cycle, is widely used in air separation plants as a cooling stage to obtain cryogenic cold, to liquify natural gas, as well as in an aircraft air conditioning systems.

The heart of the system is turbo-module unit developed and manufactured in-house for the most efficient and reliable work. The technology is based on the heating capability of air during compression and cooling down during expansion. Repetition of compression and expansion cycles allows to reach and maintain ultra-low temperatures down to  $-160\text{ }^{\circ}\text{C}$ .

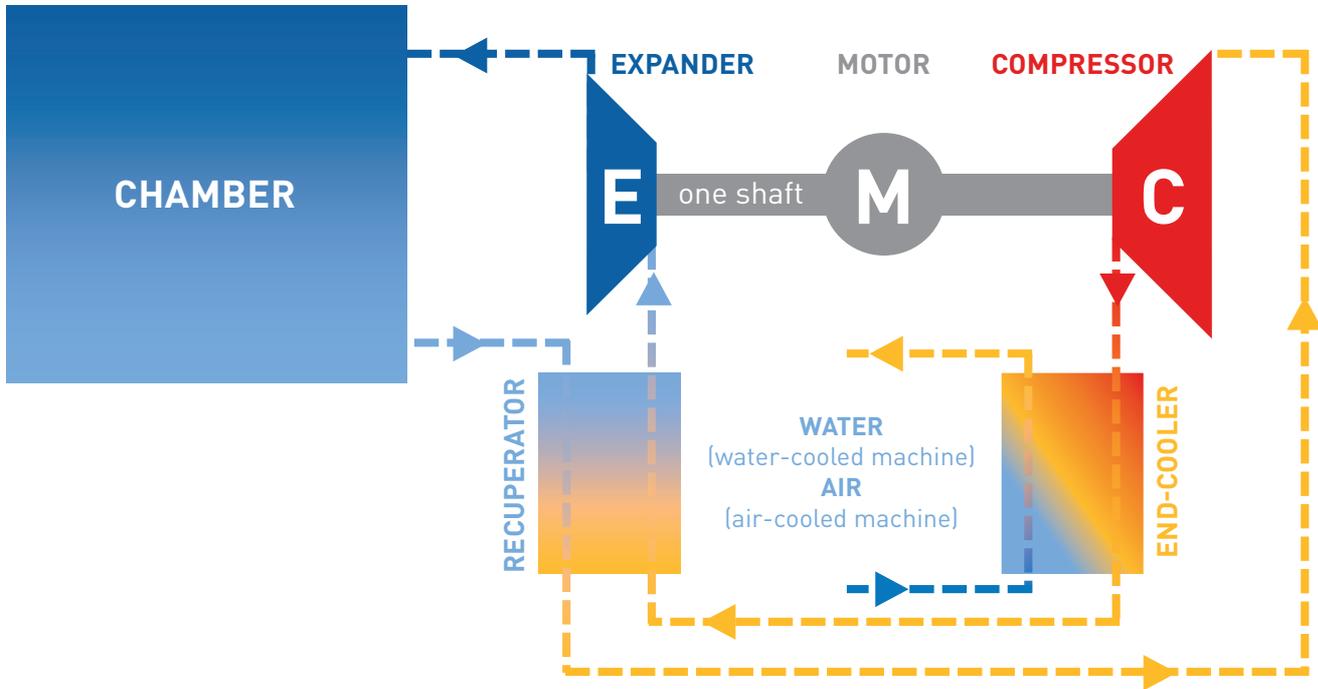
A key technological feature is that the turbo expander and compressor are located on the same shaft. The energy produced during the expansion process is transferred through the shaft to the compressor, which allows to reduce energy consumption up to 30 % compared to vapor compression systems.



## Air Bearings

Our air bearing system eliminates the need for complex oil management systems and makes our machines more reliable and maintenance-free.

When the shaft is spinning fast enough it starts to float on the air cushion created by the increased air pressure from its spinning.



### How does the Air Cycle Technology work?

Air is heated during compression and cooled through a series of heat exchangers and then expanded to reach ultra-low temperatures. While repeating the cycle of compression, cooling and expansion we can achieve temperatures down to  $-160\text{ }^{\circ}\text{C}$ .



Video of Air Cycle Technology

### Minimal service requirements

Maintenance costs are cut to the minimum. No refrigerant leakage tests or refrigerant purchase and replenishment costs are required. Air is free of charge. Long-lasting, wear-resistant parts and components ensure a long machine life, due to the oil-free operation.



# Advantages of the system

Air cycle system has a lot of advantages, and the main one is that it uses air as a refrigerant, therefore it is environmentally neutral. In addition, air cycle equipment is extremely reliable and durable, which helps to reduce maintenance costs and ensures life-long cycle without the decline in performance, unlike vapor compression cycle equipment.

A unique feature of the technology is that it can produce useful heat and can be integrated into the heat management system of the building and produce additional heating.

All MIRAI Cold machines are factory equipped with a frequency inverter, which allows consuming only the energy required to maintain set conditions; all done automatically.

Mirai Intex developed air bearings that absolutely eliminate the need for lubricants in the system. This ensures additional cost savings but mainly a safe and worry less experience for our clients.



THE MOST ECO-FRIENDLY REFRIGERATION MACHINE



MINIMAL SERVICE REQUIREMENTS



SAFEST SOLUTION ON THE MARKET



REMOTE MONITORING AND SOFTWARE UPDATES



ANY TEMPERATURE IN THE RANGE FROM -40 °C TO -130 °C



TECHNOLOGICALLY ADVANCED



HIGH ENERGY EFFICIENCY



ECONOMICAL IN USE



AUTOMATED CONTINUOUS HUMIDITY EXTRACTION



EASE OF INSTALLATION AND PROJECT PLANNING



MAXIMAL TEMPERATURE ACCURACY & UNIFORMITY



LEGAL COMPLIANCE

# Refrigeration Technology

## Comparative table

	Air Cycle	Vapor Compression	Liquid Nitrogen
Future Proof	Air as refrigerant Free refrigerant GWP = 0	Synthetic refrigerants bans  Natural refrigerants restricted by safety regulations	Transport regulations  Storage regulations
Reliability	Air-bearing compressor  No contacting pairs (no wear)	Compressor wear  Damage by liquid refrigerant  Damage due to insufficient lubrication	No moving parts  High thermal stress
Safety Machinery room	Low system pressure (from 1 to 10 bar)  No need for separate machine room	ATEX directive for respective refrigerants  Gas sensors, ventilation  Vibration damping floor	Gas sensors, ventilation  Space for LN2 storage
Maintenance	Only electrical cabinet filter cartridge exchange	Oil and refrigerant management Safety valves check Regular leakage check  Trained staff necessary	LN2 refills  Valve function check  Safety valves check
Part load	Frequency inverter included  RPM of compressor controlled automatically	Depending on system design  Usually start / stopor hot gas bypass	Dosage based
Lifecycle Cost	Almost no maintenance required  No refrigerant purchase and refills	Requires many components  Increasing price of refrigerants  Intensive costly maintenance	High long-term running costs  LN2 to be transported and stored on site



# Open cycle systems

Open cycle refrigeration machines from Mirai Intex supply air directly to the cold room, eliminating the need for evaporators and auxiliary fans inside the chamber. Operating at low pressure, open cycle systems are safer than any alternative.

At ultra-low temperatures humidity crystallizes into ice instantly and the air circulating in the system has to be ice-free. For that reason, Mirai Intex has developed a unique Humidity Extraction Device (Snow catcher), making regular defrosting procedures a thing of the past.



MIRAI Cold 10



MIRAI Cold 15



MIRAI Cold 22

## Applications

BIO MATERIAL STORAGE / FOOD STORAGE / CRYOTHERAPY / CLIMATE TESTING / PHARMACEUTICAL STORAGE / TUNA STORAGE

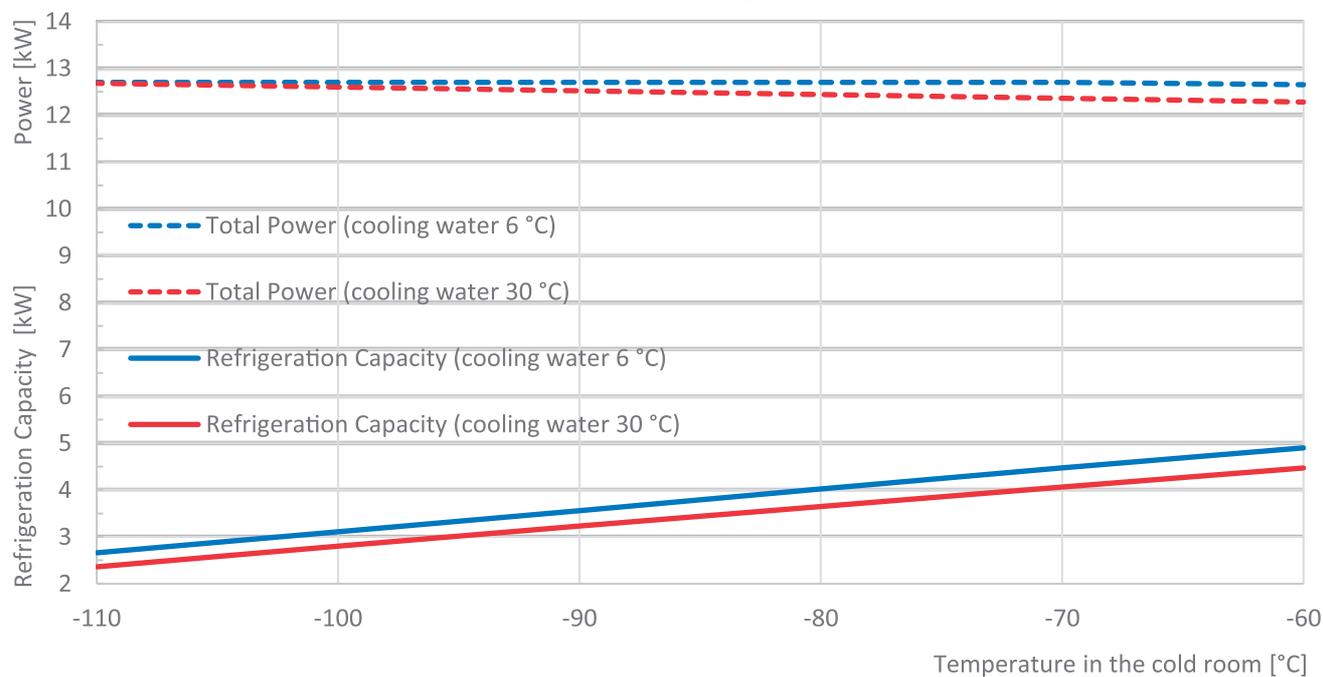
# MIRAI Cold 10

The smallest open cycle machine cooled by water is the ideal solution for whole-body cryotherapy or smaller size ULT storage projects.



<b>Model name</b>	<b>MC 10 O/W</b>
REFRIGERANT	Natural Air (R729)
TEMPERATURE RANGE	from -60 °C to -110 °C
SYSTEM COOLING	Water-cooled
REFRIGERATION CAPACITY	Up to 4.9 kW
RATED MOTOR POWER	10 kW
DIMENSIONS (L x W x H)	103 x 145 x 179 cm
WEIGHT	800 kg

MIRAI Cold 10 (MC 10 O/W) - Refrigeration Capacity & Power





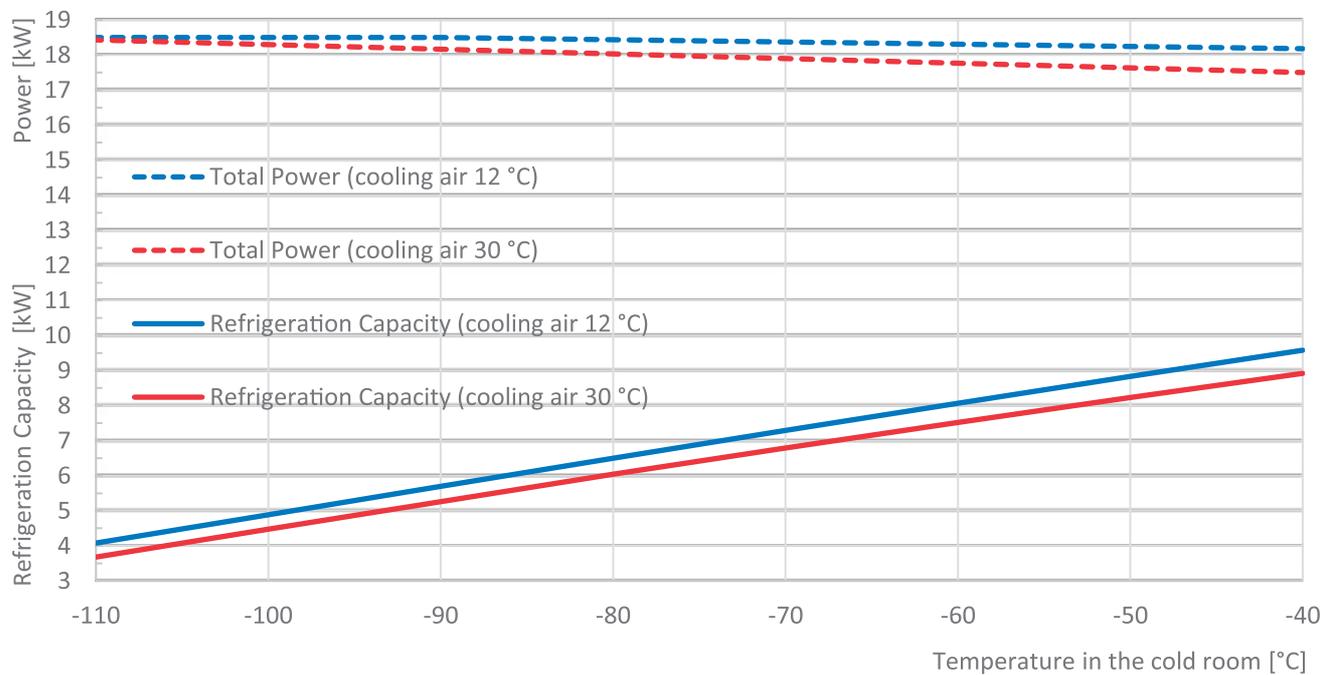
# MIRAI Cold 15

The original MIRAI Cold. The only machine cooled by air in our product portfolio. Great solution for applications where cooling water circuit is unavailable. Great choice for large whole-body cryotherapy chambers or standard ULT storage installations.

<b>Model name</b>	<b>MC 15 O/A</b>
REFRIGERANT	Natural Air (R729)
TEMPERATURE RANGE	from -40 °C to -110 °C
SYSTEM COOLING	Air-cooled
REFRIGERATION CAPACITY	Up to 9.6 kW
RATED MOTOR POWER	15 kW
DIMENSIONS (L x W x H)	155 x 187 x 204 cm
WEIGHT	2 050 kg



MIRAI Cold 15 (MC 15 O/A) - Refrigeration Capacity & Power



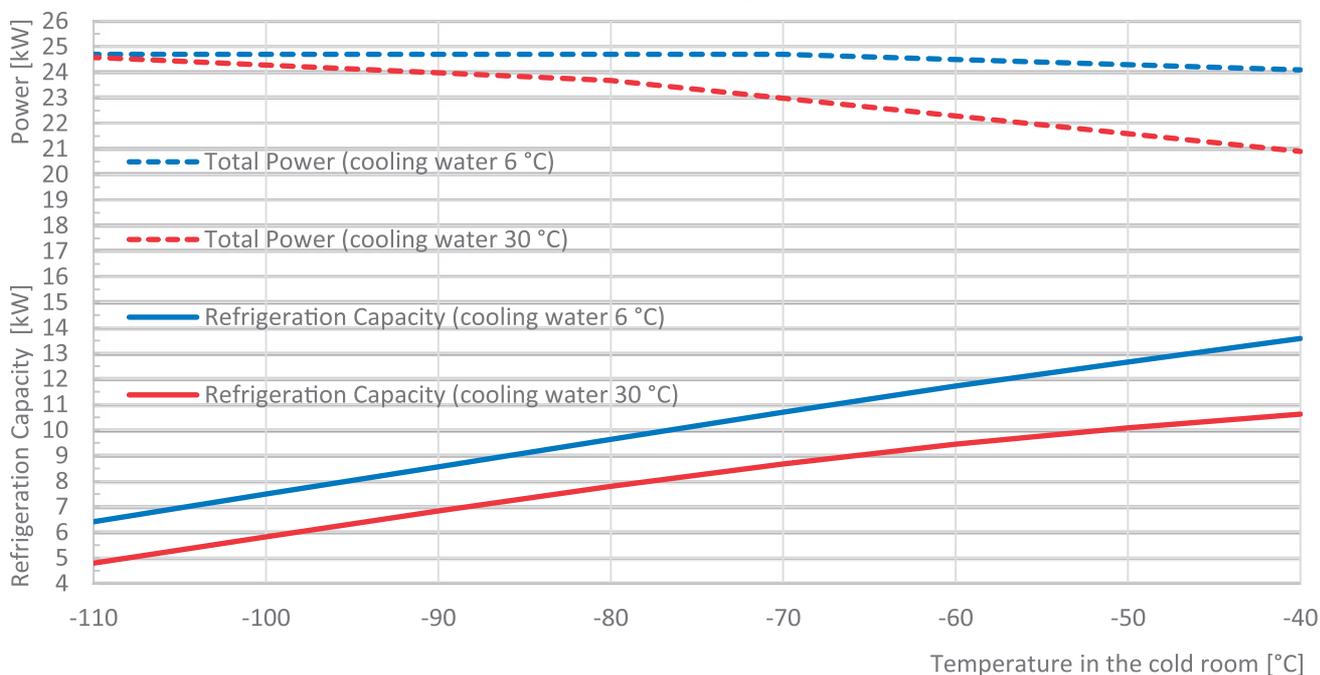
# MIRAI Cold 22

The newest addition to the open cycle range. More power packed in the dimensions of MC 15 thanks to a compact water-cooling system. Ideal for industrial and large-size ULT storage applications.



<b>Model name</b>	<b>MC 22 O/W</b>
REFRIGERANT	Natural Air (R729)
TEMPERATURE RANGE	from -40 °C to -110 °C
SYSTEM COOLING	Water-cooled
REFRIGERATION CAPACITY	Up to 13.6 kW
RATED MOTOR POWER	22 kW
DIMENSIONS (L x W x H)	155 x 185 x 200 cm
WEIGHT	1 960 kg

MIRAI Cold 22 (MC 22 O/W) - Refrigeration Capacity & Power





# Control System

MIRAI Cold machines have an integrated control system with easy-to-use touchscreen interface. Integration of digital communication protocols such as ProfiNET, EtherCAT, EtherNET/IP and Powerlink comes as standard. The system offers real-time monitoring, data archiving and remote monitoring as an option. Remote monitoring allows to check or set the performance of the machine as well as to update the machine's software online.

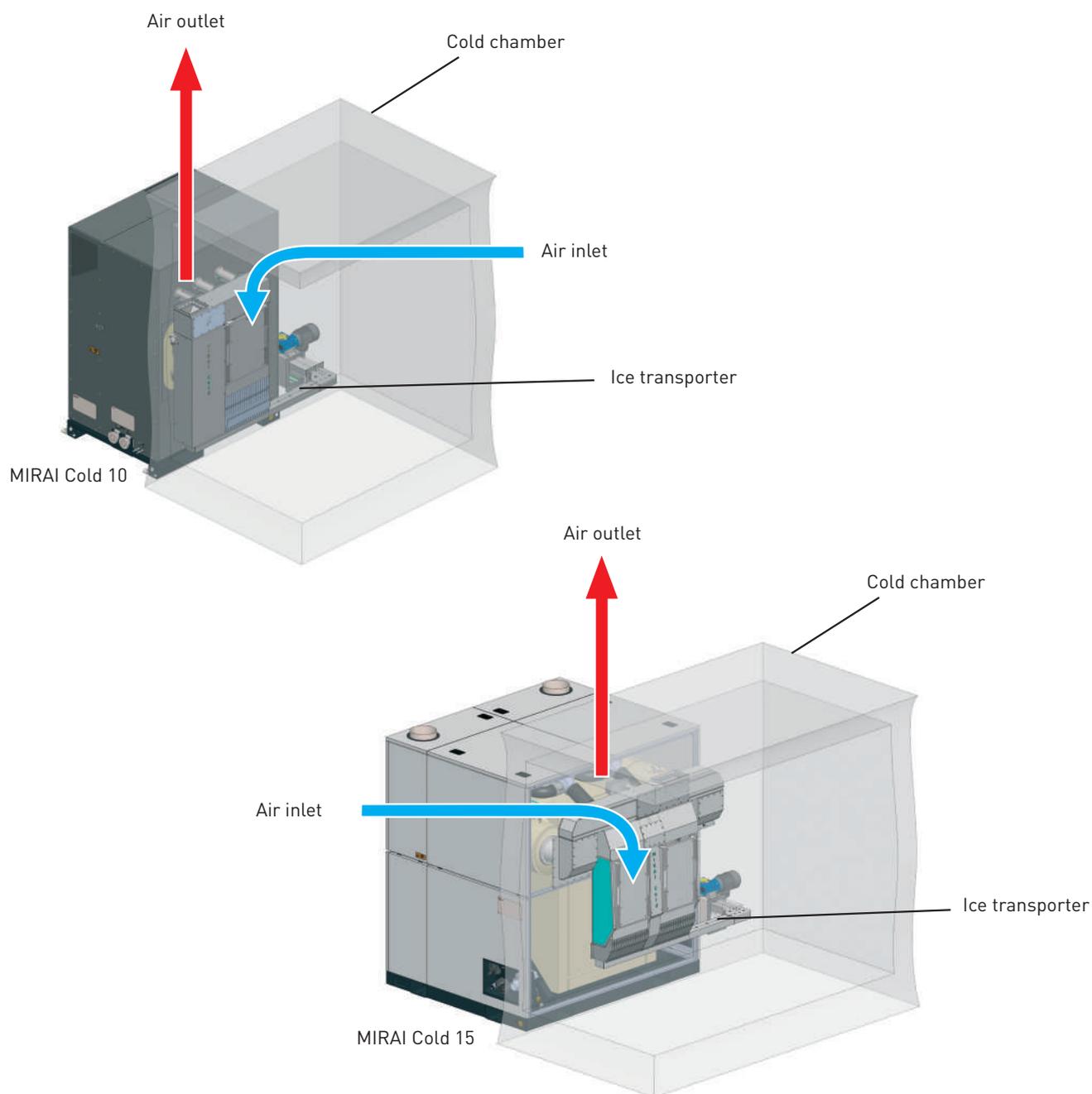
## Remote Monitoring

- Support from Mirai Intex during machine's operation and during troubleshooting
- Detection and prevention of problems
- Regular check-ups of machine condition and performance
- Software updates downloaded remotely to provide the latest version of improvements and optimizations



# Snow Catcher

## Humidity Extraction Device (HED)



At extremely low temperatures, moisture instantly turns to ice, for that reason, Mirai Intex has developed a unique Snow Catcher - Humidity Extraction Device (HED), making regular defrosting procedures a thing of the past. Allowing machine to operate continuously without defrosting procedures that consume operating cooling power and consume additional energy. Installation of the machine is very simple – only a few holes have to be cut in the cold chamber wall to connect MIRAI Cold and Snow Catcher.



# CASE STUDY

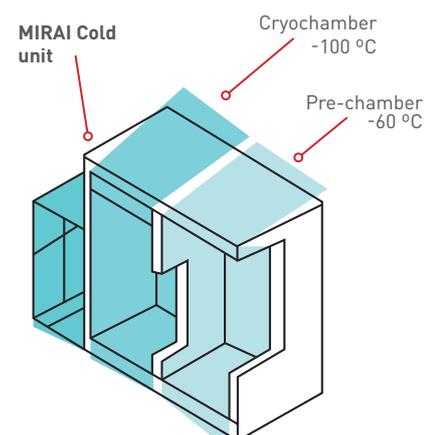
## Cryotherapy



Cryotherapy is a form of treatment that uses cold temperatures to therapeutic effect to trigger your whole body to respond in a certain way and stimulates the body's natural healing abilities.

In 2019, a revolutionary cold sauna with air-cycle refrigeration technology from Mirai Intex was developed with Refolution for COOLINN. Able to reach stable temperatures of down to  $-130\text{ }^{\circ}\text{C}$  room temperature and is characterized by many special features:

- Environmentally friendly and safe with the refrigerant air with GWP 0 and maximum pressures of 0.9 bar
- No risk of suffocation and no risk of explosion
- Real temperatures with optimal temperature distribution and uniformity, thus reaching the equal temperature at head and foot level for the best user experience and impact
- Low-maintenance and long-lasting technology - oil-free turbomachine
- Industrial design with durable and stable components
- Energy efficient
- No evaporator and auxiliary fans inside the chamber
- Continuous operation without the need for defrosting



Additionally, to the Cryochamber, a heat recovery system was installed. The Air cycle refrigeration machine heats air from the outside up to  $70\text{ }^{\circ}\text{C}$  to cool itself down. Which results in warm exhaust air being blown into the lounge next to the cold sauna for the clients to dry off before entering the chamber and to provide heating during winter time allowing our customer to minimize the costs.



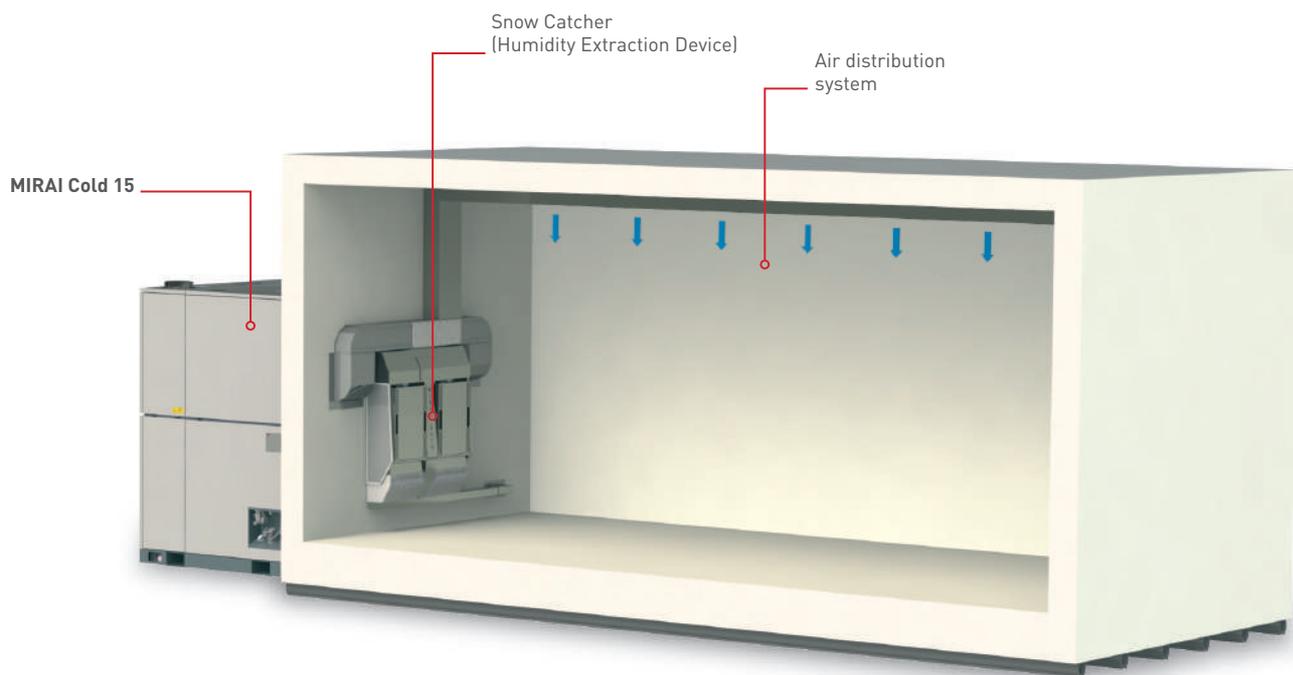
# Vaccine Storage Solution

Trouble-free, plug & play, efficient, environmentally friendly, and safe high volume storage chamber.

Delivering vaccines to every corner of the world could be a tough task. It takes a multiple-step to get so many small glass vials of vaccine to different hospitals and pharmacies where the medicine can be further used.

Storing, managing, and transporting these vital products require a chain of precisely coordinated events under controlled temperature conditions. So, temperature accuracy and quality assurance are basic requirements for manufacturers.

Temperature uniformity, optimum storage temperatures, electrical installations, loading and unloading processes and surface area are decisive factors in the energy efficiency of a cold store. The latter is the ratio of surface area to the storage volume. This is especially important when using a large number of separate refrigerators to replace one storage room.





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