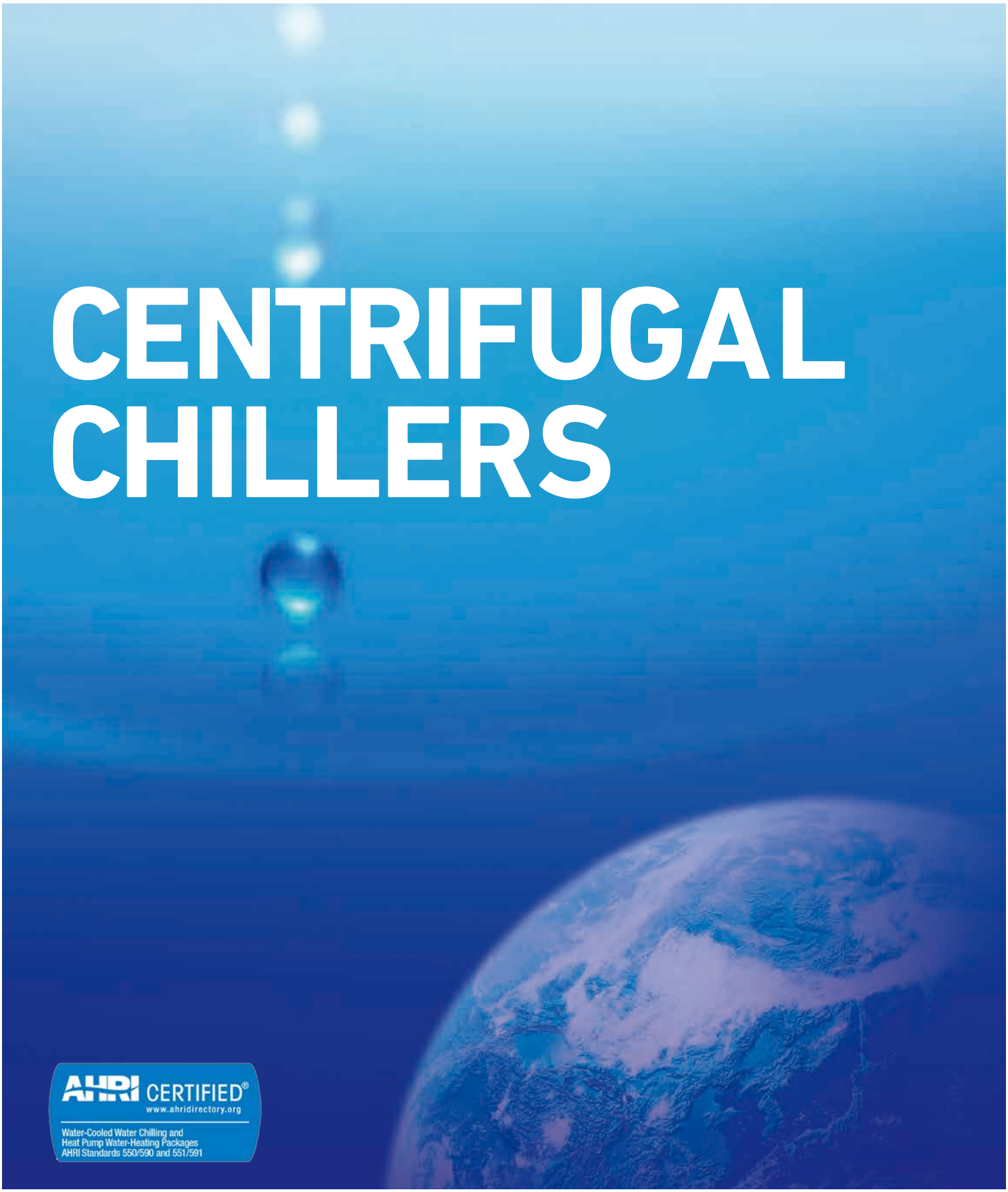
CENTRIFUGAL CHILLERS



AHRI CERTIFIED®
www.ahridirectory.org
Water-Cooled Water Chilling and Heat Pump Water-Heating Packages
AHRI Standards 550/590 and 551/591

MOVE THE WORLD FORWARD

MITSUBISHI HEAVY INDUSTRIES GROUP

MITSUBISHI HEAVY INDUSTRIES

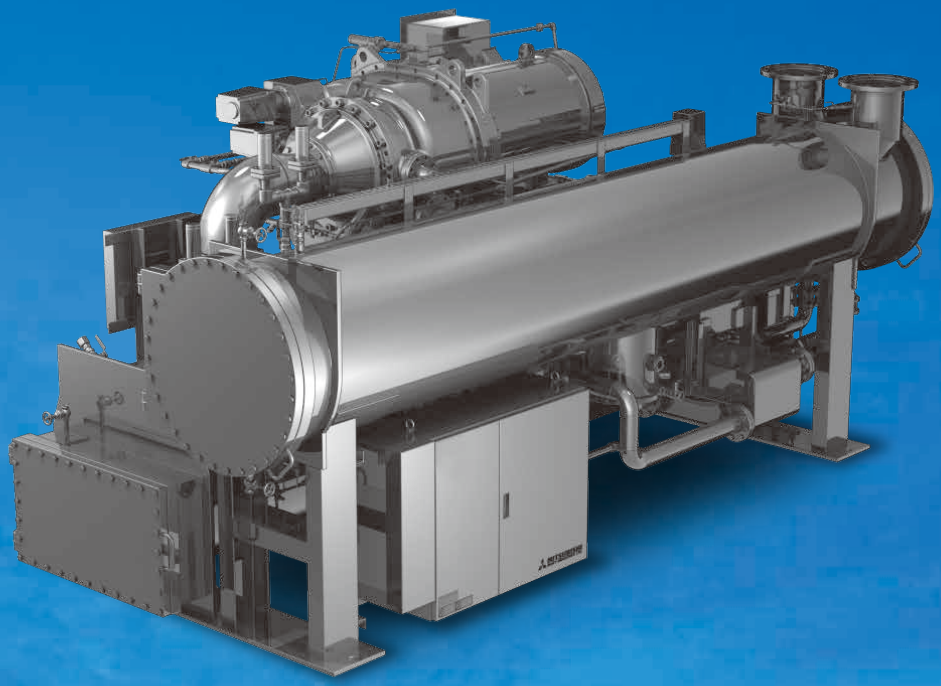
Centrifugal
Chiller

We wave a flag for environment protection by energy saving

“Mitsubishi Heavy Industries Centrifugal Chiller” is the best answer for giving due consideration to environment.

Being required for contemporary office buildings, huge shopping malls or factories,
it is an environmental protection effort.
Key issue is air-conditioning system, and most important factor is efficiency of chillers used in the system.
Our Centrifugal Chiller put drastic energy saving in the place.
Putting in high efficient chillers are not only contributing to environment conservation of
the reduction of CO_2 emissions etc., but also resolve the business challenge of saving operation cost etc.

This is the proposal from Mitsubishi Heavy Industries Thermal Systems, Ltd.

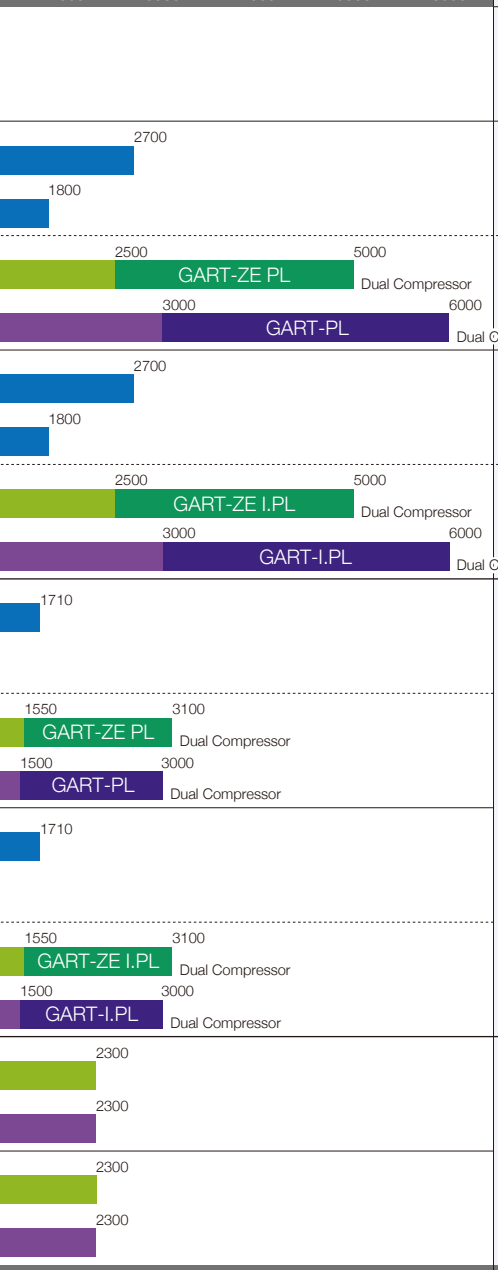


Product line

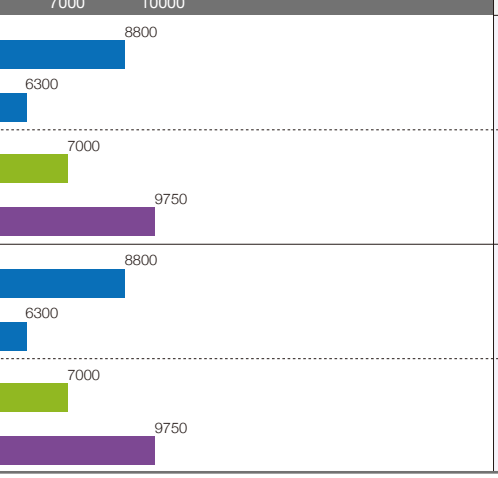
Use	Drive	Series	Refrigerant	Capacity (RT) ＊3
Air-Conditioning	Variable (Built-in Inverter)	ETI-Z *New*	Low GWP Refrigerant HFO-1233zd(E)	150-700RT
		ETI	HFC-134a	150-700RT
	Constant	GART-P	HFC-134a	500-2700RT
		GART-R	HFC-134a	420-1800RT
		GART-ZE *New*	Low GWP Refrigerant HFO-1234ze(E)	300-5000RT
		GART PL type	HFC-134a	510-6000RT
	Variable	GART-PI	HFC-134a	500-2700RT
		GART-RI	HFC-134a	420-1800RT
		GART-ZEI *New*	Low GWP Refrigerant HFO-1234ze(E)	300-5000RT
		GART-I PL type	HFC-134a	510-6000RT
Low Temperature	Constant	GART-P	HFC-134a	530-630RT 850-900RT 1540-1710RT
		GART-ZE *New*	Low GWP Refrigerant HFO-1234ze(E)	260-3100RT
		AART-H / GART	HFC-134a	180-400RT/ 400-3000RT
	Variable	GART-PI	HFC-134a	530-630RT 850-900RT 1540-1710RT
		GART-ZE.I *New*	Low GWP Refrigerant HFO-1234ze(E)	260-3100RT
		AART-H.I / GART-I	HFC-134a	180-400RT/ 400-3000RT
Heat Recovery ＊1	Constant	GART-ZE.HR *New*	Low GWP Refrigerant HFO-1234ze(E)	330-2300RT
		GART-HR / GART-R.HR / GART-P.HR	HFC-134a	400-2300RT
	Variable	GART-ZE.I.HR *New*	Low GWP Refrigerant HFO-1234ze(E)	330-2300RT
		GART-I.HR / GART-RI.HR / GART-PI.HR	HFC-134a	400-2300RT

Use	Drive	Series	Refrigerant	Capacity (kW) ＊3
Heat Pump ＊2	Constant	GART-P.HP	HFC-134a	2100-8800kW
		GART-R.HP	HFC-134a	1400-6300kW
		GART-ZE.HP *New*	Low GWP Refrigerant HFO-1234ze(E)	1200-7000kW
		GART-HP	HFC-134a	1700-9750kW
	Variable	GART-P.I.HP	HFC-134a	2100-8800kW
		GART-R.I.HP	HFC-134a	1400-6300kW
		GART-ZE.I.HP *New*	Low GWP Refrigerant HFO-1234ze(E)	1200-7000kW
		GART-I.HP	HFC-134a	1700-9750kW

＊1 Heat Recovery : Simultaneous Operation
＊2 Heat Pump : Switching Operation
＊3 Capacity range should be changed subject to temperature condition of chilled water, brine or hot water.
＊4 Control range should be changed subject to temperature condition of brine or hot water.



Temperature			Load		Flow Rate			
Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
			Standard	Option	Standard	Option	Standard	Option
4°C	12°C		100%-10%	100%-approx. 0%	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
4°C			100%-20%	-				
3°C			100%-20%	100%-10%				
4°C			100%-10%	-				
3°C			100%-10%	100%-approx. 0%				
Minus 5°C			100%-30%	-				
			100%-30%	100%-10% *4				
			100%-30%	-				
			100%-30%	100%-10% *4				
3°C		50°C	100%-30%	100%-10% *4				

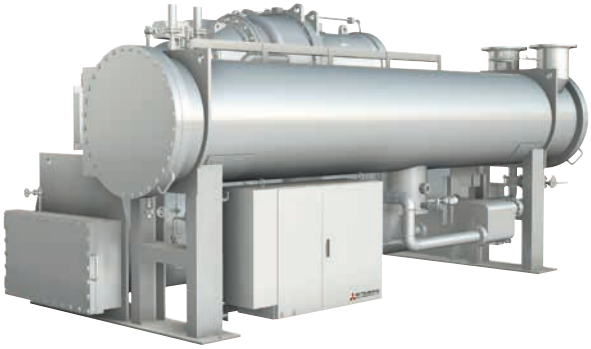


Temperature			Load		Flow Rate			
Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
			Standard	Option	Standard	Option	Standard	Option
4°C	12°C	45°C	100%-30%	-	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
3°C		50°C	100%-30%	100%-10% *4				
4°C		45°C	100%-30%	-				
3°C		50°C	100%-30%	100%-10% *4				

Features of GART series & GART-I series

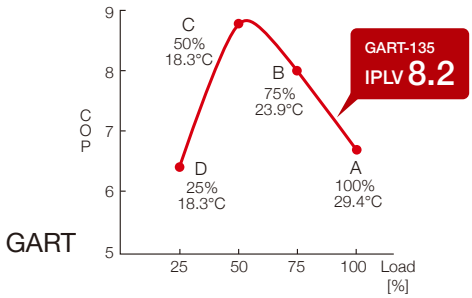
High Efficiency

- Newly shaped compressor impellers
- Improved evaporators and condensers
- Adoption of a new two-stage-compression/ one-stage-expansion/economizer/ sub-cooler cycle enhanced tracking of load fluctuations



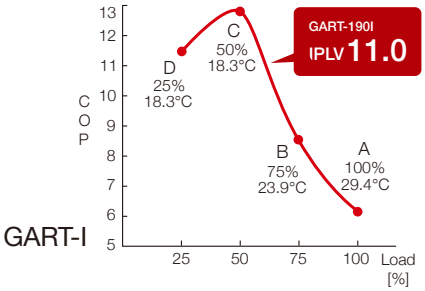
Constant speed drive **GART**

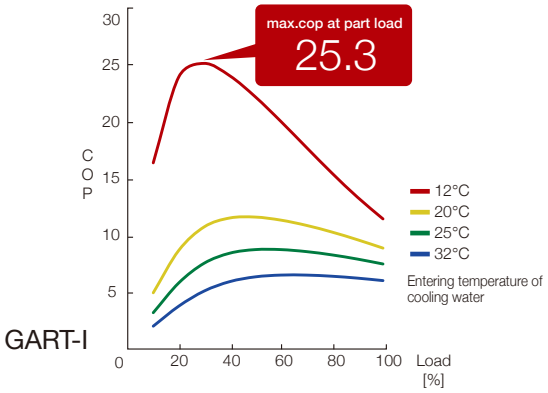
COP	IPLV
[AHRI Standard 550/590(I-P)]	[AHRI Standard 550/590(I-P)]
7.0 GART-135,190,270	**8.2** GART-135



Variable speed drive **GART-I**

Max.COPat part load	IPLV
	[AHRI Standard 550/590(I-P)]
25.3 GART-190	**11.0** GART-190





IPLV

IPLV is the formula developed by AHRI to measure the efficiency of chillers under an actual annual operating conditions. IPLV is calculated when the unit is operating at 25%, 50%, 75% and 100% of capacity and at different cooling water temperature.
[AHRI Standard 550/590(I-P)]

IPLV: Integrated Part Load Value
AHRI: Air-Conditioning, Heating and Refrigeration Institute

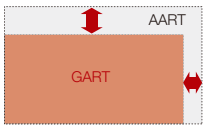
IPLV = 0.01A + 0.42B + 0.45C + 0.12D
A = COP at 100% load (29.4°C*) B = COP at 75% load (23.9°C*)
C = COP at 50% load (18.3°C*) D = COP at 25% load (18.3°C*)
Leaving temperature of chilled water: 6.7°C
*: Entering temperature of cooling water

Compact

- Chiller components are arranged in a way to use vertical space optimally
- Compressors, evaporators and condensers have been reduced in size
- Plate type heat exchanger has been introduced in the economizer

Dimensions

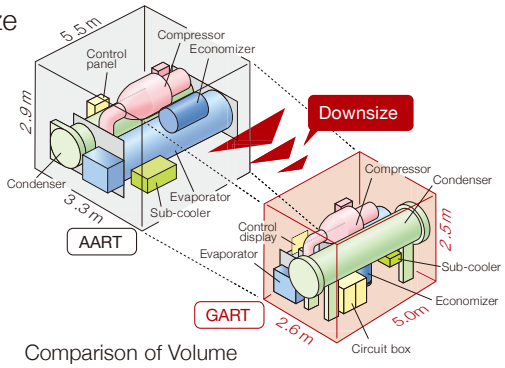
approx. **30**% reduction
〈compared to previous model : AART 1000RT〉



Comparison of Dimensions

Volume

approx. **40**% reduction
〈compared to previous model : AART 1000RT〉



Comparison of Volume

Control panel

Multifunction Microcomputer Control

Big　Clear　Smooth　Save Energy

10.4 inch Display／Digital Display／Quick Response

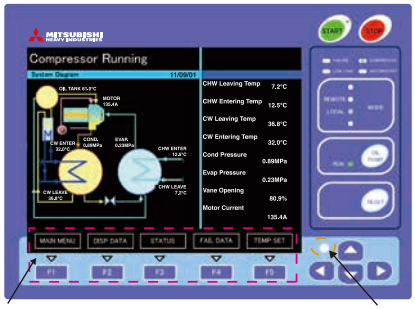
Liquid Crystal Display (LCD) with automatic lighting-up function

Relight-up by human detection sensor without touching panel

For environmental standards

Realize lead-free substrate
RoHS compliant

Separate off control display and circuit box layout of control display is free（GART / GART-I）



Function key　Human detection sensor

Followings are displayed

- Operation data　- Failure data
- Real time trend
  (max. 5 operational data and max. 3 situational data)
- Setup schedule operation condition <OPTION>

Operation Data Display

Display max. 24 data at one time.

Real Time Trend Display

Display max. 5 operational data and max. 3 situational data by real time trend graph. Displayed data is selectable.

Setup Schedule Operation Condition Display

Start-Stop set up twice per day, seven days a week can be selected.

Failure Data Display

Display max. 16 troubles with data and time at one time.

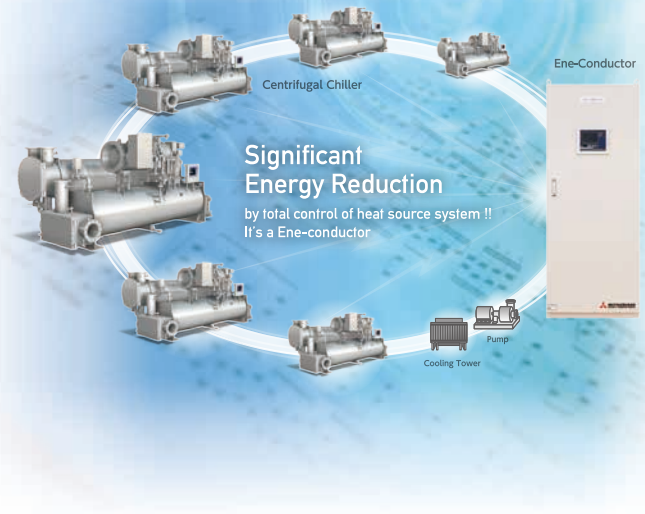
Heat source control system “Ene-Conductor”

- Improvement of system COP by optimal control which gets the best performance out of centrifugal chiller
- Various energy-saving control functions
- Remote monitoring

Significant Energy Reduction by total control of heat system

~optimization from individual equipment to whole system

Being required for contemporary office buildings, large shopping malls or factories, it is an environmental protection effort and saving energy but the key issue is the heat source system. Energy-saving had to introduce high efficiency equipment some years ago. However it has to consider energy saving on heat source system levels rather than individual equipment.

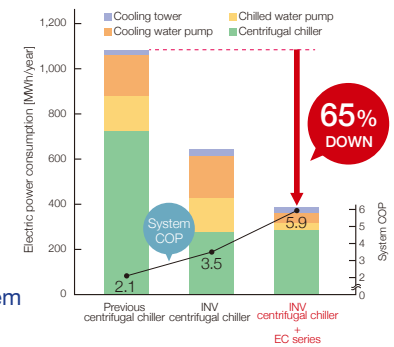


Electric power consumption in whole system 65% DOWN

Easy to use for an automatic optimization of the whole system

Estimation example

- Improvement in COP of centrifugal chiller
- Chilled water variable flow control
- Cooling water variable flow control



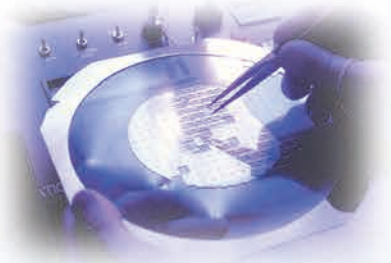
Estimation condition : chiller 400 RT x 2units,Building air conditioner use
* Auxiliary equipment : controlled by inverter

Application

Mitsubishi Heavy Industries centrifugal chiller presents more power to your production etc.

Semiconductor Industry

Supply chilled water for manufacturing imaging device like digital camera, LCD and semiconductors.



Automotive Industry

Supply chilled water to the drying oven of painting facility and other manufacturing process.
Air conditioning system for the facility requires high cooling load and constant long annual operating hours.

Clean Room

Special control like temperature, humidity, air purification, air flow and air pressure of the room for the semiconductor factories etc.

Hotel / Office

Constant temperature and humidity control for making comfortable atmosphere at luxury hotels, and office.

Data Center

Requirement in air-conditioning system for data center is reliability, stable supply of chilled water and energy saving.
Supply stable chilled water with high efficiency and continuously.

Food Industry

Prevent breeding various germs by cooling rapidly with nearly zero degree chilled water during process of sterilization of the mineral water manufacturing facility.
Also apply to cool down the water during process.
Supply stable water temperature of 10 to 30°C chilled water for cooling down manufacturing machinery.

Chemical Industry

Chilled water supply for dehumidifying the air at deaerate pre-processing phase during the manufacturing process of oxygen and nitrogen.

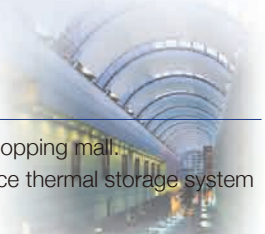
Sports Facility

Constant temperature and humidity control for making comfortable atmosphere at gymnasium and training facility.
Ice making refrigerating machine at ice skating rink.

District Cooling

District heating and cooling systems (D.H.C) are made up of one or several local plants that produce chilled water and steam for cooling and heating a certain area and hot-water supply, and a network of supply pipes that deliver
these around the clock to a number of buildings.
Centrifugal chiller is the core equipment of D.H.C system.

Shopping Mall



High efficiency is important in large shopping mall.
High efficiency centrifugal chiller and ice thermal storage system using centrifugal chiller are used,
because share of air-conditioning energy consumption is high for requiring annual cooling and constant long operation hours.
The air-conditioning load largely depends on fluctuation of visitors number.
The problem is solved by variable speed drive chiller.

Energy saving example

Sony Group Corporation Sendai Technology Center

Equipment with better energy-saving performance has been installed for the Great East Japan Earthquake (11-Mar-2011) Renovation project.

Before

Variable Speed Drive
Centrifugal Chiller
(Previous Model NART-50I 3units)
High efficiency heat source ccontrol system in 2004

After

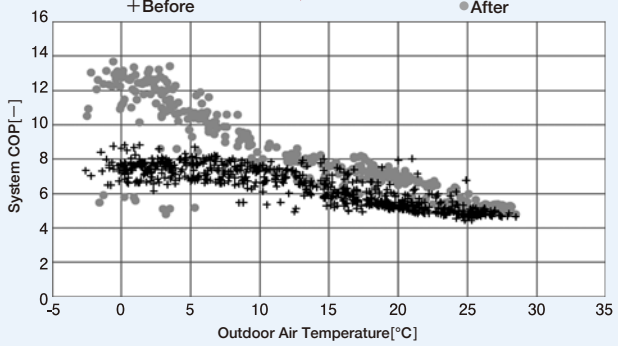
Variable Speed Drive
Centrifugal Chiller
(Existing Model ETI-50 2units)
+ Ene-Conductor


Ene-Conductor

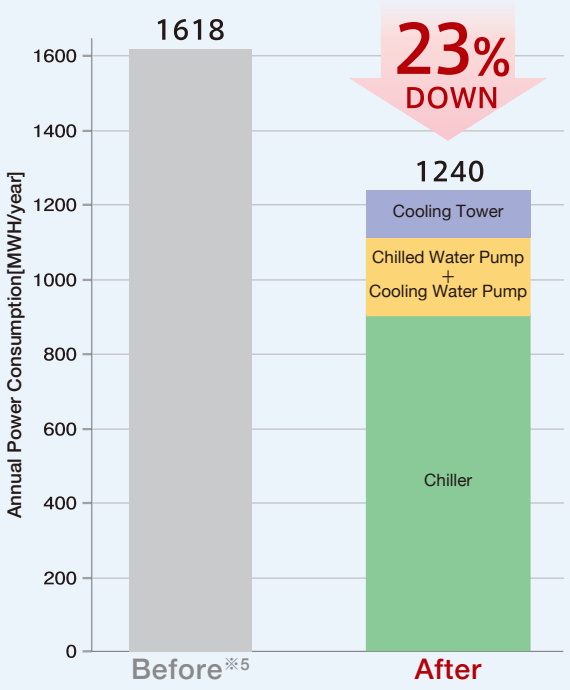

VSD Centrifugal Chiller

Average Annual System COP

Before 5.9 ※1 → After 7.7 ※2



Annual Power Consumption



Annual CO_2 Emission ※3

884ton Before → 677ton After

207 ton/year DOWN

Annual Electricity Cost ※4

18,853 Thousand yen (JPY) Before → 14,446 Thousand yen (JPY) After

4,407 Thousand yen (JPY)/year DOWN

*1 Reference: "Energy Saving Performance and Effective Operation Strategies of Cooling Plant System Using an Inverter Chiller for Building Air-Conditioning : Part1, Part2, 47th Academic Papers Award by The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE), 2009
*2 Reference: "Development of performance evaluation method for optimal controlled heat source system : Part 2", by Tai (Kyushu University) and other 8 members, , Air-Conditioning and Sanitary Engineers of Japan (SHASE), 2013
*3 CO_2 emissions was calculated using CO_2 emission factor 0.546kg-CO_2/kWh (FY2011 actual record by Tohoku Electric Power Co., Inc.)
*4 Calculated based on high voltage electricity price JPY 11.65/kWh (summer period, June-2013) by Tohoku Electric Power Co., Inc.
*5 Power Consumption (Before) is calculated based on 2012 data divided by 2004 System COP 5.9
(FY2012 Actual Power Consumption x FY2012 Actual COP / 2004 Actual COP)

Experience

More than 50 years of experience in air-conditioning and DHC system are reflected to improve performance and reliability of products.

MARINA BAY NEW DOWNTOWN

The first district cooling plant in Marina South New Downtown, Singapore, located in One Ruffles Quay (ORQ) development, has been in operation since May 2006. This plant has high-efficiency chillers with thermal storage systems. Supplies will be extended to the integrated resort, Marina Bay Financial Centre and other new commercial buildings in the Marina Bay area as they are completed over the next few years. The two plants will be interconnected via a chilled water network in the new downtown.

- 853 RT Centrifugal chiller × 1 units
- 2,844 RT Centrifugal chiller × 11 units
- 2,000 RT Centrifugal chiller × 2 units
- 3,697 RT Centrifugal chiller × 2 units
- 5,400 RT Centrifugal chiller × 2 units

(Singapore)

KUALA LUMPUR CITY CENTER

Kuala Lumpur City Centre (KLCC) area, a prime landmark in Kuala Lumpur, Malaysia's capital city is Kuala Lumpur' s main business district, perhaps best known for the PETRONAS Twin Towers: the 452-meter high, 88-storey skyscrapers completed in1997. The area is also home to the Suria KLCC shopping complex, the Aquaria KLCC oceanarium, a park and a philharmonic hall, and as a result it is always crowded with both business persons and visitors. We have received an order for 13 large-size centrifugal chillers, with a total cooling capacity of 36,400 RT.Delivery of the chillers is slated for completion in September 2014.

- 2,800 RT Centrifugal chiller × 13 units

(Malaysia)

AMARI WATERGATE BANGKOK

Amari Watergate Bangkok is a luxury 5 star hotel located in centre of Bangkok.
New Energy and Industrial Technology Development Organization (NEDO) carried out energy saving model project utilizing Japanese energy conservation technologies.
Our centrifugal chillers were adopted as air conditioning system and achieved significant energy reduction.

- 460 RT Centrifugal chiller × 2 units

(Thailand)

MADINA HAJJ PROJECT

Medina is one of Islam's two holiest cities. By enabling air conditioning of large spaces where vast numbers of pilgrims gather, Our centrifugal chillers will help provide the city's many visitors and residents with a more comfortable environment.
The 80 units will deliver a combined cooling capacity of approximately 200,000 RT, The district cooling plant will also supply chilled water to an area of 1.6 million square meters (m^2).

- Centrifugal chiller × 80 units (variable speed drive) Total 200,000 RT

(Saudi Arabia)

<Note> DHC: District Heating and Cooling HVAC: Heating, Ventilation and Air Conditioning

RAFFLES CITY CHONGQING

Raffles City Chongqing, the new landmark of Chongqing with a total construction area of over 1.12 million sqm, comprises 8 super tower buildings, including high-end residential, shopping malls, office buildings, and international five-star hotel and service apartments. Our centrifugal chillers are adopted by contractors to create clean and comfortable environment by making rational use of regional energy effectively.

- 2,500 RT Centrifugal chiller × 4 units (GART-250P)
- 840 RT Centrifugal chiller × 4 units (GART-80P)

(China)

CHINA GUANGZHOU INTERNATIONAL CONVENTION AND EXHIBITION CENTER

Our centrifugal chillers are installed in one of the most famous and elegant exhibition center in the world, which plays a very important role in the Chinese trade market.
Hermetic motor used in 10 kV / 50 Hz* power source.
(except for 380 RT below)
*Hermetic motor used in 11 kV / 50 Hz available.

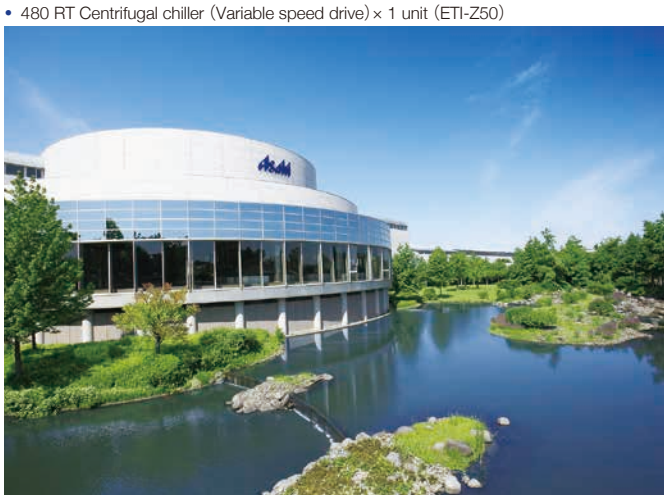
- 380 RT Centrifugal chiller × 1 unit
- 1,000 RT Centrifugal chiller × 2 units
- 2,000 RT Centrifugal chiller × 8 units

(China)

ASAHI BREWERIES, LTD. IBARAKI BREWERY

Factories of Asahi Breweries make several efforts while protecting important global environment and walking with nature.
As one of effort to reduce CO_2 emission, Ibaraki Brewery installed a high efficiency Our Centrifugal Chiller, variable speed drive ETI-Z adopting Low GWP refrigerant. Our Centrifugal Chillers support energy saving of the factory and to prevent global warming.
*GWP=Global Warming Potential

- 480 RT Centrifugal chiller (Variable speed drive) × 1 unit (ETI-Z50)



(Japan)

MINATO MIRAI 21

Our 13 Centrifugal Chillers are installed in MM21 DHC Plant where "Land Mark Tower" and "Queens Square" are located.

- 2,000 RT Centrifugal chiller × 1 unit
- 2,080 RT Centrifugal chiller × 1 unit
- 3,000 RT Centrifugal chiller × 3 units
- 4,000 RT Centrifugal chiller × 1 unit
- 4,400 RT Centrifugal chiller × 1 unit
- 5,000 RT Centrifugal chiller × 1 unit
- 5,400 RT Centrifugal chiller × 3 units
- 5,400 RT Centrifugal chiller × 2 units (variable speed drive)

(Japan)

Centrifugal Chiller

Mitsubishi Heavy Industries Thermal Systems, Ltd.
(Wholly-owned subsidiary of MITSUBISHI HEAVY INDUSTRIES, LTD.)

2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, 100-8332, Japan
https://www.mhi-mth.co.jp/en/

Our factories are ISO9001 and ISO14001 certified.

Certified ISO 9001

Certificate number: JQA-0709

Certified ISO 14001

MTHSS007, 2302 (1.0) R9

VEGETABLE OIL INK

Edited in Japan