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Blowing Agents

HFO- and HFC-based Spray Foam Compared to Water-blown Systems

Solstice® Liquid Blowing Agent and Enovate® 245fa

Proven, Cost-effective Solutions

Blowing Agents - A Big Impact on Foam Performance

Figure 1

HFO and HFC blowing agents remain trapped in the closed-cells of the foam. With water-blown foam, the CO_2 blowing agent gas quickly diffuses, leaving the foam cells.

Reducing Environmental Impact

Solstice LBA is a fourth-generation blowing agent based on HFO technology. Not only does it improve foam performance, it has an ultra-low global warming potential (GWP) of one (99.9% lower than HFCs and equal to CO_2). It is nonflammable (ASTM E-681, EU A11) and non-ozone-depleting.

When selecting a closed-cell spray polyurethane foam (ccSPF) roof system, the choice of blowing agent must be carefully considered. Foam cell walls are composed of polyurethane (PU) polymer. In fact, in 1 cubic meter of a 35 kg/m³ closed-cell foam, only 2.4% of the total volume is occupied by the polymer, while the remaining 97.6% is filled by the blowing agent.[1] The blowing agent significantly impacts the rise of the foam and resulting properties, including thermal insulation performance (k-factor), density, dimensional stability, adhesion, and other important attributes. Consequently, the foam's performance has a major impact on the overall efficiency and cost of a project.

System Prices Don't Tell the Whole Story

Spray foam that is "water-blown" means that water is added to the formulation. It reacts with the isocyanate to form carbon dioxide (CO_2) gas, which is the blowing agent. At first glance, water-blown spray foam may appear to be more economical than systems formulated with hydrofluoro-olefin (HFO) or hydrofluorocarbon (HFC) blowing agents. However, that assumption may change when you consider that water-blown foam requires greater thickness, or more material, to achieve the same insulating value. Additionally, there tends to be a higher incidence of foam shrinkage, loss of insulating value, and sprayability challenges. All of this can impact your project cost, not to mention overall quality and reliability.

Water-blown foam requires greater thickness, or more material, to achieve the same insulating value.

Review the following pages to better understand critical differences between HFO- or HFC-based ccSPF and CO_2 (water)-based systems.

The Importance of Foam Blowing Agents

Blowing agents form the foam cells or bubbles, expanding the foam and impacting its properties. With HFOs and HFCs, the blowing agent gas remains trapped inside millions of closed foam cells[2] (Figure 1). This enables the blowing agent to positively impact foam properties, providing up to 60% of its insulating value.[3] It can also improve foam performance such as yield, adhesion, water and air resistance, flammability, and other characteristics. It also impacts the foam's environmental profile.

The blowing agent provides up to 60% of the foam's insulating value.

In contrast, "water-blown" foam generates CO_2 (blowing agent gas) which quickly leaves the foam, or diffuses, after the reaction with the isocyanate. The foam's cells slowly repressurize with air, which reduces insulating value.

Not All Blowing Agents Are Created Equal

When choosing a spray foam system, it's important to evaluate how the choice of blowing agent can impact foam performance. The fluorocarbon-blown foams have many similar performance attributes. Compared to HCFC- or HFC-blown foam, Solstice LBA offers the environmental benefit of an ultra-low GWP of 1.

Water-blown foams have some disadvantages compared to the alternative blowing agents as shown in Table 1.[4]

Comparing Typical Performance of Blowing Agents in Spray Foam

	HCFC-141b	Enovate 245fa	Solstice LBA	Water-blown
Global Warming Potential (GWP)[5]	782	858	1	1
Ozone Depletion Potential (ODP)	0.1	~0	~0	~0
Thermal Insulation Performance	comparable			25% worse
Dimensional Stability/Shrinkage	comparable			25% greater volume change
Foam Density	comparable			13% higher, thus more polymer needed

Table 1

When we consider both foam thickness and lambda, about

41% more of a water-blown system is needed

to meet the insulating target of U 0.30 W/m²K.

How does this translate to your overall applied cost when you consider lambda, foam thickness, and relative system cost?

As shown in Table 1, some disadvantages of water-blown systems compared to HCFC- or HFC-blown spray foam include:

- **25% worse thermal insulation performance**
- **25% greater volume change in dimensional stability** due to the diffusion of the CO_2 gas
- **13% higher foam density so more polymer is required** to achieve equivalent foam thickness. Some roofing projects are specified by a set thickness.

Blowing Agents Impact Foam Performance and Cost

Your choice of blowing agent can not only impact foam performance, but also overall project cost. As an example, let's compare how blowing agents impact the foam thickness required to meet a U 0.30 W/m²K building design requirement (Table 2).[4]

Blowing Agent Comparison of Foam Thickness Needed to Achieve U 0.30 W/m²K

	Enovate 245fa	Solstice LBA	Water-blown
Foam Thickness (mm)	comparable		20% more foam needed
Lambda (W/mK)	comparable		25% worse
Kg of system per m² for U 0.30 W/m²K	comparable		41% more system needed

Table 2

Spray Foam Roofing System Pricing

Let's start with relative pricing for systems. We recognize that blowing agent and other system ingredient costs vary by formulation and region. This should be discussed with your Honeywell account representative or ccSPF system provider. As an example, some average relative pricing is shown in Table 3.[4]

	Enovate 245fa	Solstice LBA	Water-blown
Relative Cost/kg	1	9% higher	11% lower

Table 3

The relative pricing shows that the water-blown system may be the least expensive on a per drum basis. ***However, not every system that is cheaper per drum remains cheaper when it is installed to a specification***. Therefore, it's essential to also understand the applied cost.

Higher Applied Cost for Water-Blown Systems

By combining the data from Tables 2 and 3, we can see how relative applied costs compare. ***Water-blown systems actually cost more when you factor in the additional material needed and greater thickness to be applied*** (Table 4).[4] When you also consider increased labor, transportation, and other costs, the relative installed project cost for the water-blown foam is even higher than shown below.

	Enovate 245fa	Solstice LBA	Water-blown
Relative Applied Cost/m^2	1	10% higher	25% higher

Table 4

Comparative Cost Analysis
(Enovate 245fa Baseline)

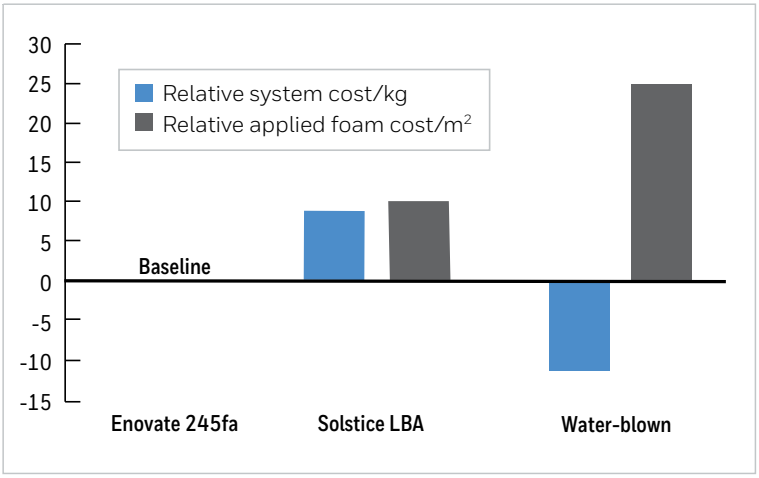

Figure 2

The relative applied cost for a water-blown system has been shown to be significantly higher than systems formulated with Enovate 245fa or Solstice LBA.[4]

Processing Considerations

In addition to the choice of blowing agent, factors such as humidity, ambient temperature, and equipment settings can also impact ccSPF performance. Therefore, it is important to carefully follow your formulator's instructions for the system being used.

The Preferred Choices: Solstice LBA and Enovate 245fa

As shown, spray foam roof systems formulated with Solstice LBA or Enovate 245fa offer distinct advantages when compared to water-blown foams. For example, less foam is needed to achieve equivalent insulating values, which can translate into big savings. Spray foam systems featuring Solstice LBA or Enovate 245fa provide:

- Excellent thermal insulation performance
- High yields
- Good dimensional stability
- Strong adhesion, and more

For your next project, choose a closed-cell spray foam system featuring Honeywell blowing agents.

1. Ostrogorsky, Glicksman, Reitz, International Journal of Heat and Mass Transfer, Volume 29, Issue 8, August 1986, Pages 1169-1176.
2. According to the criteria defined in the SG 19 Position Paper: "Thermal performance of in-situ PU polyurethane products used as thermal insulation for buildings with a new blowing agent" (NB-CPR/SG19-17/167r2, Issued: 24 January 2018). The SG 19 is the Sector Group of the Group of Notified Bodies for the Construction Products Regulation (EU) No. 305/2011 (CPR).
3. Randall, David, The Polyurethanes Book (Huntsman International, LLC / John Wiley & Sons, Ltd, 2002) p.234, Fig. 15-5.
4. These are approximate results based on data per Bayer Pearl presentation by Jose Antonio Diaz: Environmentally Friendly Solutions for PU Roof Foam, May, 2015.
5. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

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