



# **A NEW RANGE OF COOLING APPLICATIONS USING NATURAL REFRIGERANTS**

**LINE UP OF NATURAL FIVE**




**ADSORPTION CHILLER WITH RENEWABLE ENERGY**

Mayekawa Mfg.Co,Ltd  
Kunuaki Kawamura

# LINE UP OF NATURAL FIVE

# Commitment on Natural Refrigerants



-  Semi-Hermetic Screw Compressor Unit
-  Commercial / Industrial Eco-Cute System
-  Adsorption Chiller
-  Commercial / Industrial  
Air-Conditioning / Water-Supply Heat Pump
-  Dehumidifying Air Refrigerant System [Air Ref]

## "Natural Five" Refrigerants and Product Solutions

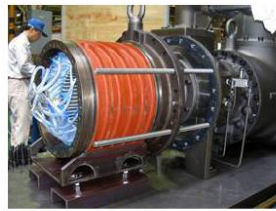
Refrigerant (Natural Five)	NH <sub>3</sub> R-717	CO <sub>2</sub> R-744	HC Hydrocarbon	H <sub>2</sub> O R-718	Air R-728
90°C		Utility hot water			
60°C	Utility hot water Heating		Utility hot water Heating HVAC	Heat recovery	
10°C	Chilled water Ice making	Chilled water Ice making		Chiller	
-15°C	Cold storage, Freezer, Fish boat				
-25°C	Specific Refrigeration needs				
-40°C	Freezer, Freeze-dry, Super Low temp storage				
-50°C			Cryogenics		Cryogenics
-60°C					
-100°C					
Notes	<ul style="list-style-type: none"> <li>•Conventional system</li> </ul>	<ul style="list-style-type: none"> <li>•Eco-Cute</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Butane + Propane</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Adsorption</li> <li>•Heat recovery</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Air-cycle</li> </ul>

**NH3**

- High Efficiency: Compressors and IPM Motors
- Low Charge:
  - \* Secondary Refrigerant System(CO2)
  - \* Direct Expansion System
- Less Leakage: Hermetic Motors

**Ammonia**





- Safety improved
- Compact
- High efficiency



**CO2**

- Hot water and Hot dry air supply Heat-Pump
- Source : Air and Water

**Carbon dioxide**



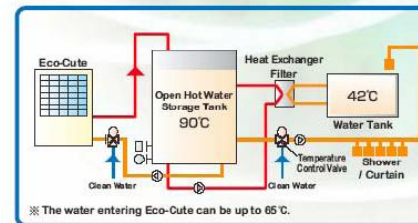
# Industrial Hot Water Production Package

# MYCOM

Awarded for: The 7th Electric-Load Leveling [Heat Pump Thermal Storage Development Awards] Equipments / systems



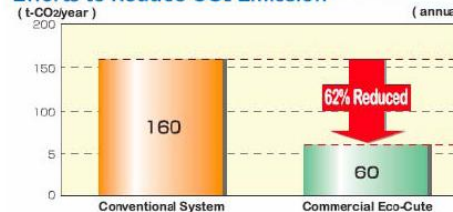
## 62% Reduction of CO2 Emission



**Targets:** Hospitals, hotels, welfare institutions, sports facilities, bathing facilities, facilities for boarding, food factories, etc.

- The best water supply ability in Japan (Air heat source 80kW, water heat source 90kW).
- Very little CO<sub>2</sub> emission, compared with equipments run by burning the energy source. Emission could be cut by more than 60% than heavy-oil boilers.
- 循環 heating operation (Water entering Eco-Cute at 65°C, exiting at 90°C).
- Flexible design of water supply system and storage tanks to meet your needs.
- Entering medium to large-scale water supply market as the electric equipment replacing hot-water boilers. The complete electrification is possible.

### Efforts to Reduce CO<sub>2</sub> Emission



### Case Study

A Company Housing where Hot Water Supply is 20m<sup>3</sup>/day  
The Number of People: 200

<Conventional System> Fuel Oil Boiler Crude Oil Equivalent	<Commercial Eco-Cute> Crude Oil Equivalent
59,040 ℓ /yr	22,153 ℓ /yr

# MAYEKAWA

MAYEKAWA Europe nv/sa



- Mixed Refrigerants Heat-Pump  
(Butane and Propane)

Hydrocarbon

# Hydrocarbon Refrigerant Packaged Unit

# MYCOM

2005 ~ 2007 NEDO [ Energy-Saving Non-Freon Air-Conditioning and Refrigeration System ]

([Industrial Technology Development Subsidizing Company])

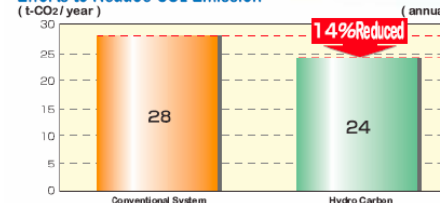


## 14% Reduction of CO2 Emission

Cooling C O P	COP=3.7 (Air-Cooled)
Heating C O P	COP=3.7 (Air-Source)
Supplying Water C O P	COP=3.3 (Supplying temperature 65°C, air-source)

Targets: Commercial / Industrial Air-Conditioning, Water-Supply		
Supply Temperature	Applications	Suitable Markets
70°C	65°C Hot Water-Supply / Heating System	Food factories, hotels
50°C	45°C Heating System	Office buildings, factories
0°C	+7°C Chilled Water Chiller System	Office buildings, factories
-5°C	+2°C Chilled Water Chiller / Supercoolice Making System	Food factories
-15°C	Ice on Coil Ice Thermal Storage System	Food factories

Efforts to Reduce CO2 Emission



### Case Study

40USRT Chilled Water Supply Machine  
Chilled Water Temperature : 7°C


### Power Consumption

< Conventional System > R134a Chilled Water Supply Machine	< Hydro Carbon >
43kW	36kW

# MAYEKAWA


MAYEKAWA Europe nv/sa

DOC.2010.1000...



H2O

- Ad-sorption Chiller Utilizing Solar Energy



Water



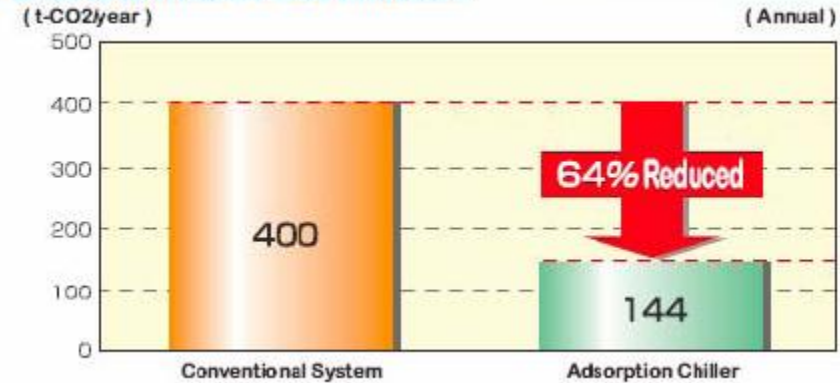
# Adsorption Chiller Packaged Unit

**MYCOM**

2005  
~2007 NEDO [ Research and Development of New System Utilizing Solar Energy ]



## Efforts to Reduce CO2 Emission



## Case Study

100USRT Industrial Process Cooling  
Cold Water Temperature : 9 °C

### Power Consumption

<Conventional System>  
R134a Cooling Water

**100kW**

<Adsorption Chiller>

**36kW**

**MAYEKAWA**  
MAYEKAWA Europe nv/sa

DOC.2010-160 R4

**AIR**

- Air Cycle Refrigeration System
- For Low Temperature Applications  
-50 ~ -120 °C

**AIR**



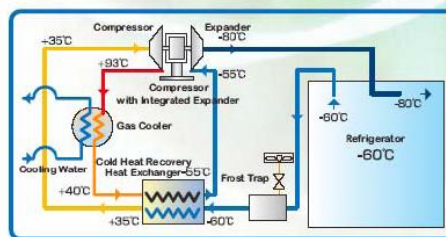
# Air Cycle Refrigeration Packaged Unit

# MYCOM

2003 Developed at [Technical Strategy for Rationalization of Energy Consumption Project]  
 -2005 NEDO



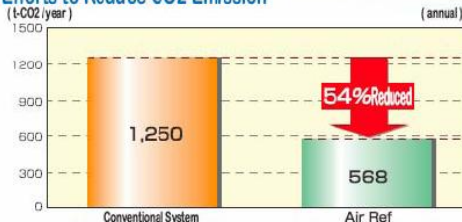
## 54% Reduction of CO2 Emission



**Target:** Ultra cold refrigerator for tunas and bonitos, rapid freezer, frost-破碎 etc.

- Using [Air] as the ultimate natural refrigerant, [Air Ref] is safe and eco-/people-friendly.
- Due to the turbo compressor with integrated expander, high COP can be achieved, saving energy by 50% comparing the conventional types.
- Due to its low operating pressure, exempt from legal regulations.
- Directly cooling the air, Air Ref does not require a fan coil unit or piping for refrigerant in the storage.
- Dehumidifying agent reduces frosting in the storage. Defrosting is not required.

### Efforts to Reduce CO2 Emission



### Case Study

2,000 ton Refrigerator Interior Temperature: -60°C	
Power Consumption	
< Conventional System > R22 2 Stage Compression Refrigerator	< Air Ref >
281kW	128kW

**MAYEKAWA**  
**MAYEKAWA Europe nv/sa**

# ADSORPTION CHILLER WITH RENEWABLE ENERGY

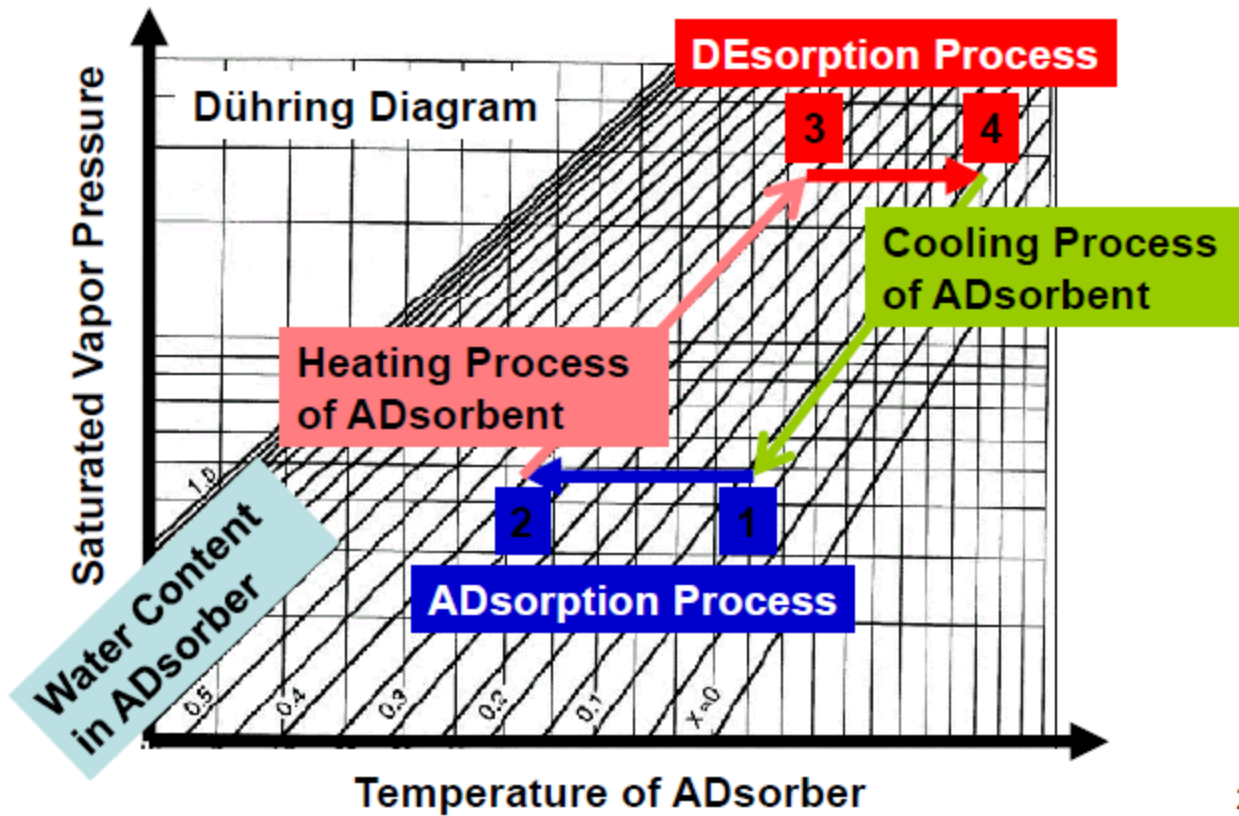
# MYCOM ADSORPTION HEAT PUMP

New Series  
(ADRef-Z Series)

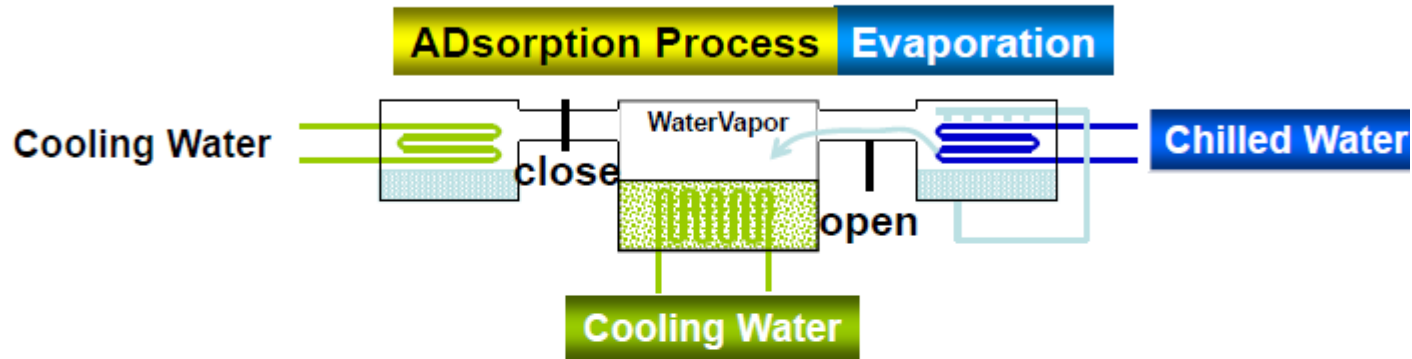


September 2009

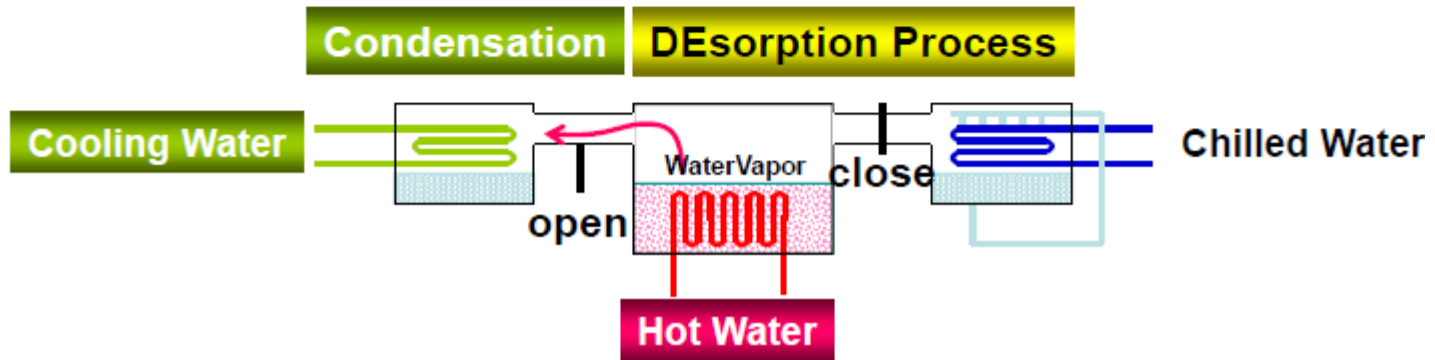
Refrigerant Behavior in ZEOLITE



## Operating Principle of ADsorbent

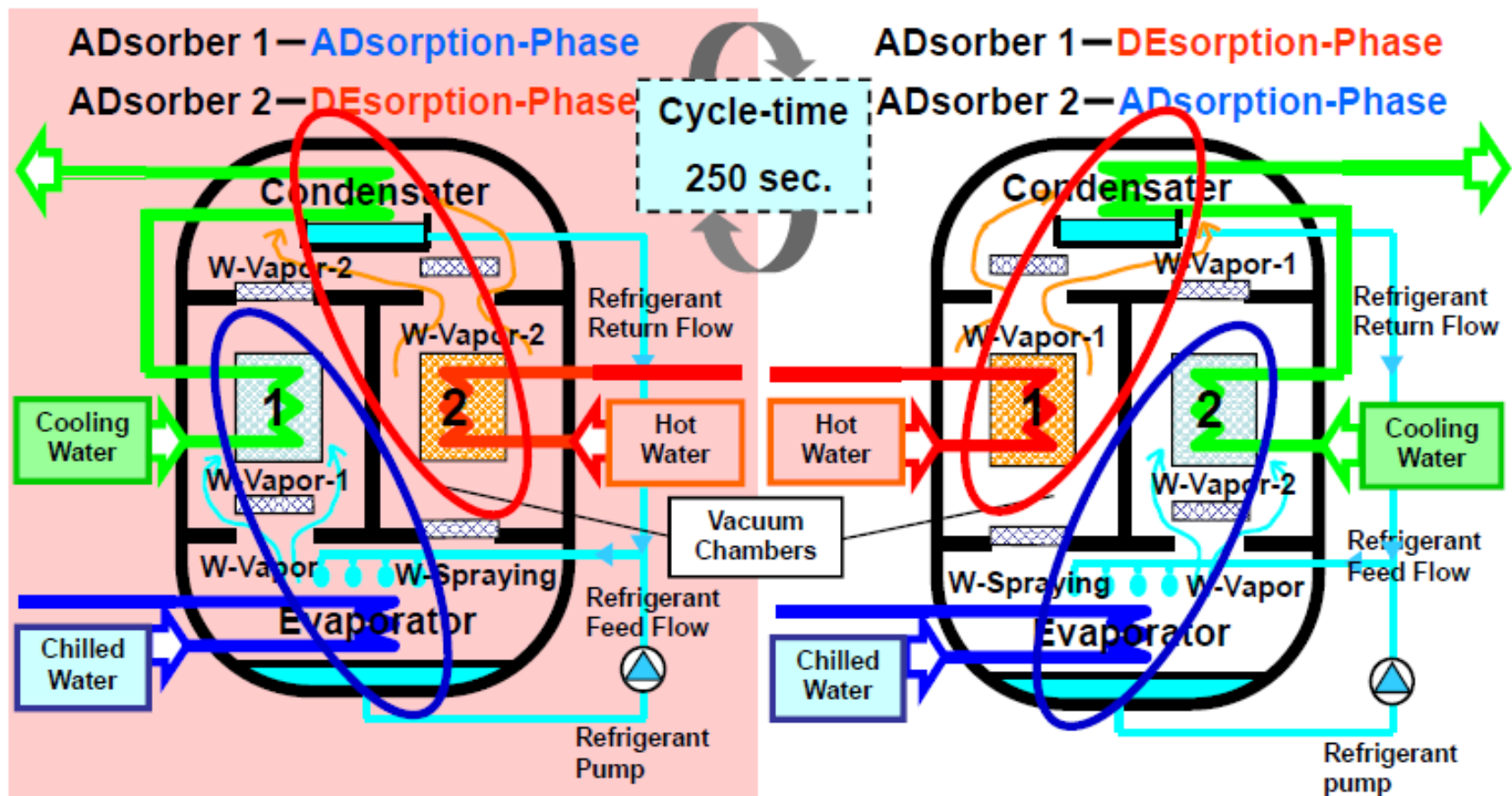


Batch Operation in Vacuum  Cycle Time: 250 ~ 600 sec.





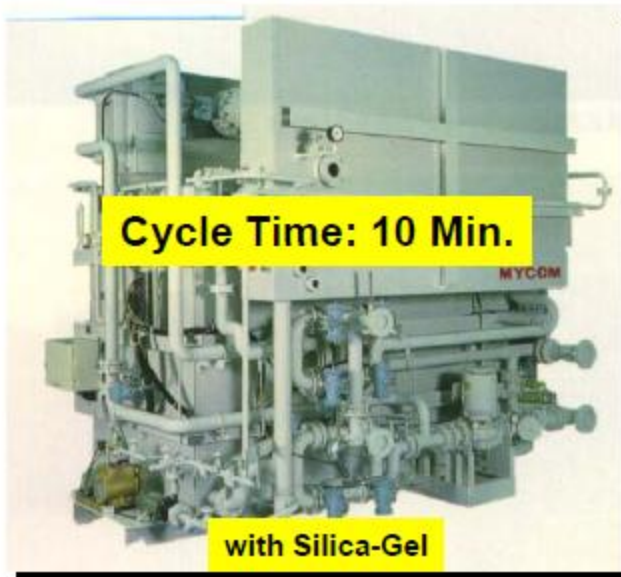
## Operating Principle and Batch Operation



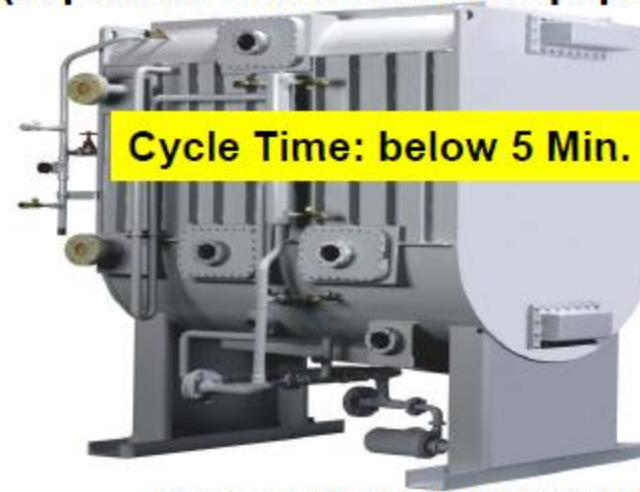


## Newly-developed Series with ZEOLITE

**Award Winner in Japan:  
Technology Prize 2009 of Environ-  
ment Protection by Nikkei BP  
(Japanese Economic Newspaper)**



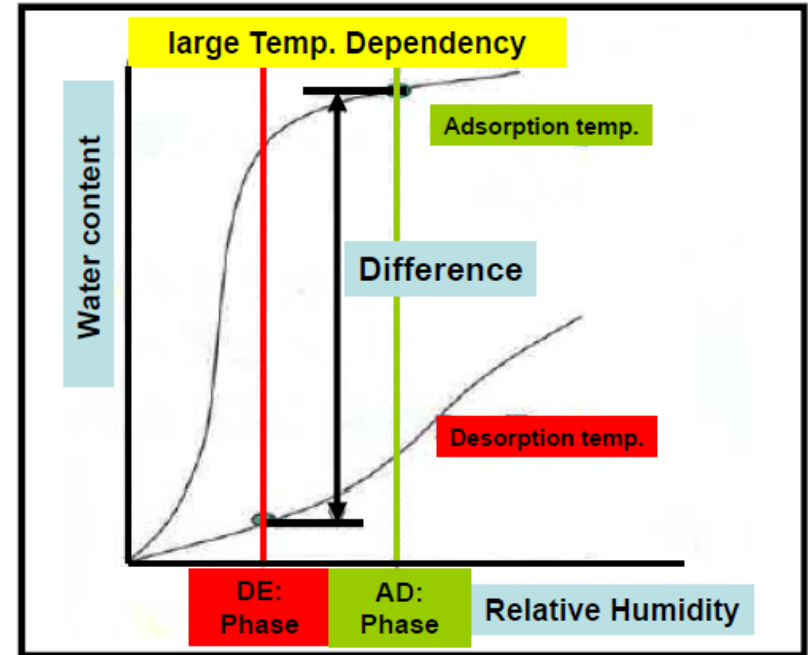
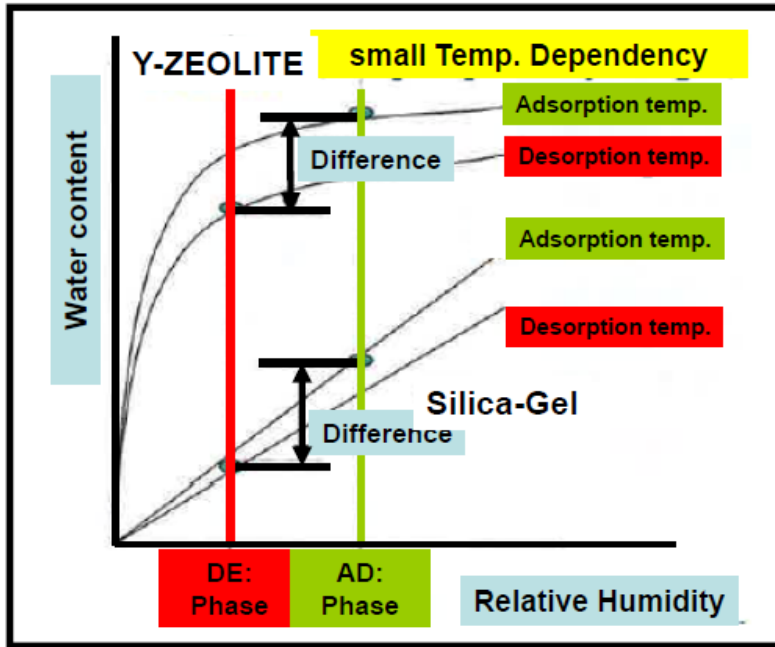
**Old Series**  
**(from 1990 till 2006)**



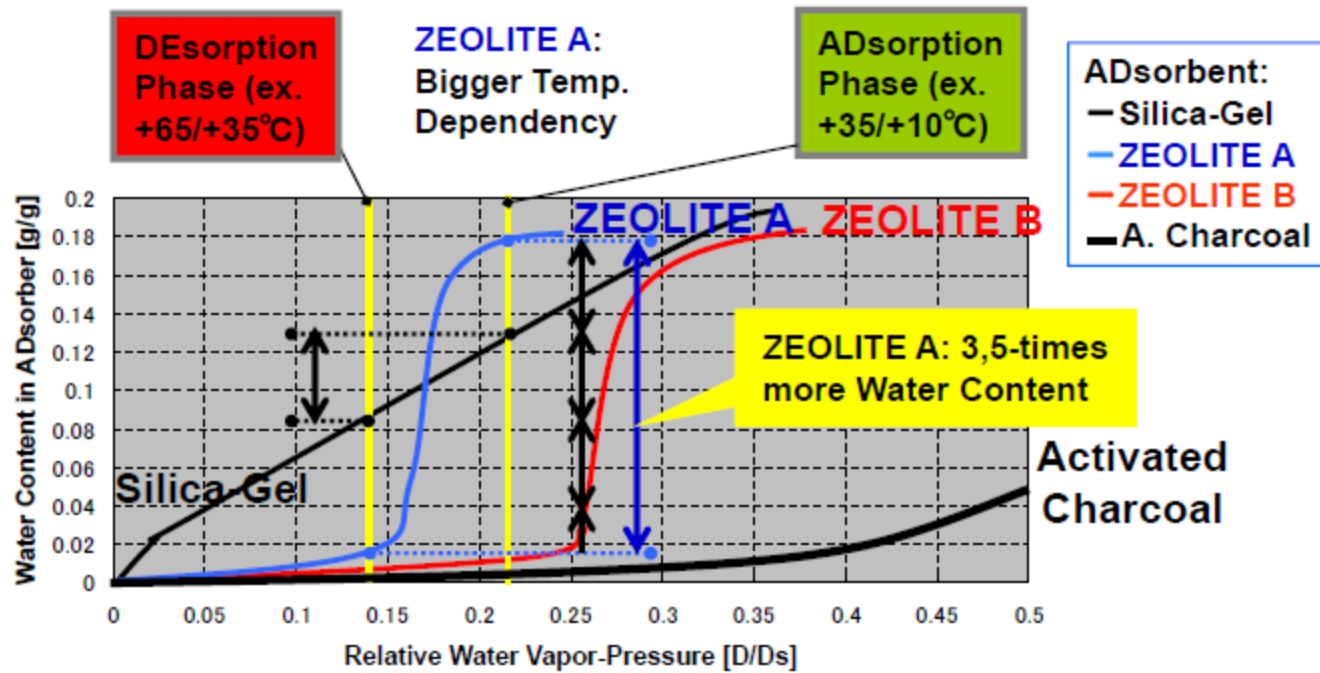
**New Series**  
**(since 2009)**

## Temperature Dependency: ADsorbent

## Temperature Dependency: ZEOLITE



## ADsorption Isothermal Curves of Vapor



Relative Water Vapor-Pressure means:  
 Ambient Saturated Water Vapor-Pressure / Saturated Water Vapor-Pressure

## ZEOLITE-coated Heat Exchanger

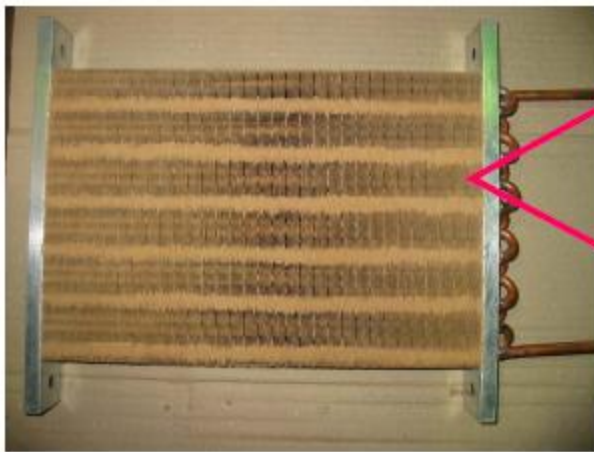
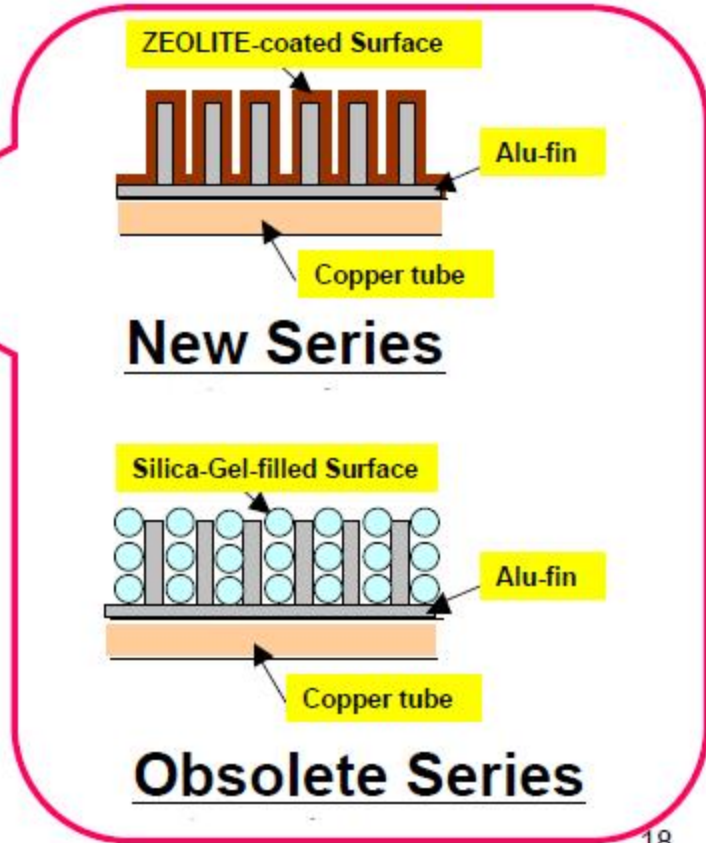


Photo: ALU-fin & Copper tube Heat Exchanger



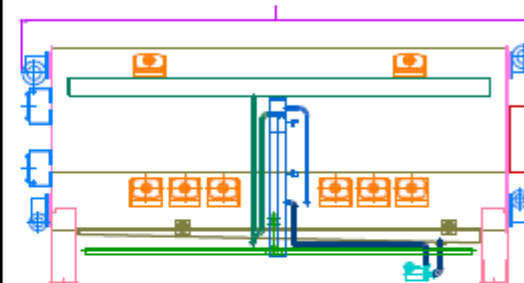
## Standard Temperature Condition

Description		Model/Type	ADR-Z3515	ADR-Z3525	ADR-Z6025
Nominal Capacity [ Capacity Ratio ]		-	110 [ 1 ]	215 [ 2 ]	430 [ 4 ]
Hot Water	Applicable Temp.	°C	+60°C ~ +80°C (+95)	+60°C ~ +80°C(+95)	+60°C ~ +80°C (+95)
	In-/Outlet Temp.	°C	+68.0 / +59.6	+68.0 / +59.6	+68.0 / +59.6
	Mass Flow Rate	m <sup>3</sup> /hr	21.3	42.5	85.0
	Heating Capacity	kW	207.0	414.0	826.0
Cooling Water	Applicable Temp.	°C	below +35°C	below +35°C	below +35°C
	In-/Outlet Temp.	°C	+27.0 / +32.6	+27.0 / +32.6	+27.0 / +32.6
	Mass Flow Rate	m <sup>3</sup> /hr	50.0	99.0	198.0
	Cooling Capacity	kW	324.0	648.0	1,293.0
Chilled Water	Available Temp.	°C	+5°C ~ +25°C	+5°C ~ +25°C	+5°C ~ +25°C
	In-/Outlet Temp.	°C	+22.7 / +15.0	+22.7 / +15.0	+22.7 / +15.0
	Mass Flow Rate	m <sup>3</sup> /hr	12.1	24.3	48.7
	Chilling Capacity	kW	108.0	215.0	429.0
C.O.P.	Coefficient	-	0.52	0.52	0.52

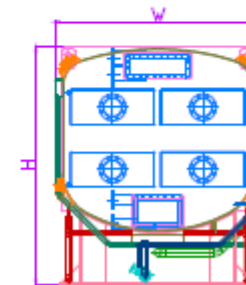
※ Figures, Mistakes and Omissions are subject to change without notice.

## Technical Specifications: ADRef-Z Series

Description		Model/Type	ADR-Z3515	ADR-Z3525	ADR-Z6025
Nominal Capacity		-	110	215	430
Hot Water	Inlet Temp.	°C	+68.0	+68.0	+68.0
	M. Flow Rate	m <sup>3</sup> /h	21.3	42.5	85.0
	Pressure Drop	MPa	0.030	0.030	0.030
Cooling Water	Inlet Temp.	°C	+27.0	+27.0	+27.0
	M. Flow Rate	m <sup>3</sup> /h	50.0	99.0	198.0
	Pressure Drop	MPa	0.098	0.098	0.098
Chilled Water	Outlet Temp.	°C	+15.0	+15.0	+15.0
	M. Flow Rate	m <sup>3</sup> /h	12.1	24.3	48.7
	Pressure Drop	MPa	0.078	0.078	0.078
Water Pump	Motor kW	kW	0.55	0.55	1.10
Vacuum Pump	Motor kW	kW	0.4	0.4	0.75
Dimensions w/o Valve set	Length: L	mm	3,700	3,700	6,100
	Width: W	mm	1,500	2,450	2,450
	Height: H	mm	2,800	2,800	2,800
Empty Weight		kg	6,600	10,000	15,000



< Side View >



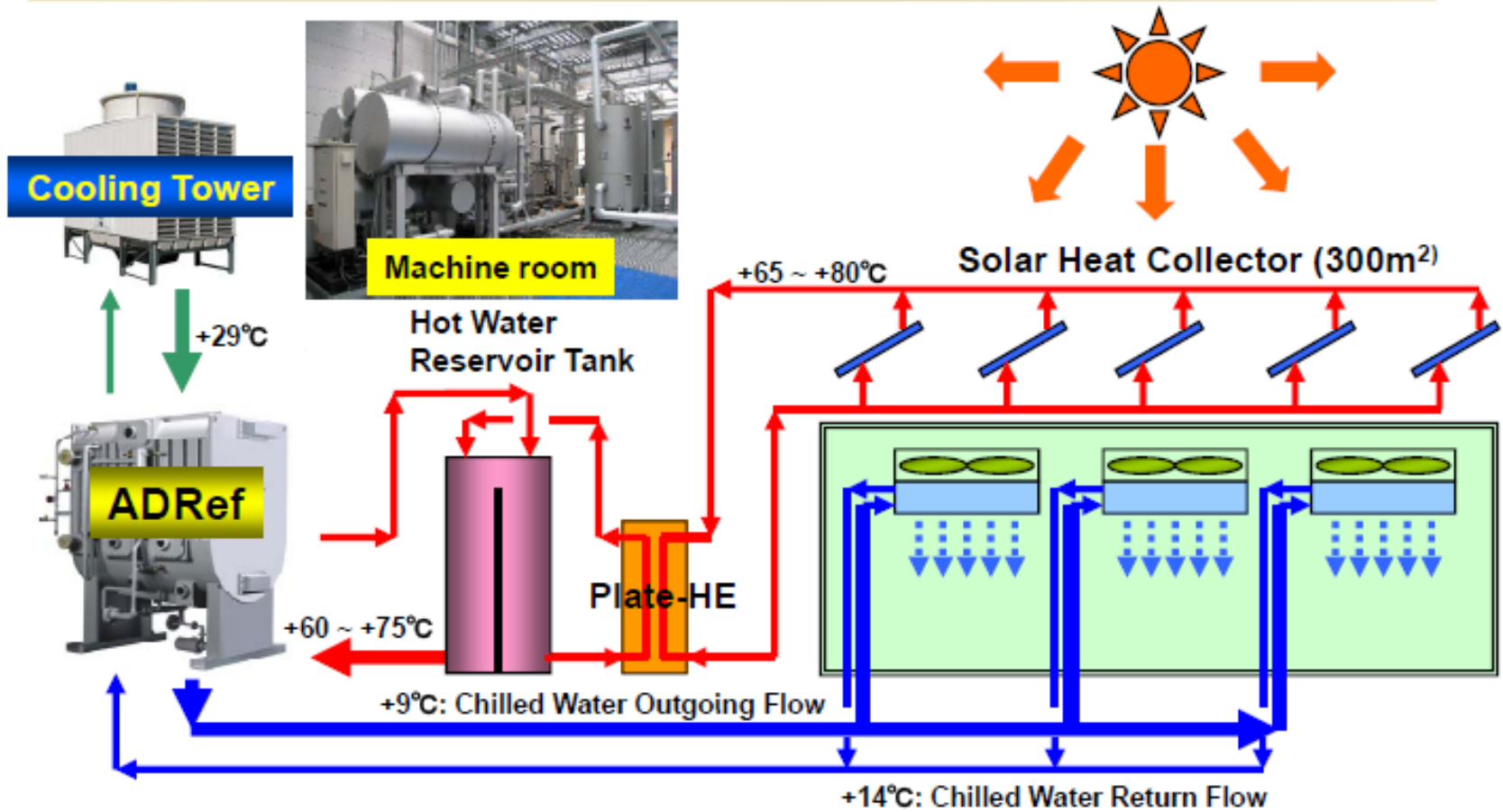
< Front View >

- ※ Figures, Mistakes and Omissions are subject to change without notice.
- ※ Excluded: Circulation Pumps and Cooling Tower
- ※ Local Control Panel is mounted on ADR-Z Water Chiller Unit.

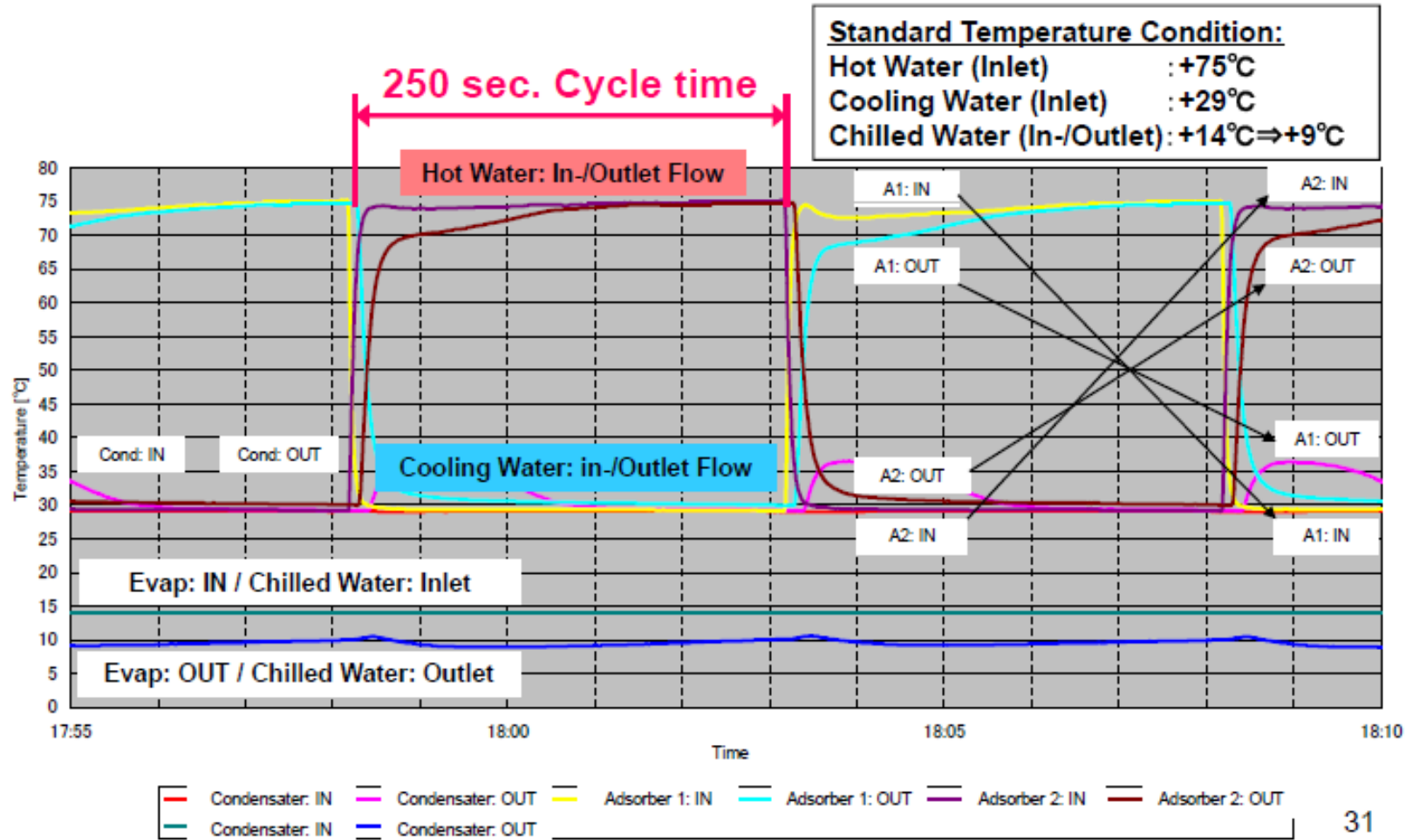


# FIELD CASES

## Heat Source: Solar Heat Energy (Application: Air-Conditioning of Shopping Center)



## Temperature Variation at Batch Operation



## Comparison of Energy-saving Effect

CO2 Emission Factor: Electricity:[0.555]kg-CO2/kWh  
 Heavy Oil A:[2.71]kg-CO2/L, Operating Hours:[6000]

Calculation Basis:  
 Capacity: ca. 350 kW, Chilled Water temperature: +7~+9°C

Model: Water Chiller	ADsorption	Centrifugal	Air-cooled	ABsorption
Driving Force: Driving Device:	Waste Heat ZEOLITE	Electricity Compressor	Electricity Compressor	Boiler Steam Lithiumbromid
Refrigerant (GWP):	Water (GWP=0)	R134a (GWP=1,300)	R407c (GWP=1,370)	Water (GWP=0)
Capacity (CWT):	350 kW (+9°C)	387 kW (+7°C)	355 kW (+9°C)	352 kW (+7°C)
Power Requirement: (Power: Auxiliary Devices)	1.1 kW (31.2 kW)	85.0 kW (7.4 kW)	74.0 kW (7.2 kW)	5.2 kW (11.0 kW)
Steam Consumption (Equivalent in kW):	Zero	Zero	Zero	390 kg/Std. (ca. 300 kW)
CO <sub>2</sub> Emission (t/yr):	ca. 104	ca. 308	ca. 270	ca. 468
System C.O.P.*1	10.8	4.2	4.4	1.1

\*1: C.O.P.: Capacity ÷ Total Power Requirement

In case of ABsorption Chiller: Capacity ÷ (Total Power Requirement + Steam Consumption in kW)

## Key Features of ADRef-Z Series

- Use of Natural Refrigerant, i.e. Water (R718): ODP=0, GWP=0
- Heat Source: Low Grade (Waste) Hot Water (Effective for: +60°C~+80°C)
- Production of Chilled Water between +5°C ~ +25°C with the Cycle time of 250 sec.
- Newly Developed Adsorbent, ZEOLITE (Coated thin layer and life-long Usage)
- Very Low Electricity Consumption (Only Refrigerant and Vacuum Pumps)
- Lighter Weight and Compact Dimension compared to Mycom Silica-Gel Version
- Easy Handling and Lower Operation and Maintenance Costs
- No Certified/Qualified Personnel is required.
- No Vibration and Noise Problems

# “HOW to”

We can eliminate HFCs using Natural Refrigerants in industrial refrigeration applications.

In the view of prevention of global warming we would like to offer 3 proposals below;

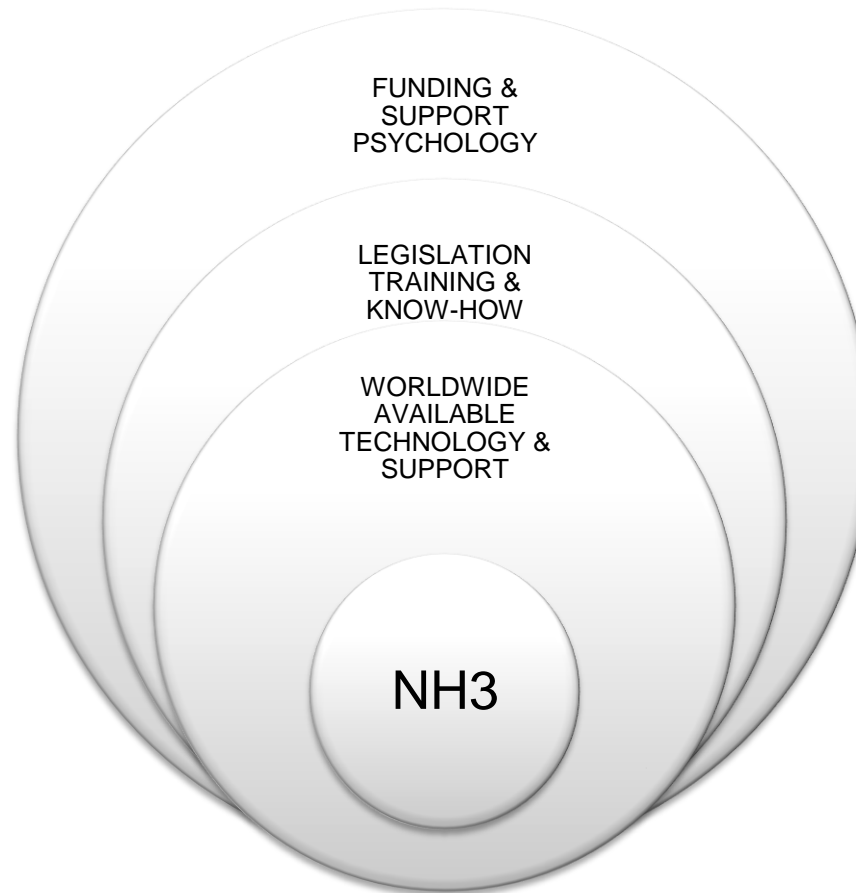
1. Promoting natural working fluids aggressively in the proven industrial field
2. Introducing natural working fluids in the possible commercial and consumer field
3. Recommending tightening of regulations of HFCs and encouraging the funding for the prevalence of refrigeration systems using natural refrigerants and its development.



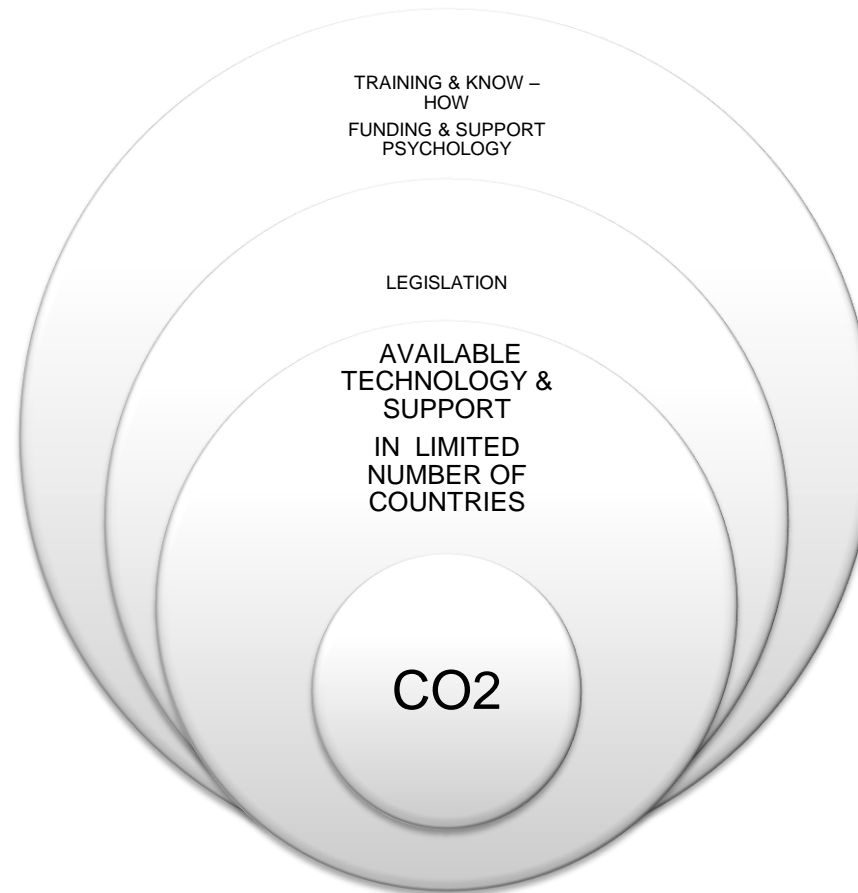
# “HOW to”

- **The choice of the natural refrigerant will depend on :**
  - Technology & safety (materials, equipment, components, fluids)
  - Legislation (policies, standards)
  - Funding and support (CDM/JI mechanisms, grants, subsidies, tax credits, direct investment)
  - Training & know-how (engineers education/certification, technical data, meetings, information campaigns)
  - Markets & marketing (advertising, competition by chemical refrigerants, profitability, demand structure)
  - Psychology (consumer acceptance, public perceptions, rumors, influence & peer groups)
- The next slides illustrate per type of natural refrigerant, applied following the MAYEKAWA line up overview shown earlier, the strongest supporting basis for use on top and the possible barriers on the bottom of the stacked Ven diagram.

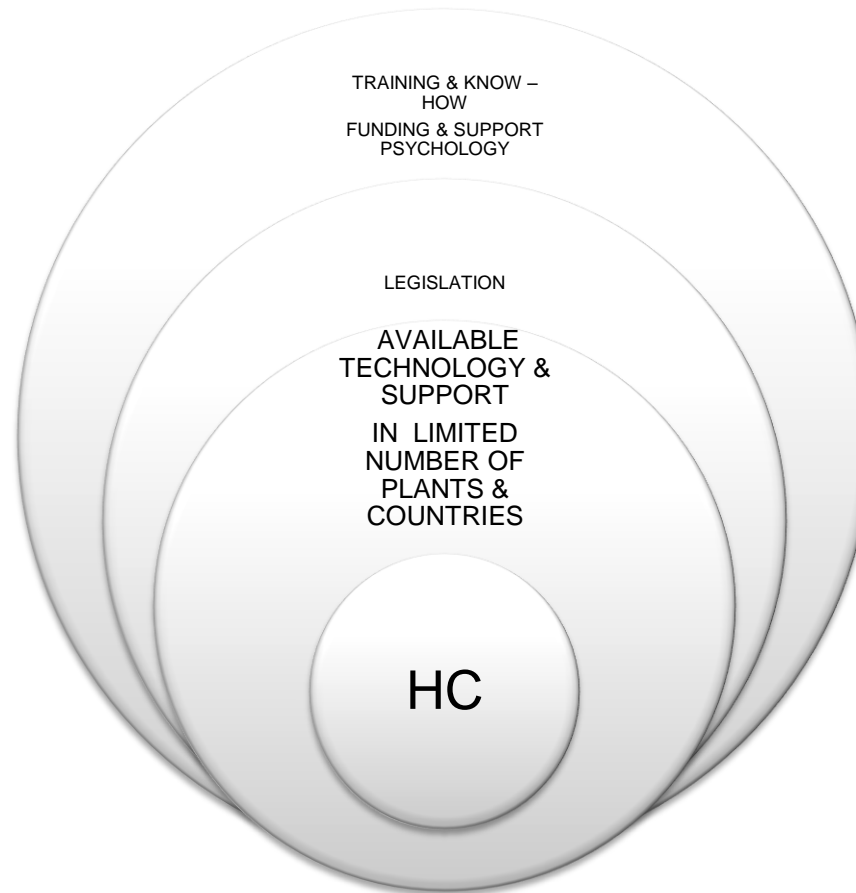
# “HOW to”



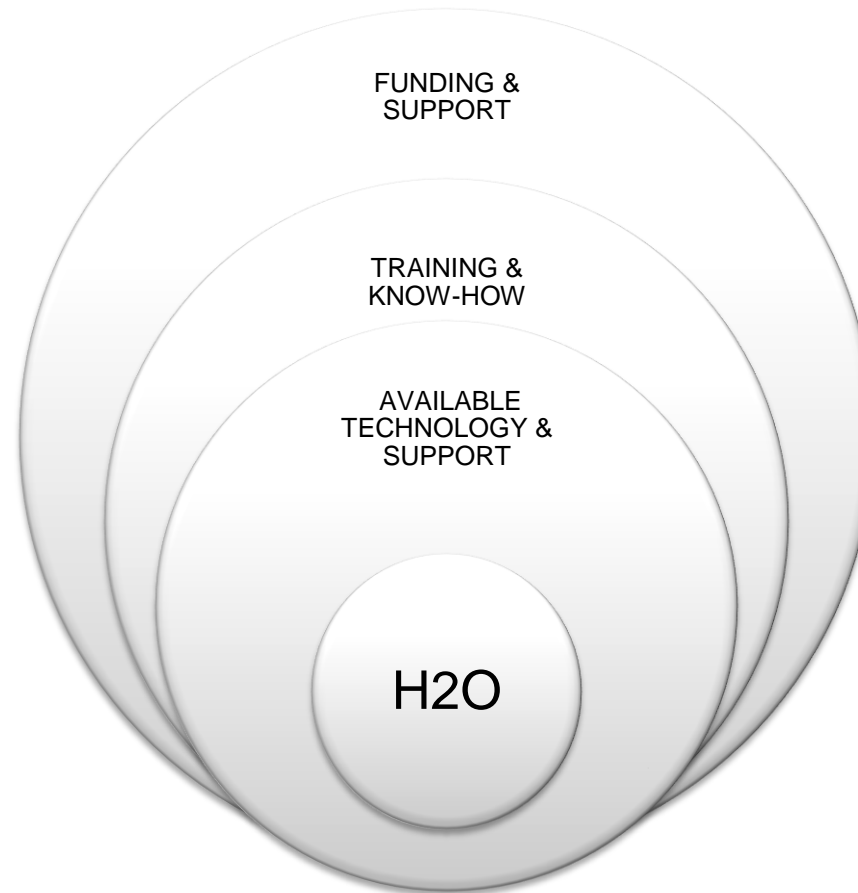
# “HOW to”



# “HOW to”

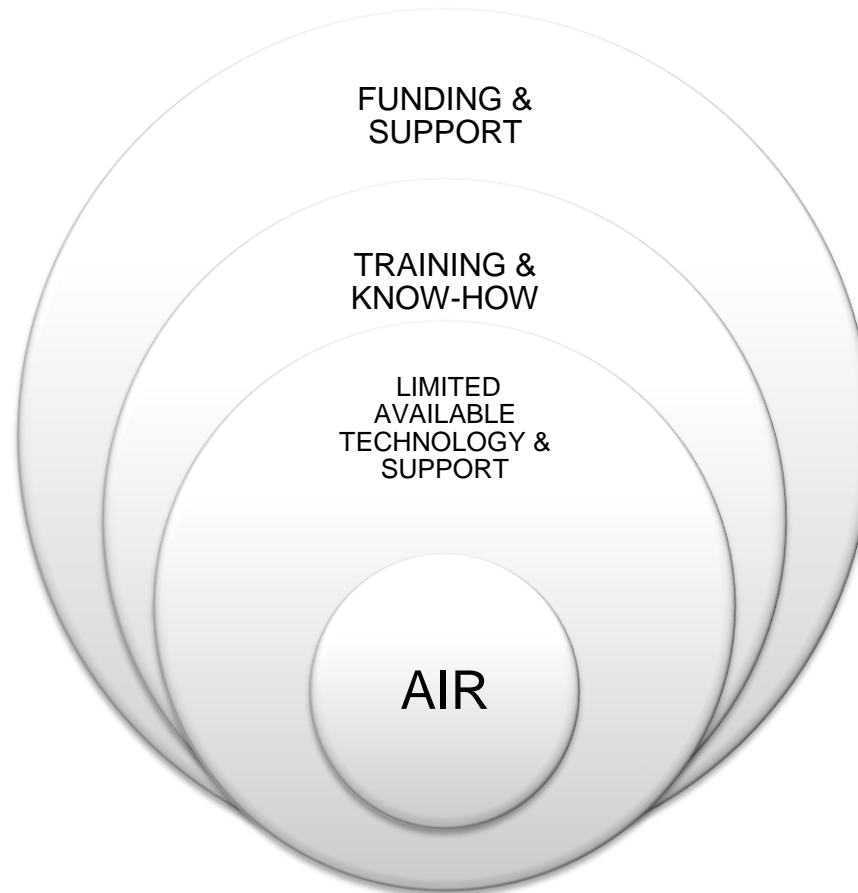


# “HOW to”





# “HOW to”



# MARKET AVAILABILITY

# MAYEKAWA Global Network

Over 70,000 Screw and Piston compressors running in more than 100 countries.



## Worldwide:

- 33 countries / 119 offices
- 8 production plants

## MAYEKAWA Europe Organization

MAYEKAWA Europe nv/sa

Leuvensesteenweg 605 1930 Zaventem Belgium

Tel.+32 2 757 90 75 Fax.+32 2 757 90 23 URL <http://www.mayekawa.eu> E-mail [info@mayekawa.eu](mailto:info@mayekawa.eu)

SWITZERLAND	Rosenbergstrasse 31, CH – 6300, Zug Tel.+41 41 726 8626 Fax.+41 41 726 8620
SPAIN	Calle Montevideo 5,Nave 13 POL.Industrial Campoporroso 28806 Alcala de Henares, Madrid Tel.+34 91 830 0392 Fax.+34 91 830 0397
RUSSIA	House 3, Flat 54, Mytnaya St.,Moscow, 119049 Tel.+7 495 230 01 76 Fax.+7 495 230 21 12
GERMANY	Gabriele-Munter Strasse 3, 82110 Germering Tel.+49 931 35 93 88-0 Fax.+49 931 35 93 88-20
FRANCE	9, Rue Michael Faraday , 78180 Montigny-Le-Bretonneux, Tel.+33 1 30 58 2600 Fax.+33 1 30 58 1937
United Kingdom	16 Oakhurst Gardens, Bexleyheath, Kent DA7 5JP Tel.+44 1322 433558 Fax.+44 1322 433164
BULGARIA	94, Hristo Botev Str.1202 Sofia Tel/ Fax +359 2 8319002
DUBAI	P.O.Box.61349, LOB. 11. No.126, Jebel Ali Free Zone, Dubai, U.A.E Tel. +971 4 887 2232 Fax.+971 4 887 2238
INDIA	1 <sup>st</sup> Floor, Balaji House, Nr.Mahalaxmi Heights, Mumbai-Pune Road, Pimpri, Pune-411 018 Maharashtra, India Tel. +91 20 2746 4537 Fax.+91 20 2746 4539
AUSTRALIA	Unit 2,44 McCauley Street Matraville NSW 2036 Australia DOC.2010-160 R4 Tel. +61 2 9695 7000 Fax.+61 2 9695 7001
NEW ZEALAND	30 Tui Street Othahuhu PO. Box 12106 Auckland New Zealand Tel. +64 9 276 2305 Fax. +64 9 276 2306

## Japan Head Office

3-14-15 Botan Koto-ku, Tokyo 135-8482, JAPAN

TEL:(81)-3-3642-8181 FAX:(81)-3-3643-7094

E-mail:[e-public@mayekawa.co.jp](mailto:e-public@mayekawa.co.jp)

Global web site <http://www.mayekawa.com/>