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Honeywell Solstice liquid blowing agent introduced for global spray foam applications

The paper summarised in the following article was originally presented at the Center for the Polyurethanes Industry conference in September 2011. To review the full details of the paper and the corresponding presentation, please visit the resource center of the product website: www.honeywell-solsticelba.com.

The change is starting. Nations around the globe are now focusing on the task of reducing the use of high global warming materials. The global spray foam industry is beginning the transition. Honeywell has officially introduced its liquid low global warming blowing agent, Solstice liquid blowing agent (LBA). With a global warming potential (GWP) of <7, Solstice LBA is a superior choice for use in spray foam insulation with the potential to significantly reduce global warming. A replacement for liquid HFC blowing agents like 245fa and 365mfc, Solstice LBA is a cost-effective solution to meet ever-increasing energy standards globally.

Honeywell has been developing blowing agents since the beginning, meeting both the environmental and technical challenges of the industry. It started with the introduction of trichlorofluoromethane, (CFC-11) in the mid-1950's. This was followed with the introduction of the HCFCs, the most common being 1,1-dichloro-1-fluoroethane, or 141b. Although conversion to 141b reduced the ozone depletion potential of blowing agents by 90 %, these materials were also earmarked for phaseout and HFC blowing agents were introduced. The most common of the HFCs was 1,1,1,3,3-pentafluoropropane, or 245fa. This material satisfied the requirements of ozone depletion regulation while, at the same time, retained the high performance and non-flammability required in many foam applications. Honeywell is now leading the development of fourth-generation fluorocarbon technology, anticipating low global warming potential requirements with Solstice LBA. Honeywell has explored the use of Solstice LBA in spray foam systems and it is an ideal replacement for 245fa. Compared to 245fa, which continues to be a product of choice in the global spray foam industry, initial small and large scale laboratory experiments, as well as a small scale field trial, show Solstice LBA to be a better blowing agent in many respects.

A low GWP blowing agent with all the benefits of HFCs

For a blowing agent to be acceptable it needs certain properties, which are summarised in **table 1.** Solstice LBA meets all these criteria and exceeds several of them.

Table 2 compares Solstice LBA to other commonly used spray foam blowing agents. Solstice LBA has a lower molecular weight than 245fa and 365mfc, which means that for an equal molar substitution, 3 % less Solstice LBA can be used than 245fa. The boiling point of Solstice LBA is 24 % higher than 245fa, which has a significant impact on system vapor pressure and spray yield. It is non-flammable and has no flame limit,

Tab. 1: *Critical properties for blowing agents*

Blowing agent physical properties
Environmentally safe Low toxicity Low molecular weight Non-flammable Appropriate boiling point
Blowing agent compatibility
Compatible & miscibility with other raw materials
Foam processing
Compatible with foam manufacturing processes
Foam quality
Low thermal conductivity Provides small size cells Thermally stable No effect on polymer

Tab. 2: *Liquid blowing agent comparative properties*

	Solstice LBA	245fa	365mfc	141b
Molecular weight	130	134	148	117
Boiling point / °C/°F	19/66	15.3/59.5	40/104	32/90
Flashpoint / °C/°F	None	None	–27/16.6	None
LFL / UFL (Vol.-% in air)	None	None	3.6–13.3	7.6–17.7
ODP (1)	~0	~0	~0	0.12
Atmospheric life	26 days	7.6 years	10.8 years	9.3 years
GWP, 100 years (2)	<7	1,030	794	725
VOC	No (pending exempt)	No (exempt)	No (exempt)	No (exempt)
PEL (3)	300	300	1,000	500

(1) No impact on ozone layer depletion and is commonly referred to as zero (Preliminary report: "Analyses of tCFP's potential impact on atmospheric ozone." Wang, Olsen, and Wuebbles, Department of Atmospheric Sciences, University of Illinois Urbana.
(2) 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 (except where noted).
(3) Manufacturers' literature except where noted

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a critical consideration for spray foam applications, since the product is produced in the field. Finally, it meets environmental and toxicity requirements. Solstice LBA has a ~0 ODP and a GWP <7. It has an atmospheric life time of 26 days, and it is anticipated to be classified as VOC-exempt in the USA.

Higher solubility in polyols

Solstice LBA offers higher solubility in polyols, significantly greater than what is seen with 245fa. The impact of this improved solubility and higher boiling point is most evident in the significant reduction in vapor pressure of polyol blends. **Figure 1** shows the significant impact on the vapor of the system most recently studied. At 22 °C the Solstice LBA system vapor pressure was 59 % lower than what was found in an equivalent 245fa system. This will allow system manufacturers the opportunity to explore alternative packaging, while reducing the potential for drum bulging during transportation, use and storage.

Since spray foam is manufactured on site, systems can be stored several months prior to use, often under non-ideal situations. It is critical to a contractor that the reactivity of a foam system is the same on the day he bought it as when it is used. The generic system recently tested showed equivalent reactivity when comparing the Solstice LBA system to the equivalent 245fa system when stored at 54 °C for four weeks or at room temperature for four months.

Spray foam application under varied environmental conditions

In 2009 and 2010, Honyewell demonstrated that Solstice LBA systems could be processed through existing spray foam equipment, and that the foam produced showed a 4–6 % improvement in lambda and was equivalent on other foam properties. However, spray foam is applied under a variety of conditions, most of which are not those found in a traditional lab environment.

One of the greatest challenges in the application of spray foam is the varied environmental conditions (temperature and humidity) in which it must be applied. To be viable, a system must be robust enough to function across a wide range of conditions. In addition to the environmental conditions, the number of layers, of lifts, of foam applied in an application can vary depending on the insulation performance required for the application. If five centimeters of foam is required to meet building energy performance, it is often applied in a single lift. However, if larger foam thicknesses are required, it is applied in multiple lifts. This insures that excessive heat does not build up during the installation. As with environmental conditions, the number of lifts in a foam application can also impact foam quality and yield. The focus of the recent study was to understand if the transition to Solstice LBA will impact the application of foam and the quality of foam produced with a wall foam formulation when:

- the environmental conditions of both temperature (16–30 °C) and humidity were varied (30–50 % RH) and
- the foam was sprayed in single and multiple lifts.

The samples for testing were sprayed using standard spray foam equipment, by a certified contractor onto 1.25 cm plywood. The foam sprayed was tested for density, closed cell content, compressive strength, dimensional stability and lambda.

The first test of the generic system was to determine if there was a loss in performance between the 245fa and the Solstice LBA system when the application environment varied from 16–30 °C. This temperature variance can be seen in a single day at a jobsite in the summer. Excellent foam was produced with both systems. The density of the foams was equivalent. However, the density variance was greater across the application range in the 245fa samples. This

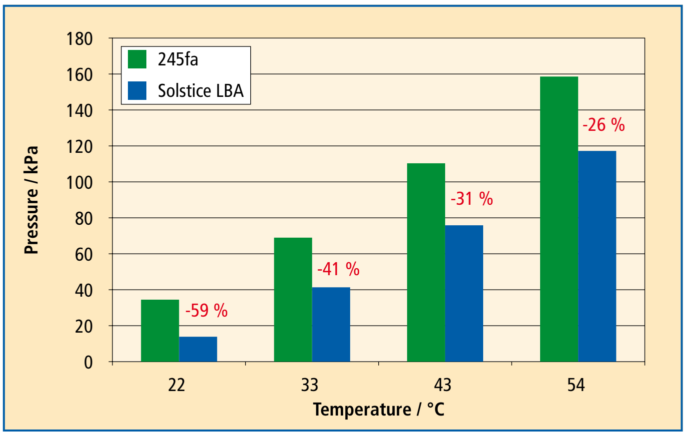

Fig. 1: Impact of Solstice LBA on generic system vapor pressure

	Application room temperature 16 °C	26 °C	33 °C
Comparison of Solstice LBA vs 245fa initial lambda	*Solstice LBA 10 % better*	*Solstice LBA 7 % better*	*Solstice LBA 10 % better*
Comparison of Solstice LBA vs 245fa aged lambda	*Solstice LBA 15 % better*	*Solstice LBA 7 % better*	*Solstice LBA 15 % better*

Tab. 3: Impact of application temperature on lambda

	Room % relative humidity 30 %	52 %
Comparison of Solstice LBA vs 245fa initial lambda	*Solstice LBA 10 % better*	*Solstice LBA 8 % better*
Comparison of Solstice LBA vs 245fa aged lambda	*Solstice LBA 15 % better*	*Solstice LBA 15 % better*

Tab. 4: Impact of %RH in application environment on lambda

provides the potential for more consistency in yield across the application window. The Solstice LBA foam dimensional stability, compressive strength and closed cell content were found to be equivalent to 245fa foams. The most remarkable variance between the Solstice LBA and 245fa foams was seen in the lambda values. **Table 3** shows the improvement seen in lambda of the Solstice LBA foams. Under certain conditions the reduction in lambda was as great at 15 %.

The next great challenge after temperature in any spray foam environment is humidity. This can have a significant impact on foam quality and yield. The generic Solstice LBA and the 245fa system were applied at 30 % and 50 % RH. The Solstice LBA foams were found to have more consistent density, dimensional stability, compressive strength than the 245fa foams. Again, the greatest improvement seen was in lambda **(tab. 4).**

The final test of foam application is in the number of layers applied. The generic systems were applied in a single and double lifts to see if the foam quality remained acceptable. The application was done at 26 °C and 36 % RH. The Solstice LBA foams were equivalent in all foam properties tested to the 245fa foam when multiple lifts were applied.

Conclusion

Solstice LBA is an ideal replacement for 245fa. It meets the critical criteria for a blowing agent in its physical and environmental properties as well foam application and foam properties. It provides significant advantages to both the formulator and applicator. Solstice LBA foams have:

- better initial and aged thermal insulation properties and
- better foam dimensional stability.

However, the true test of a blowing agent in a spray foam system is not only in the advantages it provides to formulating or the quality foam produced, but also the ability to spray it under a variety of field conditions. In addition to providing excellent formulating advantages and producing superior quality foam, Solstice LBA is comparable or better than 245fa in several key processing characteristics:

- can be processed through existing equipment,
- can be processed through a wider application window,
- provides comparable properties in multiple lift applications, and
- is applicable under a wide range of environmental conditions.

Honeywell is in the process of commercializing this new high performance, low-global-warming potential blowing agent.

Call for papers: CPI 2012 Polyurethanes Technical Conference

The **Center for the Polyurethanes Industry (CPI)** of the **American Chemistry Council** has issued a call for papers and posters to be presented at the 2012 Polyurethanes Technical Conference, scheduled for 24–26 September 2012, at the Omni Hotel in Atlanta, GA, USA.

Paper abstracts are due **1 February 2012,** and poster abstracts are due **22 August 2012.** Submission instructions, guidelines for development of papers and templates can be found on CPI's website **www.polyurethane.org.**

At the conference, paper and poster presenters will have the opportunity to reach hundreds of leaders and innovators in the polyurethane field. The conference's technical presentations are a fixture of the annual event, which drew nearly 800 attendees in 2011. At the conclusion of the conference, awards will be presented to recognise outstanding papers and posters in each category.

Papers and posters may address innovations and developments involving polyurethane chemistry or uses, including new polyurethane products or applications; raw material or additive innovations; or breakthroughs in equipment design or operation.

Papers and posters also may focus on issues associated with the manufacture, use, handling, transportation, disposal, and end-of-life of polyurethanes, as well as health, environmental and product stewardship issues. Regulatory and legislative topics, codes and standards developments are also welcome as paper and poster topics.

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