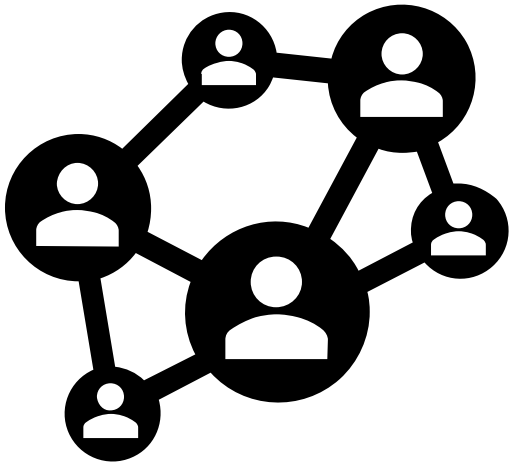
ENGINEERING TOMORROW

丹佛斯Turcocor ® VTX1600超高效大容量磁悬浮无油压缩机技术及配套方案

丹佛斯磁悬浮压缩机应用经理 刘红绍

Agenda

- Danfoss Turbocor® Compressors Value Proposition
- Danfoss Turbocor ® VTX1600 Technology Introduction
- Danfoss Turbocor ® VTX1600 Application Introduction



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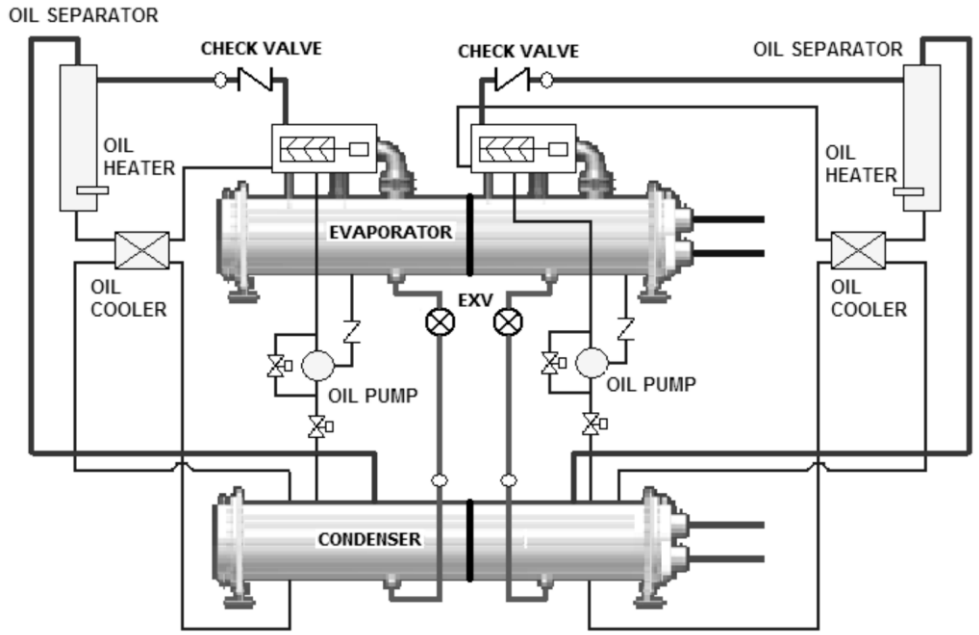
Value Proposition

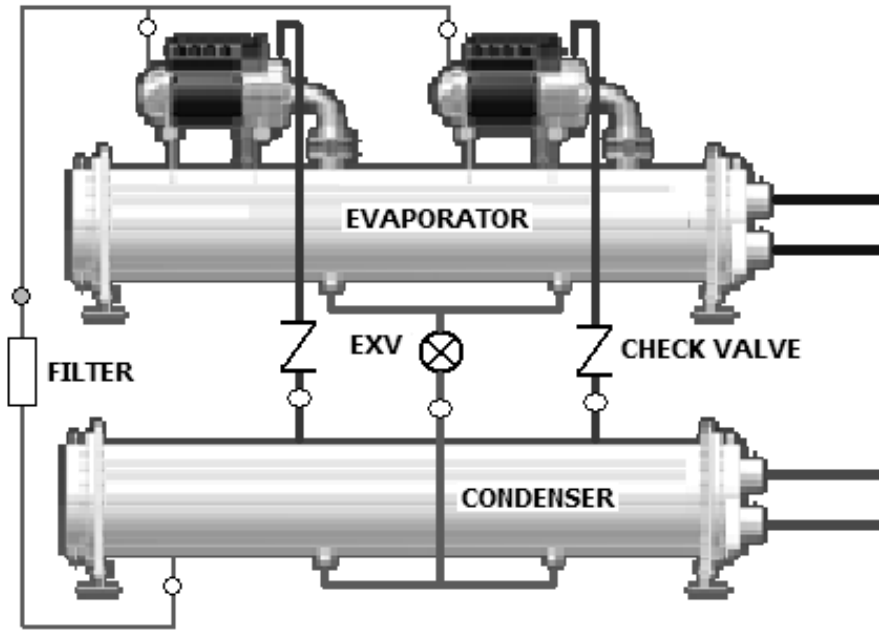
Reduced System Complexity

Typical Oil Management System



- Oil is required to lubricate bearings which are used to support rotational and linear movement of the rotor
- Form seal to prevent refrigerant from going back to suction
- Lubricate open drive compressor shaft seal to prevent refrigerant leakage

Oil Free System



- No lubrication required
- Oil Free, magnetic bearings provide a less complex and reliable design

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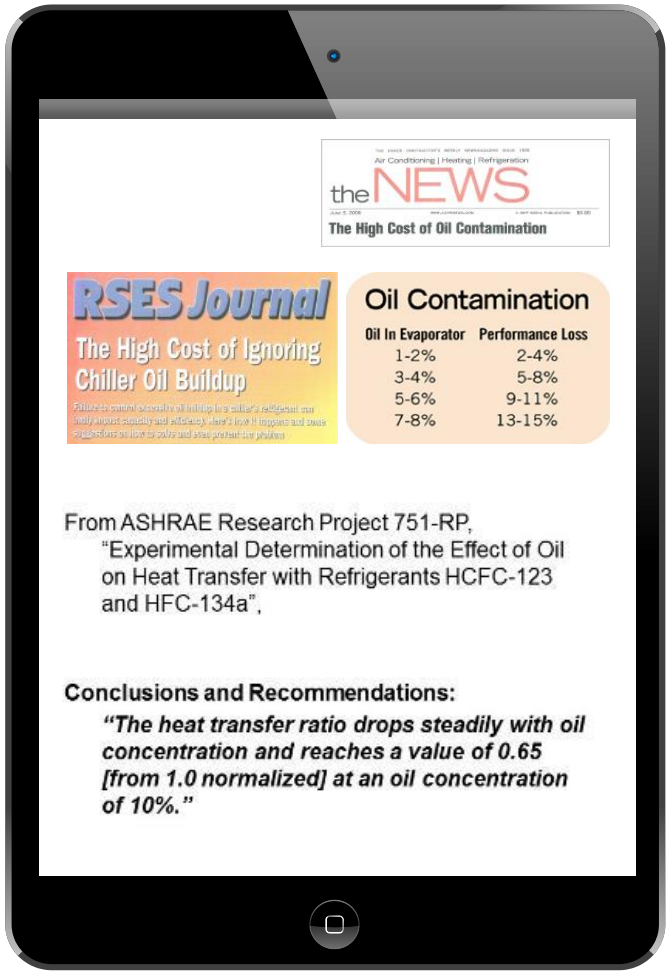
Value Proposition

Impact of Oil on a System



Numerous 3rd party studies have proven that ***the majority of chillers have excess oil charge***, resulting in degraded performance over time and is the leading cause of failures

- ASHRAE Research Project 751
- ASHRAE Research Study 601

"According to our lab, the number 1 cause — by far — of compressor failure is a lubrication issue due to lack of oil. Overcharging is the most likely culprit because refrigerant floodback causes the oil to wash out of the compressor."

June 2018 – Contracting Business Article with LG Electronics

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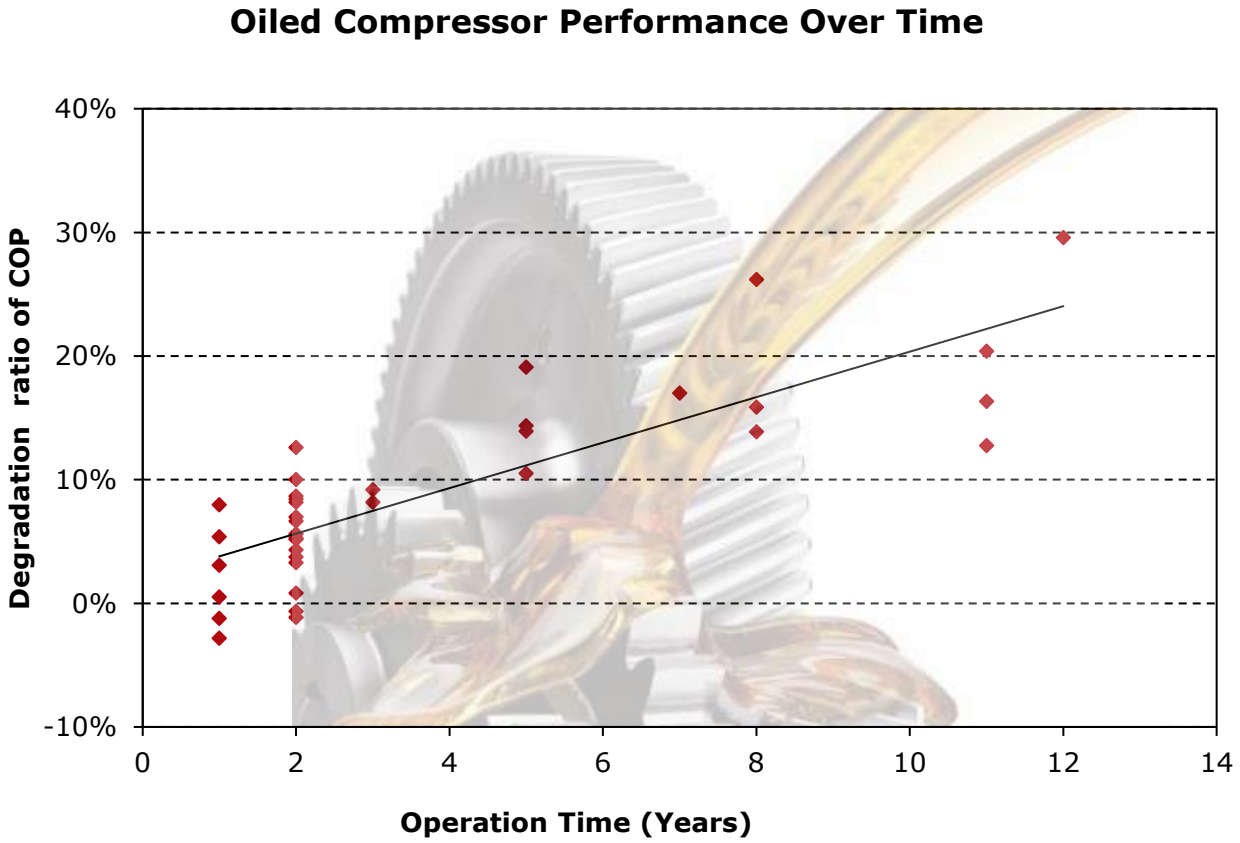
Value Proposition

No Performance Degradation due to Oil



2014 Tsinghua University Study

Tsingua University completed a project with data collecting that spanned over 6 years

- 24 buildings in study
- 36 Chillers analyzed considered "Well Maintained" (26 Centrifugal + 10 Screw)

Oiled compressors incur significant performance degradation

- **10%** efficiency loss after **5 years**
- **20%** efficiency loss after **10 years** in oil-lubricated chillers

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Value Proposition

No Performance Degradation due to Wear

Screws Wear Over Time Reduces Efficiency

Another study found that significant mechanical wear occurs on oiled screw compressors over time that affects performance due to excessive bearing wear and capacity slide damage.

Conclusions:

- *Screw compressor wear significantly impacts performance by the fifth year of operation*
- *Subsequent performance degradation was found to be as high as **26 percent** on average after **15 years** of operation.*
- *Efficiency loss cannot be recovered with teardown and rebuild – It is lost forever!*

JBS MINUS40 mla MEAT & LIVESTOCK AUSTRALIA

Final report

Project code: P.PIP. 0363

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Compressor Degradation Assessment and Wear Mitigation Strategy

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Value Proposition

Zero Performance Degradation with Oil-Free

Danfoss undertook a study in 2018 to validate long term operation of Turbocor compressors. The scope of the study consisted of:

- Testing (3) compressors in operation for 10+ years in the field
  - Hershey Factory, USA
  - ABC Studio, Melbourne Australia

- Retested compressors and compared 2018 compressor performance vs original test
- Results prove oil-free compressors incur zero performance degradation and no mechanical wear over their operational life

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Value Proposition

Maintenance Costs

Maintenance Task	Oiled Chiller Frequency	Oil Free Chiller Frequency	Cost
Check Oil Level and Oil Pressure	Daily	*Not Required*	*$-*
Change Oil	Annually	*Not Required*	*$1,600*
Replace Oil Filter	Annually	*Not Required*	*$2,000*
Inspect Key Components Oil pump, sump heater, Sump Strainers	Weekly	*Not Required*	*$-*
Oil analysis & Acidity Test	Annually	*Not Required*	*$50*

Total annual maintenance cost associated with the oil management system = $3,650

Lifetime maintenance cost associated with the oil management system = $83,950

Note: Based on 23 year chiller life expectancy per ASHRAE Handbook

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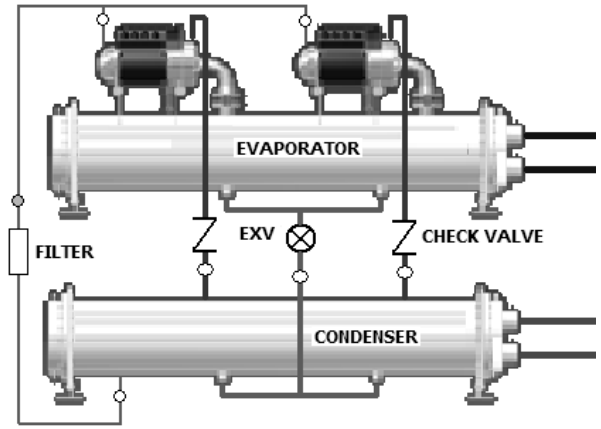
Value Proposition

Reduced System Complexity



Oil Free Chillers take Less Time to Develop

Chiller product range developments generally takes ~3 years with oiled designs
With oil-free this can be shortened to ~1.5 to 2 years

- No design of oil-management system and
- No testing/iteration of that system as part of chiller

Oiled System…

Chiller System Design	Oil-Manage. System Design	System Test Iteration 1	System Design Iteration 2	System Test Iteration 2	System Design Iteration 3	System Test Iteration 3

Oil-Free System…

Chiller System Design	System Design Verification Test	System Design Iteration	System Design Validation Test

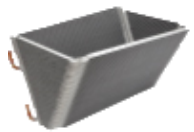
Oil-Free Time-to-Market Advantage

Save more time in development using Danfoss qualified Oil Free Components


Turbocor® Compressors

EXVs

Braze / Microplate HX



Microchannel heat exchanger

Pressure control and regulation

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Value Proposition

Benefits of Oil Elimination

	Oiled Screw Compressor	Oil Free, Magnetic Bearing Centrifugal Compressor
Mechanical Wear	Significant mechanical wear affects performance in as little as 5 years and **COP reduction on average -26% in 15 years**	**No mechanical wear over the life of the compressor**
Reliability	Oil Management is the **#1 Cause of Compressor Failure**	**No oil management needed in the system – failure mode eliminated**
Oil Concentration	Oil Concentration affects performance over time and Oiled Chiller can expect to see **COP reduction on average -20% after 10 years**	**No capacity or efficiency degradation over the life of the compressor**
Development Time	Longer Development time required to test the system for validation of proper oil management	Simpler System Design and Testing Plan - **Development time reduced by 50-67%**
Maintenance Costs	Annual **maintenance costs associated with oil management average $3,650** USD and will be around **$83,950 over a 23 year life**	**No maintenance cost associated with oil management system**

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Value Proposition

Environmental Benefits

LOW GWP REFRIGERANTS

R513A

Multiple Options – Same Compressors

HFO 1234ze

R515B

Current Refrigerant Landscape is promoting a lot of uncertainty. Take a leading position with Danfoss Turbocor® Oil-Free Compressors which allow for promotion of 'Future Proof' solutions where Chillers can potentially be converted!

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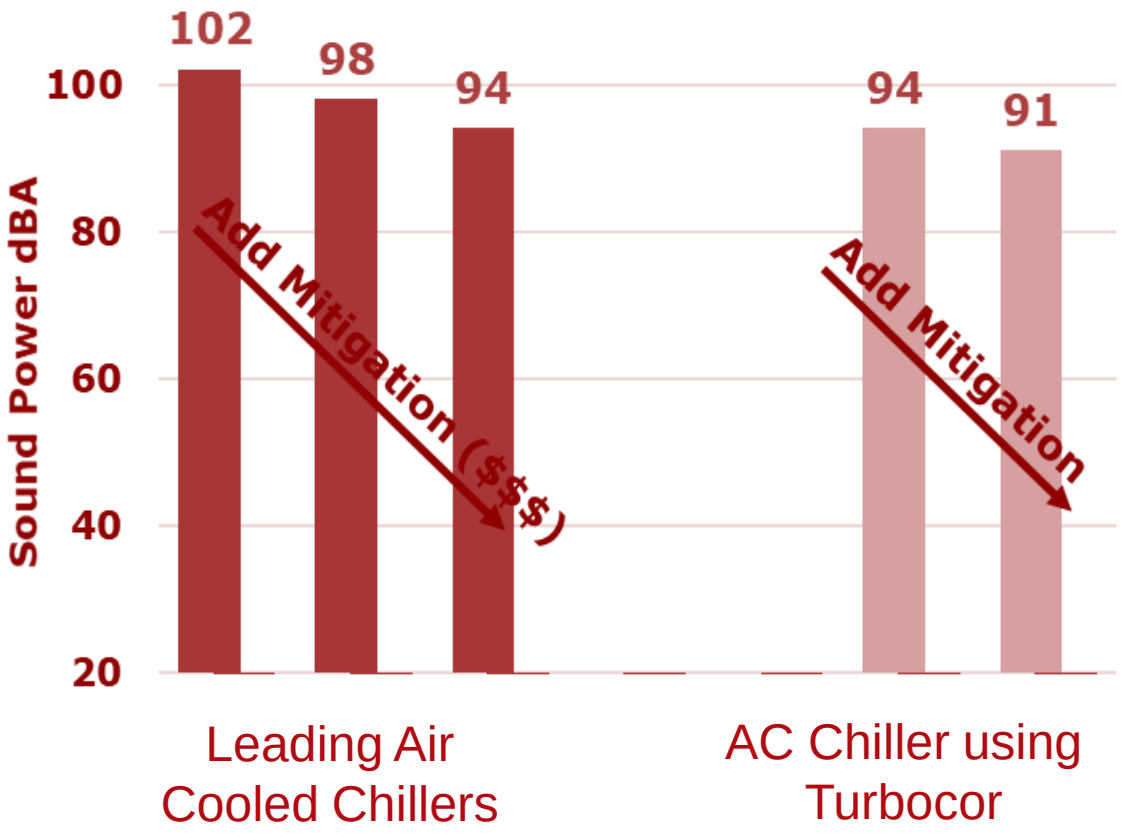
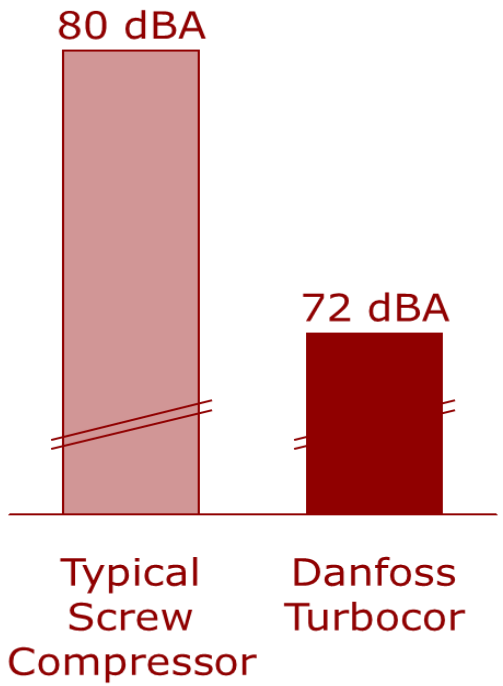
Value Proposition

Sound

11dbA Reduction on Air-Cooled



8bA Reduction on Water-Cooled



- Up to 11 dBA sound power difference between Turbocor based Chiller and Leading Competitor
- +3 dBA sound power increase = twice the energy or intensity

- No pure tone noise effect in 1/3 octave bands

- No expensive sound attenuation required on Turbocor compressors

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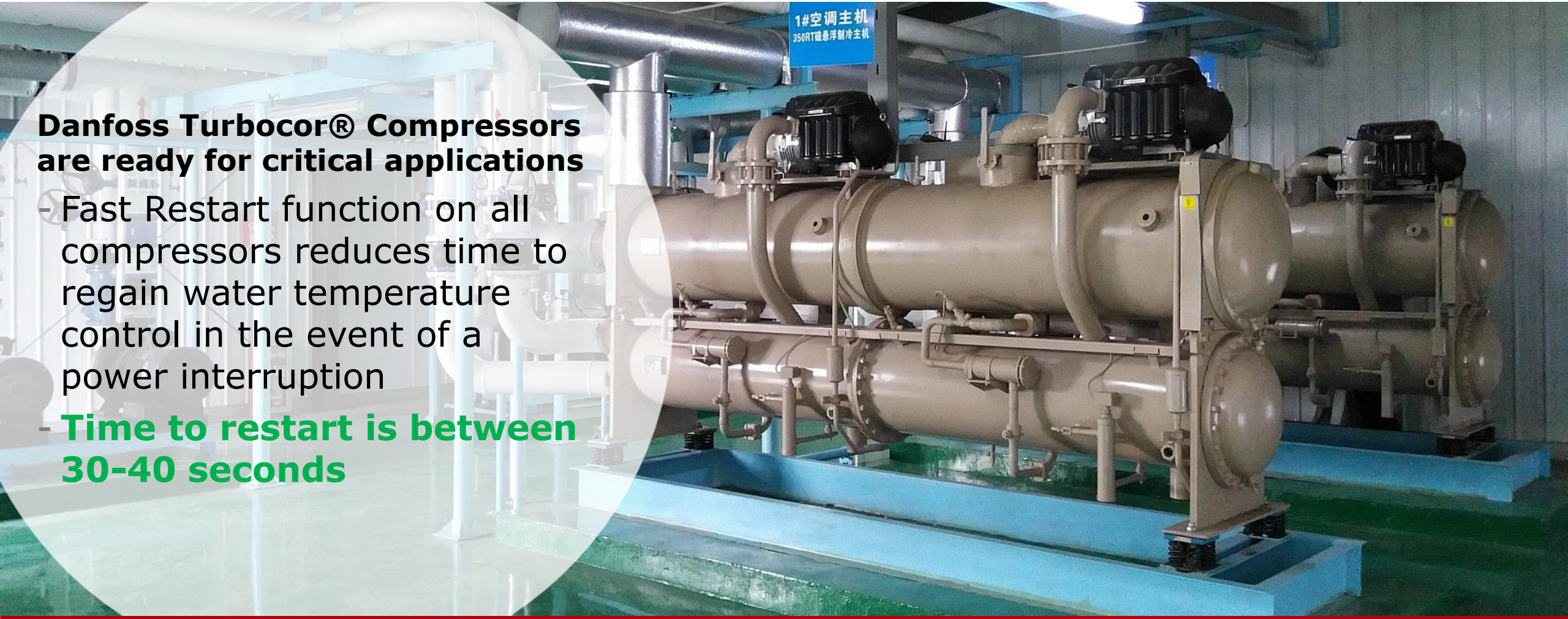
Value Proposition

Fast Restart Timing



Danfoss Turbocor® Compressors are ready for critical applications

- Fast Restart function on all compressors reduces time to regain water temperature control in the event of a power interruption
- **Time to restart is between 30-40 seconds**

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Turbocor ® Advantage

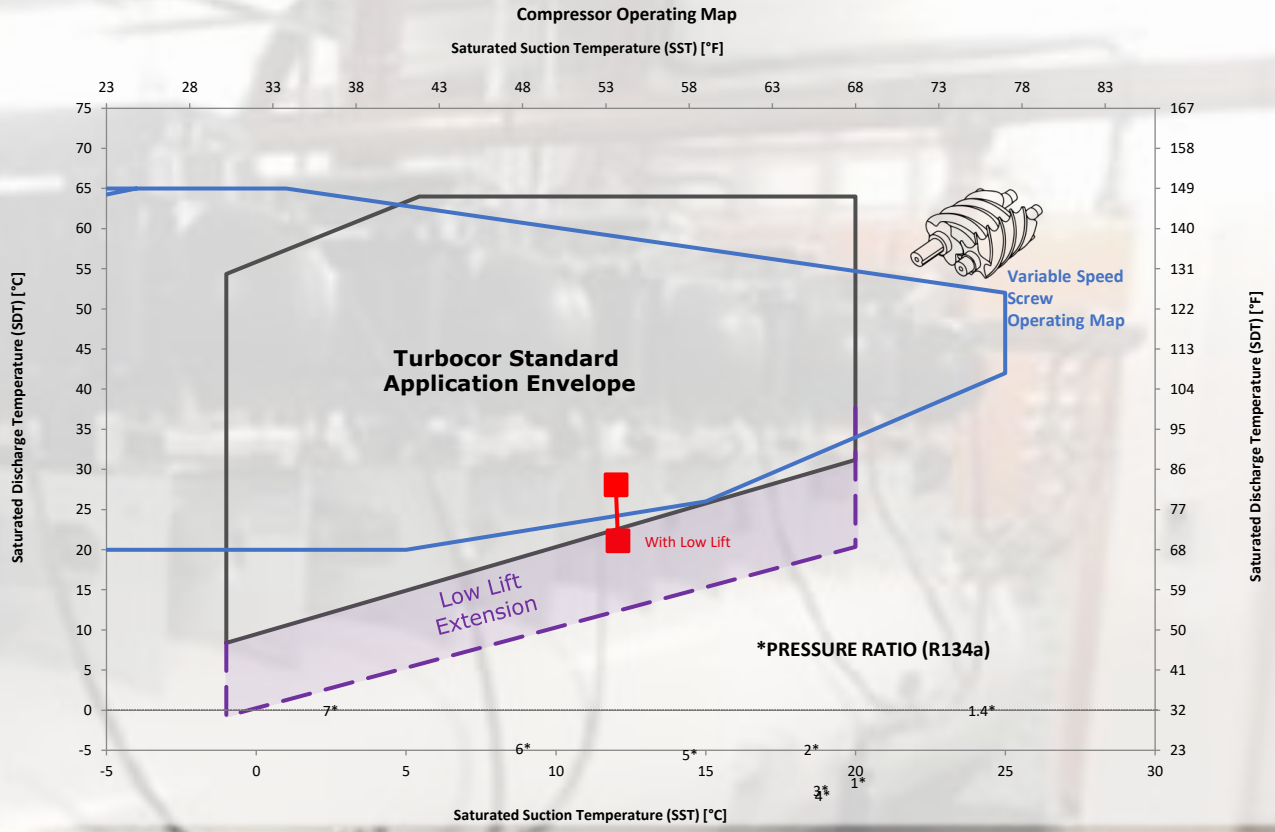
Performance at Low Lift

Take advantage of lower ambient temperatures and get huge energy savings with Turbocor® Low Lift Operation

A datacenter site having water-cooled chillers delivering 14C chilled water demonstrated the savings moving from **1.65PR** to **1.33PR** after having Turbocor® Low Lift enabled.

Improvement from **10.98 COP** to **15.99 COP**
More than 31% Improvement

Best performing screws would have a COP between 8.5-9.25 at the PR of 1.65. Operation at the 1.33 PR is outside of the typical variable speed screw operating envelope.



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Turbocor ® Advantage

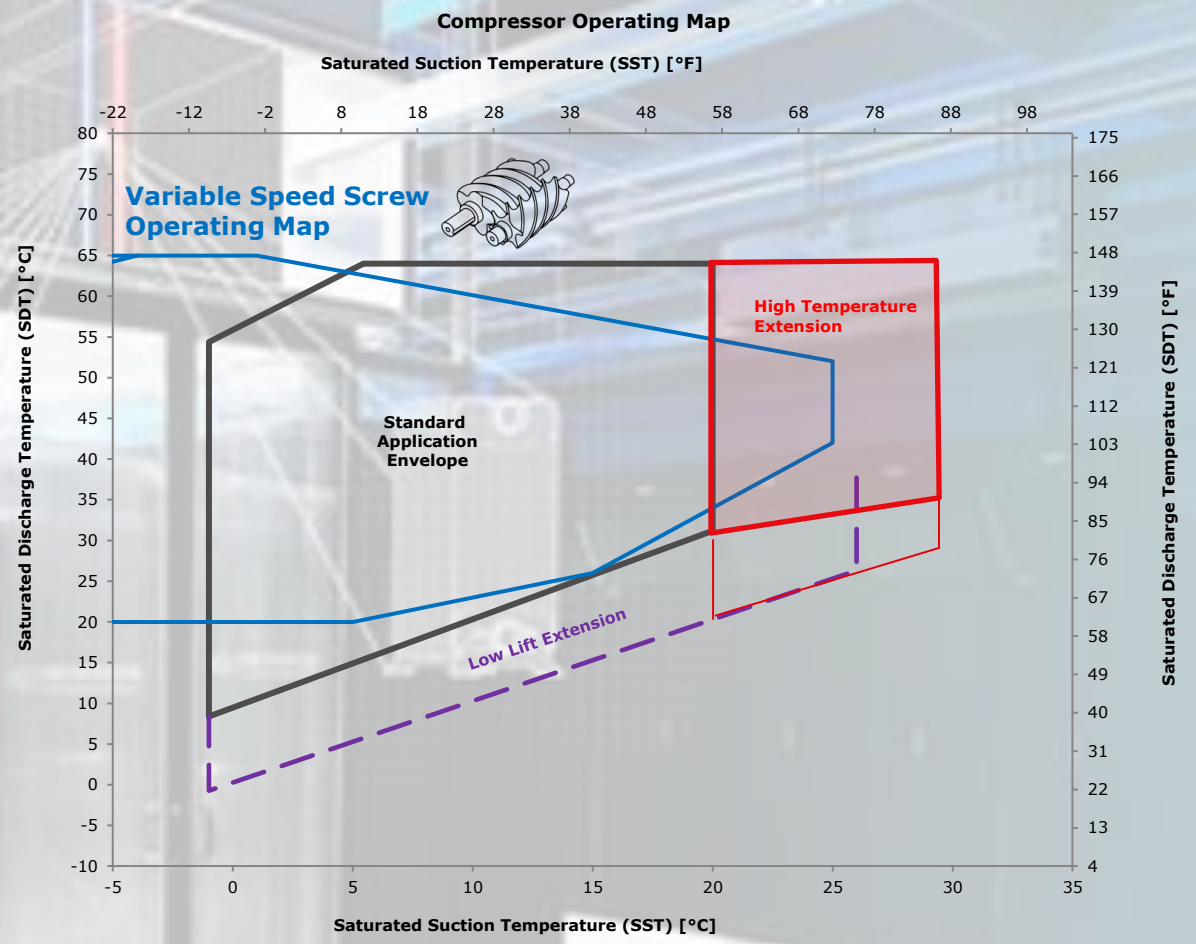
High SST Operation – Data Center Benefit

Reduce Chiller Power by increasing leaving Chilled Water Temperatures

Turbocor TT/TG Series Compressors can be ordered as **High Temperature Variants** allowing high **SST operation up to 30C**

Screw Compressor range is limited in much of this region due to oil circulation problems when PR is very low and due to effectiveness of oil-lubrication at high SDTs / high SSTs.

High SST range varies by model



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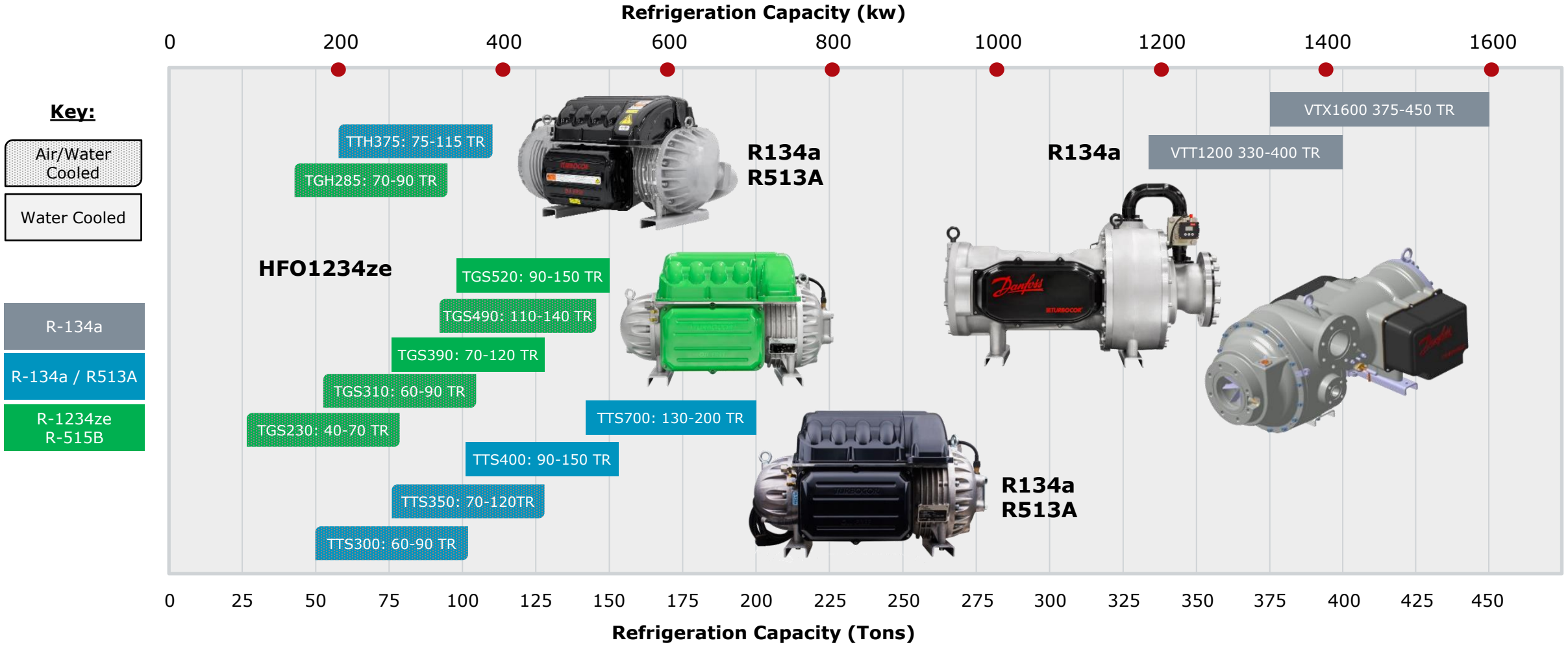
Danfoss Turbocor® Compressors

Product Portfolio 2021



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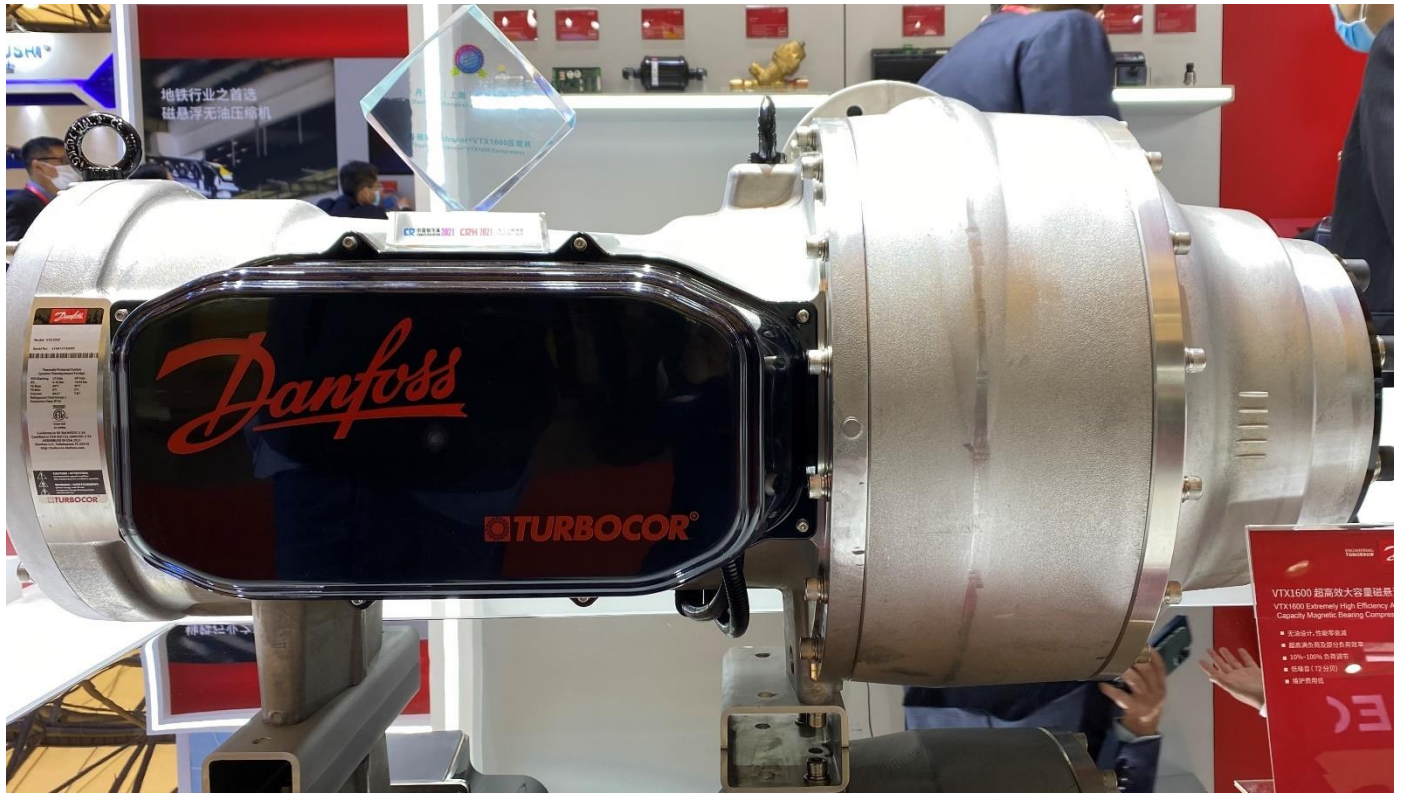
VTX1600 Compressors

CRH 2021 Innovation Product



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Classified as Business

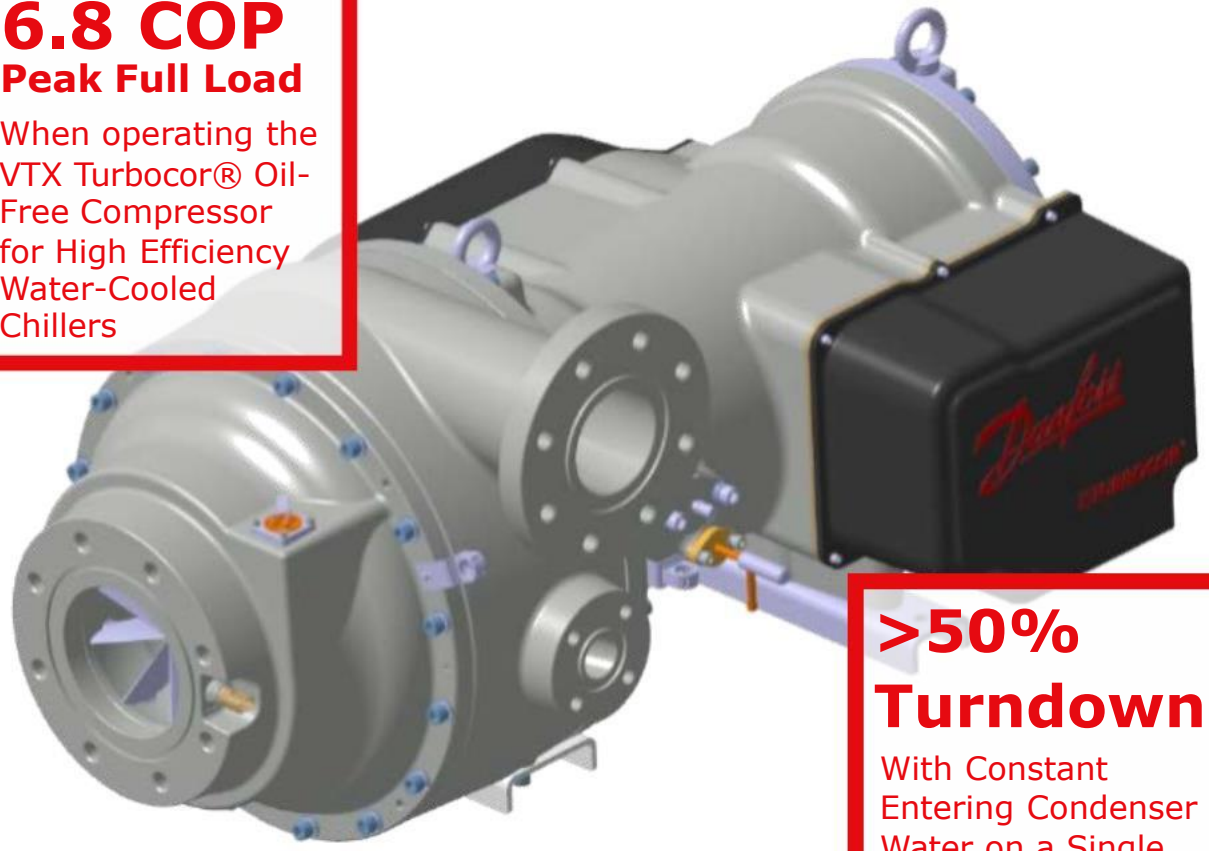
VTX1600 Compressors

Based on the VTT platform, the VTX series of compressors is a centrifugal compressor capable of delivering 450 Tons of Cooling Capacity for Water Cooled Chillers.

VTX1600 is the Highest Efficiency Turbocor® Compressor ever!

- **High Capacity & Efficiency -** VTX1600 uses the ***same oil free technology*** but delivers higher capacity and higher efficiency
- **High Efficiency Unloading** – The VTX compressors uses an ***updated Aero-Design with IGV*** for extended unloading range ***that does not sacrifice efficiency at low load Conditions***
- **Easy Chiller Integration** – The VTX compressors have ***variable discharge options*** to allow better packaging on the chiller along with ***improved power connections for either bottom or side entry***
- **Improved Ingress Protection –** IP Rating of **IP54 on Compressor** when combined with the currently available IP54 Drive Module
- **Refrigerant** – **R134a, R513A, HFO-1234ze, R515B**

6.8 COP
Peak Full Load
When operating the VTX Turbocor® Oil-Free Compressor for High Efficiency Water-Cooled Chillers



>50% Turndown
With Constant Entering Condenser Water on a Single Compressor System operating at Full Load Conditions

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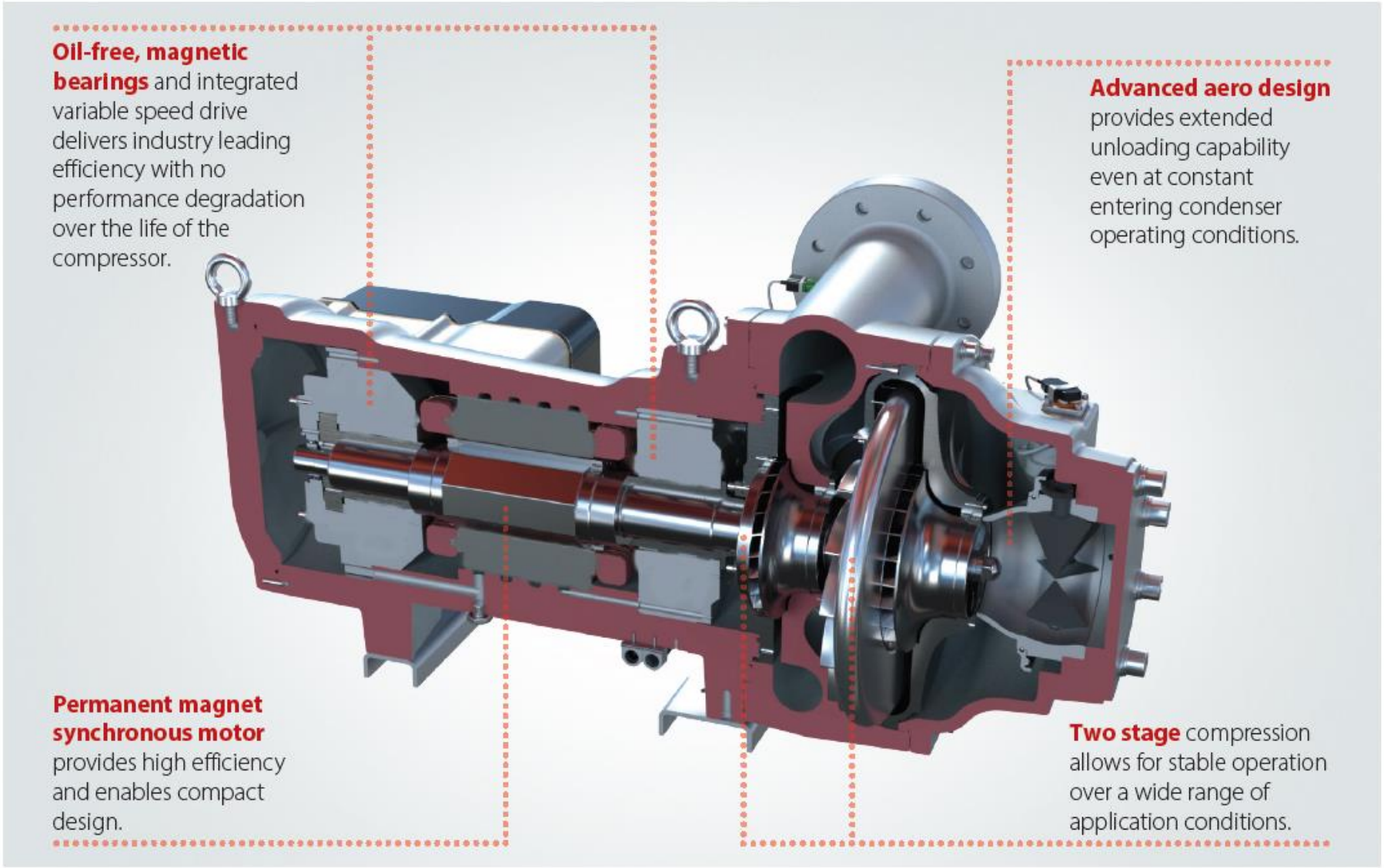
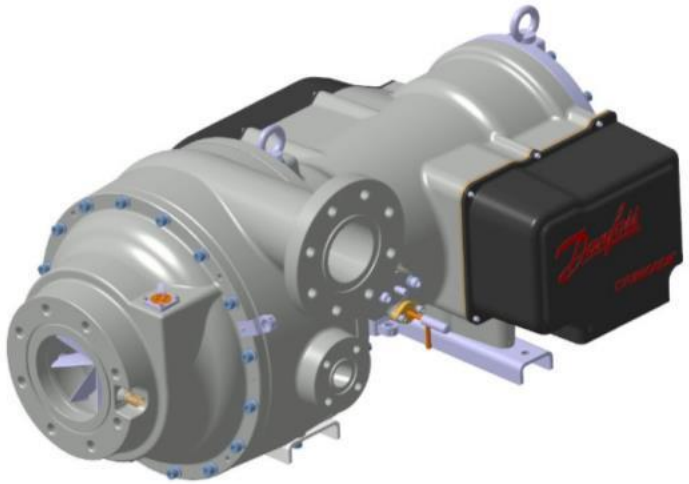
VTX1600 Compressors



VTX1600

Variable Discharge Orientation



Horizontal Discharge Rotated 0° (Standard)

Angled Discharge Rotated 45°

Downward Discharge Rotated 90°

Discharge Location Options

- Options as Horizontal Discharge (0 degree), Angled Discharge (45 degree), Downward Discharge (90 degree)
- Discharge Orientation a Configurable Option at the time of order
- Desired Discharge Orientation Shipped from the Factory

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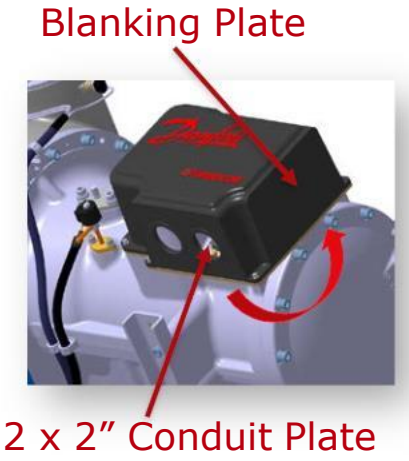
VTX1600

Improved Power Connection Options

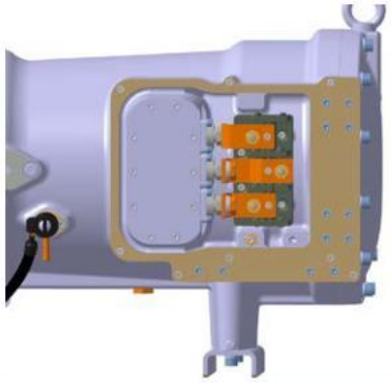
Variable Power Connections
Each Compressor Includes:

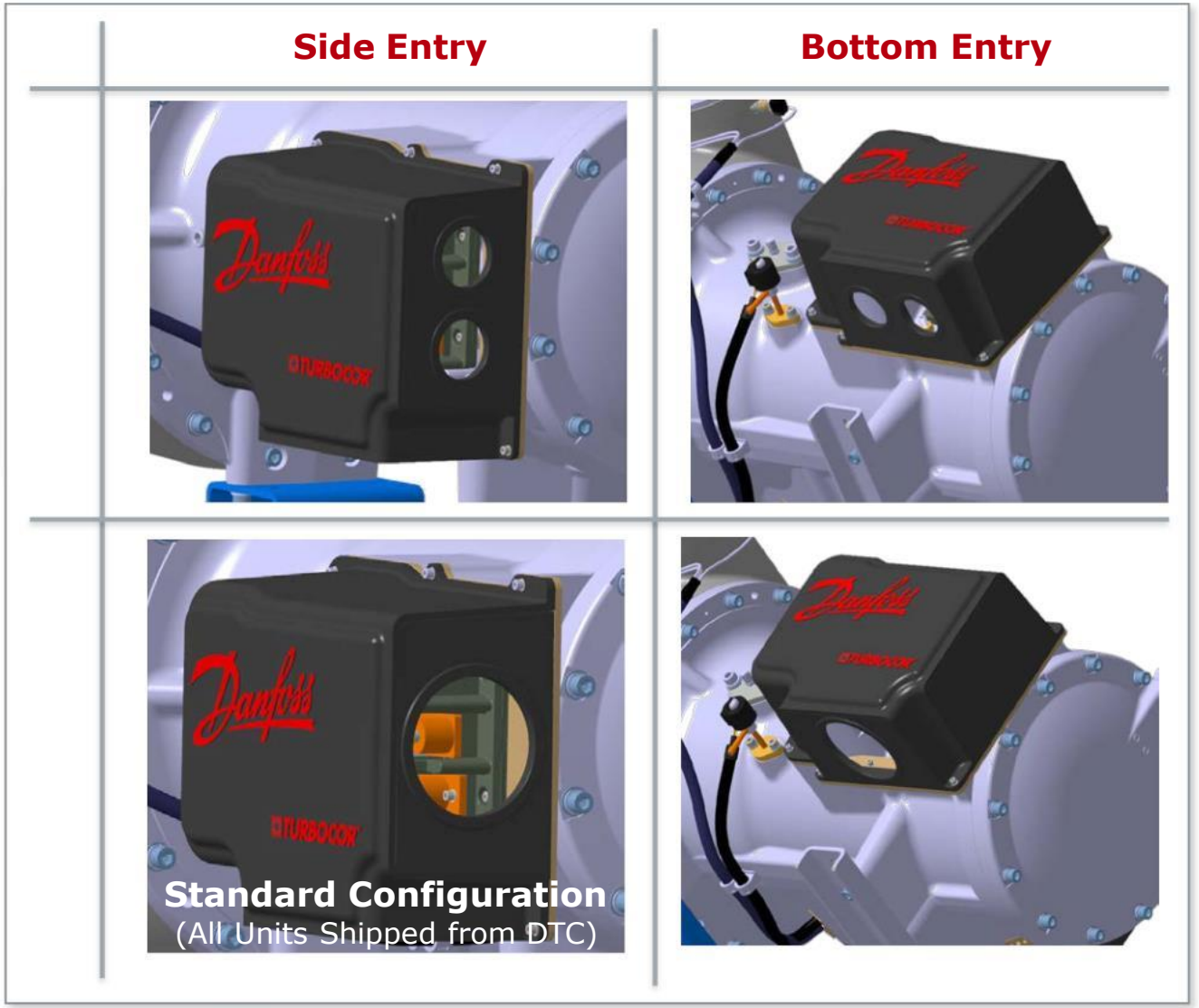
- Blanking Plate
- 2 x 2” Conduit Plate
- 1 x 4” Conduit Plate

Blanking Plate and Conduit Plates are removable and can be installed to achieve any desired configuration.



Improved Terminal Block
New Terminal Block design to allow easier mains power connections for both side and bottom entry.





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