



SOLSTICE® LBA LGWP BLOWING AGENT FOR SUPERIOR ENVIRONMENTAL AND INSULATION PERFORMANCE

Conferenza Nazionale Poliuretano ANPE - Milano, Maggio 2017

Honeywell

Honeywell



\$38.6B
in sales for 2015

53%
of sales outside U.S.

- ~1,300 sites, ~70 countries
- More than 129,000 employees
- Morris Plains, N.J. headquarters
- Fortune 100
- NYSE: HON



Aerospace









Performance Materials and Technologies



Automation and Control Solutions

Fluorine Products Generations of New Products

1987 Montreal Protocol Ozone Depletion Concerns		1996 Kyoto Protocol Global Warming Concerns		2011 EU MAC Vehicle Refrigerant GWP < 150	
CFCs Chlorofluorocarbons		HCFCs Hydrochlorofluorocarbons		HFCs Hydrofluorocarbons	
Ozone Depleting 					
ODP 1.0		ODP 0.1		ODP 0	
Global Warming 					
GWP 8000		GWP 2000		GWP 1000	
Honeywell Products		Genetron®		Genetron® Enovate®	
				Solstice®	

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Honeywell innovation to achieve environmental breakthroughs

ODP Ozone Depletion Potential is relative amount of ozone degradation compared with R11 ODP = 1.0

GWP Global Warming Potential number equivalent to CO2 impact with GWP = 1

HFCs Under Pressure for Global Reduction

Honeywell

UNITED STATES

- July 2015 EPA prohibited use of certain HFCs used in MAC, commercial refrigeration, foams and aerosols by certain dates
- March 2016 EPA proposed further HFC bans in chillers, spray foam, and certain MACs for larger vehicles

CANADA

Considering HFC phase-down, sector-specific restrictions, or a combination of both for proposal in late 2016

MEXICO

Credit for voluntary replacements of HFCs in new MAC similar to EPA's CAFE credits. Phase-out of HFCs in MAC may be effective by 2017 for 2018 models. Bans in other sectors to be considered after EPA final rule.

EUROPE

- F-Gas Regulation: for certain applications. Countries with HFC taxes in place: Denmark (2001), Norway (2003), Slovenia (2009), Spain (2014); Countries considering HFC taxes: France, Poland and Sweden
- CO2 quota scheme: 30% reduction in January 2018
- HFC ban in polyurethane applications in 2023

SOUTH KOREA

2016 implemented credit for replacement of HFCs in MACs

JAPAN

METI regulating HFCs with GWP limits in MAC, RAC, Comm Ref, and blowing agents starting 2015 thru 2025. HFC phaseout for spray foam 2020.

CHINA

Reporting required for bulk HFC imports into China

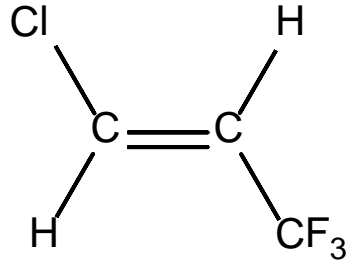
UNITED KINGDOM

Voluntary Green Guide (BRE), GWP must be <5

AUSTRALIA

Reviewing options for restricting HFCs. Options to be considered in 2016

Selected Physical Properties – Solstice LBA



- **(E) 1-chloro-3,3,3-trifluoro-propene**
- **Trans isomer**
- **1233zd**

	Solstice LBA	245fa	365mfc	Cyclopentane
Flashpoint				
°C	None	None	<-27	-7
°F	None	None	-17	19
LFL / UFL (Vol % in air)	None	None	3.6-13.3	1.5-8.7
ODP	0 ⁽¹⁾	0	0	0
GWP, 100 yr	1 ⁽²⁾	1,030 ⁽³⁾	910	<25 ⁽⁵⁾
OEL ⁽⁴⁾ (PEL)	800	300	1,000	600

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
 3. 2007 Technical Summary. Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
 4. Workplace Environment Exposure Committee / Manufacturers' literature
 5. UNEP Rigid and Flexible Foams Technical Options Committee 2010 Report
- Note: Physical properties are one of a mosaic of attributes that must be assessed to determine the suitability of any material as a blowing agent.

Solstice[®] LBA Large Scale Plant



- Q2 2014 start-up for Solstice[®] LBA
- Planning underway for 3rd and 4th plants

Regulatory Status

- **Global Regulatory Filings:**

- Current registrations: US (SNAP and PMN), EU REACH (>1,000MT), Japan, Canada, S. Korea, others
- Registrations in Process: China (1,000MT)
- No unique product safety registration requirements 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

Solstice LBA Adoptions Accelerating Globally



1 **AFINOX**

2 **BASF**
We create chemistry

3 **covestro**

4 **Dow**

5 **FESTIVO**

6 Finland:
Commercial
Freezer OEM

7 **Fisher & Paykel**

8 **Haier**

9 **Hisense**

10 **HOSHIZAKI**

11 Japan: Commercial
Appliance

12 Japan: Commercial
Appliance OEM

13 **Midea**

14 **OSO**
HOTWATER

15 **Rheem**

16 US: Domestic refrigerator,
final qualifications underway

17 **Whirlpool**

18 **ACCELLA**
PERFORMANCE MATERIALS

19 **BAYER**
Bayer Pearl

20 **DEMILEC**

21 **ELASTOCHEM**
Specialty Chemicals Inc.

22 **ICP**

23 **Henry**

24 **LAPOLLA**

25 **NCFI**
POLYURETHANE

26 **Puitem**

27 **SES**
polyurethane systems

28 **Synthesia**

29 **TOYO TIRES**
driven to perform

30 **AWIP**

31 **CIMC**

32 **Kingspan**

33 **MCNS**
MCNS Chemicals

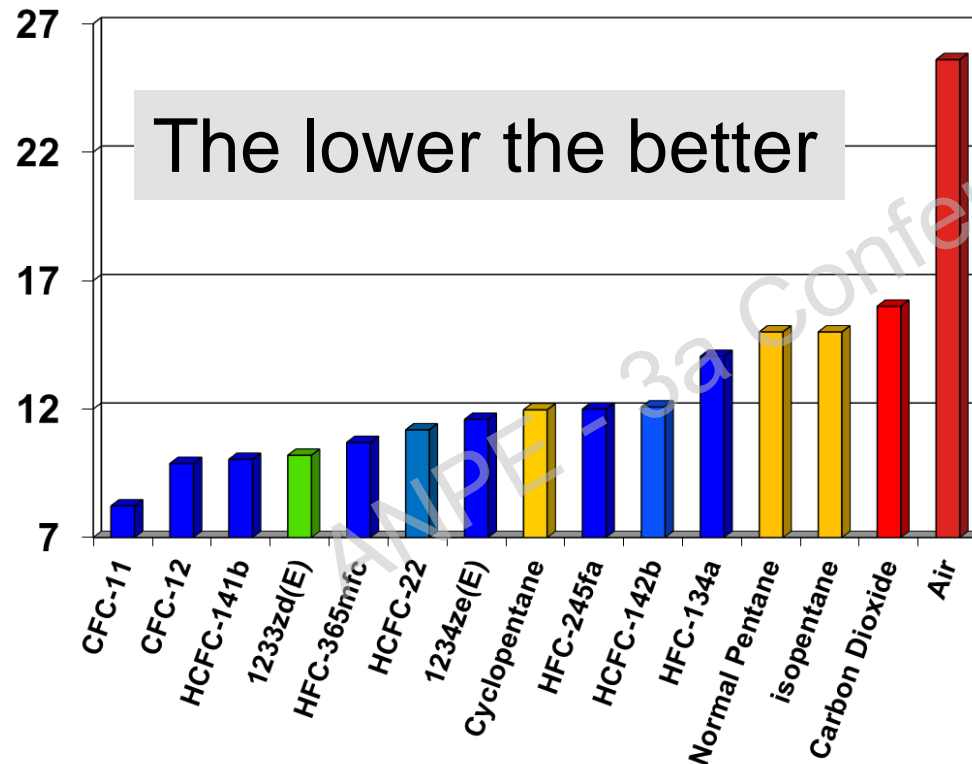
34 **UNIT45**

Insulation and blowing agents

- ◆ Key parameter is thermal insulation or lambda (λ_{foam})

$$\lambda_{\text{foam}} = \lambda_{\text{conduction(gas)}} + \lambda_{\text{convection(gas)}} + \lambda_{\text{conduction(solid polymer)}} + \lambda_{\text{radiation}}$$

60 %

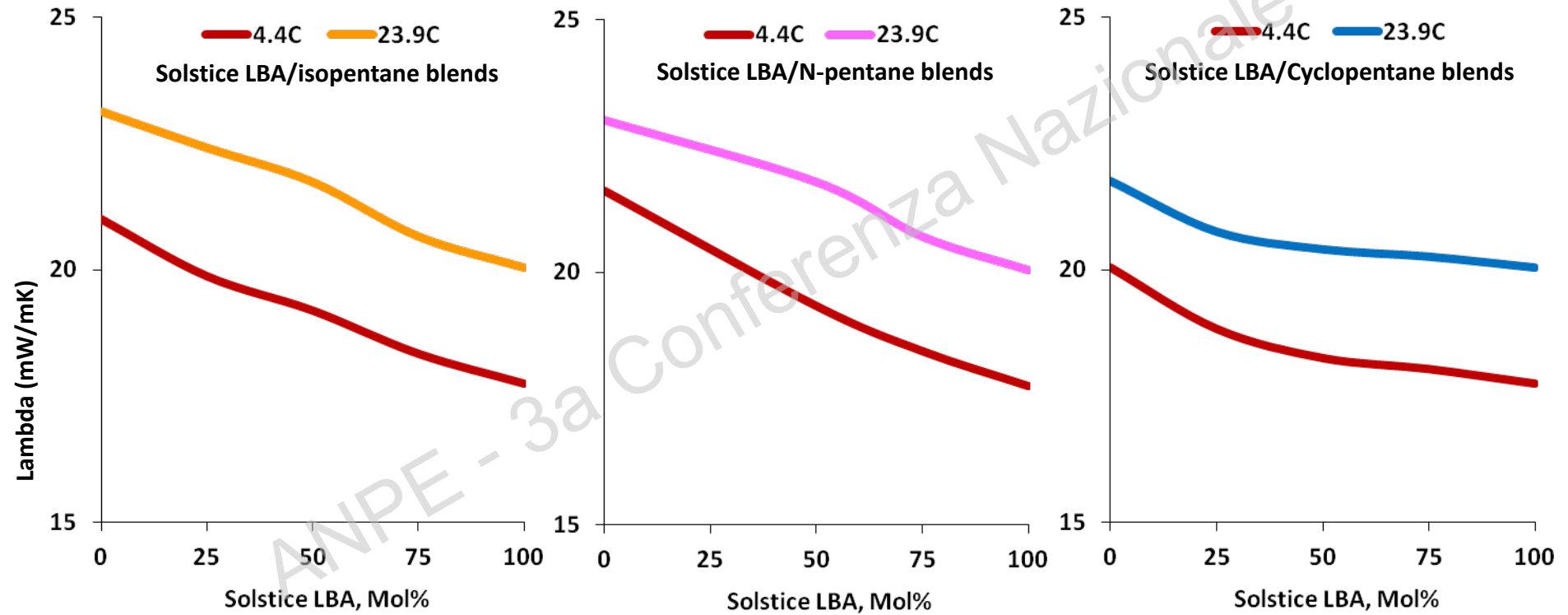


- Blowing agent stays inside the cells
- Responsible for excellent thermal insulation

Types:

- Pentane isomers (flammable)
- HFC (affected by F-gas)
- HFO
- Only water
- Different end use applications have different solutions

Solstice LBA / Pentane Blends



Equipment Considerations

Present blowing agent	Future possibilities with Solstice LBA	Capex Involved
HFC or Water-Blown	Pre-blended	None
	3rd stream directly in the mixing head	Minor
	In-line blending with formulated polyol	Minor
Pentane	3rd stream directly in the mixing head	Minor
	In-line blending with formulated polyol	Minor to none

LBA compatibility with plastics and elastomers per our guidelines in the Technical Data Sheet

- Solutions already validated by the main equipment producers

APPLICATIONS

ANPE - 3a Conferenza Nazionale

Solstice[®] LBA in Spray Foam



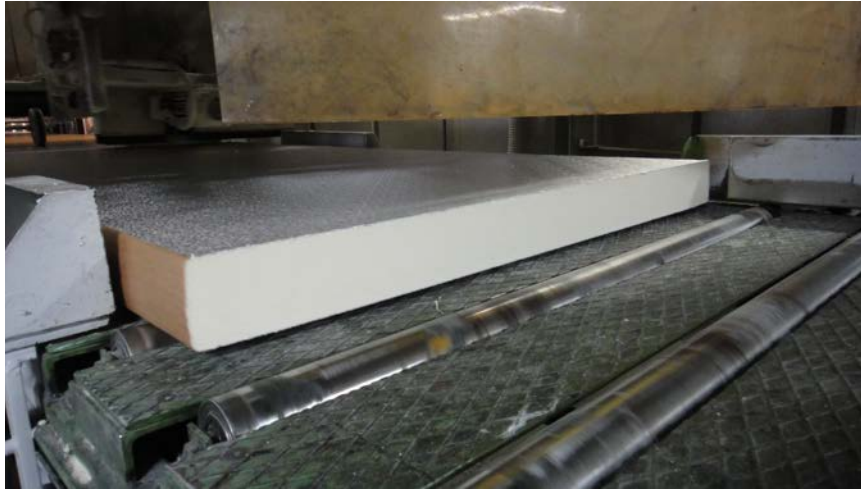
Cleveland Airport - Roof

Property	HFC 245fa	Solstice LBA
Lambda initial (mW/mK)	21-22	20-21
Shelf Life (months)	3	3
Reaction to Fire (Euroclass)	E	E
Yield (Kg/m ²)	1.9-2.1	1.7-1.9

Benefits Relative to HFC-245fa

- Up to 2-4% insulation value improvement
- Up to ~10% better yields (materials savings)
- Lower vapor pressure improves storage and handling
- Improved foam performance across a wide range of surface temperatures (extends the spray season)

Solstice[®] LBA in Flex Faced Board



Property	pentane	Solstice LBA
Lambda initial (mW/mK)	20-21	17-18
Reaction to Fire (Euroclass)	E	E
% Flame Retardant	High	Medium

Benefits Relative to pentane

- Up to 15% insulation value improvement
- Up to 15% lower board thickness
- Ideal solution for building renovation where low thickness is required.
- Enhanced flammability performance
- Better miscibility in foam

Solstice[®] LBA in Sandwich Panel



Property	pentane	Solstice LBA
Lambda initial (mW/mK)	22-25	18-20
Reaction to Fire (SBI)	Bs1d0	Bs1d0
Reaction to Fire (Euroclass)	E	E
% Flame Retardant	High	Medium

Continuous - Benefits Relative to pentane

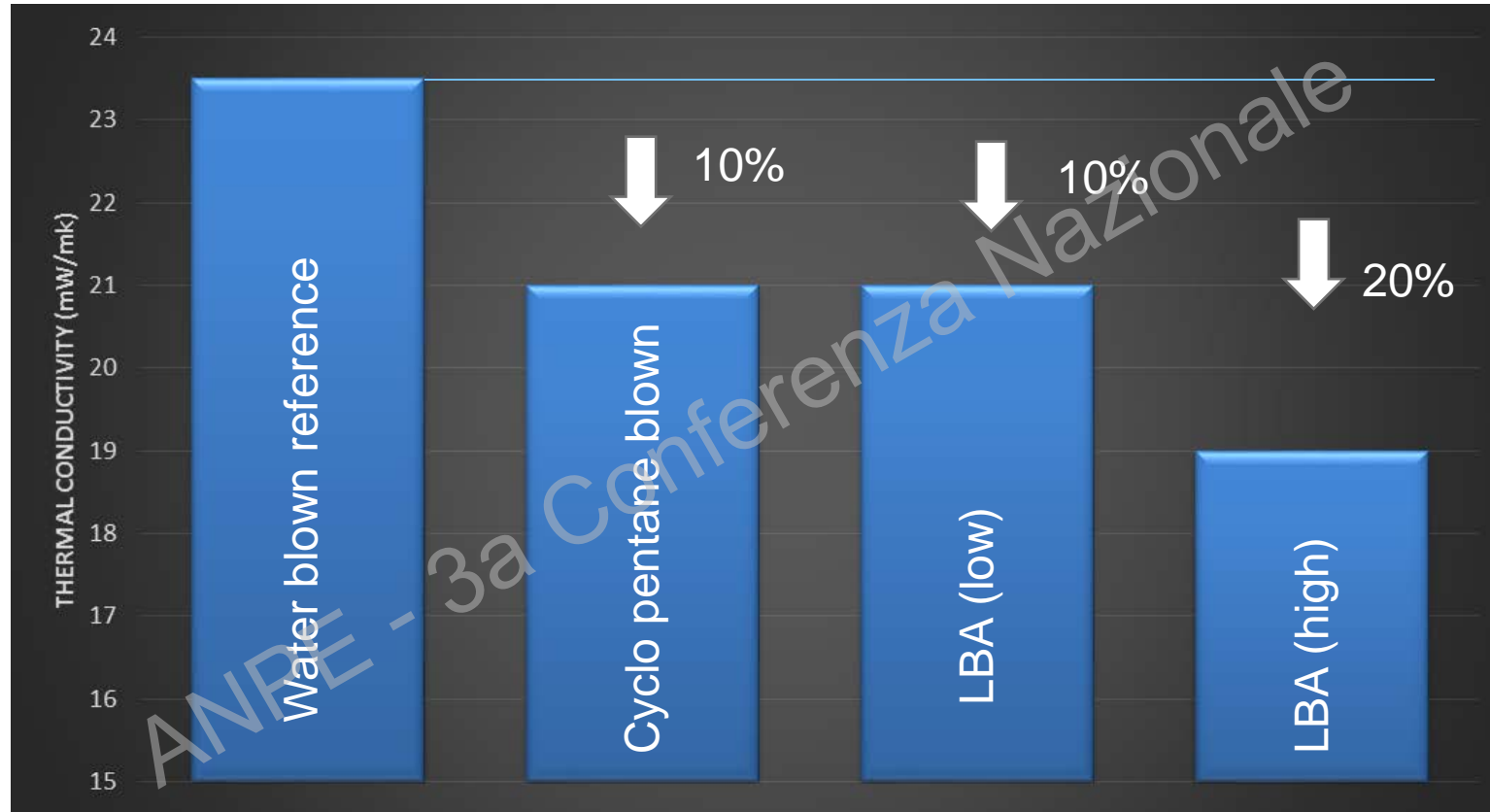
- Up to 20% insulation improvement vs. current industry average (continuous process)
- Up to 20% lower panel thickness
- Improved productivity in transportation costs
- Enhanced flammability performance

Disconti- Benefits Relative to HFC

- Not affected by F-Gas ban
- Drop-in solution while keeping performance

Commercial Refrigeration – lambda values

- Solstice based solutions can improve insulation



- Better insulation helps to improve Energy Efficiency

EXAMPLES

<https://www.honeywell-blowingagents.com/products/solstice-liquid-blowing-agent/>

Spray Foam



Honeywell | Blowing Agents

“As one of the largest Systems Houses in Europe, we are leading the development of a closed-cell spray foam system using Honeywell’s new Solstice® Liquid Blowing Agent. Not only do we want to be well ahead of legislation calling for the elimination of HFC blowing agents, we are pleased with the improvements in product performance.”

— **Tony Belmonte**, Commercial Director for Polyurethane Systems, Synthesia Internacional

Synthesia’s Spray Foam Featuring Honeywell’s Solstice® LBA Debuts in Europe

Afinox Adopting Solstice[®] LBA in Commercial Refrigerators



17% improved insulation vs.
water based foam

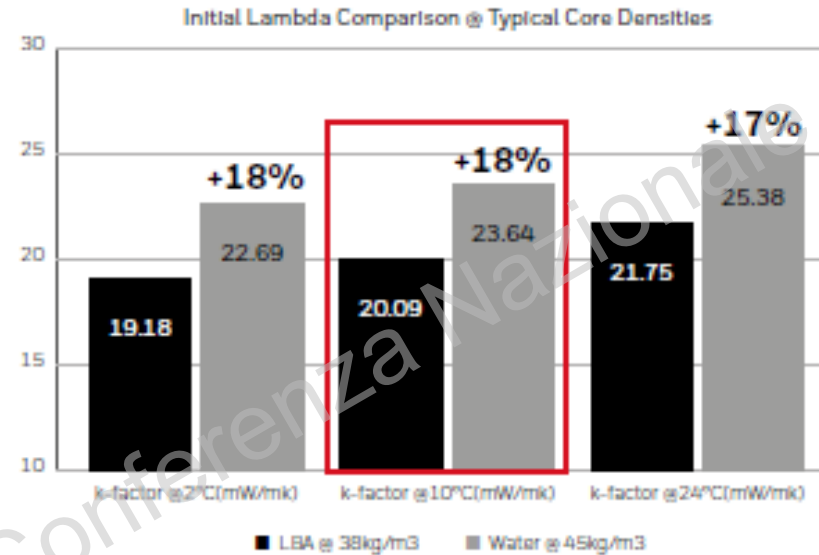
“The use of Honeywell’s Solstice LBA in the foam is helping us improve the energy efficiency of our refrigerators, which is beneficial not only to customers and manufacturers, but to society as a whole.”

Civiero Karim,
R&D Manager, Afinox Srl.

OSO Water Heaters see 10-15% Efficiency Improvement with Solstice LBA



Lambda Value Comparison – Solstice vs. Water



Honeywell's internal lab evaluations determined that test panels made with Solstice LBA showed 17% better insulation performance than water-blown PUR foam over a 180-day period.

- Solstice LBA delivered a 10-15% improvement in energy efficiency (>17% lambda improvement)
- Achieve an A-rating under the European Ecodesign Directive
- Less foam needed vs. water based systems
- Existing equipment used avoiding large capital spend

END

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