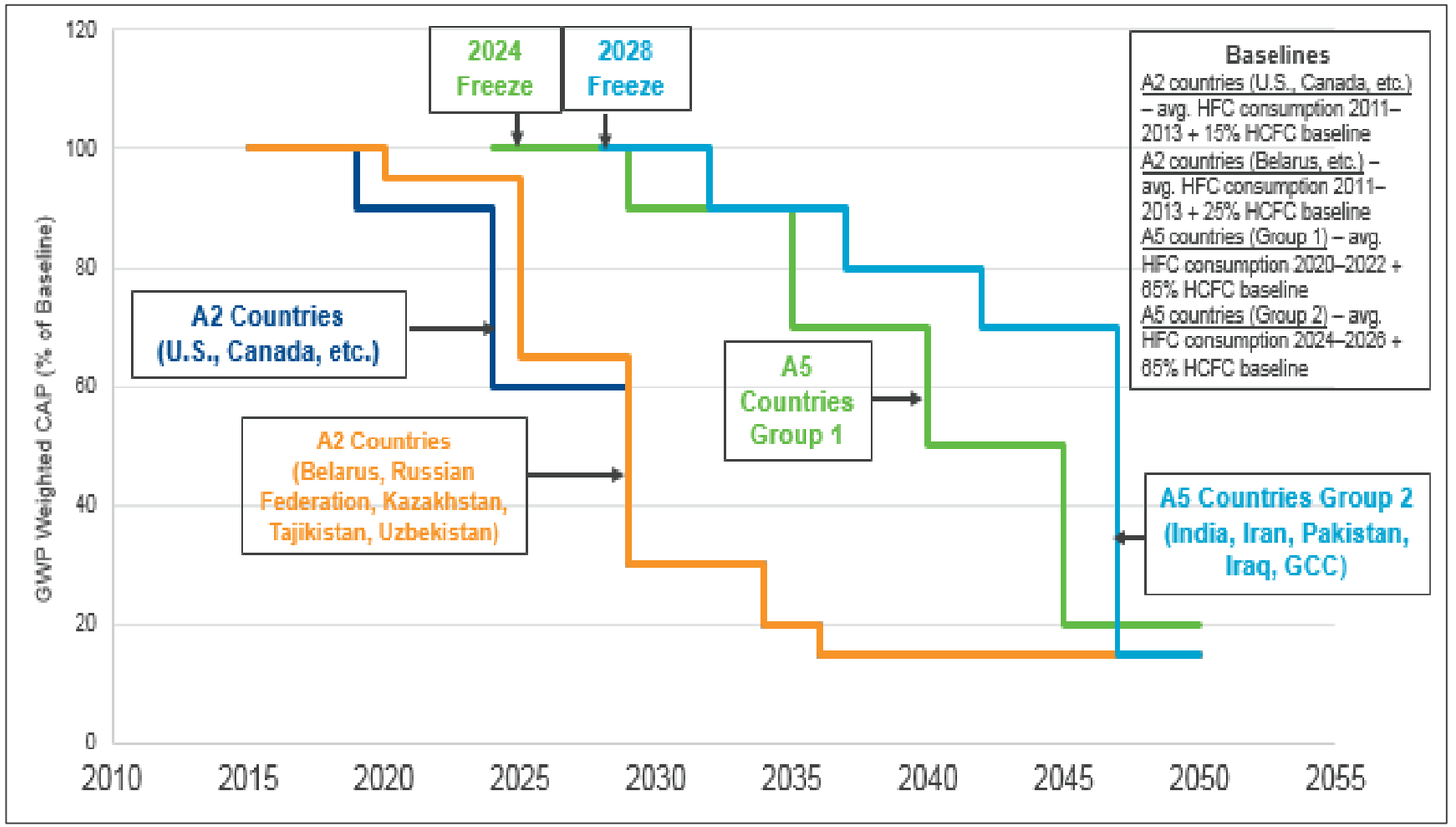
R32 Technology & Application Research & Development
R32 技术和应用的研究与开发

Warner Guo
过炜华

June 20th 2019
2019年 6月20日

EMERSON

Kigali Amendment to Montreal Protocol
蒙特利尔协定基加利修订案



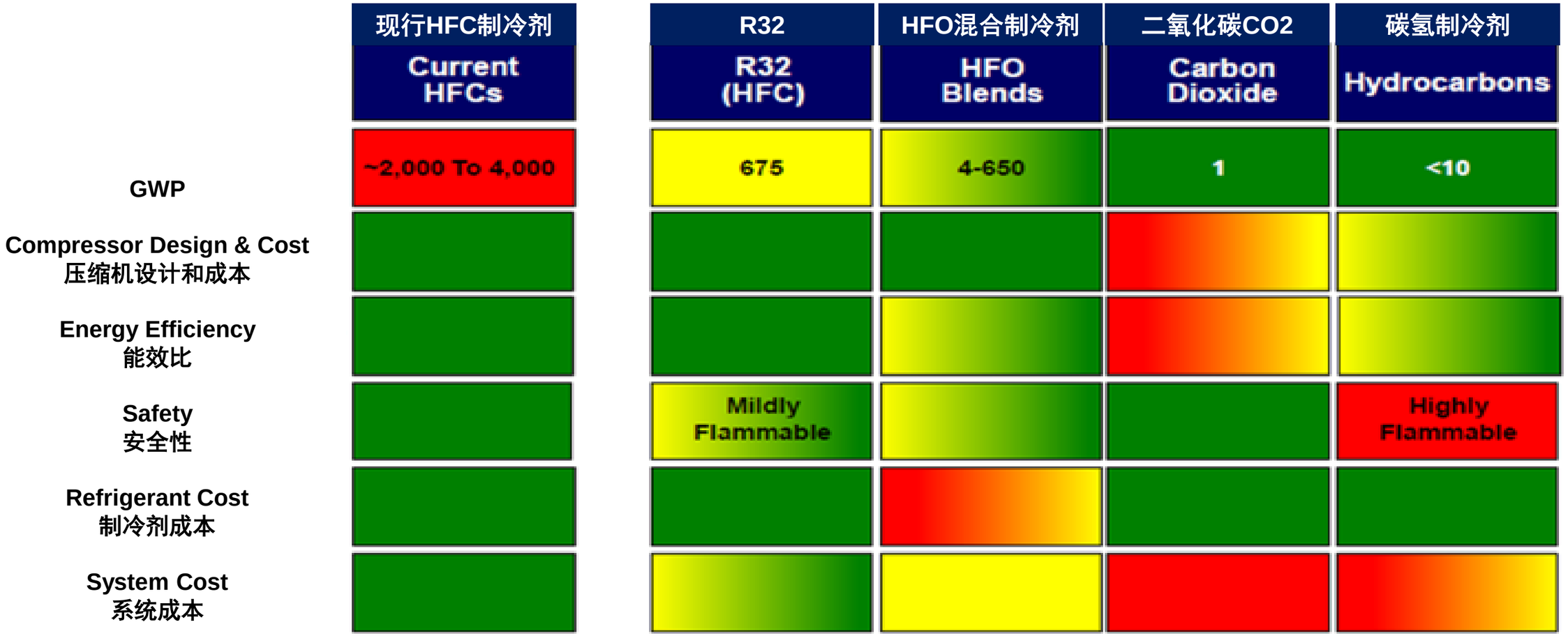
- **Global agreement on HFC phase-down reached by 197 countries in Kigali, Rwanda "28th Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer"**

- **197个国家在第28届蒙特利尔协定成员国会议上达成了关于逐步减少HFC消耗的全球协议，即基加利修订案。**

**http://conf.montreal-protocol.org/meeting/mop/mop-28/final-report/English/Kigali_Amendment-English.pdf

Kigali Amendment Ratified by 72 Countries, June 17, 2019; Went Into Effect Jan. 1, 2019**
基加利修订案已于2019年1月1日正式生效 (2019年6月17日为止，已有72个国家批准了基加利修订案)

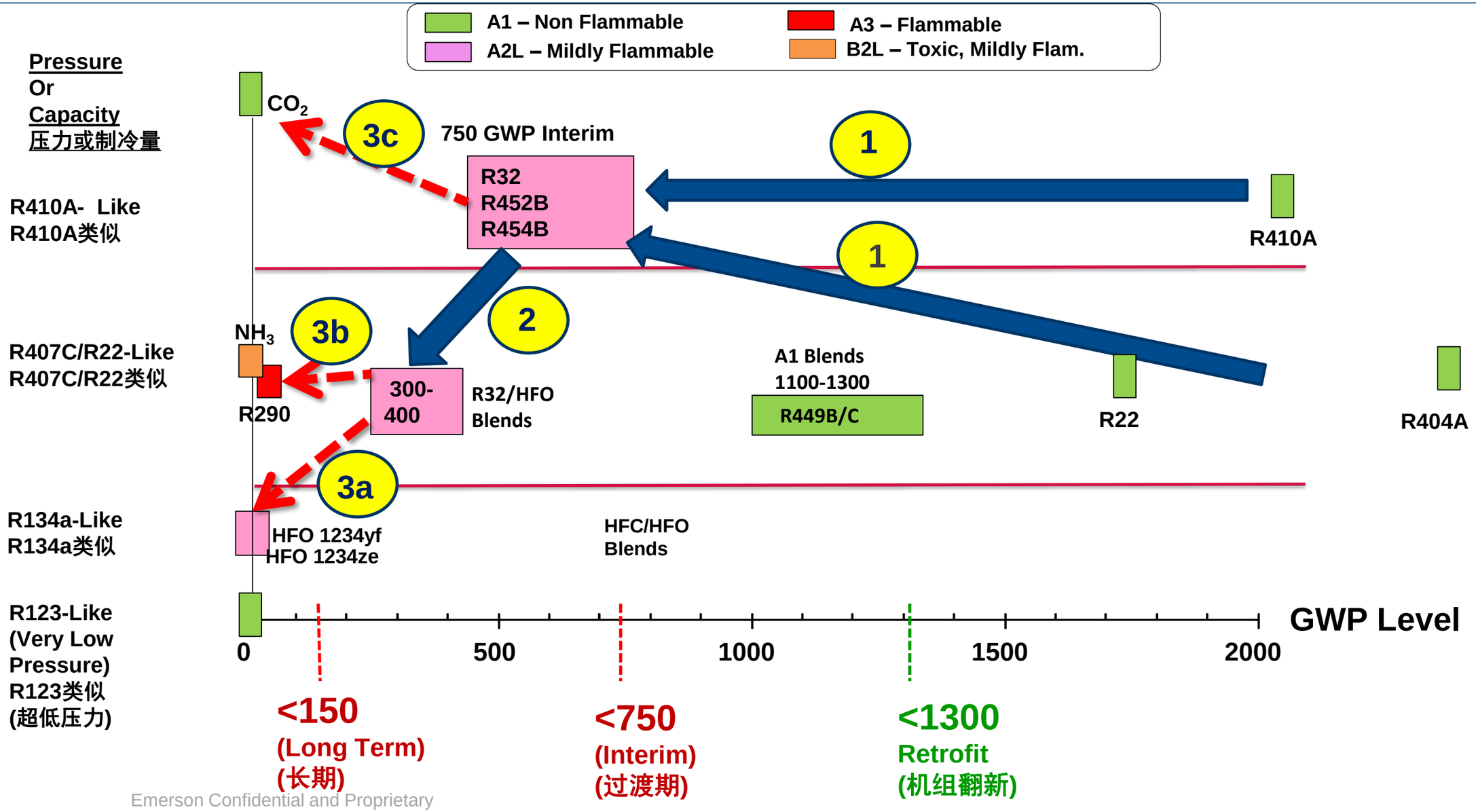
HFC Replacement Options - No Perfect Candidate
HFC制冷剂的替代选项 - 没有完美的制冷剂选择



Diversified Refrigerant Options in Different Region and Applications

未来的制冷剂会根据应用和区域等不同进行区分

Potential Long Term Low GWP Refrigerant Roadmap
潜在的长期制冷剂GWP减少路线图



Emerson Confidential and Proprietary

World Wide A2L Regulation Progress Summary
全球A2L制冷剂法规的修订进程汇总

	Standards Working Group	Focus Of Standards Activity For A2L Refrigerants
ISO (Intl.)	ISO 5149	Safety & Use; General equipment requirements
	IEC 60335-2-40	AC & Heat Pump application equipment & use requirements
	IEC 60335-2-89	Commercial refrigeration application equipment & use requirements
CEN (EU)	EN 378	Safety & Use; General equipment requirements
	EN-IEC 60335-2-40	AC & Heat Pump application equipment & use requirements
	EN-IEC 60335-2-89	Commercial refrigeration application equipment & use requirements
ASHRAE (US/Intl)	Standard 15	Safety & Use; General equipment requirements
UL (US)	Working Group #1	AC & Heat Pump application equipment & use requirements (UL 1995)
	Working Group #2	Commercial refrigeration application equipment & use requirements (UL 250, UL 471)
	Working Group #3	Refrigerant chemistry & requirements
China	**GB9237**	Develop R32 specific application requirements – AC, Heat Pump, Ref

Regulations for A2L Has Been Actively Developed World Wide
世界各地均在积极制定A2L相关法律和规范

Refrigerant Substitution - Asia Developing Countries
替换制冷剂最新动态 - 亚洲发展中国家

国家 Country	R32制冷剂替换状态 R32 Substitution Status
中国 China	*1) GB7778制冷剂安全规范 已经批准（ISO817等效）* *GB7778 Refrigerant Safety Regulation Approved (ISO817 Equivalent)* *2) GB/T9237空调设备安全规范 (ISO5149)已经在2018年7月生效.* *GB/T9237 A/C Equipment Safety Regulation (ISO5149) is Effective since July 2018.*
泰国 Thailand	*政府于2017年1月禁止HCFC制冷剂消耗。设备制造商已签订将家用空调切换到R32制冷剂的协议* *HCFC Consumption Banned since Jan 2017, OEMs Signed Agreements to Apply R32 in Residential Air Conditioners*
印度尼西亚 Indonesia	*空调制造商已经签订切换到R32制冷剂的协议，目前以R407C作为过渡方案* *OEMs Signed Agreements to Apply R32 in Residential Air Conditioners, R407C as Interim.*
印度 India	*遵从蒙特利尔协议* *Follow Montreal Agreement*

Refrigerant Property Comparison - R32 Vs. R410A, R22
制冷剂物性对比 - R32 Vs. R410A, R22

参数 Item	单位 Unit	制冷剂 Refrigerant			差异 Difference
		R22	R410A	R32	R32/R410A
蒸发温度 SST	°C	7.2			
冷凝温度 SDT	°C	54.4			
过热度 Super Heat	K	11.1			
吸气压力 Suction Pressure	Bar	6.3	10.0	10.2	2%
排气压力 Discharge Pressure	Bar	21.5	33.8	34.7	3%
压缩比 Pressure Ratio	-	3.43	3.39	3.41	1%
吸气密度 Suction Gas Density	kg/m^3	25.2	35.4	25.7	-27%
等熵压缩排气温度 Isentropic Discharge Temperature	°C	85	84	101	17K
容积制冷量 Volumetric Capacity	KJ/m^3	3,987	5,595	6,215	6-10%
理论COP Theoretical COP	(W/W)	4.83	4.41	4.52	2%

- **R32系统压缩比与R410A非常接近，高1%左右**
- **R32 System Pressure Ratio 1% Higher Than R410A**

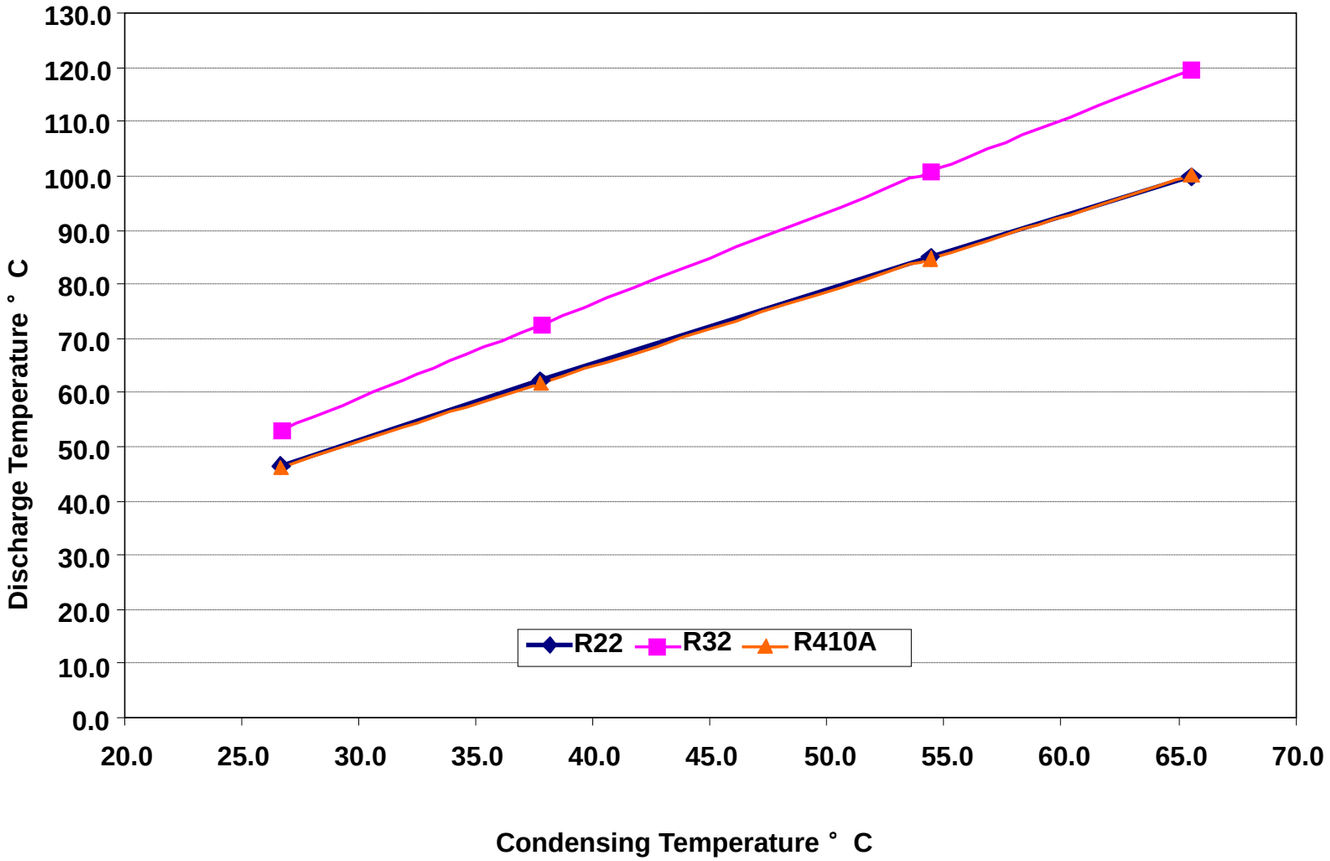
- **R32密度(质量流量)比R410A低27%，与R22相当**
- **R32 Density (Mass Flow) 47% Lower Than R410A, Similar to R22**

- **R32容积制冷量比R410A高6-10%**
- **R32 Volumetric Cooling Capacity 6-10% Higher Than R410A**

- 在等熵压缩循环名义制冷工况下，**R32的COP比R410A高2%**
- **R32 Isentropic Rated Cooling COP 2% Higher Than R410A**

R32 is Similar to R410A with Slightly Higher Volumetric Capacity
R32与R410A相近，并且容积制冷量稍高

Refrigerant Discharge Line Temperature Comparison - R32 Vs. R410A, R22
制冷剂排气温度对比 - R32 Vs. R410A, R22



- 等熵压缩循环名义制冷工况下，**R410A**的排气温度和**R22**相同
- **R410A Isentropic Rated Cooling Condition Discharge Temperature Same as R22**

- 等熵压缩循环名义制冷工况下，**R32**的排气温度比**R410A**和**R22**高**17K**左右
- **R32 Isentropic Rated Cooling Condition Discharge Temperature is 17K Higher Than R410A and R22**

- 高排气温度是**R32**压缩机的主要挑战
- **High Discharge Temperature is Major Challenge for R32 Compressor**

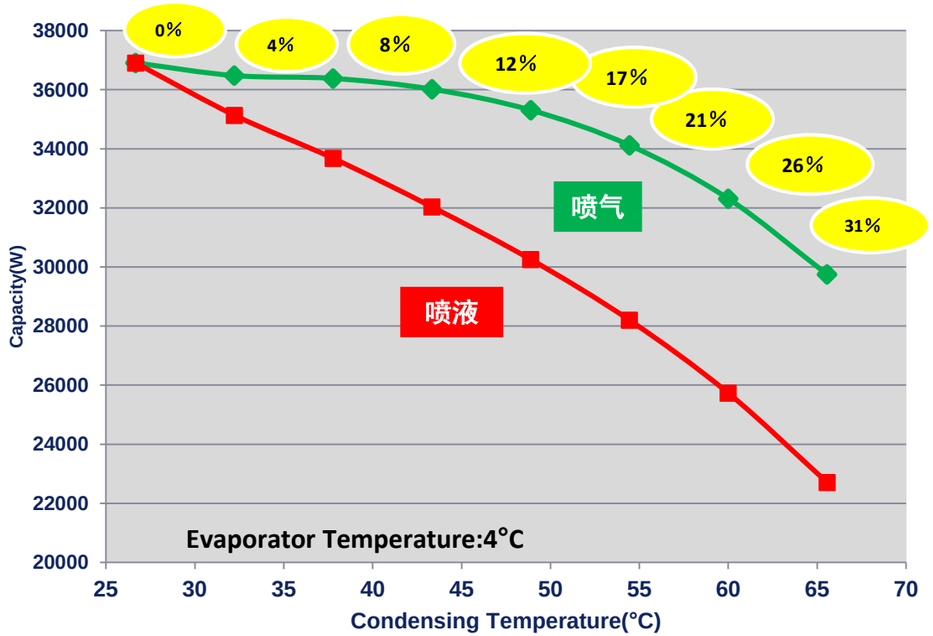
R32 Isentropic Discharge Temperature is 17K Higher Than R410A
R32等熵排气温度比R410A高17K

Solution for High Discharge Temperature - Injection
排气温度解决方案- 喷射方案

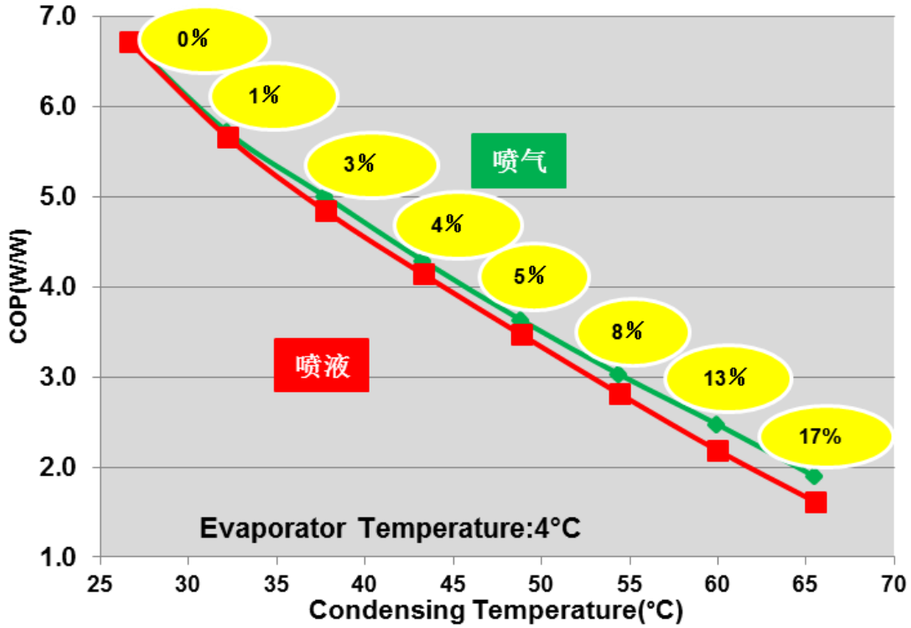
喷射解决方案控制排气温度
Injection Solution for DLT

- 喷液 Liquid Injection
- 喷气 Vapor Injection

制冷量比较
Cooling Capacity Comparison



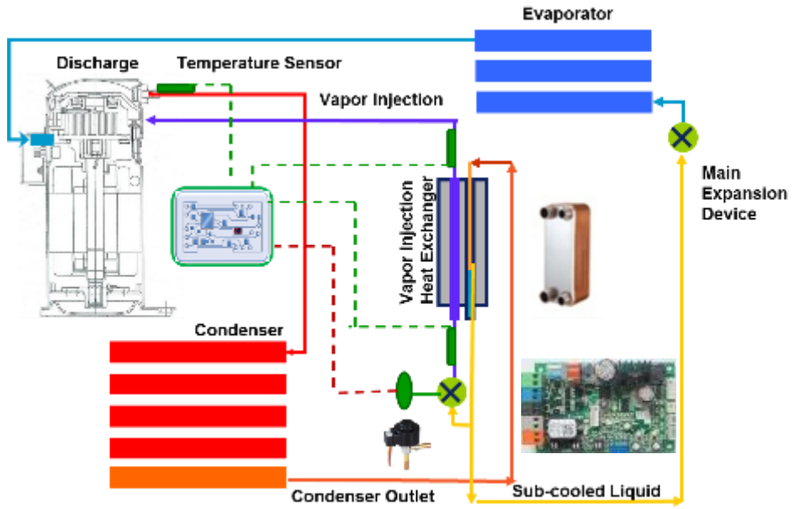
COP对比
COP Comparison



Compressor Data 压缩机测试数据

Vapor Injection Improve System COP While Solving High DLT Issue
喷气方案在有效解决排气温度的同时还相当程度地提高制冷系统的能效比

Solution for High Discharge Temperature - Injection
排气温度解决方案- 喷射方案

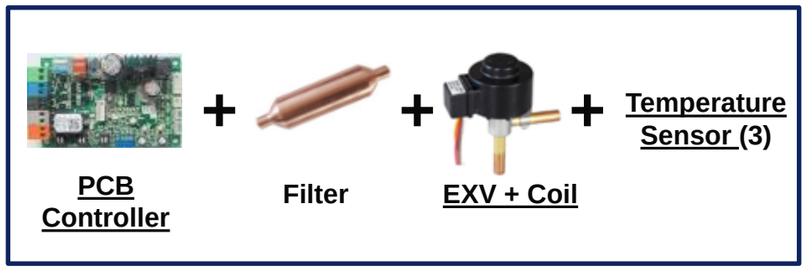


Control Logic

- DLT<110 °C
  - 3~7K Super Heat Control For Best Performance
- DLT>110 °C
  - Wet Injection
- DLT>125 °C
  - System Stop And Re-Start When DLT Below 95 °C

Advanced Solution: Liquid/Vapor Injection

Injection Kits

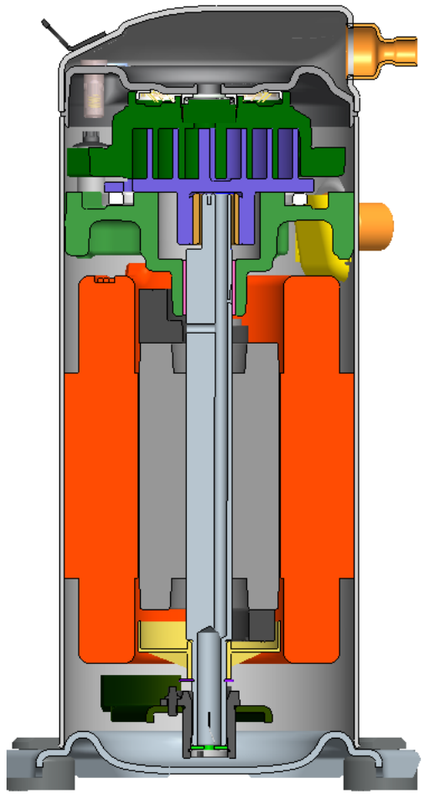


BPHE

艾默生提供整套喷气涡旋解决方案

Emerson Provides Integrated Solution for R32 Vapor Injection

Solution for High Discharge Temperature - Non-Injection
排气温度解决方案- 非喷射方案

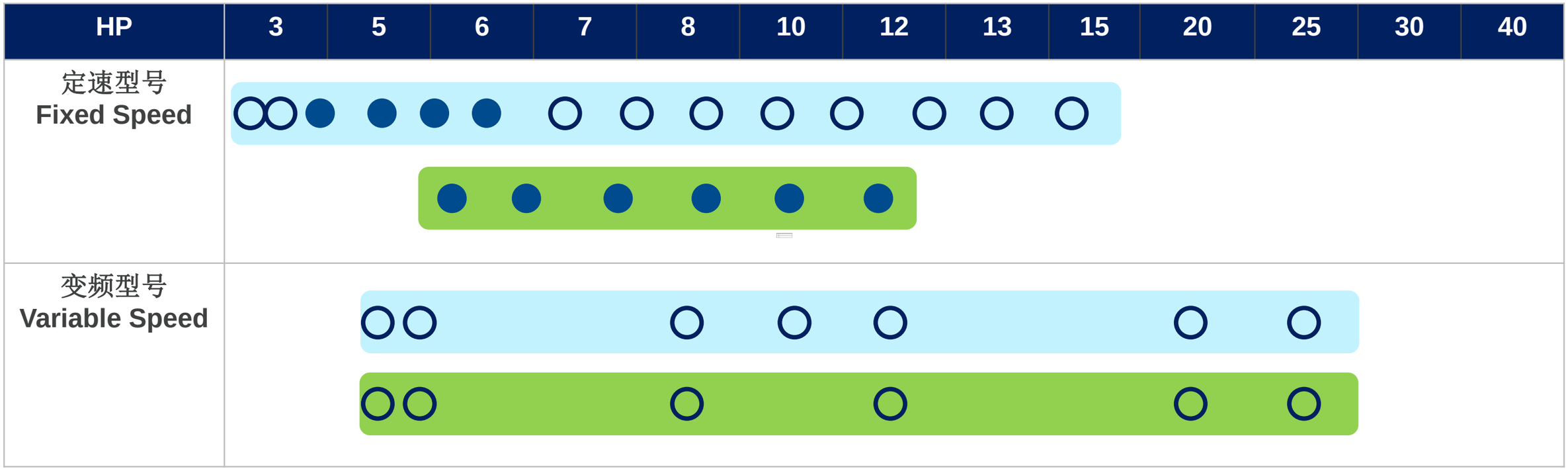


- Non-Injection Solution Simplify System Configuration and Cost
  非喷射方案简化系统设计，有效控制成本。

- Manage Compressor Discharge Temperature By Internal Design Optimization
  通过压缩机的内部优化设计对R32压缩机的排气温度进行有效管理
  - Enhanced Scroll Sealing and Lubrication
    强化涡旋内部密封设计和润滑
  - Optimized Internal Fluid Dynamic Flow
    优化压缩机内部流体的动态流路设计
  - Motor and Protector Design Improvement
    针对R32的冷媒特性改进了马达和保护器的设计
  - Designated POE Oil For R32
    开发了R32专用POE润滑油

Non-Injection Solution Resolve DLT Issue Through Internal Thermal Management Design
非喷射方案采用压缩机内部温度管理设计解决排气温度问题

Emerson R32 Scroll Compressor Line-up
艾默生R32涡旋压缩机系列



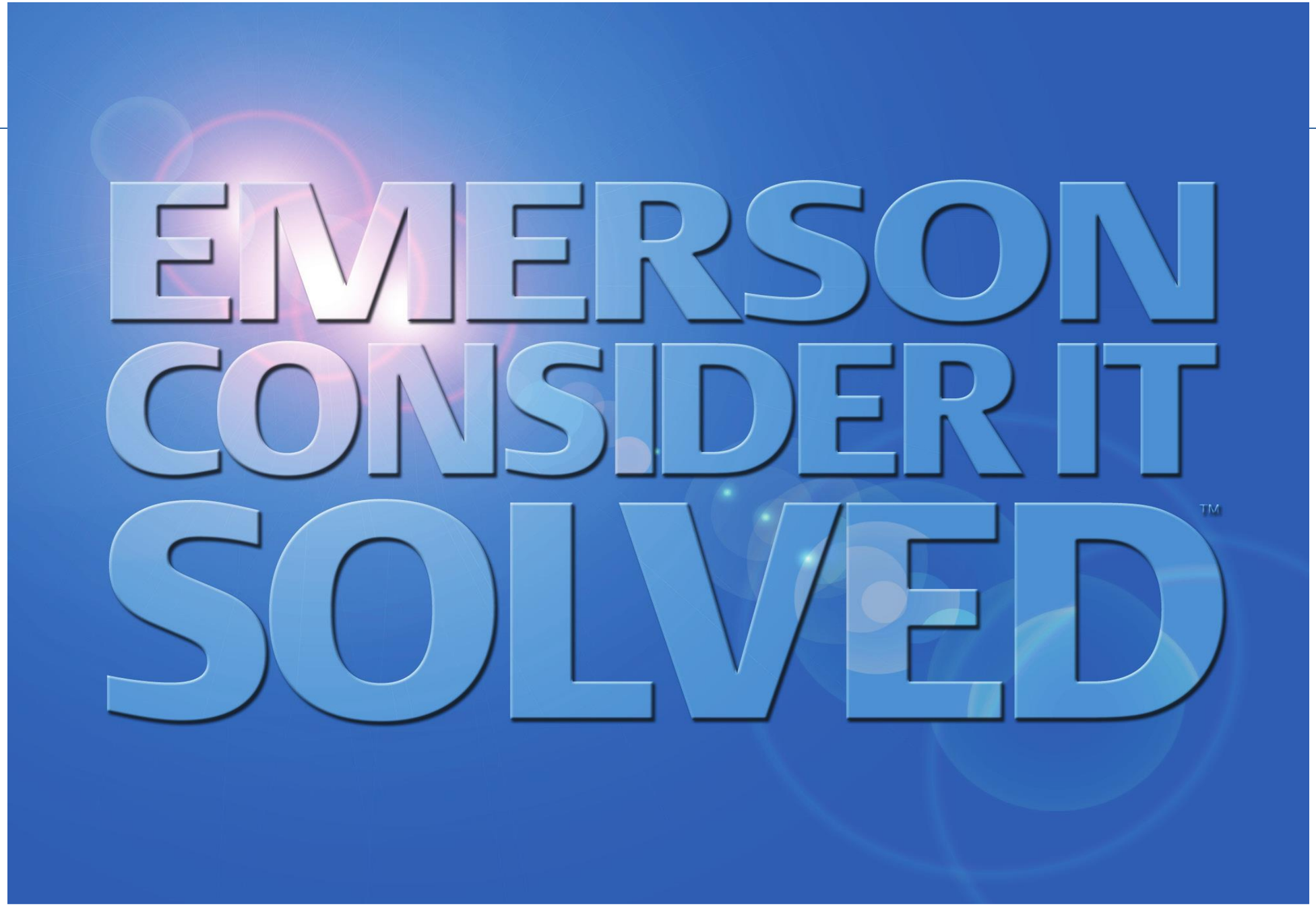
Summary
总结

- Low GWP Requirement Diversified Refrigerant Options
  低GWP冷媒的需求使冷媒的选择更多样化

- R32 A Good Interim Solution Due to Low GWP and Similar Character to R410A
  由于具备相对低的GWP值，以及和R410A相似的物性，R32是一个不错的中期替代选择
  - Minor System Design Change Required
    系统的设计变更很小

- R32 Has Higher Discharge Line Temperature Comparing to R410A
  R32的排期温度较R410A高
  - Solution Available to Resolve DLT Issue
    市场上已经有成熟的解决方案

- Emerson offers Complete Line-up in R32 Compressors
  艾默生已经准备好提供全系列的R32压缩机产品


EMERSON
CONSIDER IT
SOLVED™