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SOLKANE®

SOLKANE® 365

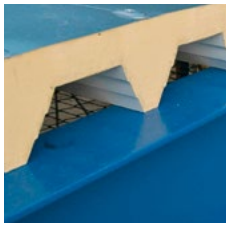
Converting Systems from HCFC-141b

1. Introduction

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 hydro fluorocarbon and a true liquid with a boiling point of 40 °C. When SOLKANE® 365mfc is blended with SOLKANE® 227ea, it can be handled as anon-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.

2. Conversion of formulations



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 to give best results in a wide range of combination 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.

2.1. 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.

2.2. Step 2: Stepwise exchange of SOLKANE® 365/227 by water

This step will optimize 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

3. Foam Example

Blowing Agent		HCFC-141b	SOLKANE® 365/227 "drop-in"	SOLKANE® 365/227 optimized
Polyol	[pbw]	100	100	100
Catalyst	[pbw]	0.8	0.8	0.8
Water	[pbw]	0.5	0.5	1.5
HCFC-141b	[pbw]	17		
SOLKANE® 365/227 93:7	[pbw]		21.7	17.5
MDI	[pbw]	105	105	123
Core Density	[g/dm^3]	40	40	33
Comp. Strength	[kPa]	160	230	165
Thermal Conductivity (λ)	[mW/m.K; initial]	18.5	21	19.5

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:

Polyether	40 pbw
Polyester	60 pbw
Non reactive Flame retardant	10 – 15 pbw
Water	1.5 – 2.0 pbw
Surfactant	1.5 pbw
Metal-Catalyst	0.6 pbw
Tertiary Amine-Catalyst #1	1.6 pbw
Tertiary Amine-Catalyst #2	0.5 pbw
SOLKANE® 365/227	15 – 17 pbw
Iso-Index	110

4. Conclusion

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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Solvay Fluor GmbH
Postfach 220
30002 Hannover
Germany
Phone +49 511 857-2444
Fax +49 511 817338
foaming.agents@solvay.com

Solvay (Shanghai) Co. Ltd.
Zhang Jiang Hi-Tech Park
Building 7, No.899,
Zu Chong Zhi Rd
Shanghai 201203,
P.R. China
Phone +86 21 50805080
Fax +86 21 50807501

Solvay Fluorides LLC
3333 Richmond Avenue
Houston, Texas 77098
USA
Phone +1 713 525-6000
Fax +1 713 525-7805

35/242/10.13/007/100

www.solvay.com
www.solkane.com