Global Solutions for Ammonia Industrial Refrigeration

MAYEKAWA's lineups and results of "Natural Refrigerants"

Atmosphere 2009

October19th 2009

Mayekawa Mfg. Co., Ltd.

Kuniaki Kawamura

Head Office of MAYEKAWA Japan

Products and Applications

1924
Piston
Compressor

1964
Screw
Compressor

1958
Multi-Cylinder
Piston
Compressor

1978
4ºK Super Low Temp.
Particle Accelerator
(Helium)

1981
Nuclear
Fusion
(Helium)

1984
MagLev
Train
(Helium)

1989
Rocket Fuel
(Hydrogen)

1993
Super GE
(Super Conductive
Electric Generator)

Ethylene Plant

LNG/LPG Tanker

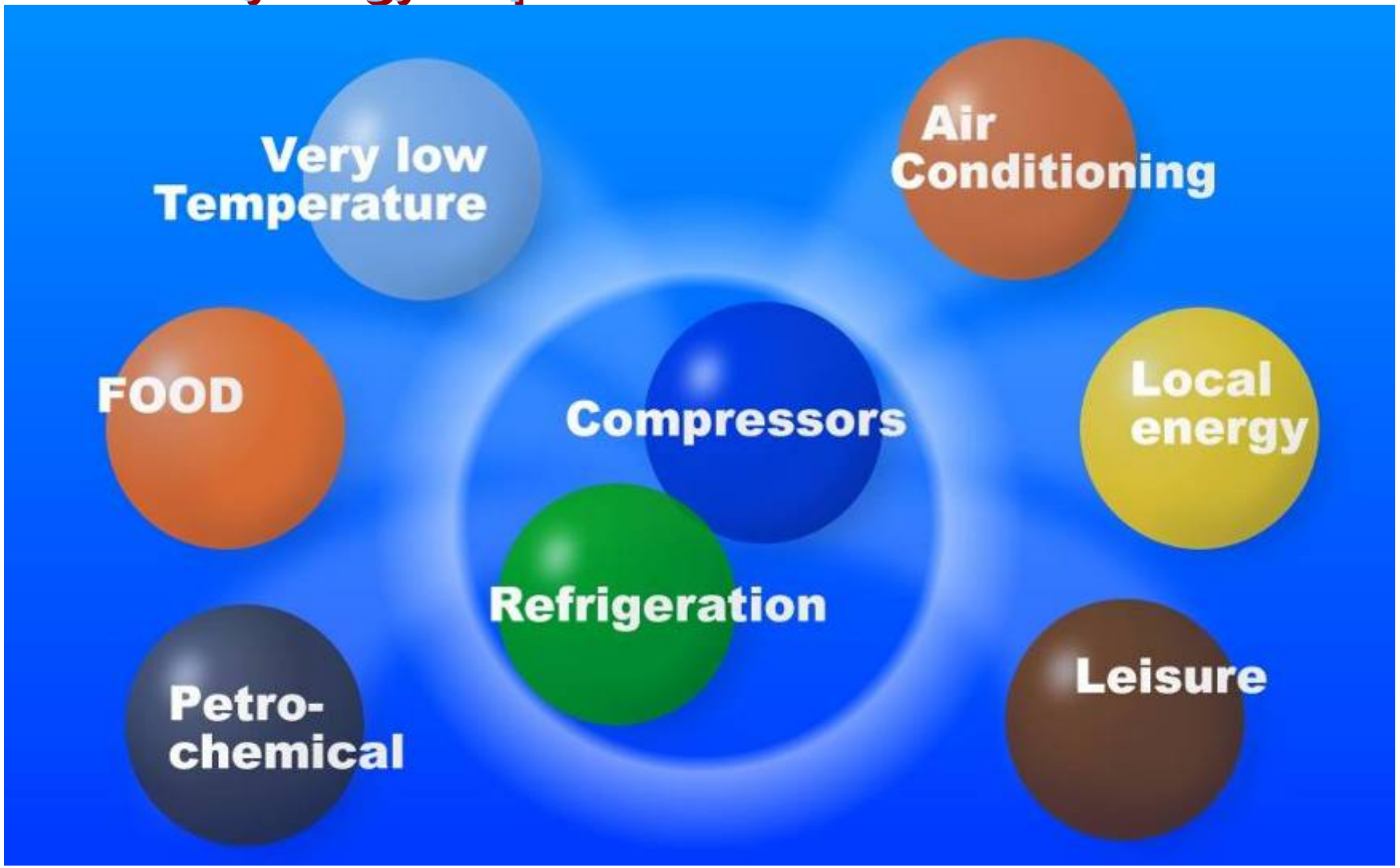
Organic(EOEG) **Inorganic (NH3)**

Pharmaceutical

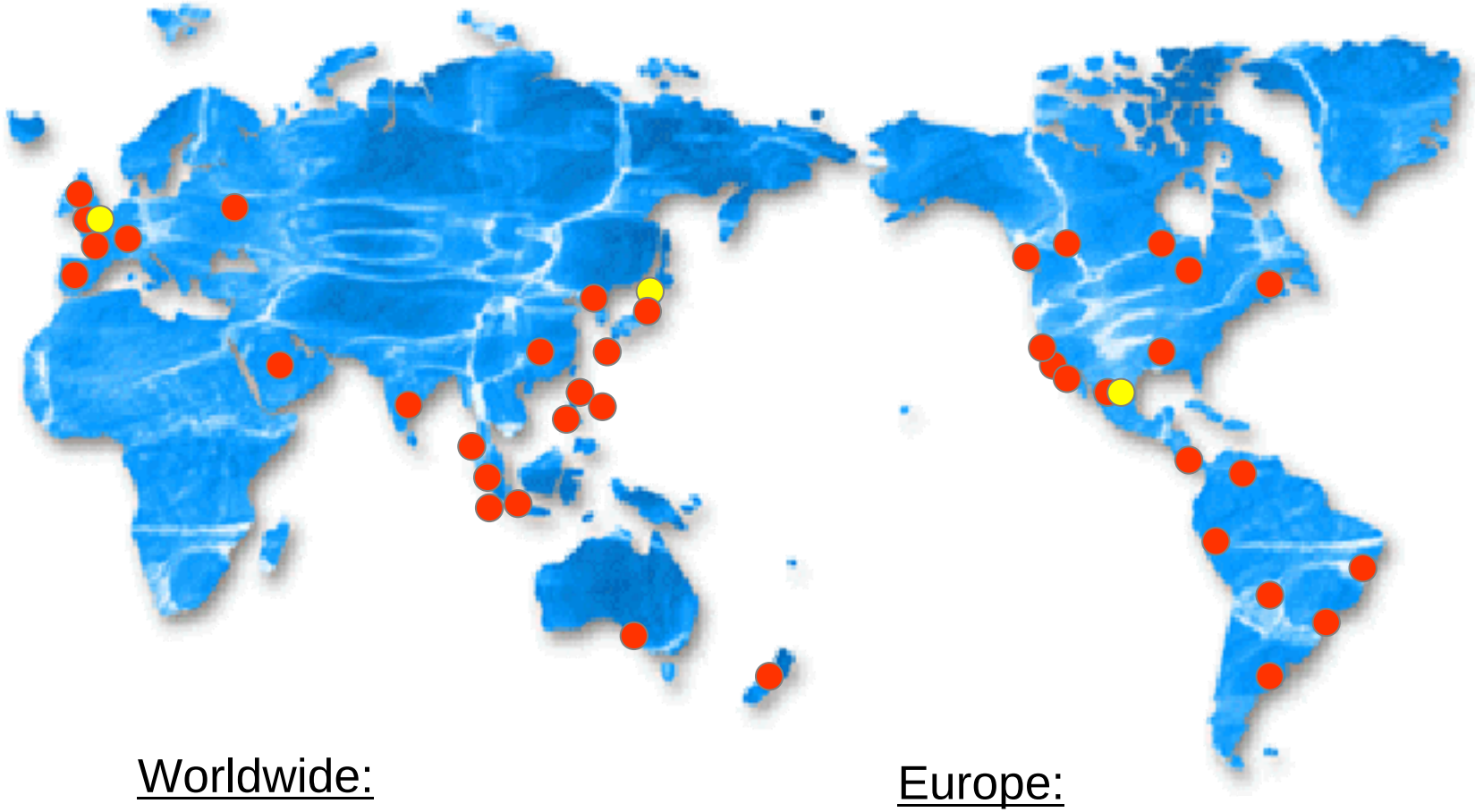
1924 1960 1970 1980 1985 1990

- Company founded in 1924.
- Over 70,000 Screw and Piston compressors running in more than 100 countries.

Synergy Expansion of Business Fields



MYCOM International Branches



Worldwide:
- 33 countries
- 8 production plants
- 119 offices

Europe:
- 1 production plant
- 6 offices

The comparison of CFC refrigerants and natural refrigerants

	HCFC	HFC	NWFs
The name of refrigerant	R22	R134a,R410A R407C,R404A	NH_3,CO_2,HC H_20,AIR
Ozone depletion potential (ODP)	0.055	0	0
Global warming potential (GWP)	1810	1770～3920	0～3
Leakage	Much	Much	No NH3 is found when leaked
Odor/Smell	No	No	NH3：Sharp odor
Flammability	No	No/Lower	NH3:Lower flammability HC：Higher flammability
Coefficient of performance (COP)	1.00	0.90	1.05～1.2

＊GWP used here is a 100-year GWP based on the data from Japan Fluorocarbon Manufacturers Association (JFMA). http://www.jfma.org/database/table.html

＊COP is the comparison value when R22=1.

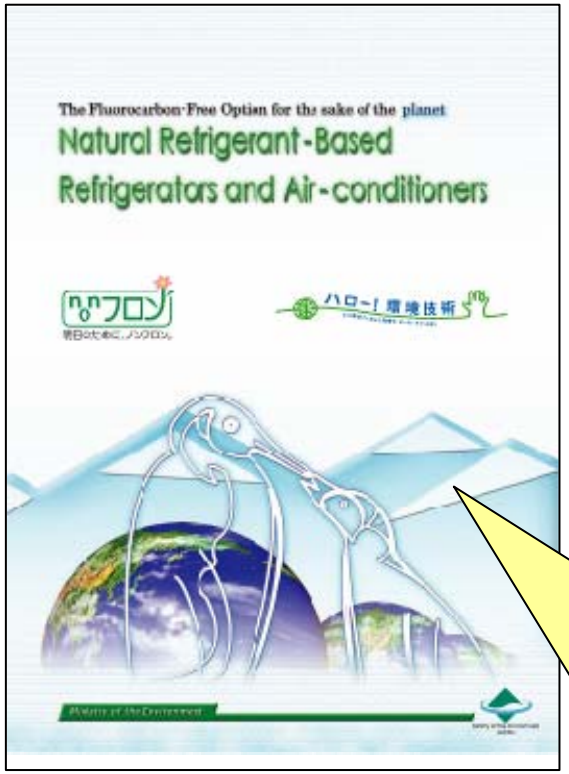
Development Concepts

- High efficiency
- Low refrigerant charge
- Less leakage

NH3 Installations in the industrial refrigeration field in Japan.

- ～1990:　less 2%
- 2008:　80%

* Tough Regulations for NH3 in Japan



The Fluorocarbon-Free Option for the sake of the planet

Natural Refrigerant-Based Refrigerators and Air-conditioners

Global Developments in Action on Fluorocarbons

The world is moving forward to prevent climate change and protect the ozone layer

When ozone layer depletion was recognized as a global environmental problem caused by fluorocarbons, the "Montreal Protocol on Substances that Deplete the Ozone Layer" was adopted, under which production of CFCs has been completely phased out in developed countries including Japan. Global actions are also being taken for the phase-out of production of HCFCs, which were introduced as the alternatives to CFCs.

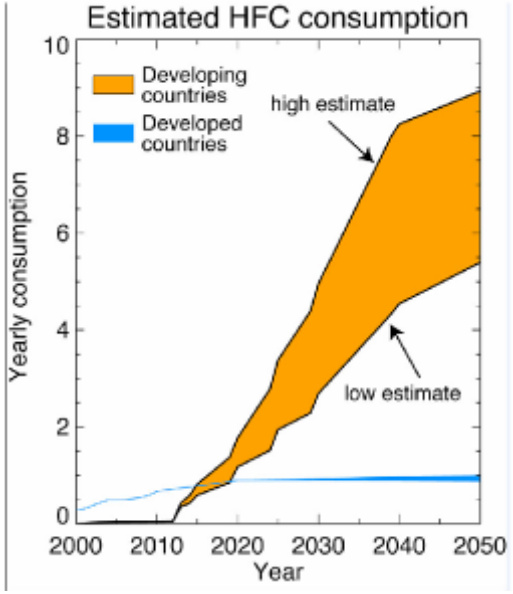
In addition, HFCs, the alternative to CFCs and HCFCs, are controlled under the "Kyoto Protocol" because they have a significant impact on climate change though they don't have any impact on ozone depletion.

In order to protect the ozone layer and prevent climate change, various measures are taken in Japan, including recovery and destruction of a fluorocarbons in equipment such as refrigerators and air-conditioners, and promotion of the use of alternative products.

Fluorocarbons are approximately 100 - 10,000 times stronger greenhouse gases than CO_2.

http://www.env.go.jp/earth/ozone/non-cfc/pamph_products/integration_en_full.pdf

Study Reveals
Growing Importance of HFCs in Climate Warming



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PNAS
Proceedings of the National Academy of Sciences of the United States of America

The large contribution of projected HFC emissions to future climate forcing

Guus J. M. Velders[a,1], David W. Fahey[b], John S. Daniel[b], Mack McFarland[c] and Stephen O. Andersen[d]

+ Author Affiliations

Edited by Mark H. Thiemens, University of California at San Diego, La Jolla, CA, and approved May 14, 2009 (received for review March 13, 2009)

Abstract

The consumption and emissions of hydrofluorocarbons (HFCs) are projected to increase substantially in the coming decades in response to regulation of ozone depleting gases under the Montreal Protocol. The projected increases result primarily from sustained growth in demand for refrigeration, air-conditioning (AC) and insulating foam products in developing countries assuming no new regulation of HFC consumption or emissions. New HFC scenarios are presented based on current hydrochlorofluorocarbon (HCFC) consumption in leading applications, patterns of replacements of HCFCs by HFCs in developed countries, and gross domestic product (GDP) growth. Global HFC emissions significantly exceed previous estimates after 2025 with developing country emissions as much as 800% greater than in developed countries in 2050. Global HFC emissions in 2050 are equivalent to 9–19% (CO_2-eq. basis) of projected global CO_2 emissions in business-as-usual scenarios and contribute a radiative forcing equivalent to that from 6–13 years of CO_2 emissions near 2050. This percentage increases to 28–45% compared with projected CO_2 emissions in a 450-ppm CO_2 stabilization scenario. In a hypothetical scenario based on a global cap followed by 4% annual reductions in consumption, HFC radiative forcing is shown to peak and begin to decline before 2050.

HCFC consumption | radiative forcing | scenarios

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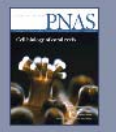

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Commitment on Natural Refrigerants

- NH_3 Semi-Hermetic Screw Compressor Unit
- CO_2 Commercial / Industrial Eco-Cute System
- H_2O Adsurption Chiller
- HC Commercial / Industrial Air-Conditioning / Water-Supply Heat Pump
- Air Dehumidifying Air Refrigerant System [Air Ref]

"Natural Five" Refrigerants and Product Solutions

Refrigerant (Natural Five)	NH_3 R-717	CO_2 R-744	HC Hydrocarbon	H_2O R-718	Air R-728
90℃ / 60℃ / 10℃ / -15℃ / -25℃ / -40℃ / -50℃ / -60℃ / -100℃	Utility hot water Heating; Chilled water Ice making; Cold storage, Freezer, Fish boat; Specific Refrigeration needs; Freezer, Freeze-dry, Super Low temp storage	Utility hot water; Chilled water Ice making; Cold storage, Freezer, Fish boat; Specific Refrigeration needs; Freezer, Freeze-dry, Super Low temp storage	Utility hot water Heating HVAC; Cryogenics	Heat recovery; Chiller	Cryogenics
Notes	・Conventional system ・National Projects	・Eco-Cute ・National Projects	・Nat'l Proj. ・Butane + Propane	・Nat'l Proj. ・Adsorption ・Heat recovery	・Nat'l Proj. ・Air-cycle

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チーム・マイナス6% www.team-6.jp
MAYEKAWA

NH3

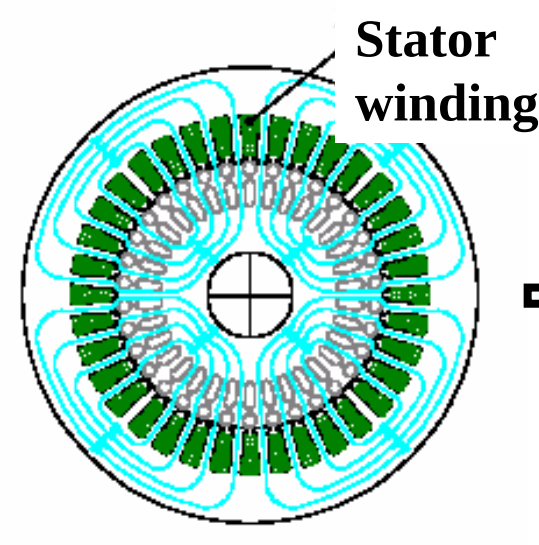
- High Efficiency: Compressors and IPM Motors
- Low Charge:
  * Secondary Refrigerant System(CO_2)
  * Direct Expansion System
- Less Leakage: Hermetic Motors

Ammonia

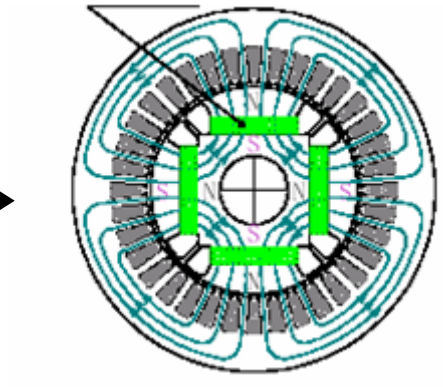
Semi-hermetic Refrigeration Package

2007 Ministry of the Environment
[Enterprise of Technical Develpment Against Global Warming]

High Efficiency Motor（IPM motor）



Conventional Motor

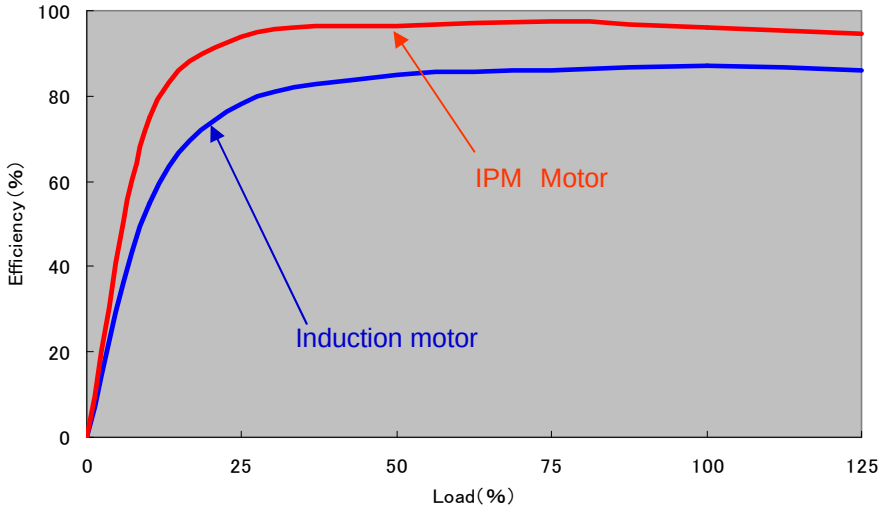


IPM Motor

Rotor

Benefits of IPM motor

- 5～10% better in efficiency
- 40% smaller in size
- Higher speed possible



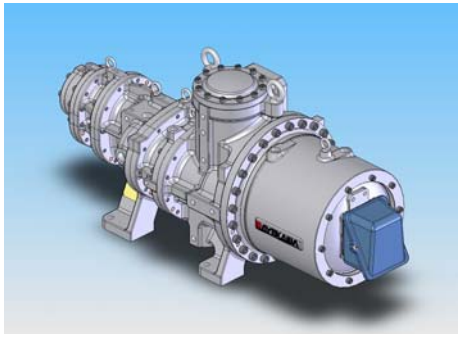
Stator

Moment of inertia is reduced, rotational response, power factor, motor efficiency improved

NH_3 Semi-hermetic motor

Motor docked to compressor

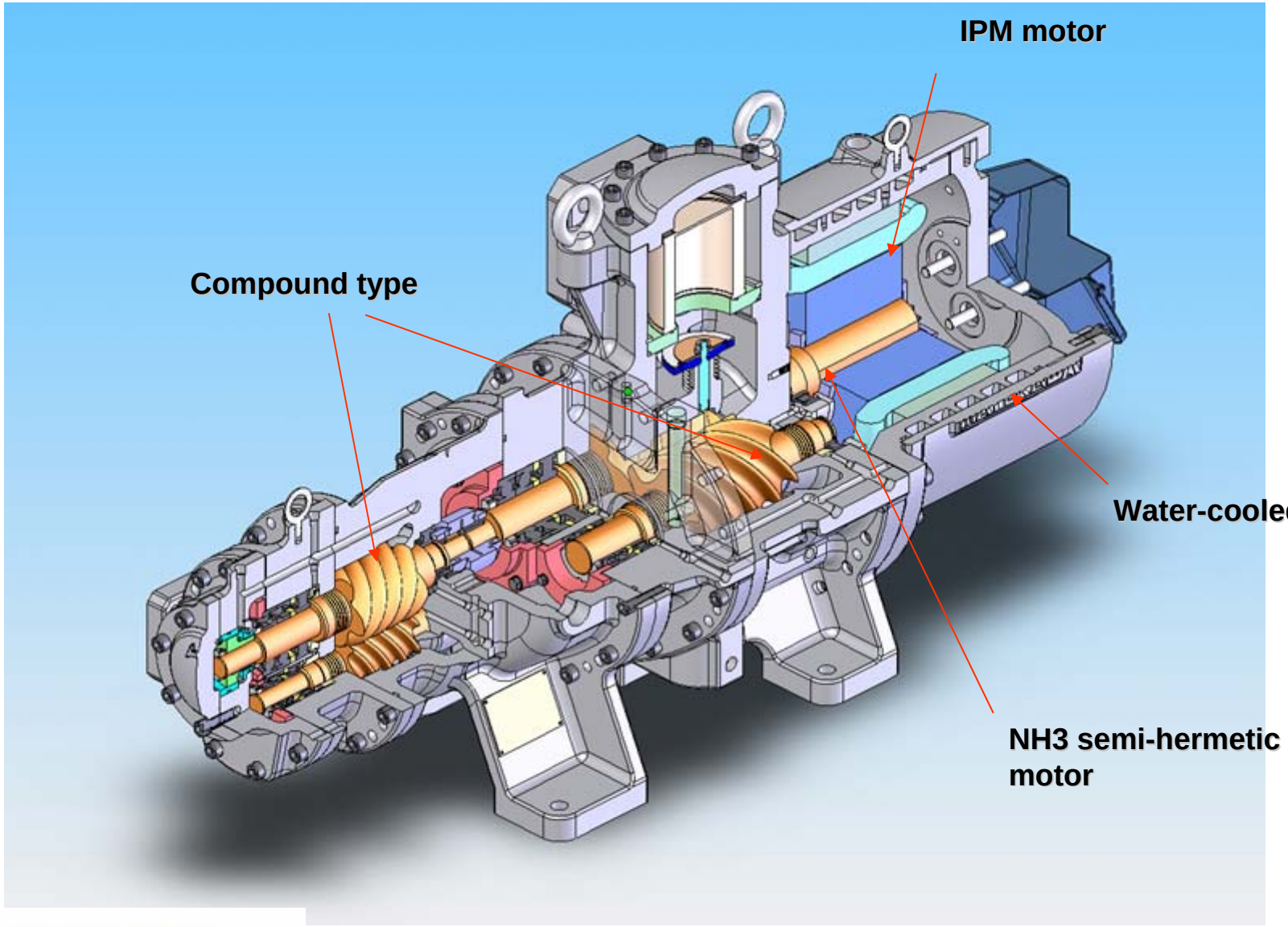
Building the stator



- Safety improved
- Compact
- High efficiency

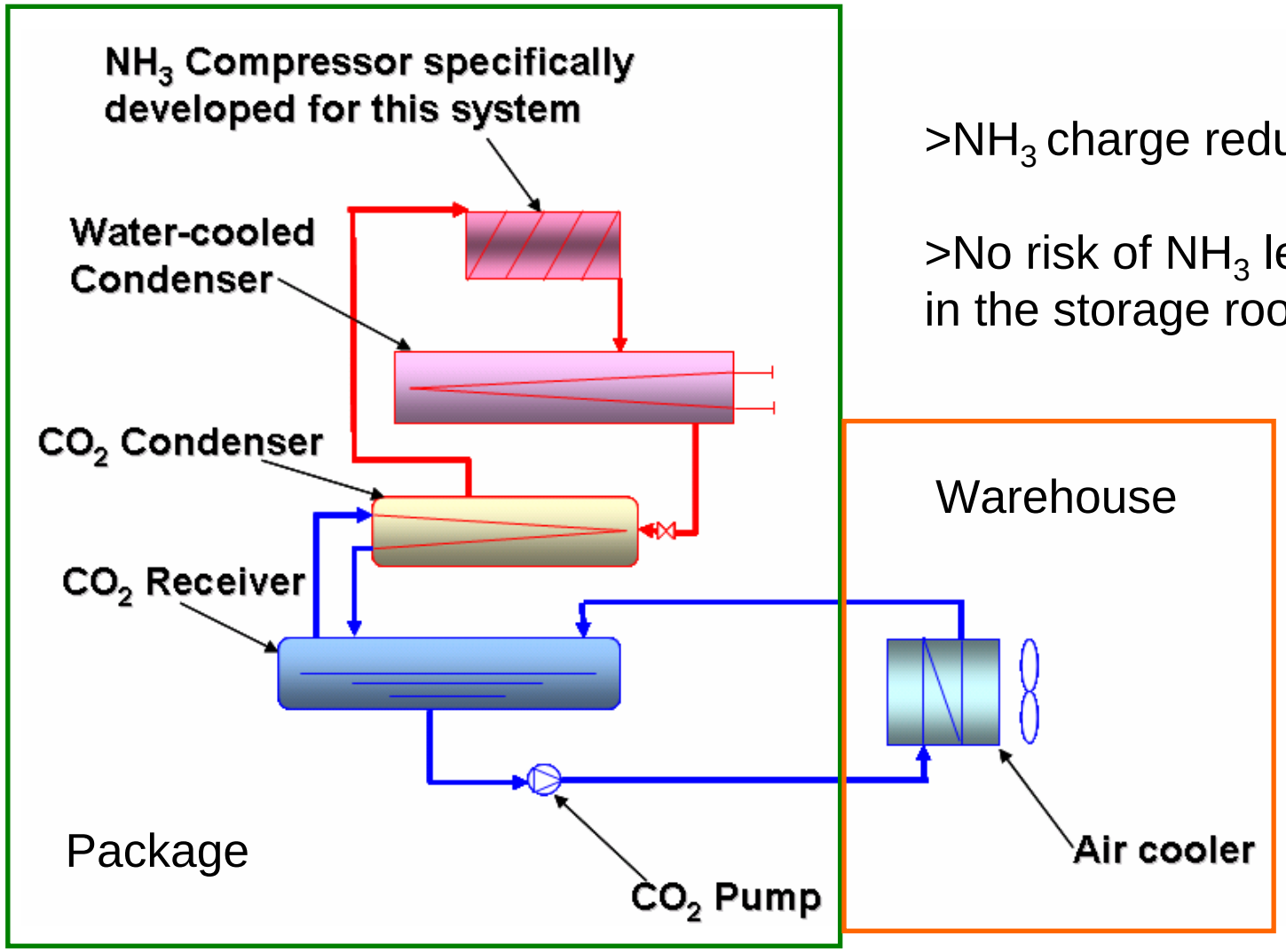
Patent Pending

NH3 Compressor with IPM motor



Application

NH_3/CO_2 system



>NH_3 charge reduction

>No risk of NH_3 leaking in the storage room

Installation in Japan

Distribution center

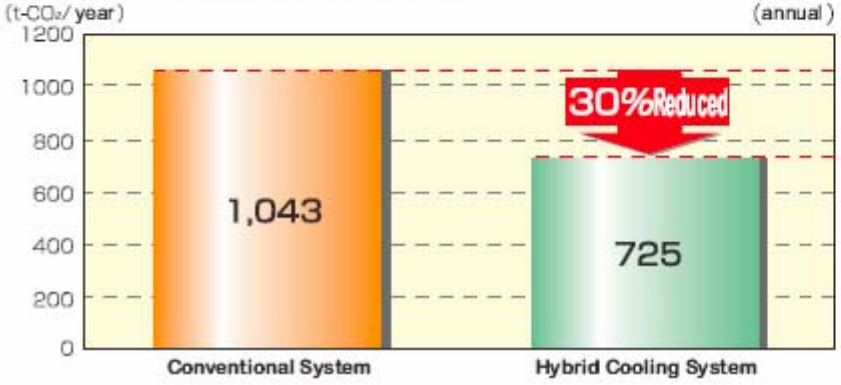
30% Reduction of CO2 Emission

Hybrid Cooling System Using NewTon3000

Target : Industrial Refrigerated Warehouses (for Class F)

- **Improved Safety** : By developing [Semi-hermetic compressor], Mayekawa improved the problem of refrigerant leak.
- **Non-Freon** : A system in which ammonia circulates as the primary refrigerant and CO_2 as the secondary refrigerant.
- **Energy Saving** : As a unit exclusively for the refrigerated wahrehouse, CO_2 2.0 at Class F. Compared to conventional Freon refrigerants, about 20% energy saving.

Efforts to Reduce CO2



Case Study

10,000t Refrigerated Warehouse

Inside Temperature: -25℃

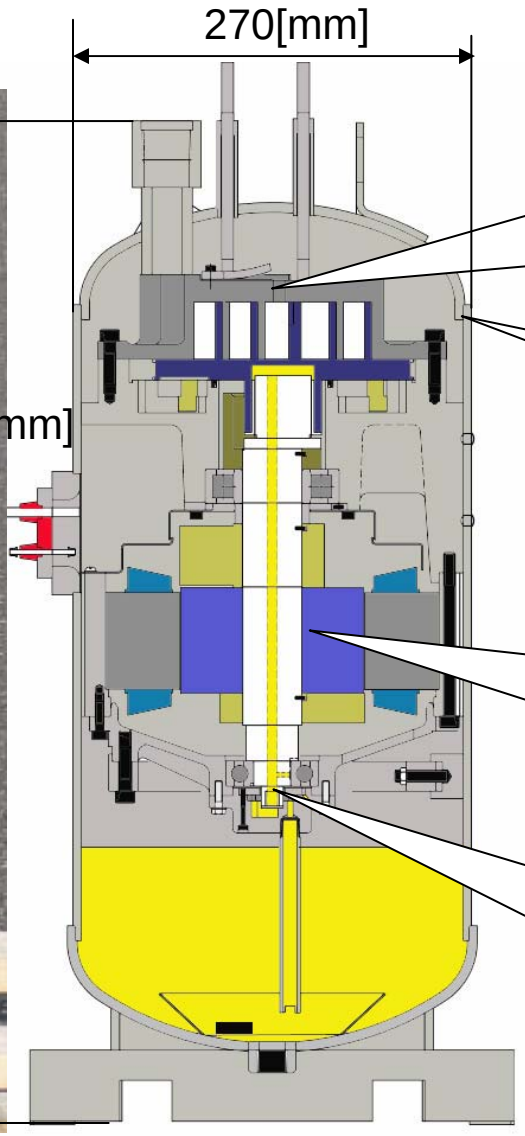
Power Consumption

< Conventional System >	< Hybrid Cooling System >
317kW	222kW

Heat Pump packages using Ammonia Scroll compressors

Capacity per Unit (-5/50C):
Cooling 35kW
Heating 47kW
Refrigerant charge: 6kg
(Direct expansion system)

Structure of scroll compressor



Wrap specifically designed for ammonia. Low and high temperature models.

Weight 100kg: flangeless , steel cased hermetic structure.

Motor efficiency improved by IPMM with aluminum windings.

Equipped with oil pump.

Easy startup.

Specifications

Item		Value	Units
Casing	Design Pressure	2.7	[MPaA]
	Design Temp.	120	[℃]
Operation Range	Cond. Temp.	30～55	[℃]
	Evap. Temp.	-35～+10	[℃]
	Cond. Pressure	1.167～2.311	[MPaA]
	Evap. Pressure	0.0931～0.615	[MPaA]
Rotational Speed		1800～3600	[rpm]
Models		Low and High temp	
Motor	Type of Motor	IPM	[-]
	Max Power	15	[kW]

CO2

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

Carbon dioxide

Industrial Hot Water Production Package

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

Water-Source Type is also availabe.

CO2 Heat Pump in Switzerland

ZÜRCHER UNTERLAND MEDIEN

Mehr Lokalpoliti

Zürcher Unterländer Die Tageszeitung für das Zürcher Unterland und amtliches Publikationsorgan der Bezirke Bülach und
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MARKTPLATZ
BranchenBox
Online Inserate
Fotomanager

Donnerstag, 15. Dezember 2005

Niederhasli: Warmes Wasser im GC-Campus durch moderne Technologie

CO2-Wärmepumpe installiert

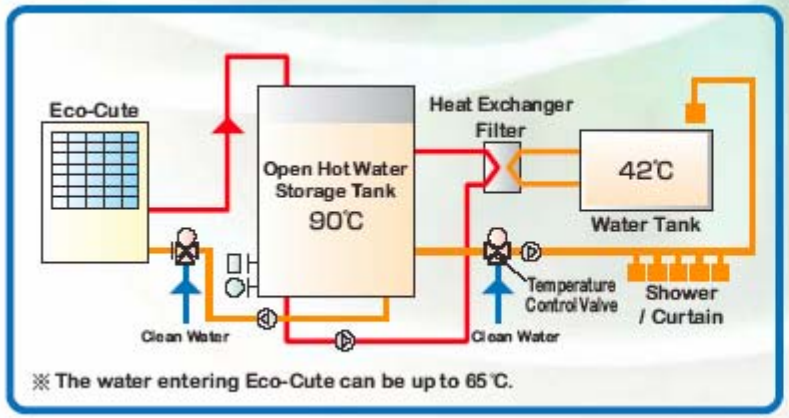
Im GC-Campus in Niederhasli liefert eine der ersten CO2-Wärmepumpen in der Schweiz pro Tag 4000 Liter Warmwasser. Die Maschine stammt aus Japan.

Inga Struve

EWZ-Projektleiter Georg Dubacher (von links), Masao Maekawa, Vorsitzender der japanischen Firma Mycom, und EWZ-Direktor Conrad Ammann erläutern die CO2-Wärmepumpe. (David Baer)

GOOG
WEIT
Niede
Wasse
durch
Bülac
Zwisch
Arbeits
Planun
Bülac
Compu
Priman
Steinn
Gemüs
werder
beheiz
Obere
Ferien
Embra

62% Reduction of CO2 Emission

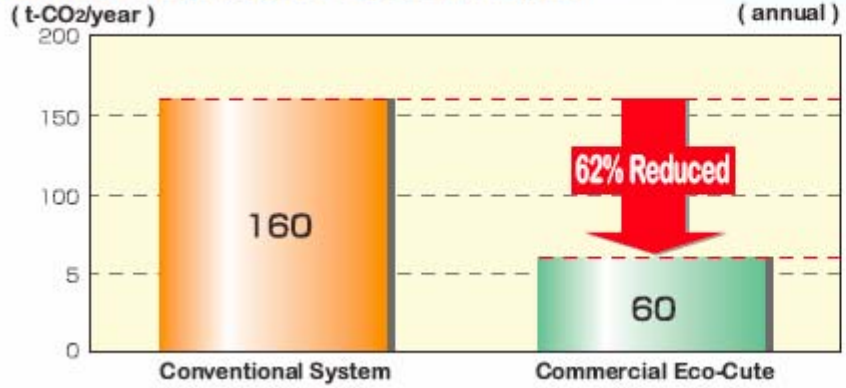


※ The water entering Eco-Cute can be up to 65℃.

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_2 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℃, exiting at 90℃).
- 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_2 Emission



Case Study

A Comapny Housing where Hot Water Supply is 20m³/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

H2O

- Ad-sorption Chiller Utilizing Solar Energy

Water

Adsorption Chiller Packaged Unit

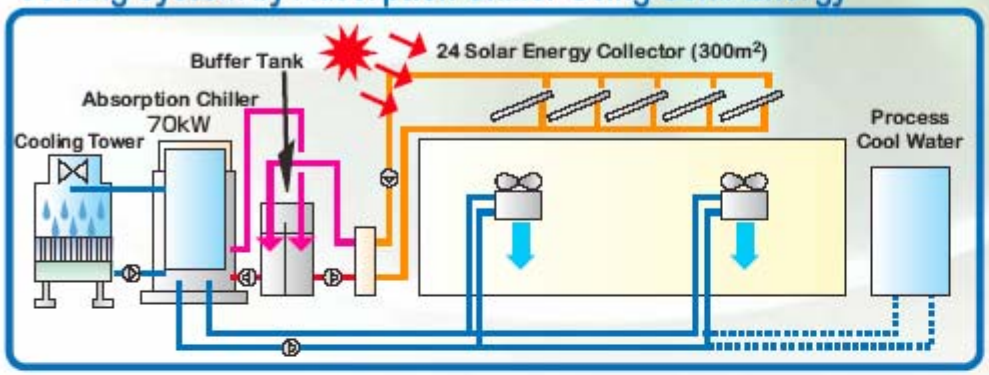
2005 ~2007 NEDO [Research and Development of New System Utilizing Solar Energy]

Installation in Japan

Air conditioner for shopping mall

64% Reduction of CO2 Emission

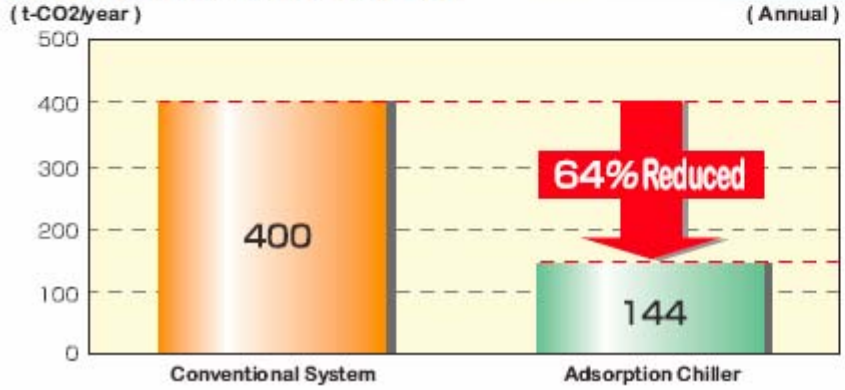
Cooling System by Adsorption Chiller Using Solar Energy



Targets : Industrial furnace, incinerator, distillation tower, air-conditioning or cooling using warm discharged water from cooling water of engines etc.

- produces cool water from low-temperature heat source (below 75℃).
- water as refirigerant, silica gel as adsorbent, therefore environmentally friendly.
- The body itself needs little electricity. Also, almost ZERO meintenance cost.

Efforts to Reduce CO_2 Emission



Case Study

100USRT Industrial Process Cooling
Cold Water Temperature : 9 ℃

Power Consumption

<Conventional System> R134a Cooling Water	<Adsorption Chiller>
100kW	36kW

- Mixed Refrigerants Heat-Pump
  (Butane and Propane)

Hydrocarbon Refrigerant Packaged Unit

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

([Industrial Technology Development Subsidizing Company])

Installation in Japan

At International Media Center of G8 Toyako summit in Hokkaido

Employed a cooling unit taking advantage of 7,000 tons of snow stocked underground, and as its subsystem, our environment-friendly building air-conditioner was introduced

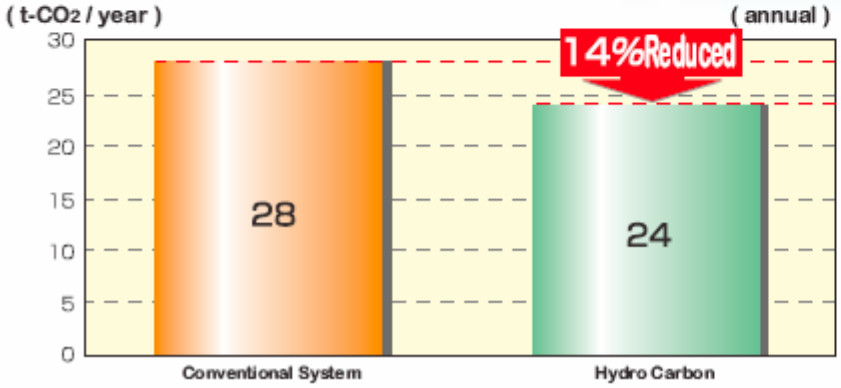
14% Reduction of CO2 Emission

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℃, air-source)

Targets: Commercial / Industrial Air-Conditioning, Water-Supply

Supply Temperature	Applications	Suitable Markets
70℃	65℃ Hot Water-Supply / Heating System	Food factories, hotels
50℃	45℃ Heating System	Office buildings, factories
0℃	+7℃ Chilled Water Chiller System	Office buildings, factories
-5℃	+2℃ Chilled Water Chiller / SupercoolIce Making System	Food factories
-15℃	Ice on Coil Ice Thermal Storage System	Food factories

Efforts to Reduce CO_2 Emission



Case Study

40USRTChilled Water Supply Machine
Chilled Water Temperature : 7℃

Power Consumption

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

- Air Cycle Refrigeration System
- For Low Temperature Applications

  -50 ～ -120 ℃

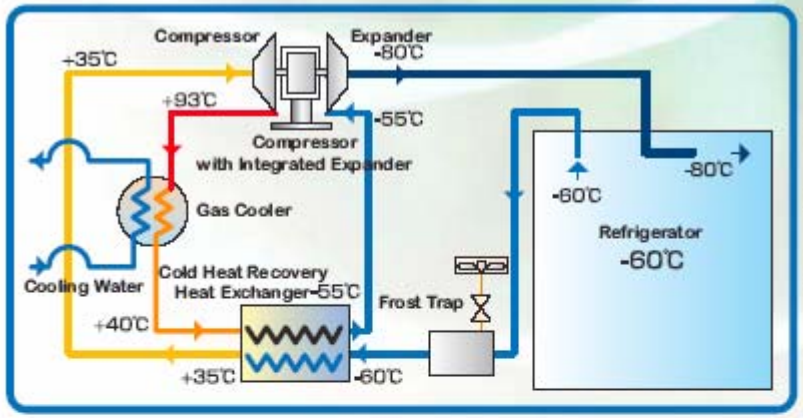
Air Cycle Refrigeration Packaged Unit

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

Installation in Japan

−60℃ ultralow cold storage

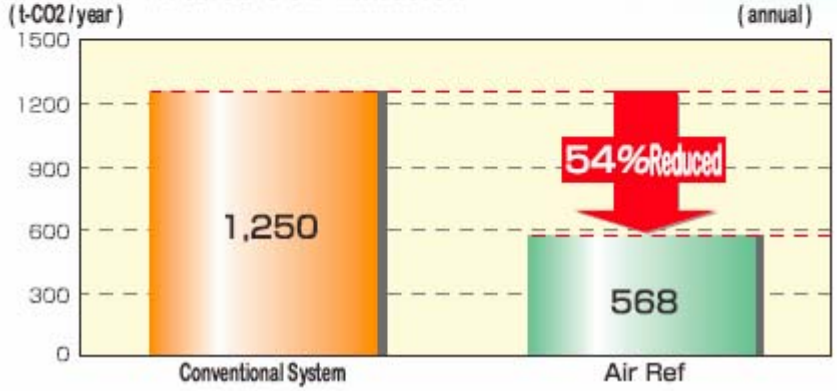
54% Reduction of CO2 Emission



Target: Ultra cold refrigerator for tunas and bonitos, rapid freezer, frost-破砕 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.
- Dihumidifying agent reduces frosting in the storage. Defrosting is not required.

Efforts to Reduce CO2 Emission



Case Study

2,000 ton Refrigerator
Interior Temperature : -60℃

Power Consumption

< Conventional System > R22 2 Stage Compression Refrigerator	〈Air Ref〉
281kW	128kW

Conclusion

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.

Thank you very much for your Attention.

MAYEKAWA

NATURE IS WHAT WE DESIGN FOR