



SMARDT



Your name., Your title, Smardt Chiller Group Inc.

SMARDT GLOBAL NO 1 IN OIL-FREE CHILLERS

SMARDT

ABOUT US

KEY FACTS



Pioneer

Founded 2005 by Turbocor founder Roger Richmond-Smith

Technology

Development centers in Stuttgart, Montreal, Melbourne

Global

Manufacturing in Germany, Australia, Canada, USA, China, Brazil

History

Largest oil-free chiller installation base with some 8000 installed

Expertise

Largest user of Turbocor compressors in the world

Know-how

Unparalleled experience across a diverse range of applications, climates and industries

Pioneer & world leader in high efficiency oil-free chillers

SMARDT Smardt magnetic bearing oil-free chillers: a 25 year timeline



SMARDT Product range



SMARDT Global presence - AMERICAS





Montreal Group operations and R&D HQ 120,000 ft² (11,150 m²)



Plattsburgh 30,000 ft² (2,790 m²) **São Paulo** Transcalor licensee

SMARDT Global presence – EUROPE, MIDDLE EAST, AFRICA





Stuttgart EMEA region 39,000 ft² (3,630 m²)

England Heat exchangers facility

SMARDT Global presence – ASIA PACIFIC





Guangzhou 49,000 ft² (4,555 m²)



Singapore SE Asia sales, service, training base



Melbourne 49,000 ft² (4,555 m²)

SMARDT Revolutionary technology



SMARDT Some 8,000 chillers installed globally...



SMARDT Is proud to support...















SMARDT Typical commercial building energy usage...



HVAC uses ≈ 60% of a building's power



Chillers consume approximately 30-50% of the total buildings power (biggest single power consumer) 20%

Smardt chillers can reduce a building's power bill

SMARDT Revolutionary compressor



SMARDT Oil-free heat pump technology





Fixed Displacement

Oil-free Dynamic Compression

SMARDT 4 benefits of the compressor



The permanent magnet motor's speed varies with the load, from 18,000 to 48,000 RPM (TT300) The inverter is integrated with the power electronics and control systems Very low starting current - 2 amps rather than a conventional compressor's 500 amps Magnetic bearings allow very high reliability Smardt's people understand this technology better than anyone else

SMAR Bach on oil's impact on efficiency



"An ASHRAE study determined that the vast majority of installed chillers have an excess amount of oil in the cooling system." ASHRAE Research Study 601 The above study depicts the loss of efficiency based upon the percentage of oil found in the chiller. Even just 5% of oil is a 10% efficiency lloss

Simple Reparch on oil's impact on efficiency



Conventional chillers degrade by more than 20% for every 10 years of operation (Source: Tsinghua Research Project 2015)

SMARDT An indication of efficiency





Approach = Water outlet – Refrigerant inside =

 $7^{\circ}C - 6^{\circ}C = 1^{\circ}C$

SMARDT How does oil impact performance?

oil Heat exchanger with oil (Brand new chiller or a Smardt oil-free (Oil-based conventional chiller) chiller) Oil accumulates and increases the Water Water approach to 3°C 7°C 7°C Refrigerant 6°C Refrigerant 4°C

Healthy 1°C approach temperature

(Difference between water temperature and refrigerant temperature)

Unhealthy 3°C approach temperature

(Oil slick/coating on the heat exchange surface)

SMARDT How does oil impact heat transfer (U) performance?



SMARDT How does oil impact performance?





Capacity decreases up to 30% 20%

Efficiency decreases up to 20%

SMARDT Reduction in failures through simplified piping





More complexity = increased failures

Guaranteeing adequate oil-return is still a challenge

Removing the need for oil eliminates the challenge



Oil-free chiller



Oil-reliant chiller

SMARDT Lowest total cost of ownership





In most situations, chillers run at part load 99% of the time!

Energy profile Smardt chillers

Unbeatable efficiencies at part load

Revolutionary energy savings—lowest overall cost of ownership

SMARDT Lowest total cost of ownership

BENEFIT **OPERATION** COSTS A disadvantage OPERATION COSTS turns into a benefit MAINTENANCE MAINTENANCE SOFT START KIT DISADVANTAGE NOISE REDUCTION FIRST COSTS FIRST COSTS SMARDT LEADING **OIL-FREE CHILLER** SCREW CHILLER

TOTAL COST IN 2 YEARS OF OPERATION S. Diego

SMARDT Product range summary



SMARDT Water-cooled chillers - WE series



SMARDT T^w-Class | WE series 85-1200 TR (300-4000 kW)



SMARDT Tw-Class | R134A Base Models WE series Capacity Range



Cooling Capacity [kWR]



Note: based on standard AHRI conditions.

1 CAPACITY RANGE

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Largest capacity range in oil-free water-cooled chillers

ECONOMIZERS

Economizers are available on all models extending the capacity of the chiller and/or further increase its operating efficiency

SMARDT G-Class | R1234ze Base Models WE series Capacity Range



Cooling Capacity [kWR]



ECO

R513A) available

(R1234ze,

FRIENDLY

Low GWP refrigerants

3

Note: based on standard AHRI conditions.

SMARDT WE series | Design Flexibility



Side-by-side

Stacked

4 ADAPTABLE BY DESIGN

Stacked and side-by-side option for all base models. Customizable configurations to meet space requirements.



Grooved connections are supplied as standard on all models. Flanged options available.

SMARDT WE series | Adaptable by Design and Serviceability





High performance flooded shell-and-tube heat exchangers.



- Stainless steel tube sheets and water boxes are available on all WE models to extend the service life.
- For extreme environments, cupronickel and titanium heat exchanger materials can also be supplied.
- Anodic and cathodic protection options are available.

SMARDT WE series | Design Flexibility





of all chiller field problems relate to failures in compressor oilreturn!

RELIABILITY & REDUNDANCY

 On multiple-compressor models, mechanical and electrical isolation provides significant redundancy.

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In the event of a compressor outage, Smardt chiller controllers automatically adjust to continue serving the chilled water load with the remaining available compressors. Should a compressor require servicing, it can be quickly and easily isolated or removed, without stopping the chiller.

SMARDT WE series | Design Flexibility





WORLD LEADING CHILLER CONTROLS

- Proven across years of industry experience in oilfree chiller operation,
 Smardt's advanced chiller controllers optimise the performance and capabilities of the WE TWclass range.
- Capacity can be reduced to as little as 10% of full-load capacity (or less, in some models). Simple integration with building management systems via MODBUS RTU is provided as standard.

SMARDT WE series | HTML Interface

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Chiller Sto	atus		
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	38.0 ℃	۲	698.0 kW
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- Web-based alternative to traditional hardware controls
- Ease-of-use of a traditional control panel and the flexibility of a web panel.
- The web panel software is installed on any digital device (e.g., cell phone, tablet or computer)
- Switching between different control panels is as easy as following a web link.
- Modem connection option so any device connected to the internet can remotely access the chiller via a secure password protected connection.

SMARDT WE series | Smardt Lift





Smardt Lift allows the operation at very low pressure ratios, delivering the required cooling capacity at reduced power consumption levels.

Monitoring mode: during higher pressure ratio conditions, Smardt Lift remains in monitoring mode, providing cooling without assistance.

Active mode: As pressure ratio decreases, Smardt Lift activates, allowing the chiller to maintain the required cooling load.

SMARDT WE series | Smardt Lift



Load Point	W/ Smardt Lift	W/out Smardt Lift	Improvement
80%	8.23 COP	8.04 COP	2.75%
60%	9.36 COP	9.01 COP	7.0%
50%	10.96 COP	10.19 COP	6.51%
40%	15.32 COP	12.36 COP	19.32 %
20%	27.35 COP	13.37 COP	51.12%
10%	32.1 COP	12.45 COP	61.21 %

(Real-world performance example)
SMARDT 9 Benefits of Smardt Lift











Standalone controls interfaced to the chiller controller



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Seamless scalable chiller integration



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Free cooling bridge mode



High chilled water supply temperature applications

SMARDT 9 Benefits of Smardt Lift

Chilled Water Conditions of 44/54°F 1 0.9 Seasonal 0.8 9 Advantage 0.7 85F Efficiency [kW/TR] 0.0 70 8 Energy comparison of Summer Mode 85°F = 29.5°C chilled water, with seasonal ambient Winter Mode conditions. 40°F = 4,5 °C 40F 0.3 0.2 0.1 0 50 100 150 250 0 200 300 Cooling Capacity [TR]

Ability to Operate with Low Condensing Temperature

SMARDT V-class water-cooled chillers



SMARDT V-class water-cooled chillers 350-3200TonR (1230-11250kWR)



- Largest capacity oil-free chiller range
- Utilizes Danfoss Turbocor VTT compressors
- Small footprint & light weight
- Refrigerant: R134a or R1234ze (G-Class)
- "Pony Express" mixed compressors design option
- Other special options:
- Modular type
- Series counter-flow

SMARDT V-Class | capacity range



Cooling Capacity TR [kWR]

SMARDT



LADDER+GRATING APPX. WEIGHT: 700 lbs



Rochester Energy Development (Rochester, NY)

- 7000 kW (2000 TR) capacity
- Dual circuit unit
- 2 compressor circuit 1
- 3 compressor circuit 2



University of Toronto

- Series counterflow
- Each section 4200 kW (1200 TR) cooling capacity
- Ships in two sections
- Interconnecting piping provided by factory



Capital Chiller (Pittsburgh, PA)

- 4200 kW (1200 TR) capacity
- 3 module design
- Each circuit weighs 5,900 kg (13,000 lbs)



112 West 34th Street (Ottawa, ON)

- 4200 kW (1200 TR) capacity
- Pony Express design 3 VTT + 1 TT400 compressors

SMARDT Air-cooled chillers - AE series



SMARDT Air-cooled chillers - AE series 60-500 TR (200-1800 kW)



SMARDT T^A-Class | R134A Base Models AE series Capacity Range



Cooling Capacity [kWR]



Note: based on standard AHRI conditions.



A base range with options to suit any air-cooled application



Revolutionary energy savings—lowest overall cost of ownership



EFFICIENCY

Unbeatable efficiencies at part load

SMARDT G-Class | R1234ze Base Models AE series Capacity Range



Cooling Capacity [kWR]



Note: based on standard AHRI conditions.



Low GWP refrigerants (R1234ze, R513A) available

5 ECONOMISERS

Economisers are available on all models extending the capacity of the chiller and/or further increase its operating efficiency



6 EN DI

ENGINEERING & DESIGN

Precision built for trouble-free and sustained operation across the entire chiller load range



SERVICE

Engineered for ease of maintenance and serviceability



Manufactured globally, acceptance tested and precommissioned prior to deliver ensuring simple commissioning and start-up



ADAPTABLE BY DESIGN

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- The AE base is flexible in performance and footprint.
- Extendable condenser design allows for a range of different efficiency options based on job location, application and critical operating environment.
- An extensive range of performance, functional and connectivity options are offered – all specific to project application and the individual customer.





- All-aluminum microchannel – ideal for efficient and economical operation, allowing reduced refrigerant charge
- Tube and fin ideal for hostile environments, featuring a robust marine-grade aluminum frame, and available in a number of materials and finishes.





- designed with hostile environmental conditions in mind, utilizing a range of corrosion-resistant materials and industry-leading coatings.
- Engineered polymer condenser and compressor covers are factory-fitted as standard.
- Protection of the coils:
 - Aluminum or copper fins
 - Hydrophobic + epoxy fin coating, or
 - Nano hydrophilic coating, or
 - SBS electrophoretically dipped coating



SMARDT AE series | Smardt Lift



12 SMARDT LIFT

Smardt Lift allows the operation at very low pressure ratios, delivering the required cooling capacity at reduced power consumption levels.

SMARDT AE series | HTML Interface

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Chiller Sto	atus		
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SMARDT AE series | Additional Options





For installations where stringent time of use noise restrictions apply, i.e. residential nighttime applications, Smardt's Active Noise Control system allows the user to limit the chiller's noise levels throughout specific periods of operation.

SMARDT AE series | Additional Options



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CONDENSER ACCESS HATCHES

- Complete access to the inside of each condenser module allows faster and more complete maintenance of the condenser coils and fans.
- This option may be factory-fitted on all AE TA-class models.

SMARDT Oil-free heat pump technology - lift



SMARDT Oil-free heat pump technology - summary

- SMARDT's oil-free benefits can now be applied to heat pump applications
 - Proven higher efficiency
 - ✓No oil = no oil degradation performance
 - No complicated oil return piping or circuit restrictions
 - ✓Lower maintenance
 - ✓Compact
 - ✓Quiet operation
- Lift required dependent on "heat source" and "delivery temperature"
- Lower lift applications delivers higher efficiency
- Higher lift applications limits capacity and efficiency

SMARDT Oil-free water source heat pump



SMARDT Heating efficiency – full load performance



SMARDT Heating efficiency – part load performance



SMARDT Heating efficiency - summary

- Lower lift performance enhanced by system approach to design
- Oil-free heat pumps for > 1MMBTU applications
- Electricity carbon footprint will continue to diminish
- Gas carbon footprint reduction opportunities limited
- Oil-free heat pumps deliver greater energy utilization
- Oil-free heat pumps reduce carbon footprint
- Oil-free heat pumps increase performance under part load

SMARDT Oil-free dynamic compression



SMARDT Oil-free heat pumps – additional opportunities



SMARDT Oil-free heat pumps – additional opportunities



SMARDT Conclusions

- SMARDT PCM allows end users to go green without intense input of utility resources for grid interconnection studies and equipment
- Customer does not have to worry about what to do with excess energy – they don't have to invest in grid protection and grid interconnection
- Install and permit times shortened
- Customers choice on form, combination and supply of renewable
- Better manage demand costs mechanism for demand response



SMARDT Increased application scope - High-lift compressor



TTHCOOSIGREGEIOON

- -Balanike de sech proprio fitt of bines
- turbines Greater stability in operation
- Strong axial magnetic bearing Reduced axial loads permit withstands high axial higher operating pressure pressure loads

SMARDT Increased application scope - High-lift compressor

applications

Pressure Ratio



Capacity

MAP LIMITS

- TT300
- 90TR comfort cooling
- 4.8 pressure ratio limit
- TT350
- 120TR comfort cooling
- 5.2 pressure ratio limit
- TTH325
- 110TR comfort cooling
- 6.3 pressure ratio limit
SMARDT Increased application scope - High-lift air-cooled



SMARDT Increased application scope - High-lift heat

racavary

AHRI 550/590 Water Cooled Heating Standard Rating									
Water Source		Water Heating		Cooling	Heating	Cooling Efficiency	Heating Efficiency		
Supply	Return	Supply	Leaving						
60.00 F	48.99 F	95.00 F	105.00 F	100 TR	1489 MBH	0.848 kW/TR	17.56 Btu/W.hr		
48.99 F	40.56 F	105.00 F	120.00 F	110 TR	1707 MBH	1.030 kW/TR	15.05 Btu/W.hr		
40.56 F	35.00 F	120.00 F	140.00 F	100 TR	1611 MBH	1.205 kW/TR	13.37 Btu/W.hr		



SMARDT Increased application scope - High-lift heat pump

AHRI 550/590 AC Heat Pump High Heating Standard Rating									
Ambient Dry Bulb	Ambient Wet Bulb	Leaving Water Temperature	Heating	Heating Efficiency					
47.00 F	43.00 F	105.00 F	1310 MBH	12.72 Btu/W.hr					
47.00 F	43.00 F	120.00 F	1250 MBH	10.96 Btu/W.hr					
47.00 F	43.00 F	140.00 F	1120 MBH	8.54 Btu/W.hr					

