



New Case studies on Low GWP alternative refrigerants for HFCs.

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5th March 2014

Honeywell



\$39-39.5B

in sales*

54%

sales outside U.S.

- 1,300 sites, 70 countries
- 132,000 employees
- Morristown, NJ headquarters
- Fortune 100



Aerospace



Performance Materials and Technologies



Automation and Control Solutions



Transportation Systems



Cost Effective

Keeping operating costs lower than expected

- Lower initial cost than other alternatives
- Universal solutions in all climates
- Skills needed are similar to those used for current equipment



Environment

Safe And Sustainable

- Meeting ever-increasing global energy standards
- Low-GWP and low-TEWI designs
- Near drop-in solutions with performance that allow for low cost of adoption and reduction of maintenance requirements



Performance

Solstice™ refrigerants help enhance energy efficiency in all climates

- Commercial refrigerant solutions for supermarkets, air conditioning, transportation, climatization, vending and more
- All solutions designed to maximise energy efficiency
- Developed for installation ease and long service life

Solstice: A Growing Family of Molecules and Blends

Honeywell

Auto Air-conditioning



Aerosols / Solvents



Blowing Agents



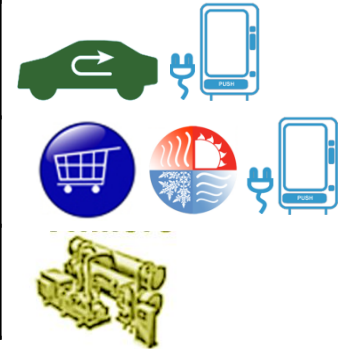
Stationary A/C and Refrigeration



Pipeline of 4th Generation Products being commercialized

Honeywell's Solstice™ low GWP refrigerants

Solstice™ HFO's – low and medium pressure applications			
Current Product	Non Flammable (ASHRAE A1)	Mildly Flammable (ASHRAE A2L)	Examples of Potential Applications
HFC-134a GWP=1430		Solstice yf GWP <1	Auto A/C, Vending, Refrigerators
		Solstice ze GWP <1	Chillers, Heat Pumps, CO2 Cascades, Refrigerators
R-123 GWP= 77	Solstice zd GWP <1		Centrifugal Chillers

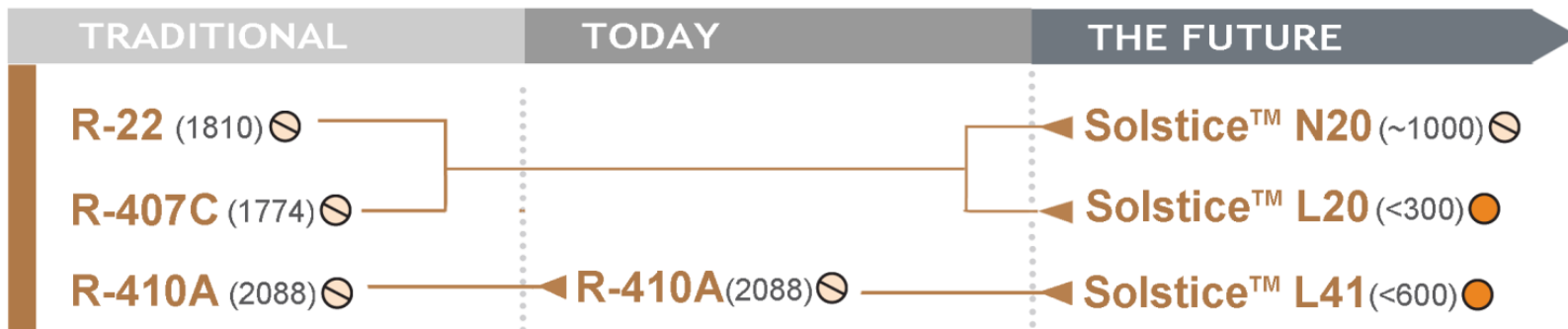


Solstice™ HFO Blends			
Current Product	Solstice™ N Series Reduced GWP Option Non Flammable (ASHRAE A1)	Solstice™ L Series Lowest GWP Option Mildly Flammable (ASHRAE A2L)	Examples of Potential Applications
HFC-134a GWP=1430	N-13 – GWP ~600		Chillers, Med-temp Refrigeration, CO2 Cascades
HCFC-22 GWP=1810	N-20 - GWP ~1000	L-20 - GWP <300	Stationary A/C, Refrigeration
R-404A GWP=3922	N-40 - GWP~1380	L-40 - GWP <300	Med- & Low-Temp Refrigeration
R-410A GWP=2088		L-41 - GWP <600	Stationary A/C Applications



Low GWP Refrigerants in Stationary AC Systems

Stationary AC



- ⊖ Non-flammable (A1)
- Mildly flammable (A2L)

		ODP = 0	ODP = 0 Low GWP	
Operating Pressures ↑	System redesign necessary if using refrigerants with higher operating pressures	HFC 410A	Non-flammable GWP = 2088 Properties enable cost-effective efficient system	<div style="border: 1px solid gray; padding: 5px; display: inline-block;">CO₂</div> <p>Very high pressure Major changes needed Typically higher adoption cost Low efficiency; GWP = 1</p> <div style="border: 1px solid green; padding: 5px; display: inline-block; background-color: #e0ffe0;">HFO L41 HFC32</div> <p>Mildly flammable GWP = 675 (R32) GWP < 600 (L41) 410A Performance R32 - high discharge T</p>
		HCFC 22	HFC 407C	Non-flammable GWP=1824 Utilizes R22 design

Solstice™ L41: Utilizing R410A design



- ⊖ Non-flammable (A1)
- Mildly flammable (A2L)

Haier Network Smart Appliance Project - World's first Solstice L41 A/C

- ◆ More than 70% reduction in GWP versus R410A
- ◆ Lower discharge pressure than R32
- ◆ Lower discharge temperature than R32
- ◆ Lower power consumption than R410A and R32 at high ambient temperature



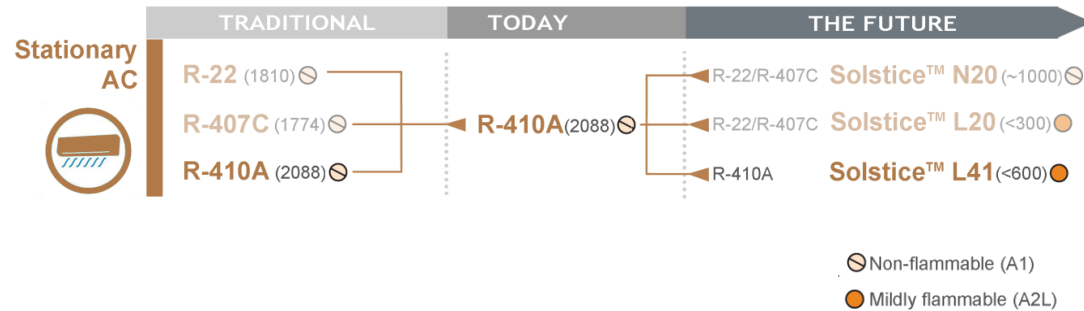
Solstice™ L41 outperforms other alternatives in high ambient A/C

Solstice™ L41 vs R32 vs R410a in stationary A/C

- ◆ R-32 has been proposed as an R-410A replacement

- Similar performance to R-410A
- GWP of 675, a 67% reduction

- ◆ Solstice L41 blend outperforms R-32:



1. GWP

- GWP of 600 for L41 vs. 675 for R-32

2. Discharge Temperature

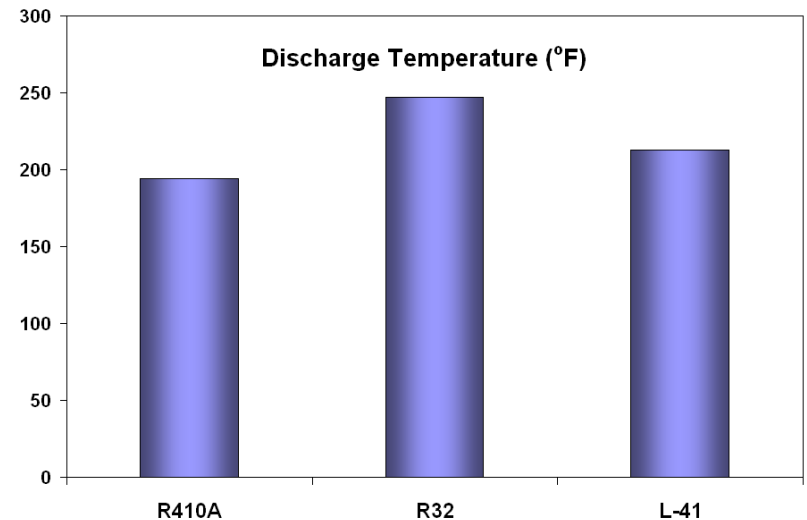
- L41 has lower discharge temperatures than R32
- Important in very warm climates
- Less cost to mitigate

3. High Ambient Temperature Performance

- R32 power consumption increases at high temps
- Adds to peak electricity demand issues

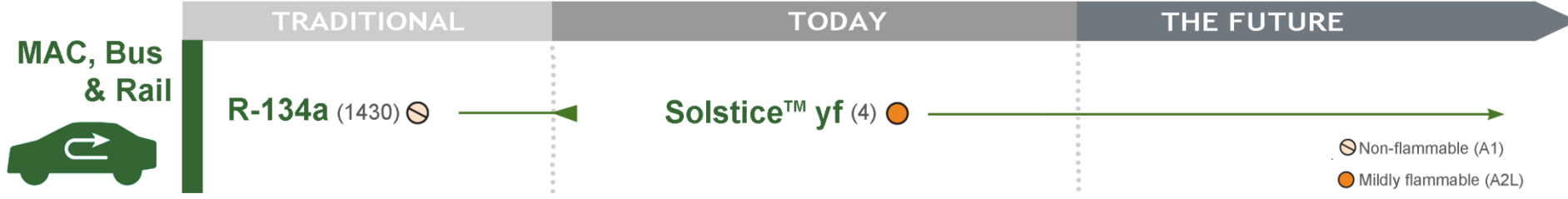
4. Flammability

- L41 has higher minimum ignition energy and lower flame speed – lower risk
- Much less flammable than propane (R290)
- Lower cost to mitigate

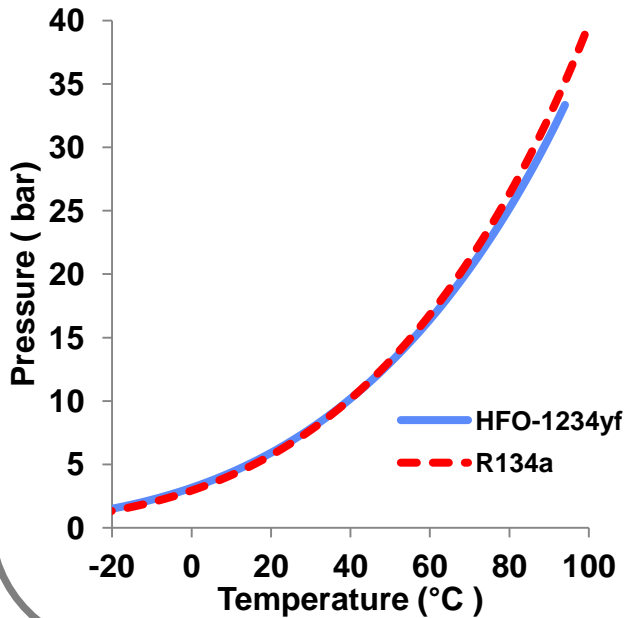


HFO blends offer cost-effective performance

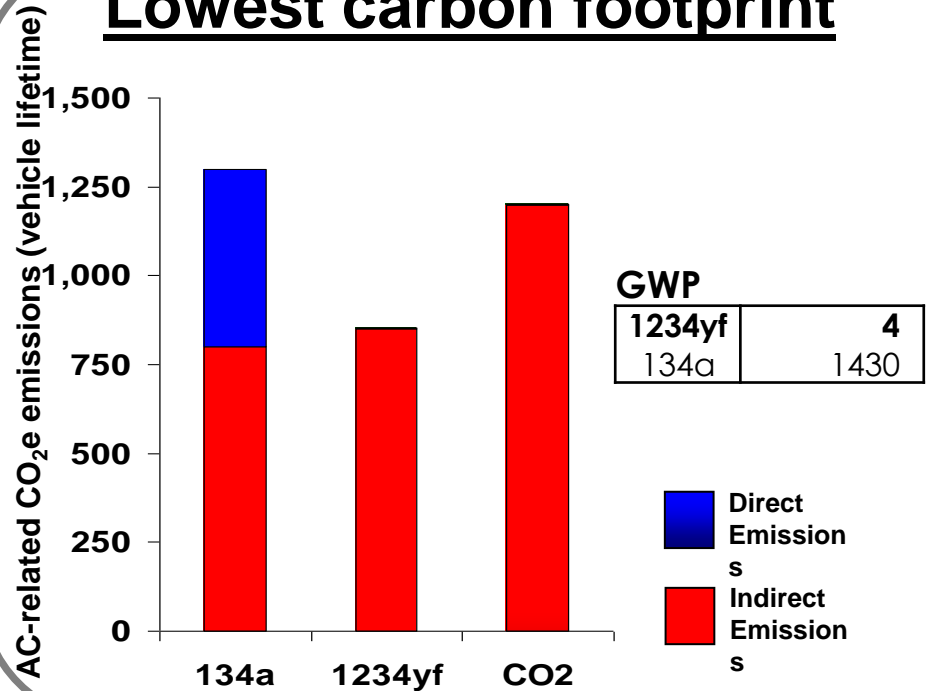
HFO-1234yf: lowest carbon footprint in Automobile



Similar performance



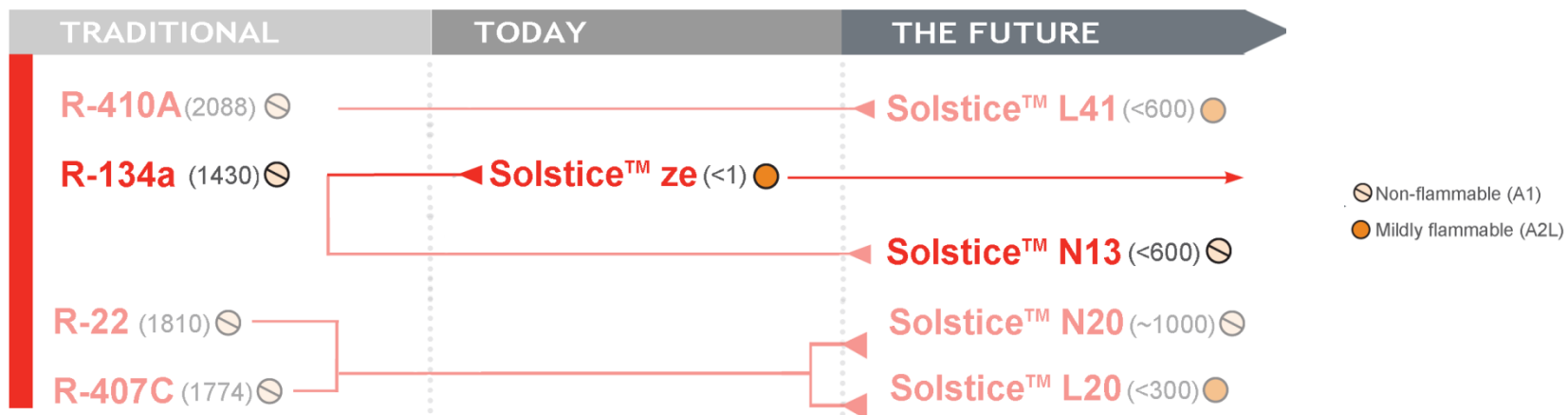
Lowest carbon footprint



HFO-1234yf : lowest carbon footprint of all AC technologies

Solstice ze: replacing R134a in medium pressure chillers

Chillers & Heat Pumps



- Solstice™ N13 & Solstice™ ze: similar efficiency to R134a
- Solstice N13: potential use in existing equipment
- Solstice ze good candidate for new equipment
 - Up to +5% CoP in chiller
 - Cooling capacity -25% @ ARI conditions
 - Can be overcome by design
 - Examples available in the market

Solstice ze&N13: potential use in medium pressure chillers



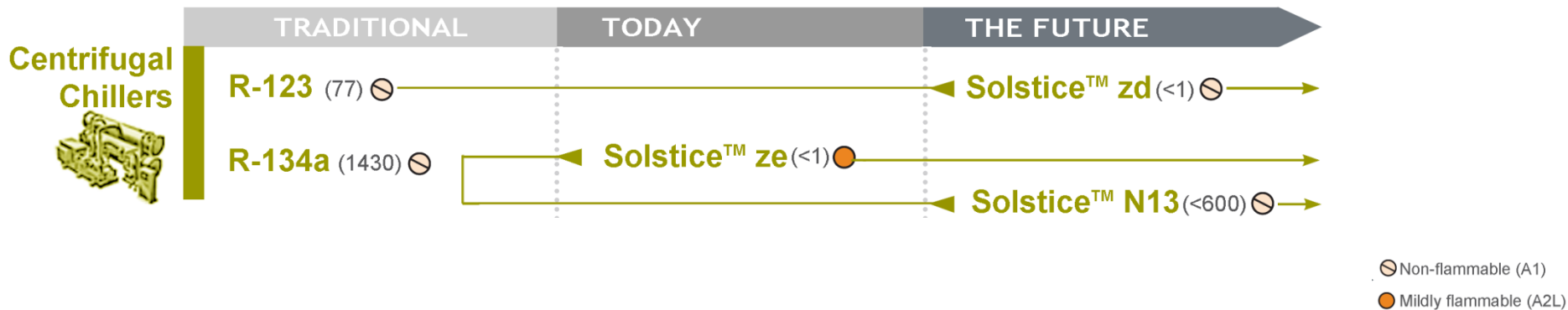
Solstice™ ze Screw Chiller
(Geoclima)



Solstice™ ze Centrifugal Chiller
(Geoclima, Turbocor Compressor)

Solstice™ ze in chillers in exhibition shows

Solstice zd : replacing R123 in low pressure centrifugal chillers



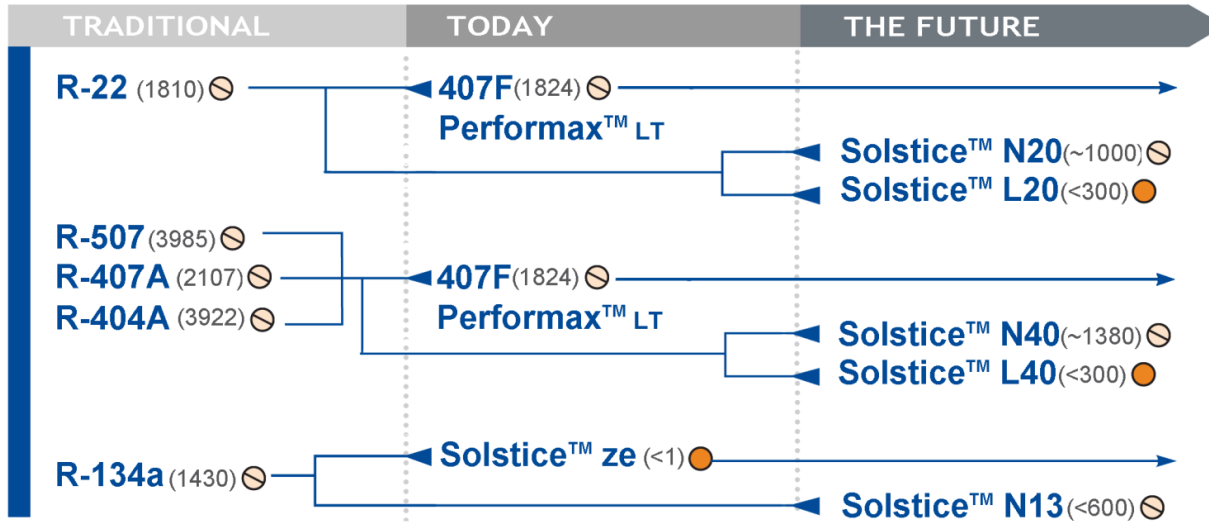
Solstice™ zd

- Replacement of R123
- Similar efficiency to R123
- It can provide higher capacity with minor system modifications
- Due to higher pressure than R123, system modifications may be required

Solstice™ zd can match efficiency of R123 and provide higher capacity

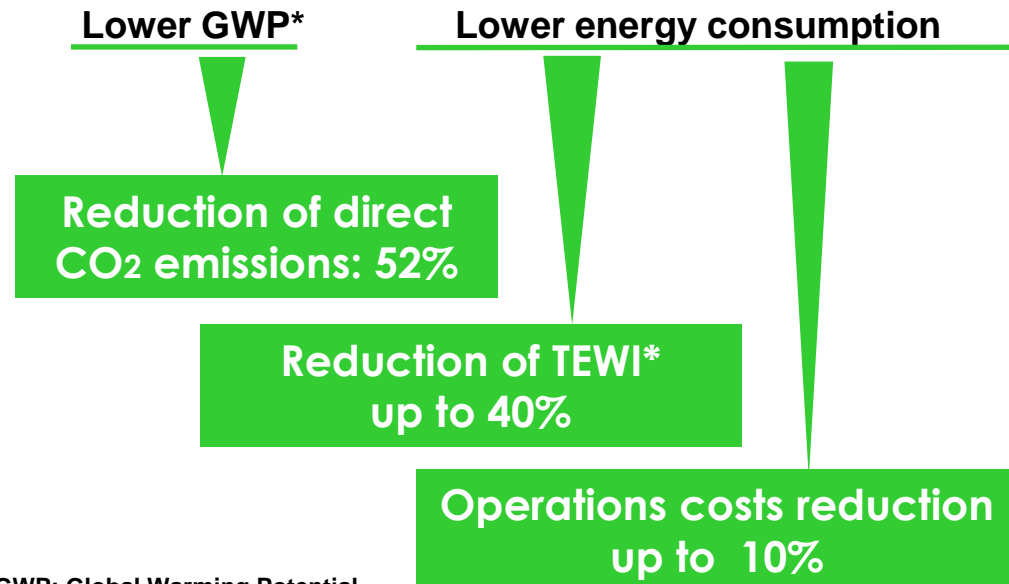
Commercial Refrigeration and 407F

Commercial & Transport Refrigeration



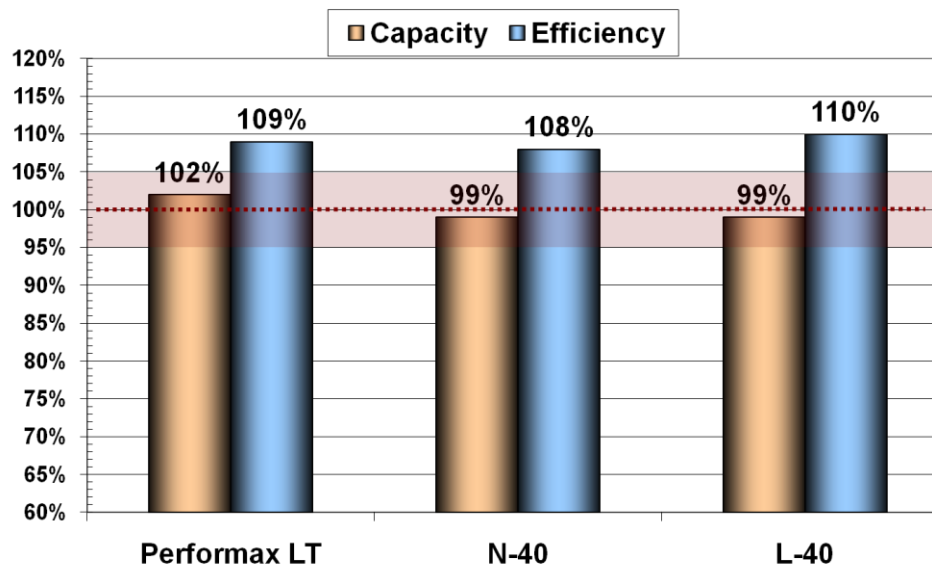
Performax™ LT: the best solution

- Mimics R22 performance
- Composed of commonly used HFC components
- Meets refrigeration specifications
- Limited modification at installation
- No change of major components
- Known system technology
- Safety and service standards as R22/R404A
- Same skills for technicians
- Same installation
- More than 600 installations and no issues



* GWP: Global Warming Potential
TEWI: Total Equivalent Warming Impact

Best solution to improve efficiency and reduce carbon footprint & running cost



Reduced GWP Options:

- Currently available refrigerant - Performax LT (**R-407F**)
 - GWP reduction of over 50% relative to R-404A. GWP ~15% lower than R-407A.
 - Performance is superior to both R-404A and R-407A.
- We have a developmental refrigerant, N-40
 - N-40 can be used in existing R-404A equipment with little or no modifications
 - GWP reduction of over 65% as compared to R-404A with higher efficiency.

Low GWP Options:

- L-40 is the lowest GWP option that has capacity consistent with R-404A
 - GWP reduction of over 90% relative to R-404A with superior efficiency.



Conclusions

Honeywell

- Stationary AC Systems
 - Solstice L41 good option as R410A replacement.
 - Outperforms other alternatives in high ambient conditions
 - High COP at high condensing temperatures
 - Solstice L20 and N20: potential alternatives to R22/R407C in residential AC
 - ♦ Solstice L20 performs well in high ambient
- High Pressure Chillers
 - Solstice L41 good option as R410A replacement
 - ♦ Minor system modifications may be required
 - ♦ Critical temperature higher than 410A&R32 → Better suited for high ambient
 - ♦ Lower GWP than 410A&R32 and lower discharge temperature than R32
 - Solstice L20 is a potential alternative to R407C
- Medium pressure centrifugal chillers – Replacing R134a
 - Solstice™ ze for new equipment: high efficiency, available on the market
 - Solstice N13 promising option for replacing R134a in existing equipment
- Low pressure centrifugal chillers
 - Solstice™ zd as replacement of R123: higher capacity, similar efficiency



Solstice platform is key for the future of your business

Solstice™ yf

- In commercial use by auto industry now
- Sample quantities available today for stationary applications

Solstice™ ze

- Commercially available today
- Announced world scale plant for 2013

Solstice™ zd

- Commercial plant on stream 2nd quarter 2014
- Sampling for chiller, foam and solvent applications

Solstice™ Blends

- Contains Solstice ze and/or yf blended with other products
- Recently announced availability of Solstice™ L-41
- Currently sampling to OEM's, compressor manufacturers and AREP

Working with Industry to Commercialize Solstice™

Partners all around the world

- Technology leadership enables our partners to
 - Achieve real progress
 - Create positive impact in their business and in their world
- Trialling Honeywell's Genetron® and Solstice™
 - Thermodynamic analysis
 - ♦ Genetron Properties Suites → most advanced simulator in the market (free)
 - ♦ Three R&D laboratories (US, India, Shanghai)
 - ♦ Experts' support
 - Samples
 - Analysis of results
 - Publications, media exposure, congresses...



We look forward to collaborating with you in trials / research programs

Honeywell

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