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# SOLKANE® 365

## Co-blowing PU Systems with Pentane

# Introduction

The quality and performance of polyurethane foams are determined by many different parameters. The physical properties are usually designed for the specific application of the foam (insulation panels, construction elements, pour in-place solutions etc.).
Normally one type of foaming agent is used, either Pentanes or HFCs, but rarely a blend of both.

This leaflet introduces a practical and sustainable concept to save costs while maintaining or even improving the foam's performance. The concept uses Pentane isomers and SOLKANE® 365mfc blends as physical blowing agents and produces surprising effects with respect to foam quality and total costs.

In a series of laboratory and industrial trials it is demonstrated that a relatively small substitution of Pentanes by SOLKANE® 365mfc can improve thermal conductivity compressive strength and reduce the foam's flammability at a given foam density. The intrinsic physical properties of SOLKANE® 365mfc, such as boiling point and gas phase lambda are responsible for physical improvements in the resulting foam.

Cost saving is achievable by using less raw material (isocyanate and polyol) to produce an overall lower density foam. In comparison with the physical data of a pure Pentane foam at a dedicated density, SOLKANE® 365mfc-Pentane co-blown foams can be produced with up to 10 % lower density, at comparable or even improved physical properties.

| | Formulation | |
|---|---|---|
| **Lab evaluation Steel Sandwich** | **Standard** | **Co-blowing** |
| | [pbw] | [pbw] |
| System | 100 | 100 |
| Catalyst 1 | 3.6 | 3.6 |
| Catalyst 2 | 1.1 | 1.1 |
| n-Pentane | 7.9 | |
| SOLKANE® 365mfc/n-Pentane (30:70) | | 8.9 |
| MDI | 150.3 | 150.1 |
| **Total** | **262.9** | **263.7** |
| | | |
| Core Density [kg/m³] | 39.3 | **37.0** |
| Comp. Strength [kPa] | 120 | **129** |
| Lambda [mW/m·K] | 21.8 | **20.9** |

**Figure 1:** By simply exchanging n-Pentane with SOLKANE® 365mfc/n-Pentane 30:70 basic properties improve significant.

# Lab Evaluation of Properties

## Improvement of compressive strength and material density

In the construction sector, sandwich panels must pass the approval procedure where compressive strength of the PU is one of the key factors for panel producers.

Introducing the SOLKANE® 365mfc Co-blowing concept to panel systems will evidently benefit the compressive strength in the resulting foam as indicated in the bar chart (figure 2) below.

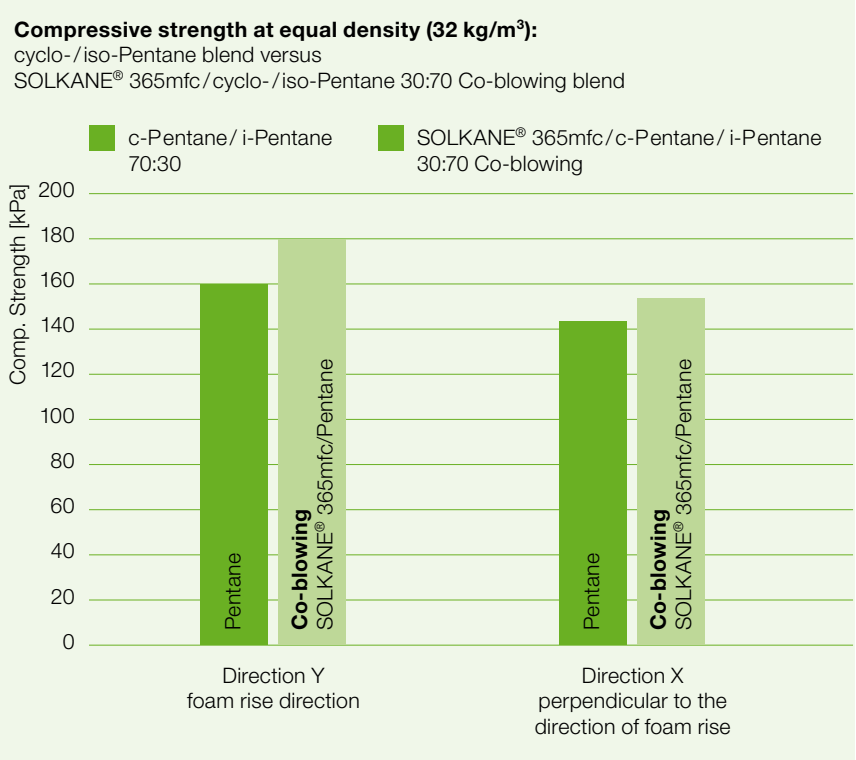


**Figure 2:** Comparing the compressive strength at equal density of foam blown with a Pentane blend of c-/i-Pentane (70:30) versus Co-blowing blend SOLKANE® 365mfc/c-/i-Pentane (30:70). Co-blowing shows an improvement towards higher values.

## Insulation Value and Thickness of Panels

Traditionally, insulation value is a core competence of HFC blown PU foam in general, particularly of SOLKANE® 365mfc. Figure 3 depicts effects of the Co-blowing concept on standard Pentane formulation in an industrial scale.

An improvement of 1 mW/m·K is standard and going this way consequently, including all options improvements around 2.5 mW/m·K are achievable.

In some cases the density of the foam could be reduced due to higher mechanical stability, in all cases the thickness for use could be reduced. Both will remain in a reduction of costs.

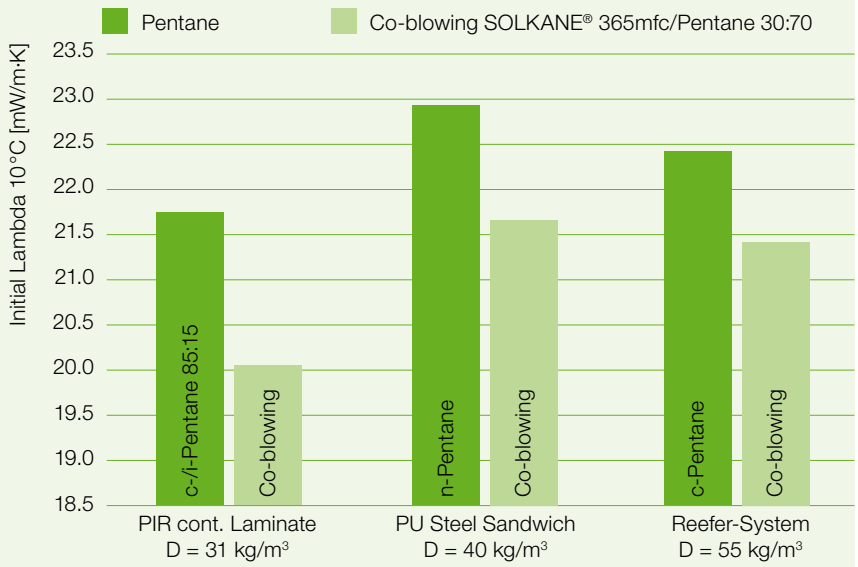


**Figure 3:** Initial insulation values for Pentane and Co-blown lab foam samples.

Typical metal sandwich panel.

Panel production line.

## Reduced Flammability

Typical Pentane blown polyurethane foams reach Euro-Class E or D according to the SBI test*. Switching these systems to SOLKANE® 365mfc Co-blowing agent, Euro-Class C – close to Euro-Class B – can be easily obtained.

* Source: Single Burning Item (SBI), according to EN 13823

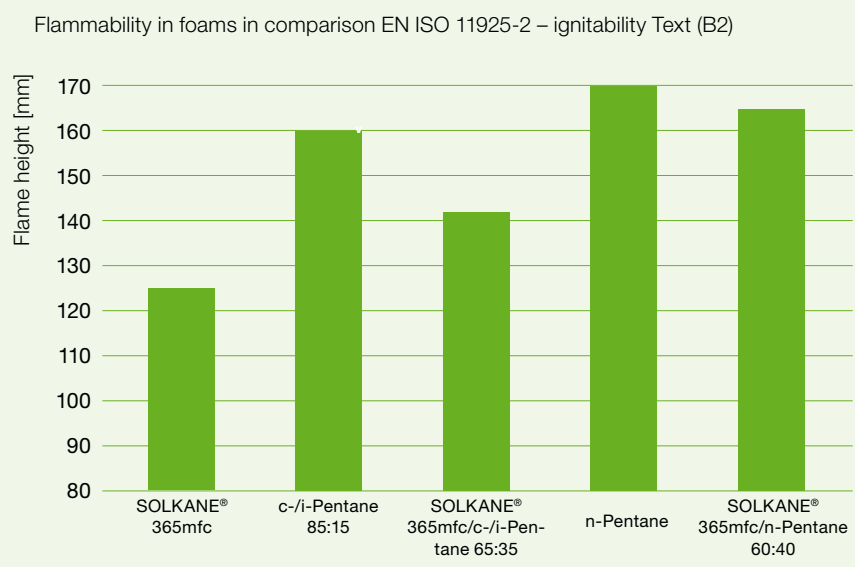


**Figure 4:** Lab evaluation of fire behaviour for different blowing agents.

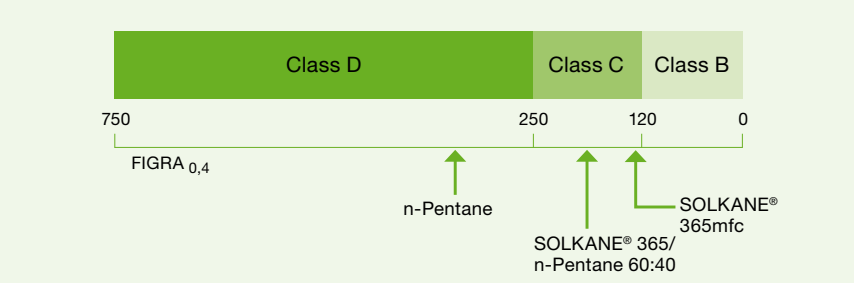


**Figure 5:** SOLKANE® 365mfc positive impact on fire class rating (flexible facing).

As already indicated the SOLKANE® 365mfc Co-blowing concept can help you to manufacture a better product at lower costs. In the example beside, based on an industrial trial, the density was reduced by about 10 % for a SOLKANE® 365/227-n-Pentane co-blown PU foam panel, while slightly improving the compressive strength.

| | | Standard n-Pentane | SOLKANE® 365/ n-Pentane |
|---|---|---|---|
| Plate Thickness | [mm] | 100 | 100 |
| Density, overall | [kg/m$^3$] | 35 | 31.2 |
| Core Density | [kg/m$^3$] | 33.2 | 29.8 |
| Comp. Strength | [kPa] | 120 | 140 |
| Lambda, ini, 10 °C | [mW/m·K] | 22.4 | 20.8 |

**Figure 6:** Results of industrial panel production (flexible facing).

## Cost Saving

SOLKANE® 365mfc is more expensive per kg than Pentanes. The table below impressively shows how this is over-compensated by reduced costs for raw materials as a result of reduced foam densities.

| | Formulation | | Relative Factors | |
|---|---|---|---|---|
| **Lab Evaluation Steel Sandwich** | **Standard** | **Co-blowing** | **Standard** | **Co-blowing** |
| | [pbw] | [pbw] | [factor/m$^3$] | [factor/m$^3$] |
| System | 100 | 100 | 37.99 | 35.64 |
| Catalyst 1 | 3.6 | 3.6 | 2.11 | 1.94 |
| Catalyst 2 | 1.1 | 1.1 | 1.09 | 0.98 |
| n-Pentane | 7.9 | | 1.72 | |
| SOLKANE® 365mfc/n-Pentane (30:70) | | 8.9 | | 4.33 |
| MDI | 150.3 | 150.1 | 57.09 | 53.48 |
| **Total** | **262.9** | **263.7** | **100.00** | **96.37** |
| | | | | |
| Core Density [kg/m$^3$] | **39.3** | **37.0** | | |
| **Difference [factor/m$^3$]** | | | | **– 3.63** |

**Figure 7:** Standard n-Pentane versus SOLKANE® 365mfc Co-blowing formulation: saving cost on lower density due to less raw material consumption with Solvay's Co-blowing concept is possible (difference calculated as relative factors).

## Conclusion

Nevertheless, the concept requires customization for each individual application and polyol system in order to maximize the benefits. Co-blowing is not to be understood as a 'simple drop-in' approach and the achievable degree of improvement will vary from case to case.

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