

Honeywell



Innovating to Enable Industry Compliance

## **Evolution of Honeywell Blowing Agents**

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Blowing Agents Developed to Address Montreal and Kyoto Protocol Issues

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#### **Appliances**

Enovate

- Enovate, cyclopentane, 141b, Solstice<sup>®</sup> LBA
- Energy efficiency standards drive product design
  - Insulation efficiency
  - "Sealed side" (compressor, etc.) efficiency
- North American OEMs use Enovate to achieve energy efficiency requirements – moving to LBA
  Asian OEMs converting from cyclopentane to
- Enovate to improve energy efficiency • Solstice<sup>®</sup> LBA shows better energy efficiency than





#### Spray Wall Foam

- Enovate, 141b, 365mfc/227ea, CO<sub>2</sub>(water), Solstice<sup>®</sup> LBA
- Increasing energy efficiency standards in residential and commercial buildings globally
- Replacement of fiberglass in walls with closed cell spray foam can lower energy costs by up to 35%
- Industry initiative to promote the use of spray foam in residential and commercial wall insulation
- Enovate is the global blowing agent of choice for spray foam
  - energy efficiency
  - non-flammability
  - Liquid
- Solstice<sup>®</sup> LBA promising as an Enovate replacement in spray foam
  - 3-5% better insulation value
  - Systems houses in Japan and USA converting to Solstice<sup>®</sup> LBA

Maximizes The Energy Efficiency of Foam Insulation

#### **Spray Foam Roofing**

- Enovate, 141b, 365mfc/227ea, Solstice® LBA
- Cost effective method to apply energy efficient and weather proof coating to commercial & industrial roofs
- Spray foam roofing holds up better in severe weather than traditional roofing (hurricane)
- Enovate is blowing agent of choice for spray foam
  - energy efficiency
  - non-flammable
  - liquid
- Enovate used in roofing spray foam in N. America, Japan, & Europe
- HBA-2 showing excellent results in trials globally







### Walk-in Cooler / Building panels

- Enovate, HFC-134a, HCFC-141b, HCFC-22, hydrocarbons, CO<sub>2</sub>(water), 1234ze(E), HBA-2
- Foam used as structural element, adhesive, and thermal insulation
- Panels used for commercial and residential construction
- Enovate is the fluorocarbon blowing agent of choice for low temperature applications
  - Highest insulation value low temperature applications
  - Allows for use of thinner panels or smaller refrigeration equipment
- Enovate used in low temperature panel applications in North America, and Asia
- Enovate apreferred in applications where high resistance to fire properties are required.

•1234ze(E) and HBA-2 showing good promise in industrial trials

Optimal properties for rigid foam applications

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#### **One and Two Component Froth Foams**

- HFC-134a, HCFC-22, 1234ze(E)
- •Requires a gaseous blowing agent
- Gas acts as both a blowing agent and a propellant
- HFC-134a is the product of choice
  - Vapor pressure
  - Non-flammability





Honeywell Blowing Agents – Optimal properties for rigid foam applications

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#### **Extruded Thermoplastic Foams**

- HFC-134a, HCFC-22, HCFC-142b, CO<sub>2</sub>, butane
- Requires a gaseous blowing agent
- HFC-142b is current product of choice in N. America
- 0 ODP technologies
  - N. America: HFC-134a
  - Europe: HFC-134a, CO<sub>2</sub>
  - Japan: butane









### **Other Foam Applications**

- Enovate, HCFC-141b, HCFC-22, HFC-134a, hydrocarbons.
- CO<sub>2</sub> (water), 1234ze(E), HBA-2

• Properties of Enovate make it a good choice for many rigid foam applications

- Compatible with foam processes designed for HCFC-141b (no capital requirement)
- Non-flammability
- Liquid
- Low thermal conductivity

Enovate finding utility where high performance, good fire resistance, or low conversion costs are important
1234ze(E) aad HBA-2 will find utility in similar applications

Honeywell Blowing Agents – Optimal properties for rigid foam applications

# **Global Labs**

- Buffalo Base Global Technology Development and Coordination
  - Regional Labs Participate as Needed (One Virtual Global Lab)
- Regional Labs (BRL, SHL, HITC)
  - Applications Development / Technical Support for Their Regions
  - Adapting Base Technology to Meet Local Needs
  - Developing New Technology to Meet Local Needs

• All labs fully equipped with foam processing and testing equipment needed to develop new products and serve customers' technical needs.



Highly coordinated, fully equipped global labs

## Solstice: A Growing Family of Molecules and Blends

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## Auto Air Conditioning

- Product: Solstice YF
- Environment: GWP of <1 vs. 1,430
- **Performance:** Same Cooling Efficiency
- **Safety:** SAE International Approved
- Cost Effectiveness: Near Drop-in Replacement
   Commercialised; Plants Being Built

### **Foam Blowing Agents**

- Products: Solstice LBA and Solstice GBA
- Environment: GWP = 1 vs. 1,030-1,430
- **Performance:** Better or Equal Energy Efficiency
- Safety: Dramatically Safer than Hydrocarbons
- Cost Effectiveness: Lower Capital and System Costs

#### GBA and LBA: Commercialised, Plants being built

## Aerosols

- Product: Solstice Performance Fluid
- Environment: GWP of <1 vs. 1,430
- Performance: Meets all Requirements
- Safety: Dramatically Safer than Hydrocarbons
- Cost Effectiveness: Economic in Use Today
   Commercialised; Plants Being Built

## **Stationary Air Conditioning**

- Products: Solstice L-41 and Solstice L-40
- Environment: >50% GWP reduction
- **Performance:** Same Energy Efficiency
- Safety: Dramatic Improvement vs. Hydrocarbons
- **Cost Effectiveness:** Solution by Application

#### Near Term Commercialisation, strong customer interest

Pipeline of 4th Generation Products Being Commercialized

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	HONEYWELL OPTIONS		
	Low Global Warming Products	<b>GWP</b> <sub>100</sub>	
	Solstice™ GBA	<1	
Foams	Solstice <sup>™</sup> LBA	1	
Refrigerants	Solstice™ MAC	<1	
	Solstice <sup>™</sup> ZE	<1	
	Solstice™ HFO Blends	200-500	
Solvents	Solstice™ Performance Fluid	1	
Aerosols	Solstice <sup>™</sup> Propellant	<1	

Honeywell is committed to Commercialization of Low GWP Products

## **Comparative Physical Properties – Solstice™ LBA**

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#### • Solstice LBA = (E) 1-chloro-3,3,3-trifluoropropene

Environmental Property	Solstice LBA	245fa	365mfc	Cyclopentane	141b
ODP	01	0	0	0	0.11
Atmospheric Life	26 days <sup>2</sup>	7.7 years <sup>2</sup>	8.7 years <sup>2</sup>	Days	9.2 years <sup>2</sup>
GWP <sub>100</sub>	1 <sup>2</sup>	858 <sup>2</sup>	804 <sup>2</sup>	<25 <sup>3</sup>	782 <sup>2</sup>
VOC (US EPA Status)	No	No	No	Yes	No
Safety Property					
Flash Point, <sup>o</sup> C / <sup>o</sup> F	None	None	<-27 / -17 <sup>4</sup>	-35 / -37 <sup>5</sup>	None
LFL / UFL (Vol % in air)	None	None	3.6 <b>-</b> 13.3 <sup>4</sup>	1.5 -8.7 <sup>5</sup>	7.6 <b>-</b> 17.7 <sup>6</sup>
PEL, ppm	800 <sup>5</sup>	<b>300</b> <sup>5</sup>	1000	600 <sup>5</sup>	500 <sup>7</sup>
Physical Property					
Molecular Weight, g/mol	130	134	148	70	117

1. No impact on ozone layer depletion and is commonly referred to as zero, Reference: Preliminary report: Analyses of tCFP's potential impact on atmospheric ozone; Dong Wang, Seth Olsen, and Donald Wuebbles Department of Atmospheric Sciences University of Illinois, Urbana, IL

2. Global Warming Potentials and Radiative Efficiencies of Halocarbons and Related Compounds: A Comprehensive Review; Hodnebrog et. al., Reviews of Geophysics, April 2013. Not previously included in IPCC Technical Summary (see note 3)

3. FTOC 2010 Assessment Report

4. Solvay Literature

5. WEEL

6. NIOSH

7. Honeywell

Solstice LBA Has Excellent Blowing Agent Properties

## Whirlpool Adopting Solstice LBA in 2013





- In refrigerator trials, Solstice LBA saves costs:
  - 10-12% more efficient than cyclopentane
  - 2% more efficient than 245fa
- Results proven with OEMs in US, China, Korea, Europe, M. East
- Similar performance for spray and panel foam

Lowest cost option for meeting stringent efficiency standards

## Solstice LBA – Arrives at the Cleveland Airport

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#### **CLEVELAND AIRPORT**



#### **PROJECT DETAILS**

- Roof damaged during Hurricane Sandy in Oct 2012.
- Solstice LBA selected due to the severe hail rating from FM Global, one of the world's largest property insurers .
- Meets 'FM Approvals' other requirements for wind uplift, flammability, leaks, and foot traffic

#### **BENEFITS RELATIVE TO 245fa**

- 2-4% higher insulation
- ~10% better yields (materials savings)
- Better compressive strength
- Higher hail rating from FM
- Lower clogging of guns (contractor benefit)

#### Solstice LBA offers several benefits vs 245fa

## **Solstice LBA: A Global Program**

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Successful Global Program in All Major Applications

# **Commercial Plant #1 Timeline**

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### **Current Status**

- Infrastructure in place, structural build underway
- All major equipment has been purchased, delivery and installation in process
- On track for start up mid-Q1'14
- Targeting first commercial product by end of Q1

On track for first commercial product by end of Q1 2104

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# **Regulatory Status**

- Global Regulatory Filings:
  - Current registrations: US (SNAP and PMN), EU REACH (<10MT), China (<10MT), Japan, Canada, S. Korea, others
  - Registrations in Process: EU REACH (1,000MT), China (1,000MT), Australia, Philippines, New Zealand
  - No limitations on sales in: India, Indonesia, Mexico, Brazil, S. America, Central America, M. East, Africa
- VOC Exempt: August 2013
  - US EPA Ground Level Ozone measure
  - Akin to POCP in Europe

## **Commercialization Status**

- Global commercial trials on-going across multiple applications
  - Appliance: US, China, Korea, Japan, Europe
  - Spray foam: US, Canada, Japan, Europe
  - Panel (continuous and discontinuous): US, Europe, Japan
  - Chillers: US
  - Solvents: US, Europe
- Initial commercial sales started in Q2, 2013:
  - Appliance (US)
  - Spray foam (US, Canada and Japan)
- Supply availability
  - Today: Large "semi-commercial" plant
  - Q2 2014: World class, large scale plant
  - Planning / Engineering on 2<sup>nd</sup> large-scale plant

Global interest across multiple applications; Supply plans in place

# Summary

### Superior Energy Efficiency Performance

- 2-4% more energy efficient than 245fa
- 8-10% more energy efficient that Cyclopentane

## Strong environmental properties

- GWP of 1 (=  $CO_2$ ), non-ODP, VOC-exempt, non-flammable

## Commercially available today

- Today: Large "semi-commercial" capacity
- Q2 2014: World class, large scale plant

## - Commercial sales have begun globally in multiple applications

### Registered globally

- Current registrations: US, Japan, Canada, Mexico, Brazil, S. Korea, others
- Registrations in Process: EU (>1,000mt), China (>1,000mt), Australia, Philippines, New Zealand
- No limitations on sales in: India, Indonesia, Mexico, Brazil, S. America, Central America, M. East, Africa

# SUMMARY – Honeywell Blowing Agents

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- 50+ years of experience in supplying fluorocarbon blowing agents to the foam industry
- Leader in the development of new products to meet regulatory and performance requirements
- World class product development and technical support capabilities
- Global presence with local knowledge and expertise
- Established industry presence
  - Technology team well established as industry experts
  - Significant participation in Trade Associations and other industry groups.

Partnering With the Industry to Commercialize New High Performance Blowing Agents