SOLKANE® 365
Converting Systems from HCFC-141b
The Montreal Protocol and national regulations have led to the phase out of HCFC-141b for use as a physical blowing agent in polyurethane (PU) foams. Although there is a wide choice of alternative chemicals, there are only a few that can fulfill the preferred technical requirements of the polyurethane industry.

SOLKANE® 365mfc is a hydrofluorocarbon and a true liquid with a boiling point of 40 °C. When SOLKANE® 365mfc is blended with SOLKANE® 227ea, it can be handled as a non-flammable liquid. It is the preferred solution for a wide number of applications. This document will help you to modify typical HCFC-141b formulations in order to comply with the above mentioned regulations and optimise the use of SOLKANE® 365/227 and SOLKANE® 365mfc.

1. Introduction

The replacement of HCFC-141b by SOLKANE® 365mfc or SOLKANE® 365/227 is quite simple, as SOLKANE® 365mfc is fully compatible with all main used PU raw materials such as polyols, flame retardants, catalysts, surfactants and isocyanates. In case of the surfactant we recommend to change from a type for high soluble blowing agents to medium soluble Blowing Agents, for example all Pentane-Type surfactants should be usable.

The choice of the right conversion recipe is different for each specific case or application and is linked to the target parameters such as
1. density
2. thermal conductivity
3. compressive strength
4. adhesion

The use of SOLKANE® 365mfc and SOLKANE® 365/227 has the advantage of giving the best results in a wide range of combinations with water in the formulation. Therefore we recommend the following guidelines to optimise the substitution of HCFC-141b.

Note: the conversion to SOLKANE® 365/227 has an additional effect for Integral Skin Foams and foams produced in mouldings. The shrinkage effect after de-moulding is lower than with HCFC-141b, comparable to the behaviour of CFC-11 formulations used in the past.

2. Conversion of formulations

2.1. Step 1: Replace HCFC-141b with SOLKANE® 365/227

The first step is to exchange HCFC-141b with SOLKANE® 365/227 in the weight ratio of 1.26 or molar weight ratio of 117:148. Example: 10 pbw HCFC-141b should be replaced by 12.6 pbw SOLKANE® 365/227 or SOLKANE® 365mfc. Following our experience the foam will exhibit the following characteristics in most cases:
1) Improved mechanical properties i.e. compressive strength and dimensional stability: this is related to the lower solubility of the SOLKANE® 365mfc in the foam matrix. The softening effect caused by HCFC-141b has more or less completely disappeared in the SOLKANE® 365mfc based foam. As such, it is possible to reduce the foam density in general when SOLKANE® 365/227 is used as HCFC-141b replacement.
2) Slightly higher thermal conductivity value (λ or k-value). This modification could be explained by the specific thermal conductivities of the pure compounds and possible condensation effect with SOLKANE® 365mfc.

This step will optimise the thermal conductivity while limiting the extra cost for the substitution. This is possible by stepwise substitution of a portion of the physical blowing agent SOLKANE® 365/227 with water. This replacement should occur by applying a molar weight ratio of nearly 150:18. An additional amount of water could also be added to compensate the reduction of the foam density. The replacement should be done, down to original HCFC-141b-values.

Example: reduction of the amount of SOLKANE® 365/227 by 4.2 (pbw) and compensated by 0.5 (pbw) first and adding an additional amount of water, another 0.5 pbw of water, for the reduction of foam density secondly by 17% for the given formulation. To achieve an optimum for the targeted specification of the final foam, we recommend doing the exchange stepwise.

Note: pbw = parts by weight
In the example, the second column describes step (1) i.e. substitution of HCFC-141b by SOLKANE® 365/227 while the third column provides step (2) i.e. stepwise exchange of SOLKANE® 365/227 by water.

First a similar weighted molar ratio was applied for exchange of HCFC-141b by SOLKANE® 365/227: 21.7 pbw SOLKANE® 365/227 to replace 17 pbw HCFC-141b in the formulation.

Finally the amount of SOLKANE® 365/227 is reduced by 4.2 (pbw) and compensated by 0.5 (pbw) for molar conversion (~ 150:18) and another 0.5 (pbw) water for the reduction of foam density by 17% for the given formulation. This is possible due to the better mechanical properties achieved with SOLKANE® 365/227. Even with this significant density reduction we are at the same level of compressive strength compared to the HCFC-141b foam in this example.

As an example a spray foam formulation from EU/Canada Region:

<table>
<thead>
<tr>
<th>Blowing Agent</th>
<th>HCFC-141b</th>
<th>SOLKANE® 365/227 “drop-in”</th>
<th>SOLKANE® 365/227 optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyol</td>
<td>[pbw]</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Catalyst</td>
<td>[pbw]</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Water</td>
<td>[pbw]</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>HCFC-141b</td>
<td>[pbw]</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>SOLKANE® 365/227 93:7</td>
<td>[pbw]</td>
<td>21.7</td>
<td>17.5</td>
</tr>
<tr>
<td>MDI</td>
<td>[pbw]</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>Core Density</td>
<td>[g/dm³]</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Comp. Strength</td>
<td>[kPa]</td>
<td>160</td>
<td>230</td>
</tr>
<tr>
<td>Thermal Conductivity (λ)</td>
<td>[mW/m.K; initial]</td>
<td>18.5</td>
<td>21</td>
</tr>
</tbody>
</table>

The above described guidelines should enable you to achieve the replacement of HCFC-141b by SOLKANE® 365/227 or SOLKANE® 365mfc in your formulation. By doing so comparable foams can be produced for a wide range of end uses. The new formulation should be optimised to achieve the specification of your polyurethane foam. These optimisation effects must be checked for each specific formulation and application.

The additions of water as suggested in the second phase will reduce not only the pricing of the overall formulation but should also overcome the “condensation effect” of SOLKANE® 365mfc and reduction of the thermal conductivity value (λ or k-value).
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