ASHRAE Macao

New Generation Centrifugal Chiller using Low GWP Refrigerants, Beyond Refrigerants & Magnetic Centrifugal Chiller Unit

Air conditioning Energy saving new tool- Magnetic Bearing Centrifugal Chiller Unit

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Outline

1. Energy consumption and energy saving opportunities for air conditioning systems .

2. Analysis of characteristics of Magnetic Bearing Centrifugal Chiller Unit

   Interpretation the Characteristics of each Chiller unit and related performance data

3. Development of Magnetic Bearing Centrifugal Chiller Unit in Taiwan.

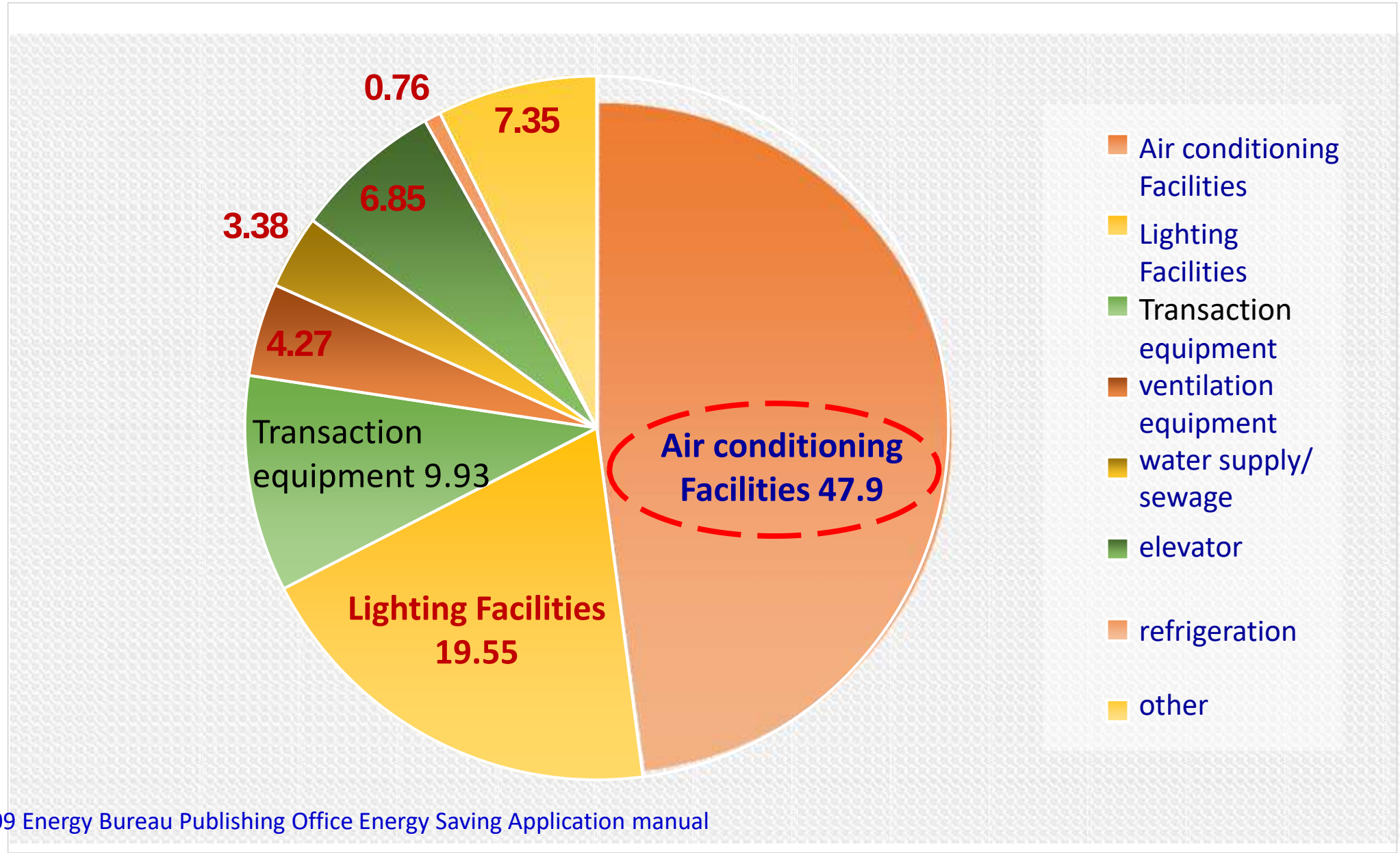
   The development course and achievements of Chiller Unit in ITRI

   The usage performance of Chaoyang University and Taiwan Power Building

4. Conclusion and recommendations

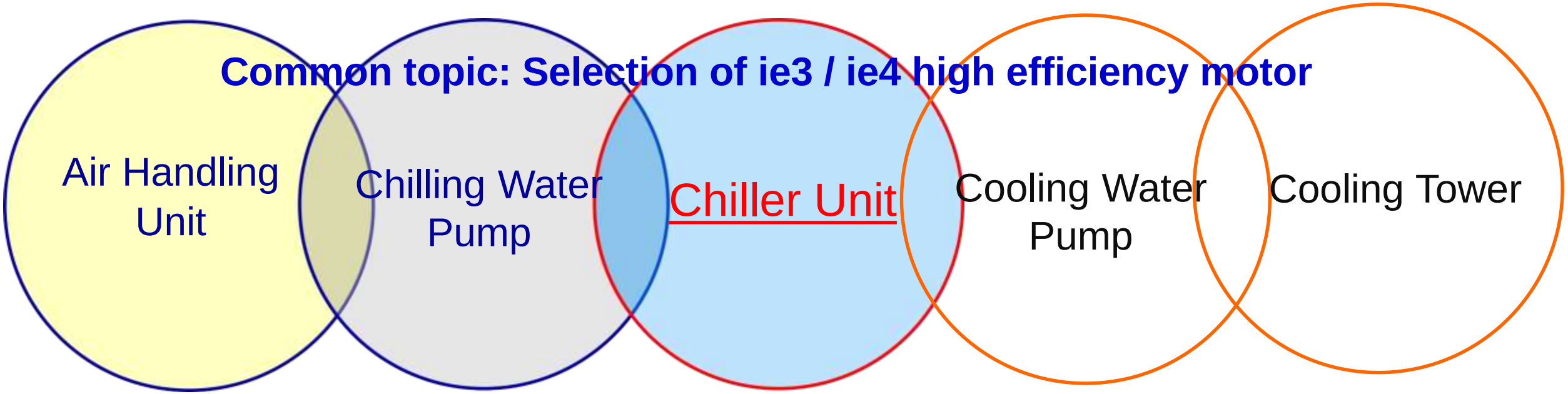
1. Energy consumption and energy saving opportunities for air conditioning systems

Proportion of power consumption in various facilities of Taiwan office building(%)



Source: 2017.09 Energy Bureau Publishing Office Energy Saving Application manual

Energy-saving opportunities for air conditioning systems



1. Maintenance heat transfer efficiency
2. Reduces air filter pressure drop
3. Reuse of condensate water
4. Variable Air volume design
5. Use heat recovery for reheat needs
6. Optimal positive pressure control of clean room
7. The comprehensive effect of optimal control with Chiller unit

1. Choosing the right lift and volume Pumps
2. Piping for low friction
3. Selection of low friction valves
4. Variable Flow Design
5. Correct point of pressure difference selection for feedback control

1. Increased operational efficiency
2. Optimal operation of Management
3. Temperature Adjustment of chilled water
4. The comprehensive effect of optimal control with cooling water temperature
5. Multi-Chiller control strategy
6. Separate design of dual temperature system

1. Choosing the right lift and volume Pumps
2. Piping for low friction
3. Selection of low friction valves
4. Variable Flow Design
5. Correct temperature difference monitoring feedback point selection
6. The comprehensive effect of optimal control with Chiller unit

1. High Efficiency equipment Selection
2. Good Ventilation place
3. Control strategy of wet bulb temperature as base point
4. Ventilation fans with Synchronous Variable Speed control
5. Maintenance of heat transfer materials and Ventilation fans

Energy saving scheme for air conditioning system

- Energy-saving operation of Chiller Unit
- Optimal capacity control of air handling unit
- Optimal flow control of chilled water pump
- Optimal flow control of cooling water pump
- Optimal fans speed control of cooling tower

Air conditioning system has 95% of the time, equipment was operated at over capacity, to improve the partial load of the equipment , is the key point for energy saving.

Key points of energy saving of Chiller Unit

- Choosing an efficient Chiller Unit
  - ✓ Comparison of energy consumption (KW/RT), taking into account the efficiency under the conditions of full load and partial load (IPLV)
  - ✓ A 500RT Chiller as base load, compare 0.6 kW/RT with 0.7 kW/RT, save 400,000 kWh/yr (8,000 hours/yr.)
- Configure the number of Chiller and units with the appropriate capacity
  - ✓ Chiller capacity selection: Based on the actual requirements of the load, not the capacity of the device
  - ✓ Multi-Unit design: Comparison of the same capacity and difference size
- Regular maintenance, with the most appropriate operation
  - ✓ Regular detection of Chiller efficiency (approach temperature and operating power)
  - ✓ Regular maintenance and optimal operation of SCADA* system

Note:* SCADA (Supervisory Control And Data Acquisition)

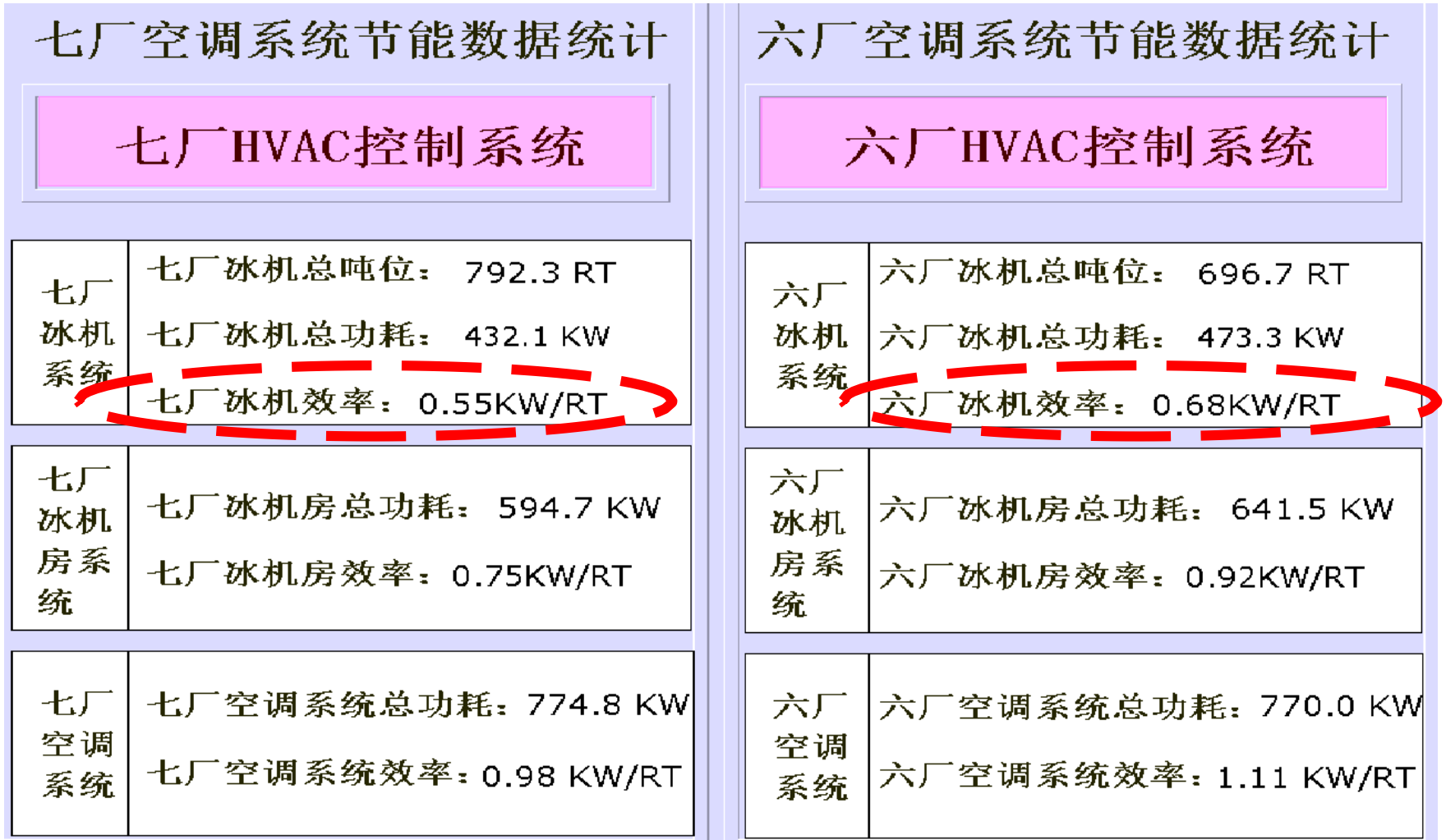
Optimal efficiency of air conditioning systems

- At present, how about the total efficiency of Chilled facilities is reasonable?
  - ✓ Chiller Unit + cooling tower + cooling water pump + chilled water pump
- How much can the optimal overall efficiency of the air conditioning system be achieved at present?
  - ✓ Chiller Unit + cooling tower + cooling water pump + chilled water pump + air side facilities (A/H & F/C, etc.)
- The best strategy for the operation model (Group Control Strategy & reduce Start-stop)

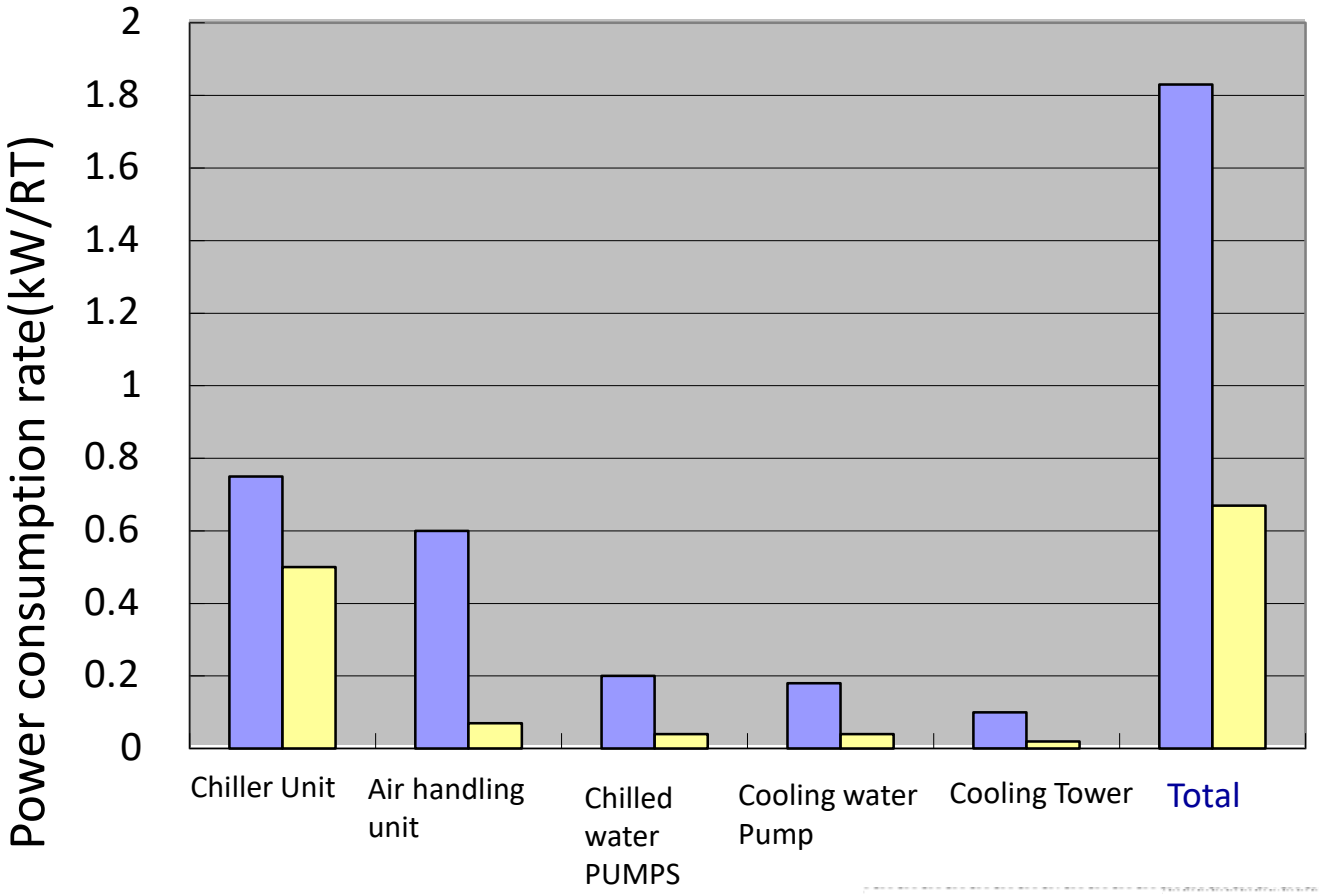
Air conditioning energy saving should not sacrifice human health and comfort.

Analysis of operation efficiency of air conditioning system

Two sets of the same specifications, the use of the same age of Chiller Unit, but the performance is different 20%, why?



Energy saving potential of air conditioning system



	A : Original air Conditioning power consumption	B: energy-saving air conditioning power consumption
Chiller Unit	0.75	0.5
Air handling unit	0.6	0.07
Chilled Water PUMPS	0.2	0.04
Cooling water Pump	0.18	0.04
Cooling Tower	0.1	0.02
Total	1.83 kW/RT	0.67 kW/RT

A more than B consumes 63% of the electricity, which means A is 2.73 times than the power consumption of B

2. Analysis of magnetic centrifugal Chiller Unit

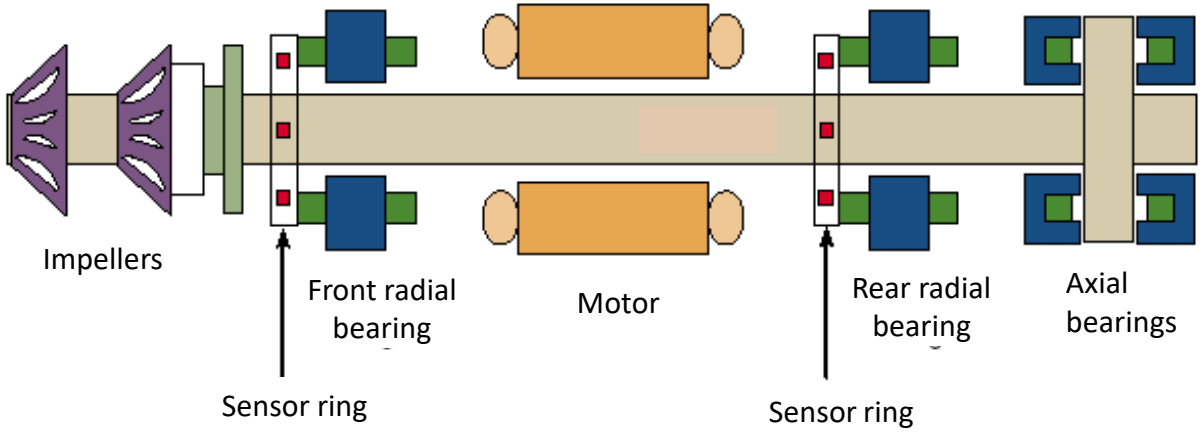
- Characteristic explanation and related performance data of each Chiller
- The advantage of magnetic centrifuge compressor-no Refrigeration oil required
- Partial load operates much more efficiently than other units

Development trend of refrigerant centrifugal compressor

- Friction-free bearings (magnetic bearings)

TURBOCOR

Eliminate mechanical friction loss and improve operation efficiency



Magnetic Bearings

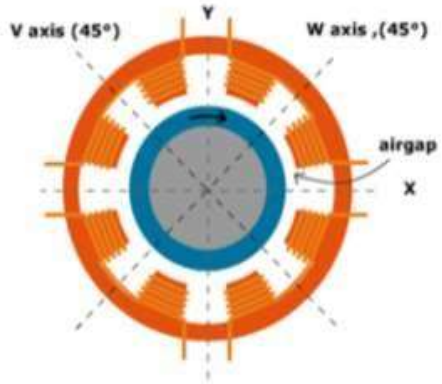
- Low friction bearings (ceramic bearings)

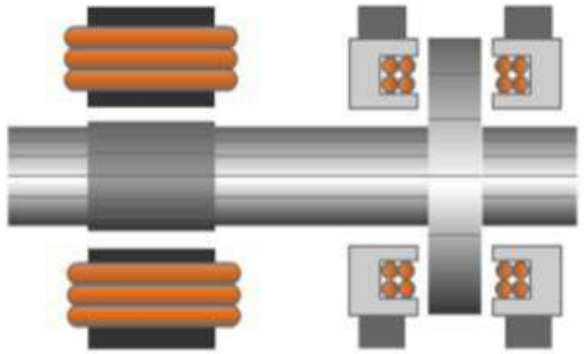
TRANE S-Series Earth Wise Cen TraVac

The use of composite ceramic bearings, ultra-high hardness ceramic beads with metal rollers, and refrigerant instead of oil lubrication, can constitute an oil-free compression system

Difference between Magnetic bearings and Conventional bearings

Magnetic bearings (no contact)





Magnetic bearings

Using electromagnetic force, the rotating shaft is floated

radial magnetism: Avoid of the rotating shaft deflection

axial magnetism: control of the rotating shaft position

without contact, no mechanical contact no friction loss

mechanism power consumption <0.5 kw

Conventional bearings (lubricants)

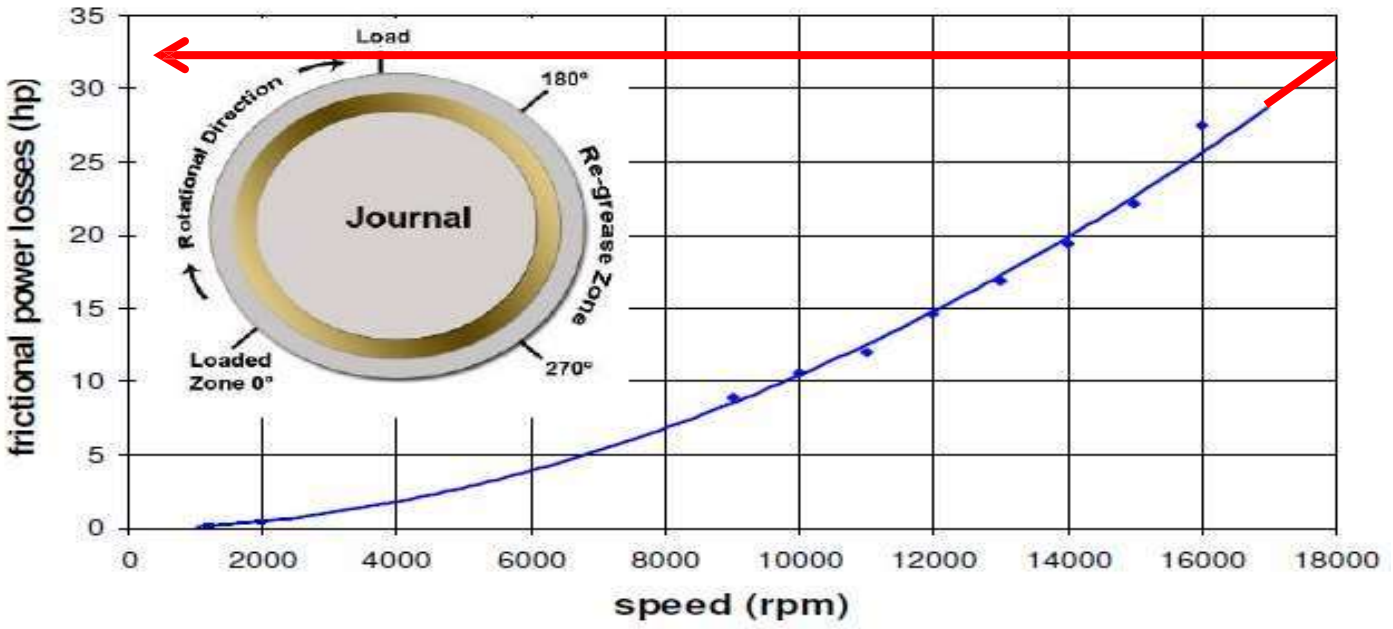
Liquid dynamic pressure bearings

Ball bearings

Reference: LEADING ELECTRIC & MACHINERY Co., Ltd.

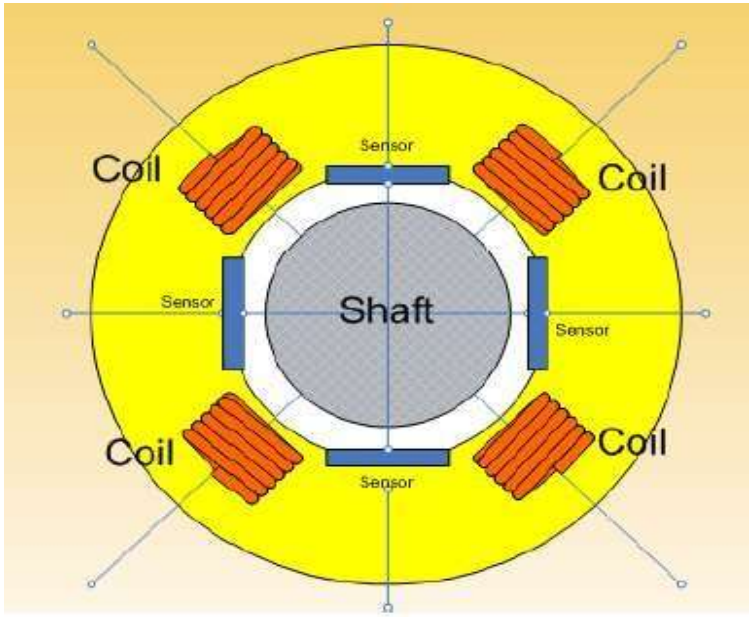
Difference of power consumption between magnetic and Conventional bearing

Take R-134a 550RT single-stage compressor as an example, the speed is about 18000 rpm, input power approx. 310 KW



Liquid dynamic pressure bearings

(Power consumption 32hp, accounting for 7% of input power)

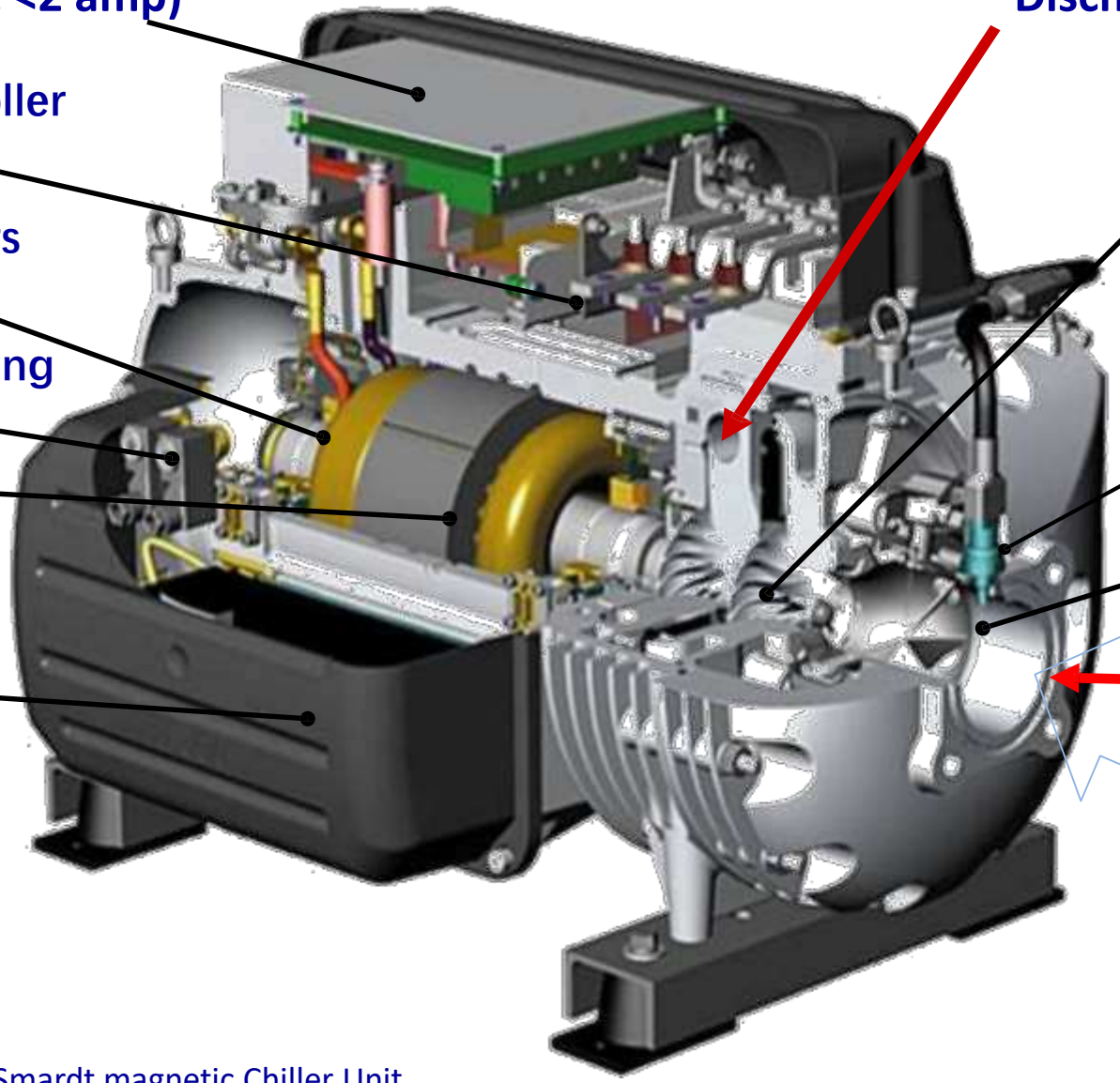


Magnetic bearings

(Power consumption < 0.5 KW)

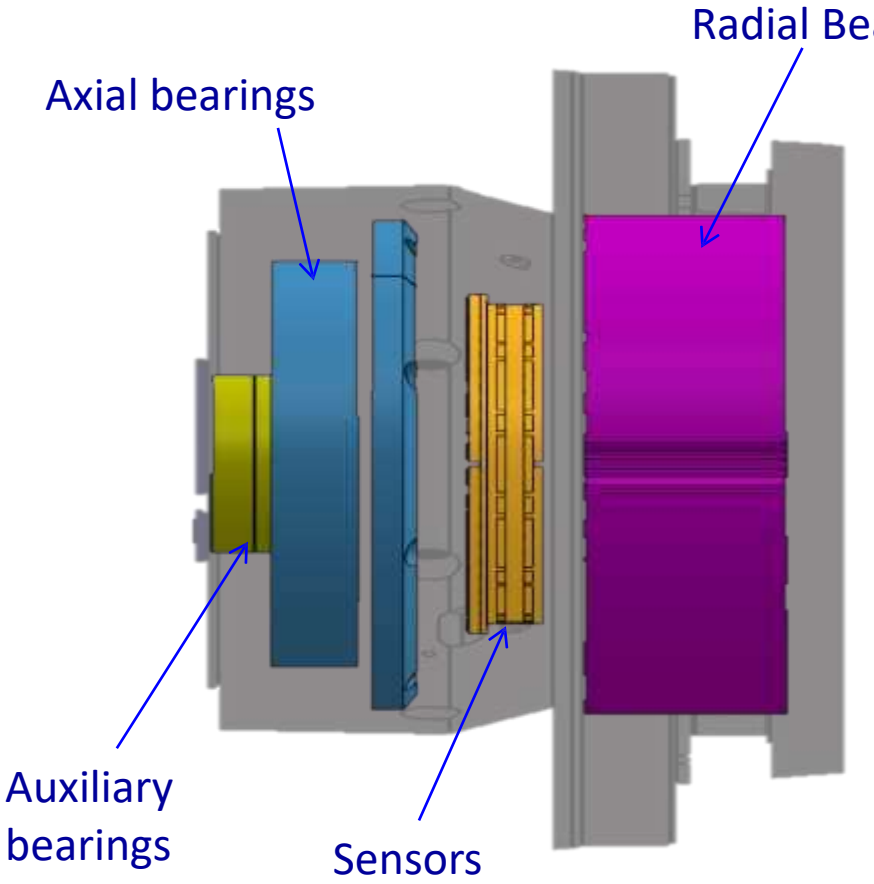
Resources： Advancements in Centrifugal Chillers Magnetic Bearing Oil-Free Technology

Magnetic Bearing Centrifugal Compressor Section View

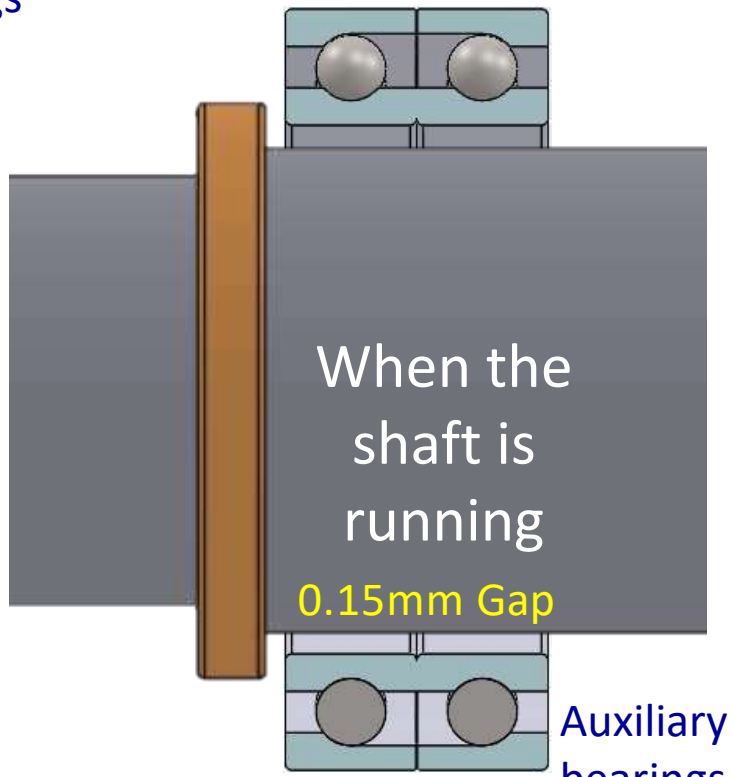


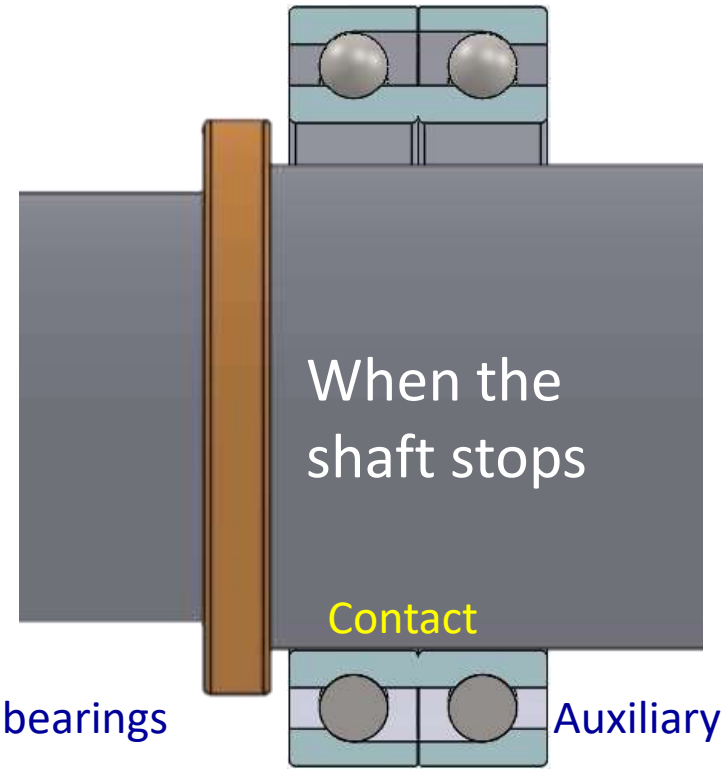
Reference: Cheng Long Energy Technology -Smardt magnetic Chiller Unit

Magnetic Bearing Module



Internal configuration of Bearing modules



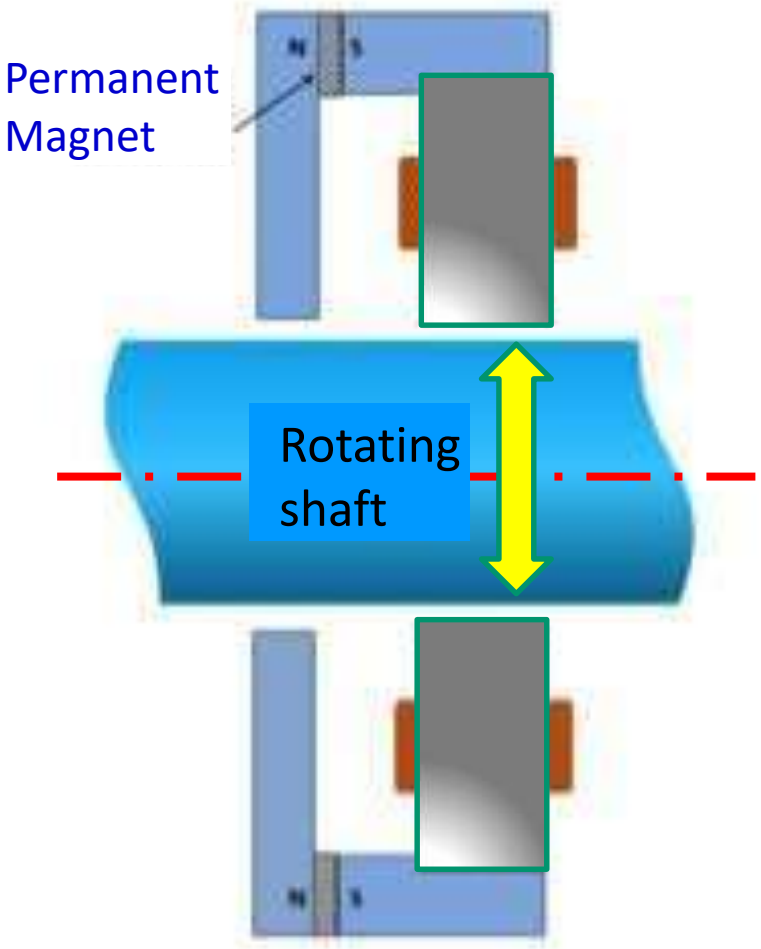


Auxiliary bearings

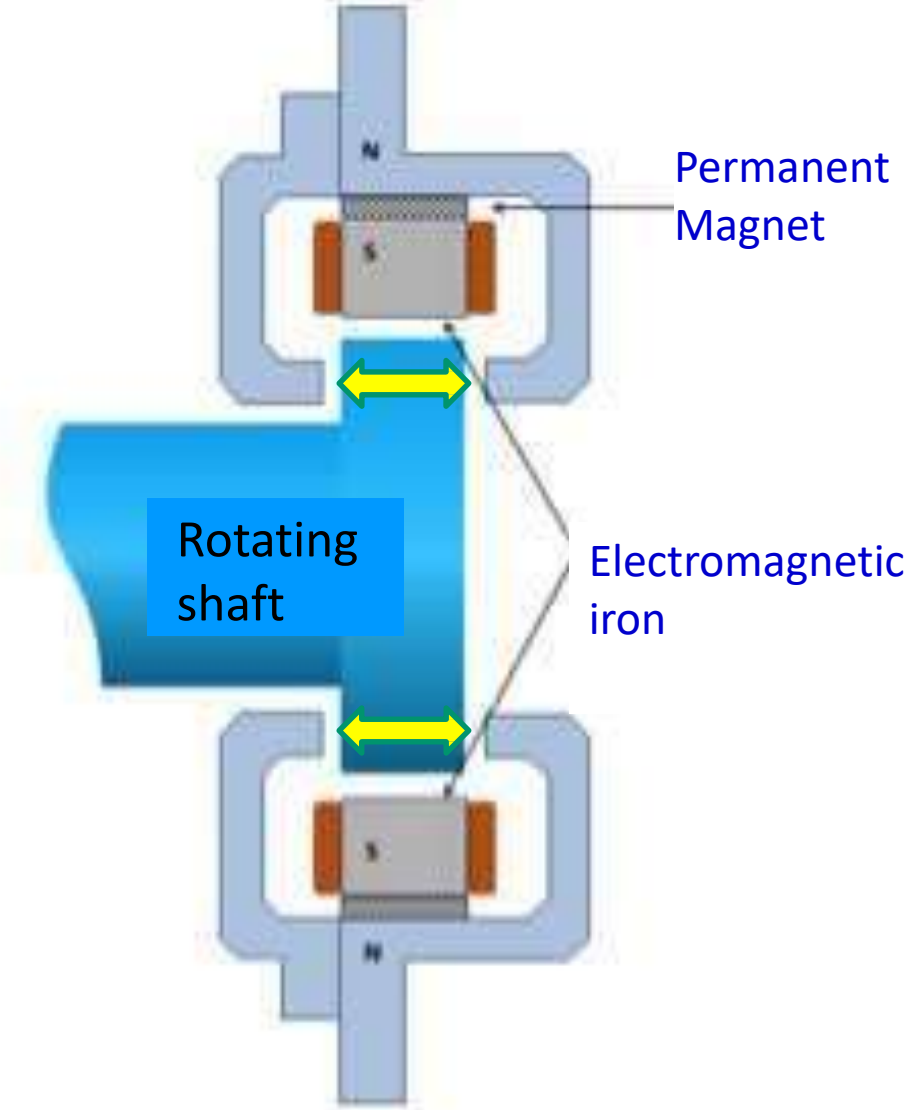
- Auxiliary bearings are built in the magnetic bearing module (1 groups before and after)
- When the shaft is in normal operation, it is floated by magnetic bearing and is not in contact with the auxiliary bearing
- provides shaft support to protect magnetic bearings during normal or abnormal shutdown
- Auxiliary bearings are ceramic bearings that can be replaced when damaged

Reference: Hanbell Precise Machinery Co. Ltd. -magnetic Chiller Unit

Magnetic bearing basic structure



Radial Bearing structure diagram



Axial bearing structure diagram

Magnetic bearing protection System

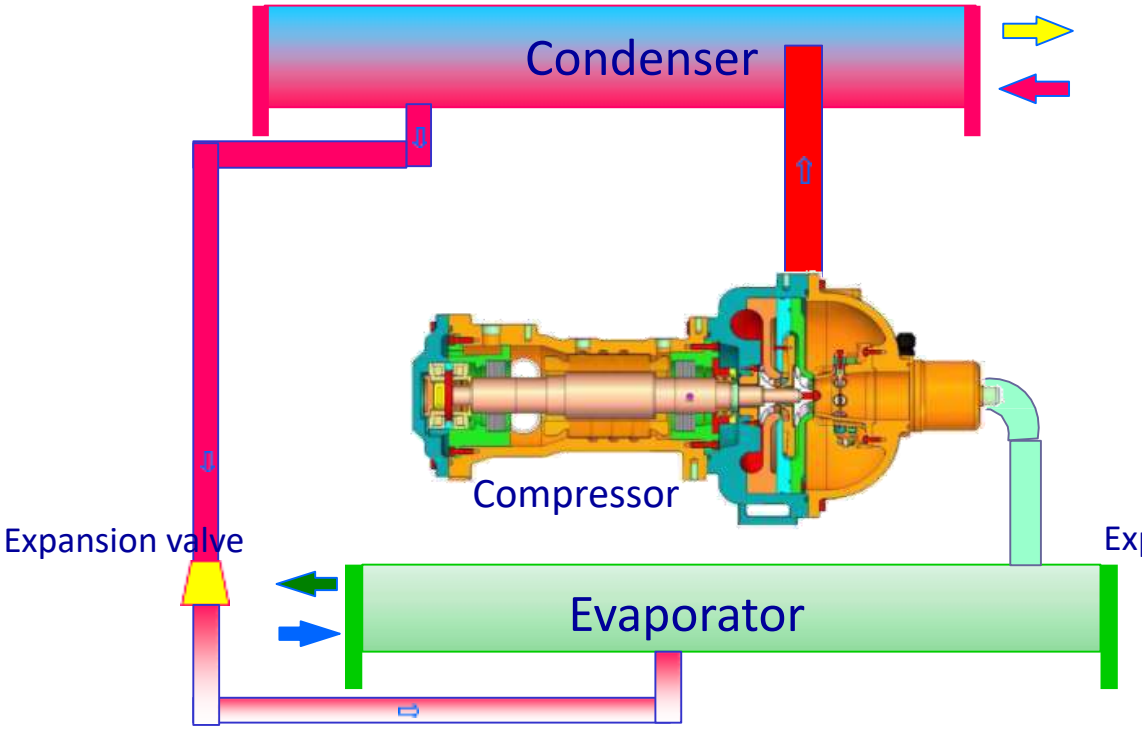
Protection projects	Set Protection values
Shaft position Protection	Radial: >0.09mm warning, >0.1mm shutdown axial: >0.08mm warning, >0.1mm shutdown
Shaft Unbalanced protection	Radial: >0.038mm warning, >0.045mm shutdown axial: >0.05mm warning, >0.06mm shutdown
Shaft elongation Protection	>0.3mm Warning, >0.4mm shutdown (avoid shaft high temperature)
Steering protection	Ensure that the steering is correct
Temperature protection of magnetic bearing Controller	>60℃ Warning, >70℃ shutdown
Bearing temperature protection	>75℃ Warning, >85℃ shutdown (>75℃, turn on auxiliary liquid cooling)
Motor Temperature Protection	>90℃ Warning, >100℃ shutdown (>90℃, turn on auxiliary liquid cooling)

Reference: Hanbell Precise Machinery Co. Ltd. -magnetic Chiller Unit

No need for refrigeration oil lubrication, is the key advantage of magnetic centrifuge chiller unit !

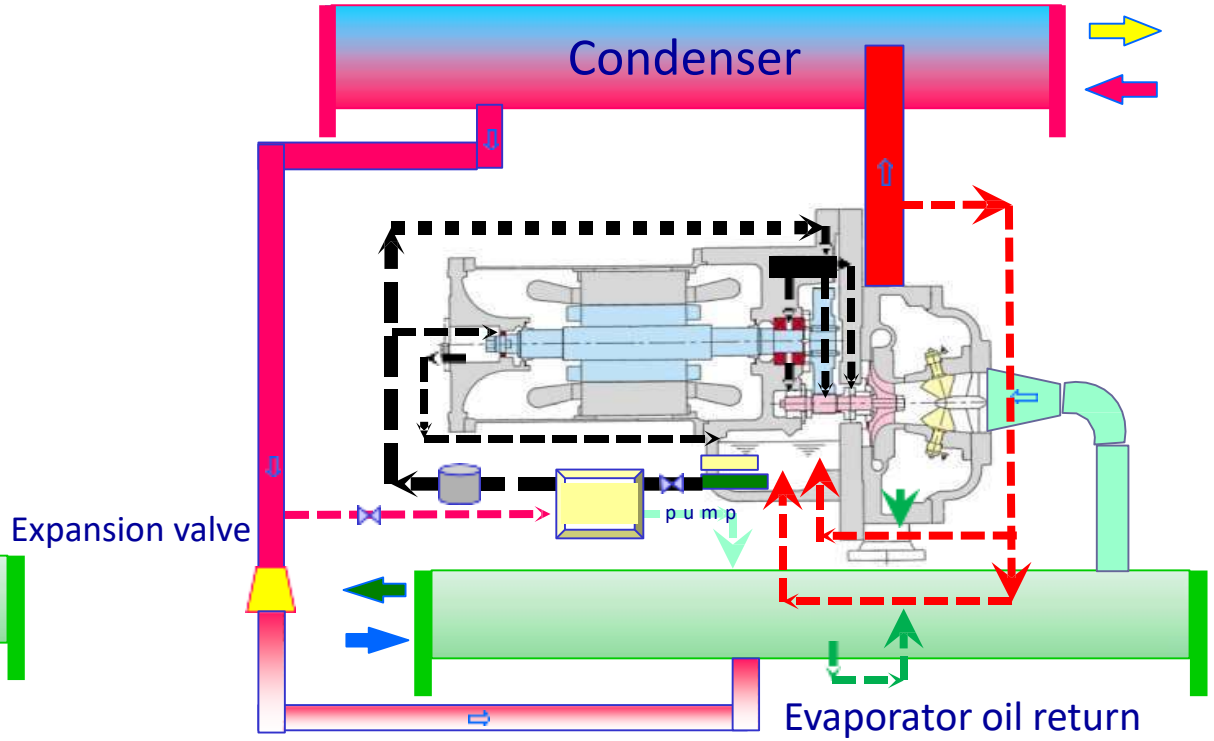
Comparison of lubrication system between magnetic and conventional Chiller unit

magnetic centrifugal Chiller Unit



Simple lubricant free cooling system

Conventional centrifugal Chiller Unit



Complex oil lubricant system

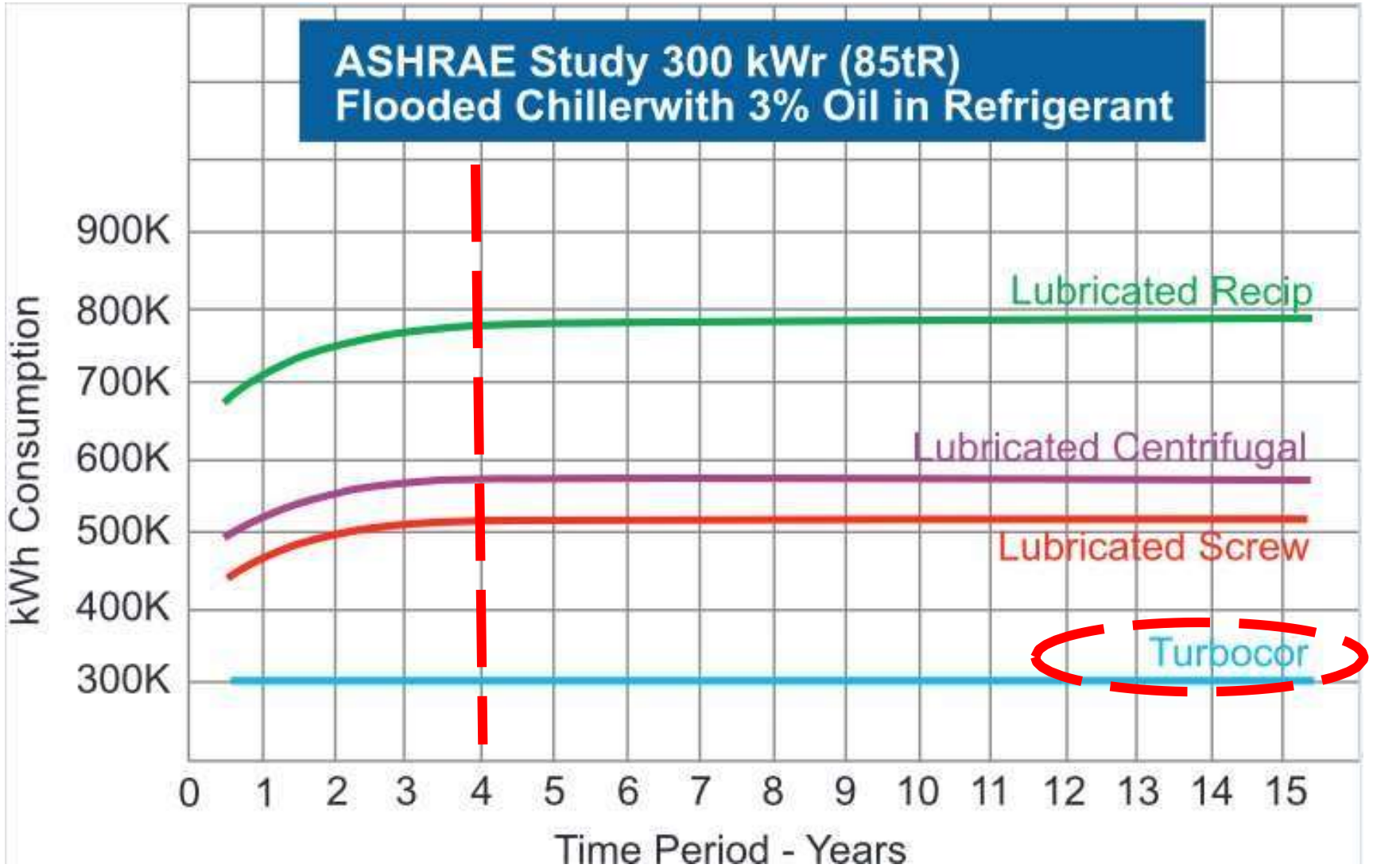
Oil tank/pump/Oil Heating & Cooler/Oil Filter/Oil pressure protection/oil supply & return tube and valve parts, etc.)

Reference: LEADING ELECTRIC & MACHINERY Co., Ltd.

Components and costs of Refrigeration oil lubrication

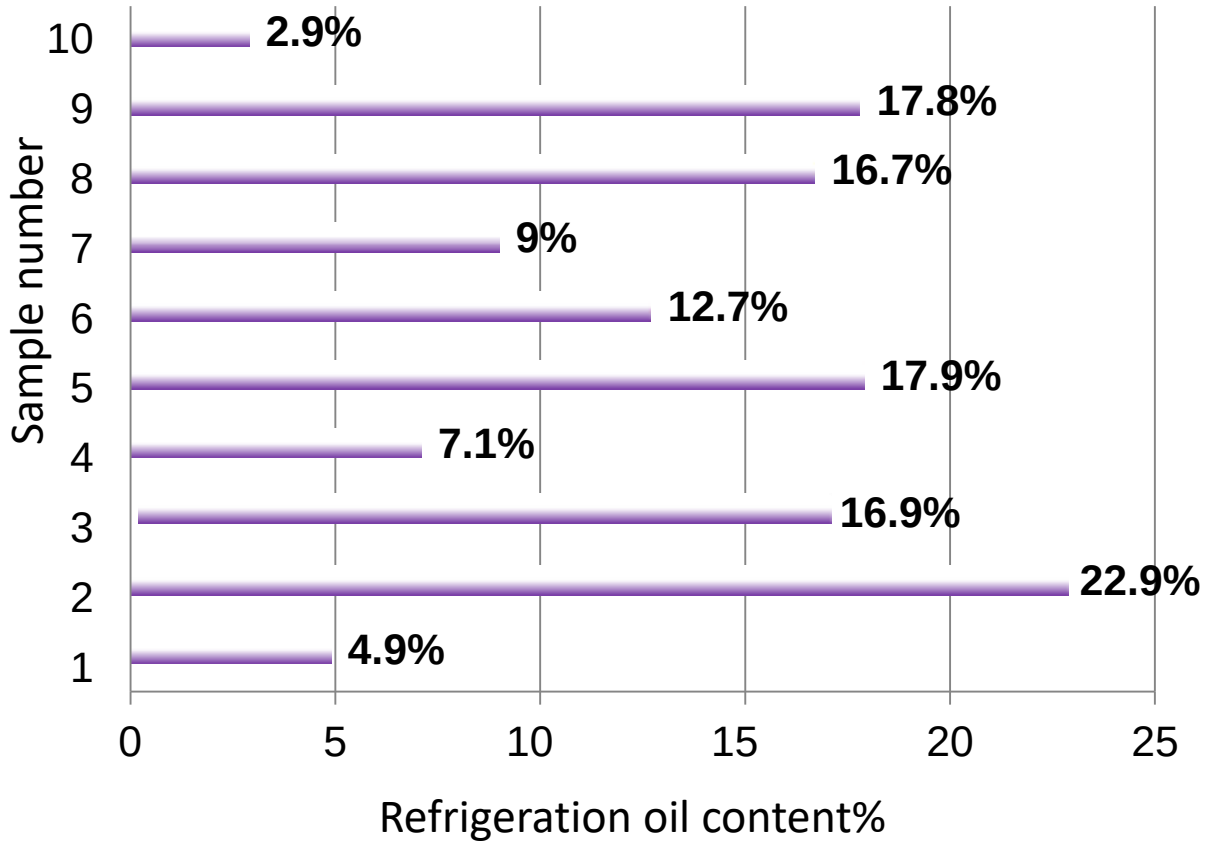
Lubrication Component	Magnetic chiller unit	Conventional chiller unit
•Refrigeration oil	Don't need	Need
•Oil storage barrel	Don't need	Need
•Oil heater	Don't need	Need
•Oil cooler	Don't need	Need
•Oil Pumps & Starter Components	Don't need	Need
•Oil filter	Don't need	Need
•Tubing Road & amp; valve Parts	Don't need	Need
•Oil temperature Sensing/controller	Don't need	Need
•Regular refrigeration oil maintenance / renew	Don't need	Need
Summarize	No friction, no efficient loss, exemption from replacement oil and lubrication system parts and other maintenance costs	The risk of system failure must be borne, as well as the associated maintenance and update costs

(heat transfer efficiency will decrease by 8% after 4 years)

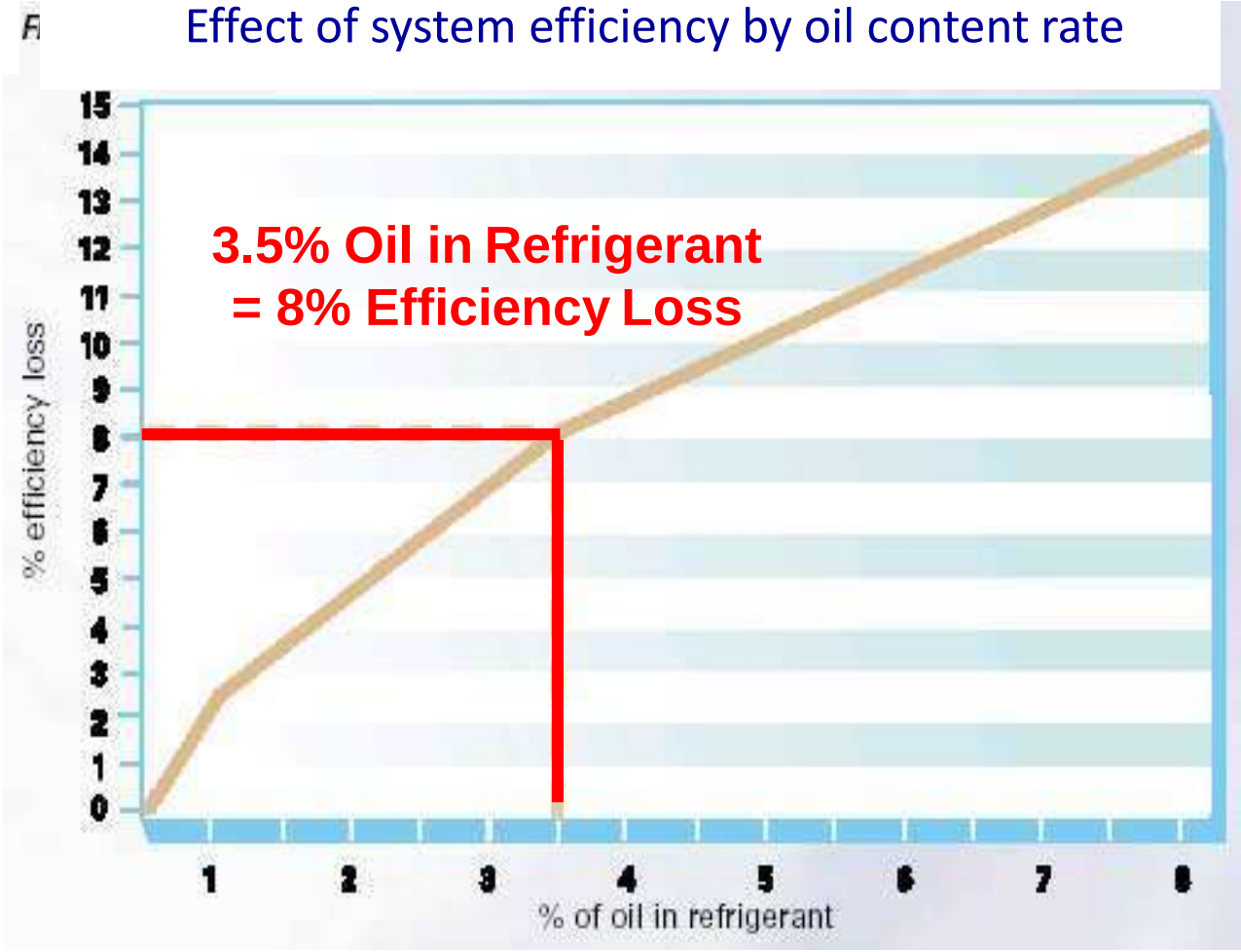


ASHRAE Report: Oil content and influence of centrifugal Chiller unit

Investigation on oil content in refrigerant of old centrifugal Chiller Unit

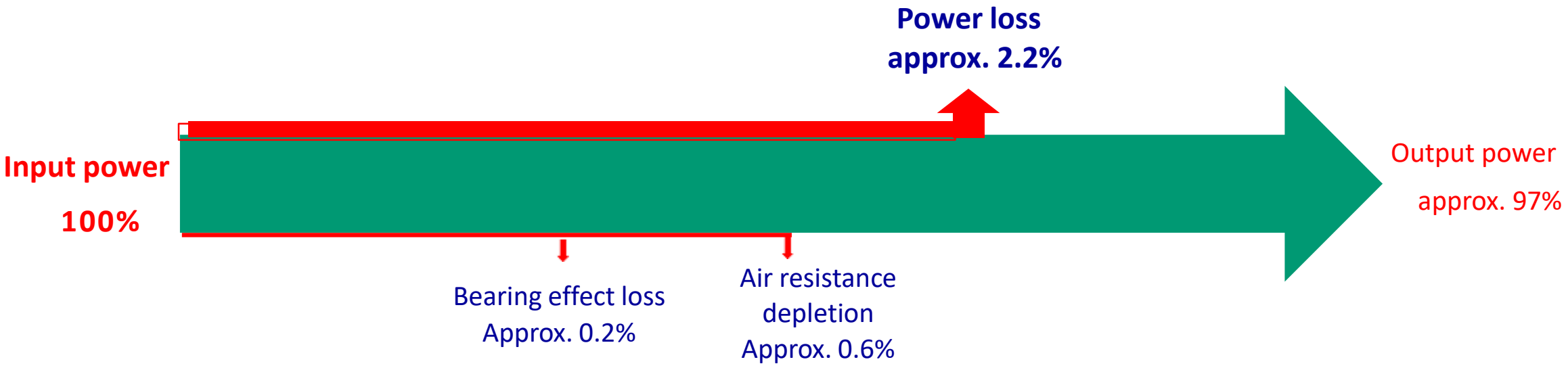


Effect of system efficiency by oil content rate



Efficiency of permanent magnet synchronous motor

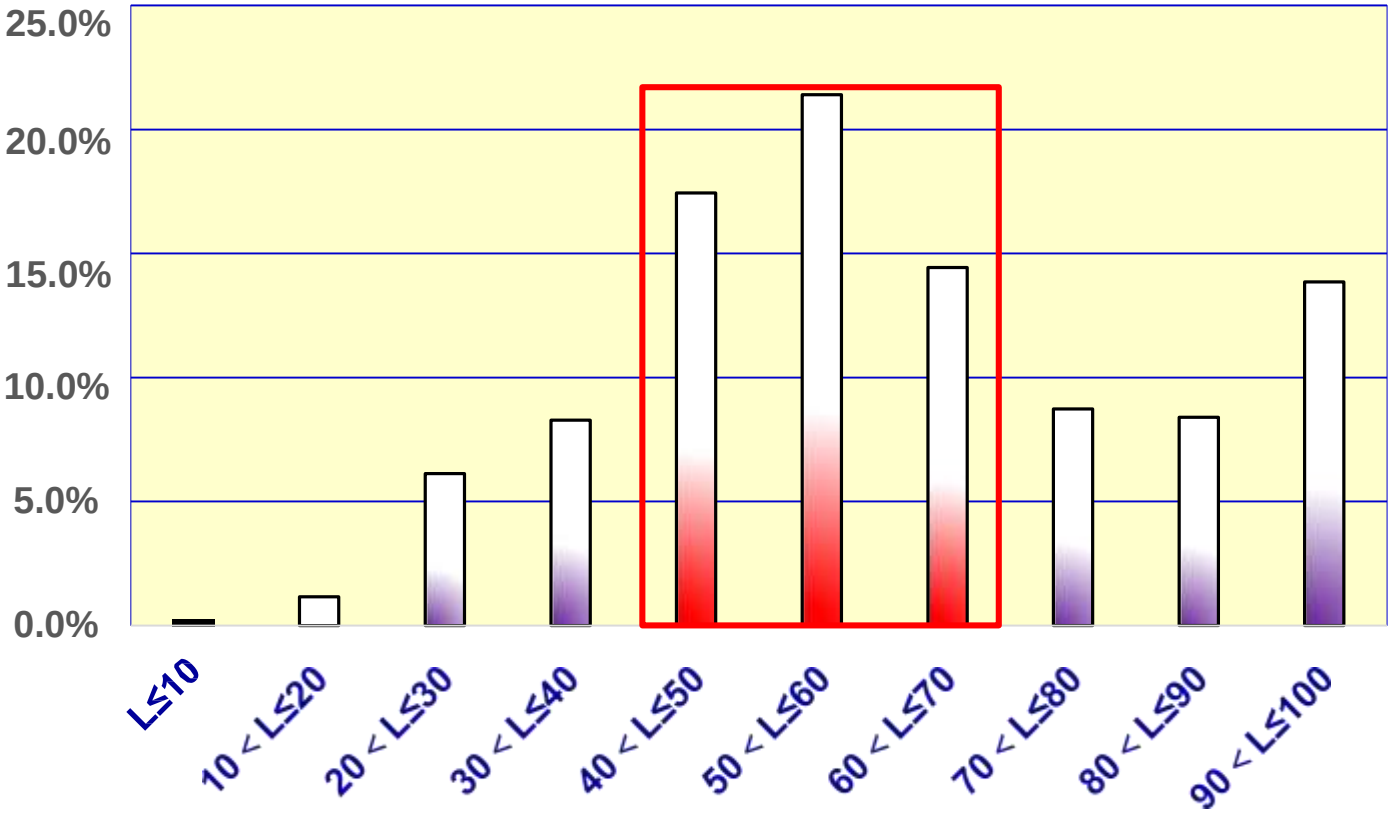
- Motor Direct Drive
- Light weight and small size
- Low noise Rating (<75 dBA)
- Adjustable speed control
  - ✓ Adjustable Speed 7800~13500rpm
  - ✓ Effectively improve the performance of partial load



Reference: Hanbell Precise Machinery Co. Ltd. -magnetic Chiller Unit

Analysis of load characteristics of Chiller Unit

- ARI 550/590 statistics, Chiller Unit 99% is running in partial load
- Most of the load on the air conditioning system is concentrated in 40~70%



Annual operating load ratio (%) distribution of Chiller Unit

Integrated partial load energy efficiency:

IpLv=1%xA + 42%xB + 45%xC + 12%xD

In the formula:

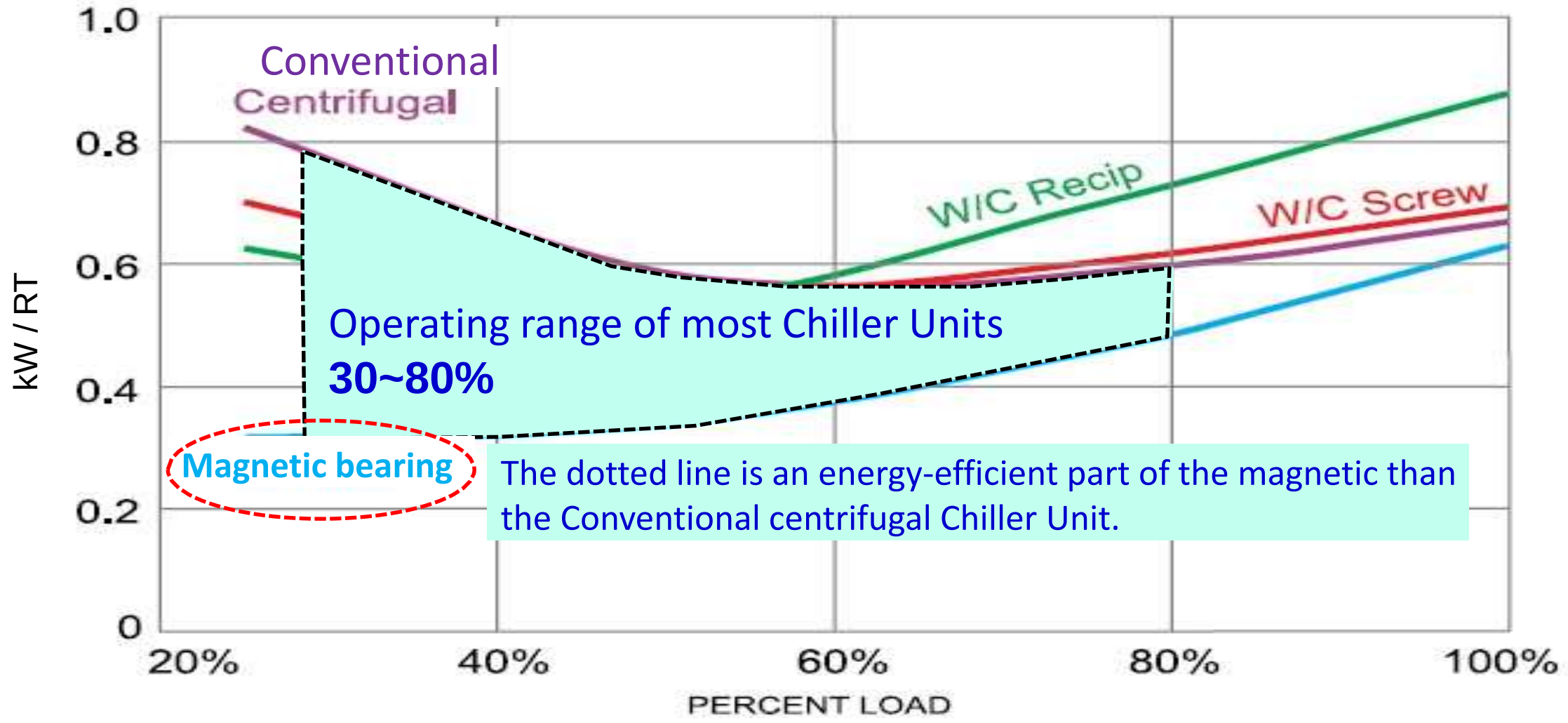
A-Performance coefficient when 100% load cop

B-75% load coefficient of performance cop

C-50% load coefficient of performance cop

D-25% load coefficient of performance cop

Comparison of energy efficiency of all kinds of Chiller Unit

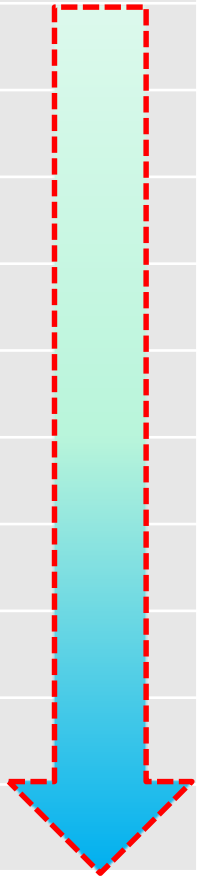


Note: 250TR water-cooled Chiller unit performance comparison reference

Reference: Cheng Long Energy Technology -Smardt magnetic Chiller Unit

magnetic and Conventional Chiller unit energy efficiency ratio

LOAD [%]	Magnetic Oil Free		Conventional		% DIFF. IN PERFORMANCE
	EER	kW/RT	EER	kW/RT	
100	6.07	0.579	5.66	0.621	6.8%
90	6.80	0.517	6.17	0.570	9.3%
80	7.79	0.451	6.74	0.522	13.5%
70	9.00	0.391	7.21	0.488	19.9%
60	10.33	0.340	7.74	0.454	25.1%
50	12.13	0.290	8.34	0.422	31.2%
40	12.58	0.279	8.36	0.421	33.5%
30	13.22	0.266	8.13	0.432	38.5%
20	13.91	0.253	7.88	0.446	43.4%
10	14.94	0.235	6.84	0.514	54.2%



Condition at AHRI 550/590 relief, Evap. 7 /12 ℃, Cond. 30 / 35 ℃

Reference: Mitsubishi Electric Climaveneta High-tech water-cooled Chiller

Power consumption Analysis (for reference)

Load Rate %	Chiller capacity RT	Magnetic Chiller Unit COP	Conventional Chiller Unit COP	Energy consumption Differences %
100	250	5.98	5.55	7.2
75	187.5	8.07	6.72	16.7
50	125	11.0	7.82	28.9
25	62.5	12.4	7.48	39.7
Average energy consumption difference%				23.1

Note: Chilled water temperature 7 ℃/12 ℃, cooling water temperature 30 ℃/35 ℃

Reference: Mitsubishi Electric Climaveneta High-tech water-cooled Chiller

Using power comparison (for reference)

IPLV=1% x COP at 100% + 42% x COP at 75% + 45% x COP at 50% + 12% x COP at 25%

Magnetic Chiller unit = 0.01 x 5.98 + 0.42 x 8.07 + 0.45 x 11.0 + 0.12 x 12.4 = 9.89

Conventional Chiller Unit= 0.01 x 5.55 + 0.42 x 6.72 + 0.45 x 7.82 + 0.12 x 7.48 = 7.29

Chiller Unit	Chiller unit capacity **RT**	Average input power **kW**	Running time per day **hr / day**	Annual Power consumption **kWh / yr.**
Magnetic Chiller unit	**250**	**88.9**	**10**	**324,485**
Conventional Chiller Unit	**250**	**120.6**	**10**	**440,190**
Annual electricity power saving **(kWh / yr.)**				**115,705**

IPLV ：Integrated Part Load Value

According to the price difference of commercial electricity and the investment of equipment in Taiwan, renew the Conventional Chiller Unit with magnetic, the recovery period is about 3-4 years.

Reference data: Mitsubishi Electric CLIMAVENETA High-tech Water-cooled Chiller

Comparison of Noise spectrum

Note: in accordance with AHRI Standard 575 magnetic centrifuge Chiller test at 1 m distance noise approx. 77dBA

Reference: Cheng Long Energy Technology -Smardt magnetic Chiller Unit

Selection of refrigerant for magnetic centrifugal Chiller Unit

Comparison of refrigerant R134a and HFO1234ze

HFO 1234ze
GREENEFFICIENCY

Refrigerant	Chemical composition	Molecular weight (*g/mol*)	Critical T (*°C*)	Critical p (*bar*)	Normal boiling point (*°C*)	Safety Class	ODP	GWP
R134a	CH_2FCF_3	102	101.1	40.59	-26.0	A1	0	1430
HFO1234ze	$CHF=CHCF_3$	114.04	79.0	36.32	-20.0	A2L	0	6

3.Development of Magnetic Bearing Centrifugal Chiller Unit in Taiwan

- Development course and achievements of Chiller Unit in ITRI
- The real case of Chaoyang University and TaiPower Building

Development course and achievements of Chiller Unit in ITRI

工業技術研究院
Industrial Technology
Research Institute

- The Industrial Technology Research Institute (ITRI) was established in 1973, the Headquarters is located in Hsinchu, Taiwan, is a consortium established by the Ministry of Economy, with branches and centres in 6 counties and cities, inclouded 7 Labs.,9 Centers, is the core of Taiwan's scientific and technological development. Projects related to energy-saving of air conditioners, mainly at the green Energy and Environment Lab.
- 2013 Green Energy Lab. started the development of high IPLV * magnetic centrifugal Chiller Unit
- 2014 has developed of 100RT, 200RT and 400RT Three type, efficiency (COP) for 5.5, 5.8 and 6.2,IPLV 10.0, 11.0 and 12.0 of different models Chiller, and authorized domestic company to manufacture magnetic chiller units.

* Note: IPLV (integrated part load value) , using COP to represent part of the load efficiency of the Chiller unit

Brief introduction of magnetic centrifuge products

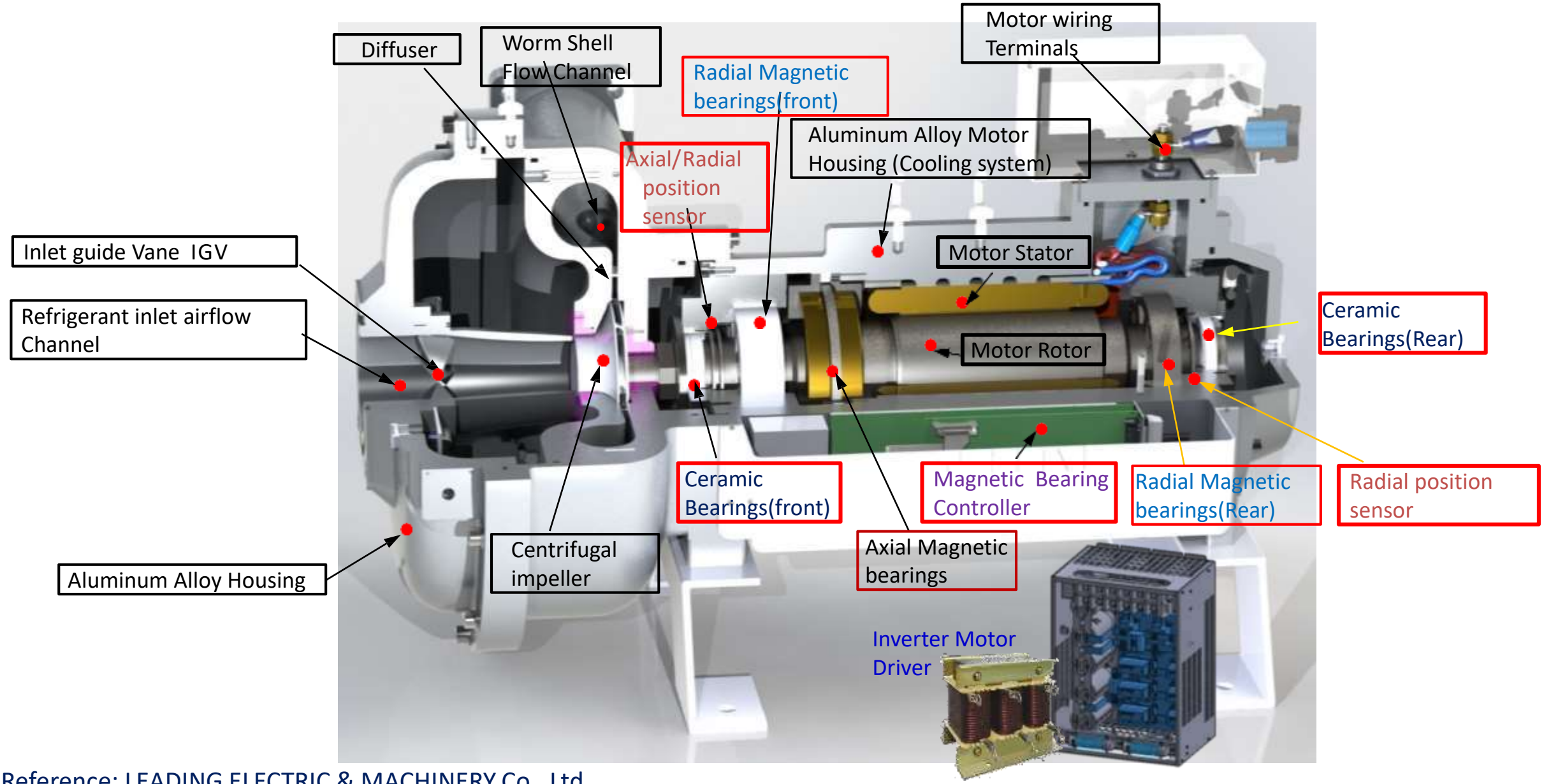
Magnetic flotation Centrifugal Compressor

ITRI (Taiwan Industry Technology Research Institute) development

- Single stage impeller compression refrigerant cycle
- Using R-134a refrigerant
- Capacity 200RT～250RT
- Radial and axial Magnetic bearings
- Backup of front and rear ceramic bearings
- UPS (Uninterrupted power system) backup
- Variable Diffuser Flow Channel
- IGV (Inlet Guide Vane) flow control (optional)
- High speed inductive motor
- All aluminum alloy Housing
- Refrigerant cooling motor and magnetic mechanism
- VFD Frequency Conversion Control

Reference: LEADING ELECTRIC & MACHINERY Co., Ltd.

Magnetic bearing centrifugal Compressor structure



Reference: LEADING ELECTRIC & MACHINERY Co., Ltd.

ITRI Magnetic Chiller unit test station

The first set of magnetic Chiller unit located in Chaoyang University

朝陽科技大學
CHAOYANG UNIVERSITY OF TECHNOLOGY

IPLV performance test data of magnetic centrifuge in Chaoyang University

項目		單位	A(100%)	B(75%)	C(50%)	D(25%)
蒸發器	入口溫度	℃	12.185	11.022	9.590	8.464
	出口溫度	℃	7.235	7.160	7.190	7.193
	溫差	K	4.95	3.862	2.400	1.271
	冰水流量	L/min	4012	4006	4004	4016
冷凝器	入口溫度	℃	29.679	24.319	18.854	18.907
	出口溫度	℃	34.314	27.834	20.948	20.012
	溫差	K	4.64	3.515	2.094	1.105
	冷卻水流量	L/min	5004	5012	5014	5005
機組消耗功率	電壓	V	376.5	377.4	377.9	377.7
	電流	A	409.5	237.75	100.56	58.49
	頻率(一次側)	Hz	60	60	60	60
	功率因數	—	0.943	0.927	0.916	0.855
	消耗功率	kW	251.8	144.0	60.3	32.7
能力與效率	冷凝器散熱能力	kW	1618.14	1229.09	732.50	385.85
		kcal/h	1391597	1057019	629952	331828
	蒸發器製冷能力	kW	1385.52	1079.37	670.43	356.11
		kcal/h	1191551	928260	576570	306257
		USRT	394.1	307.0	190.7	101.3
	性能係數(COP_R)	kW/kW	5.503	7.493	11.119	10.885
	IPLV(COP_R)	kW/kW	9.382			
	能源效率比(EER)	kcal/W-h	4.73	6.44	9.56	9.36
	每冷凍噸總消耗功率	kW/USRT	0.64	0.47	0.32	0.32
熱平衡百分比	允許誤差（名詞說明5）	%	<5.18	<5.66	<6.97	<10.06
	實測誤差	%	1.18	-0.46	-0.24	0.77

Note: This table is taken from the ITRI Test report, which was implemented on December 7, 2014 at the performance testing laboratory of the Green Energy Lab. of Hsinzhu County Chudong

Test name: magnetic centrifugal chiller unit

Chiller Unit factory Brand: : LEADING ELECTRIC & MACHINERY Co., Ltd

Compressor Brand: Taiwan Ling Fung (authorized by the ITRI)

Model: LDC-0400-V6A

Compressor model and Quantity: 200IM ×2

machine number: Lm1041004-1

Compressor serial number: 200-13b-201511-001, 200-13b-201511-002

Power supply: 3ø/380v/60hz

Refrigerant: r-134a

IPLV performance test of magnetic Chiller in Chaoyang University

Project		Unit	A(100%)	B(75%)	C(50%)	D(25%)
Evaporator	Inlet temperature	℃	12.185	11.022	9.590	8.464
	Outlet temperature	℃	7.235	7.160	7.190	7.193
	chilled water flow	L/min	4,012	4,006	4,004	4,016
Condenser	Inlet temperature	℃	29.679	24.319	18.854	18.907
	Outlet temperature	℃	34.314	27.834	20.948	20.012
	Cooling water flow	L/min	5,004	5,012	5,014	5,005
Energy Efficiency	Condenser capability	kcal/h	1,391,597	1,057,019	629,952	331,828
	Evaporator capability	kcal/h	1,191,551	928,260	576,570	306,257
		USRT	394.1	307.0	190.7	101.3
	Power consumption per RT	kW/USRT	0.64	0.47	0.32	0.32

1: The measured value in the table, when Chiller unit in stable operation, capture more than 15 minutes of data average (CNS 12575 standard),Calculation capacity and efficiency and percentage of thermal balance accordingly

2: This laboratory has TAF(Taiwan Accreditation Foundation) certification number: 0876, approved project: CNS 12575 & AHRI Standard 550/590

Air conditioning system Chiller Unit improvement case

Comparison of relevant data before and after this case improvement		
Project	Before the improvement	After improvement
Device capacity	Screw Type Chiller Unit (300RT×2)	Magnetic centrifugal Chiller Unit(400RT× 1)
Measurement capability	201RT & 194RT	400USRT
Device Running power consumption	272.9 KW & 271.9 KW	251.8 KW
Equipment operating Efficiency	1.31 Kw/RT & 1.41 Kw/RT	0.47 Kw/RT
Hours of operation per year	2,790 hr	
electricity rate	3.29 NT$/kwh	

Reference: J.POWER System Engineering Co., Ltd.

Benefit analysis of Chiller Unit before and after improvement

Before improvement:

The effectiveness of the existing Chiller Unit is: 1.31 Kw/RT, 1.41 kw/RT (taking the average value of 1.36 kw/RT). Chiller Unit operates for one year with an average load rate of 70%

Chiller Unit operating power consumption for one year: 395 RTx1.36 kw/RTx2,790 hrx70%=1,049,152 kWh

Chiller Unit operating electricity rate for one year: 1,049,152 kWhx3.29 NT$/kwh=3,451,709 NT$

After improvement:

Magnetic Chiller unit operating power consumption for one year: 400RTx0.47kw/RTx2,790hrx70%=367,164kwh

Chiller Unit operating electricity rate for one year: 367,164kwhx3.29 NT$/kwh=1,207,970 NT$

Total electricity savings: 1,049,152 kwh-367,164 kwh=681,988 kWh

Total savings in electricity costs: 681,988 kWhx3.29 NT$/kwh=2,243,741 NT$

Improved energy saving rate = (1,049,152kwh−367,164kwh) ÷1,049,152kwhx100%=65%

Reference: J.POWER System Engineering Co., Ltd.

The Second Magnetic Bearing Centrifugal Chiller Unit located in TaiPower Building

Taiwan Power Company

TaiPower Building wins 2018 APIGBA Award

APIGBA 亞太地區智慧綠建築聯盟
Asia Pacific Intelligent Green Building Alliance

- Thin-Film Solar Power Demonstration System (10 kW)
- **Energy saving rate : 19.5%**
- Carbon reduction : 1,805 tons
- EUI(kWh /m^2.yr) from 2012 (EUI=106) to 2017 (EUI=75)

Introduction to the award

- Main Building (127.5 m): B3-27F
- Annex Building (43.24 m): B2-11F
- Employee number : 2,800
- One of Taipei's landmarks,
- also the name of a metro station
- Responsible for Stable Power Supply in Taiwan
- Stepwise Renovation for 36-Years-Service Building
- A Series of Energy Saving Activities
- Central Air Conditioning System Equipped with **Magnetic Bearing Centrifugal Chiller**
- Elevators Installed with Energy Recovery Devices
- Green Data Center with In-Rack Cooling System
- Central Control Room with Integrated Systems
- IAQ Monitoring System with Automatic Notification
- Database of Building's Systems with Visualized Graphic Control Interface
- Multi-Purpose Recycled Rainwater System

Performance test data of magnetic Chiller IPLV in TaiPower Building

項目		單位	測試點 1	測試點 2	測試點 3	測試點 4
蒸發器	入口溫度	℃	12.246	11.165	9.725	8.621
	出口溫度	℃	7.153	7.102	7.108	7.141
	溫差	K	5.09	4.06	2.62	1.48
	冰水流量	L/min	4022	4023	4022	4024
冷凝器	入口溫度	℃	30.173	24.633	19.230	19.013
	出口溫度	℃	35.349	28.600	21.698	20.499
	溫差	K	5.18	3.967	2.468	1.486
	冷卻水流量	L/min	4800	4795	4790	4788
機組消耗功率	電壓	V	377.6	375.2	375.9	376.6
	電流	A	398.10	238.90	114.40	65.4
	頻率(一次側)	Hz	60	60	60	60
	功率因數	—	0.944	0.93	0.921	0.864
	消耗功率	kW	245.8	144.4	68.6	36.9
能力與效率	冷凝器	kW	1733.45	1327.06	824.74	496.41
	散熱能力	kcal/h	1490765	1141269	709281	426911
	蒸發器製冷能力	kW	1429.21	1140.28	734.35	415.45
		kcal/h	1229121	980643	631543	357283
		USRT	406.5	324.3	208.9	118.2
	性能係數(COP_R)	kW/kW	5.815	7.898	10.705	11.272
	IPLV(COP_R)	kW/kW	9.792			
	能源效率比(EER)	kcal/W-h	5.00	6.79	9.21	9.69
	每冷凍噸總消耗功率	kW/USRT	0.60	0.45	0.33	0.31
熱平衡百分比	允許誤差（名詞說明5）	%	<5.14	<5.55	<6.68	<9.13
	實測誤差	%	-3.37	-3.19	-2.64	-8.89

Note: This table is taken from ITRI Test report, which was implemented on February 19, 2016 at the performance testing laboratory of the Green Energy Lab. of Hsinzhu County Chudong .

Test name: magnetic centrifugal Chiller unit

Chiller Unit factory Brand: : LEADING ELECTRIC & MACHINERY Co., Ltd

Compressor Brand: Taiwan Ling Fung (authorized by the ITRI)

Model: LDC-0400-V6A

Compressor model and Quantity: 200IM × 2

machine number: Lm1041107-1

Compressor serial Number: 200-16B-201602-003 & 004

Power supply: 3ø/380v/60hz

Refrigerant: R-134a

Magnetic centrifugal Chiller Unit in TaiPower building IPLV Performance test Data

Project		Unit	A (100%)	B (75%)	C (50%)	D (25%)
Evaporator	Inlet temperature	℃	12.246	11.165	9.725	8.621
	Outlet temperature	℃	7.153	7.102	7.108	7.141
	chilled water flow	L/min	4,022	4,023	4,022	4,024
Condenser	Inlet temperature	℃	30.173	24.633	19.230	19.013
	Outlet temperature	℃	35.349	28.600	21.698	20.499
	cooling water flow	L/min	4,800	4,795	4,790	4,788
Energy efficiency	Condenser capability	kcal/h	1,490,765	1,141,269	709,281	426,911
	Evaporator capability	kcal/h	1,229,121	980,643	631,543	357,283
		UsRT	406.5	324.3	208.9	118.2
	Every RT Power consumption	Kw/usRT	0.60	0.45	0.33	0.31

Development and application of Magnetic Bearing Chiller Unit in Taiwan

Energy saving 40%

Chaoyang University
Library Bdg.400RT
(2015.12)

Green Building
Energy Saving 30%

TaiPower Building
400RT (2016.2)

High load fluctuation

Tainan Airport Station
200RT X 2 (2016.9)

24 Hours of operation

Cheng Kung University
Medical Dormitory
200RT (2016.9)

Note: Compressor: ITRI Provide/Chiller Unit: LEADING ELECTRIC & MACHINERY Co., Ltd.

Development and application of Magnetic Bearing Chiller Unit in Taiwan

Load between Day and night fluctuation

ITRI 89Museum 200RT (2016.12)

Green Building & Mute Demand

ITRI Guangfu New Bdg. 200RT (2017.1)

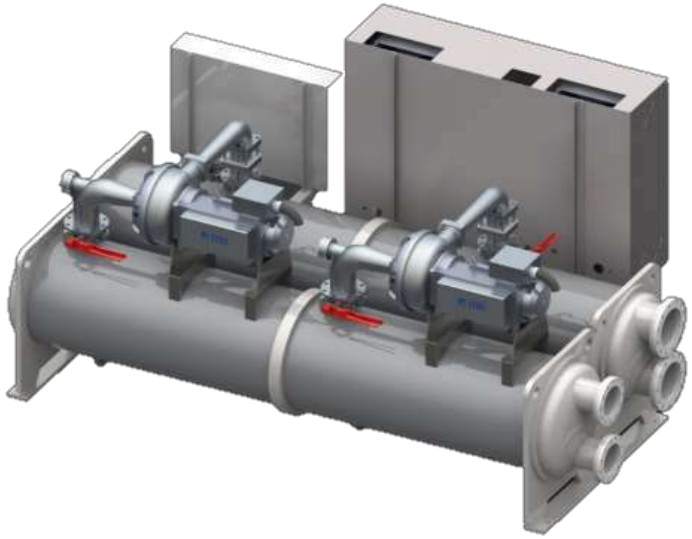
Transparent ICT Room Mute challenge

ITRI Bdg-24 200RT (2018.10)

Note: Compressor: ITRI Provide / Chiller Unit: LEADING ELECTRIC & MACHINERY Co., Ltd.

Opportunities for Taiwan to develop magnetic Chiller Unit

- Magnetic compressor localization, technology can be improved
- Higher efficiency and a wider range of operations
- Low noise value for quieter and smoother operation
- Minimal regular maintenance needs and expenses
- Localization of technology, maintenance can be autonomous
- Localization of parts, fast service and low cost
- Establish a professional team to provide a total solution services

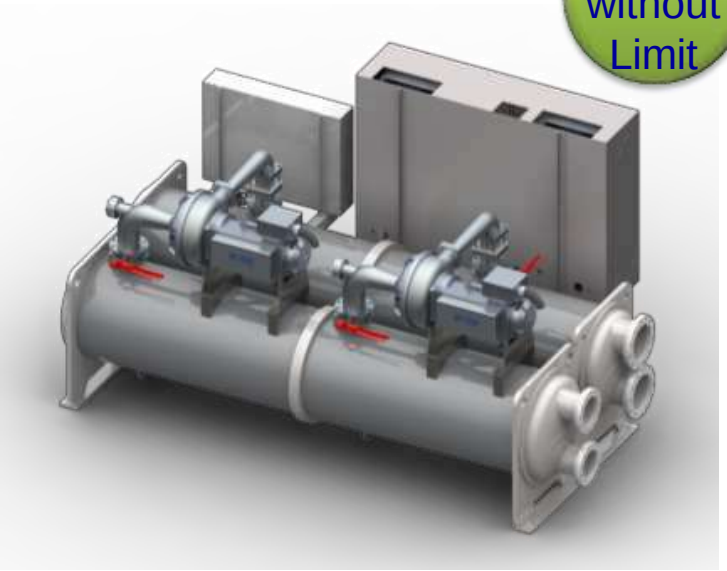


magnetic centrifugal Chiller Unit

Summary

Comparison of magnetic and conventional centrifugal Chiller Unit		
Project	Magnetic centrifugal Chiller Unit	Conventional centrifugal Chiller Unit
Operational efficiency	High	Low
Operating power consumption	Low	High
Mechanical loss	Low	High
Refrigeration oil filling	No	Yes
Operating noise	Low	High
Operating Vibration	Low	High
Compressor volume	Small	Big
Compressor weight	Light	Heavy

Advantages of magnetic centrifugal Chiller Unit



magnetic centrifugal Chiller Unit

Oil-free	Chiller Unit refrigerant system is simple	Lubrication Required Oil systems
Parallel without Limit	Compressor parallel operation Easy, unlimited	Generally dual-machine
Stable, unlimited efficiency	Flexible operation in winter	The condensation temperature needs to be controlled, Restricted operation
Reduce 35~50%	Compressor Weight	100% Weight
Low cost	Low maintenance	High cost
Quiet Vibration Small	Low Operating Vibration Noise	Large noise
Magnetic No friction	No wear and tear, long life span, low with less fault	Bearings will wear
System Oil-free	heat transfer efficiency of evaporator	Poor oil content in the system

Conventional centrifugal Chiller Unit

Reference: LEADING ELECTRIC & MACHINERY Co., Ltd.

Thoughts on the opening of air conditioners

∵ Turn on the air conditioning just as throw the garbage (indoor heat load), emissions (dropped) to the outdoor

sages said: Don't unto others as we wish them don't unto us

∴ It is a unethical act to turn on the air conditioner and throw the rubbish.

- If air Conditioning is lacking the fresh air , indoor air quality is poor, and harmful to health
- Warm reminder: Less turn on air conditioning, or operation with fans, the application of wind speed effect, room temperature can be higher by 3 ℃, energy saving 15%, save money and environmental protection!

Q & A

By the way, share your idea on today's topic

Wang Mao-Jung

1. The Principal of Mao Jung Energy Service & Management Consulting Co., Ltd at Taiwan.
2. Energy Saving Consultant for various Taiwan Engineering Companies, such as Delta Electronics, CompAir Energy Technology, J-Power Systems Engineering, etc.
3. Independent Director, Shenghui Engineering Technology Co., Ltd at Taiwan

Experiences :

1. 11/2011~12/2014, assisted Delta Electronics to achieve 50% energy-saving tasks.
2. 2011 ~ Present, American Institute of Energy Engineers (AEE) Certified Instructor
3. 04/05~17/05/2003, 14 days to complete the reconstruction of the SARS Special Medical Building of Tri-Service General Hospital Songshan Branchto accommodate the SARS patients
4. 1996 elected as one of the Top Ten Outstanding Engineers.
5. 1989 awarded the Refrigeration and Air Conditioning Professional Engineer
6. 1988~2011 Industrial Technology Research Institute Senior Manager of Energy Conservation & Knowledge Management Consultant (23 years)
7. 1975 ~ Present, Refrigeration, Air Conditioning and Energy Management Consulting Service (43 years)
8. 1999 ~ Present, the Secretary-General, the President of the Branch, the District Chief Executive, and the Education Lecturer of the General Council of the Kiwanis International Club in Taiwan
9. TAF (CNLA) Laboratory Certification Member of the Technical Committee for Temperature and Thermal Test Evaluation, Reviewer
10. Director of Sino-German Technical Cooperation Research Association
11. Supervisor of Taiwan ESCO Association

Formerly:

1. Refrigeration and Air Conditioning Technician Verification Procurator,
2. Member of China Engineering Arbitration Association, North County Environmental Assessment Committee,
3. Standing Director of the National P.E. HVAC&R Association,
4. Director of ASHRAE Taiwan Chapter,
5. Director of Taiwan Cleaning Technology Association,
6. Director of Refrigeration and Air Conditioning Society