



Progress beyond

Versatility of SOLKANE[®] 365/227(Blends) & Brominated Polyether Polyols in PUR Systems

By
Abdulmalik Mohammad
Manager Technical Marketing
SOLVAY Fluor GmbH
Hannover, Germany





Agenda

1. SOLKANE® 365/227 (Blend(s)) & IXOL® versatile components in PUR Foam Industry
 - ✓ Comparison of different Blowing Agents with SOLKANE® 365mfc & SOLKANE® 365/227 (Blend(s))
 - ✓ Minimum Ignition Energies & Sources of Ignition
 - ✓ Recommended Methods for Flash Point Measurement
 - ✓ SOLKANE® Blown foams & cost reduction by reducing the foam density
 - ✓ Solubility of Blowing Agents with different components of PUR Foam Systems.
 - ✓ Examples of Applications where SOLKANE can be used
 - ✓ IXOL® Brominated Polyether Polyol for fire rated foam formulations.
 - ✓ Summary

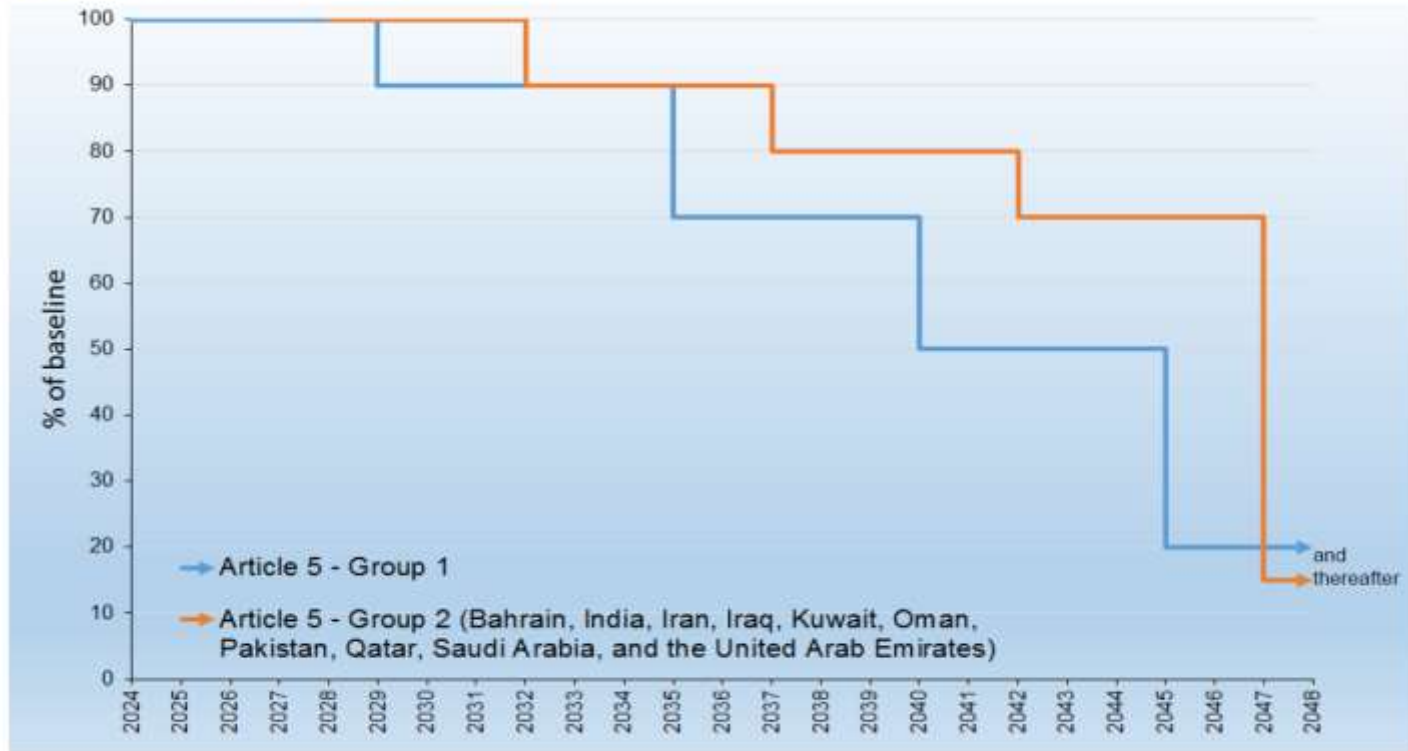
Properties of Blowing Agents

Blowing Agent	HCFC 141b	SOLKANE® 365/227 87:13	SOLKANE® 365/227 93:7	HFC 245fa	Cyclo-Pentane	Methylal	Methyl Formate	HFO 1336mmz	HFO 1233zd
Structure	<chem>CCl2F-CH3</chem>	<chem>CF3-CH2-CF2-CH3</chem> <chem>CF3-CHF-CF3</chem>	<chem>CF3-CH2-CF2-CH3</chem> <chem>CF3-CHF-CF3</chem>	<chem>CF3-CH2-CHF2</chem>		<chem>CH3-O-CH2-O-CH3</chem>	<chem>H-CO2-CH3</chem>	<chem>CF3-CH=CH-CF3</chem>	<chem>CF3-CH=CHCl</chem>
MW (g/mol)	117	150,8	149,5	134	70	76	60	164	130
BP (°C)	32	24	30	15,3	49,5	42,3	31,5	33	19
Vap. Pressure (Bar) 20°C	0,64	0,93	0,7	1,24	0,34	0,4	0,83	N/A	N/A
Lambda (mW/m.K) 25°C	9,5	10,8	10,7	12	11,6	13,1	10,7	10,7	10,2
Flash point (°C)	none	none	none	none	-37,2	-18	-32	none	none
Flammability of liquid	none	none	none	none	yes	yes	yes	none	none
LEL (%vol)	6	3,6	3,6	none	1,4	2,2	5	N/A	N/A
UEL (%vol)	18	13,3	13,3	none	8,3	19,9	23	N/A	N/A
AIT (°C)	550	580	580	412	361	237	449	N/A	N/A
MIE (mJ)	20.000	>1.000	>1.000	N/A	0,24	0,5	0,5	N/A	N/A
GWP	725	1.190	964	950	11	negligible	~1	2	1
ODP	0.11	0	0	0	0	0	0	0	0,00034

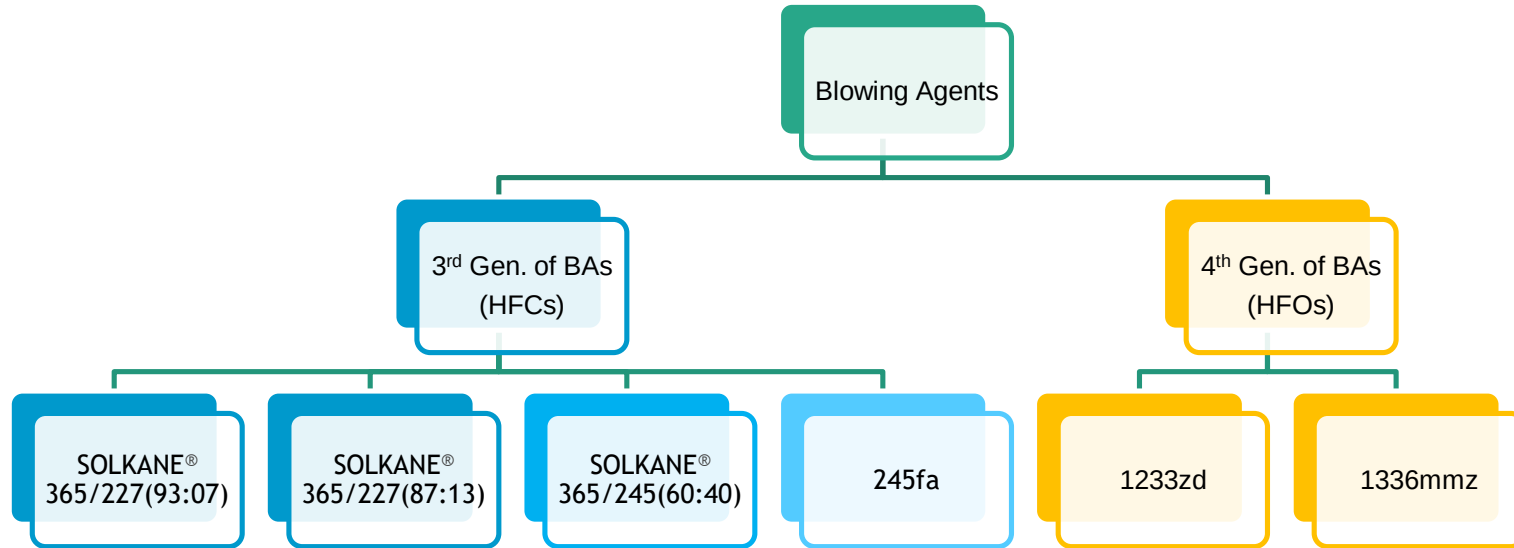
Allowance of HFCs in Article 5 Countries



Phase-down schedule



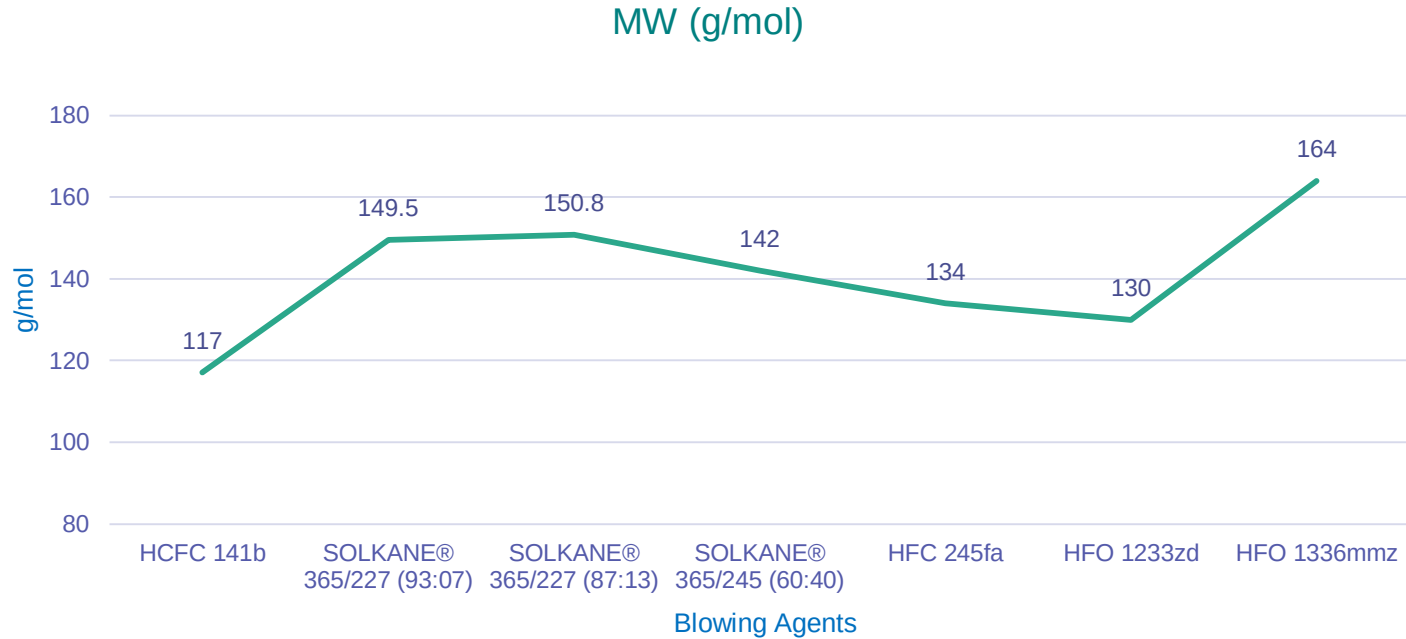
Next Generation of Physical Blowing Agents?



These are non
flammable

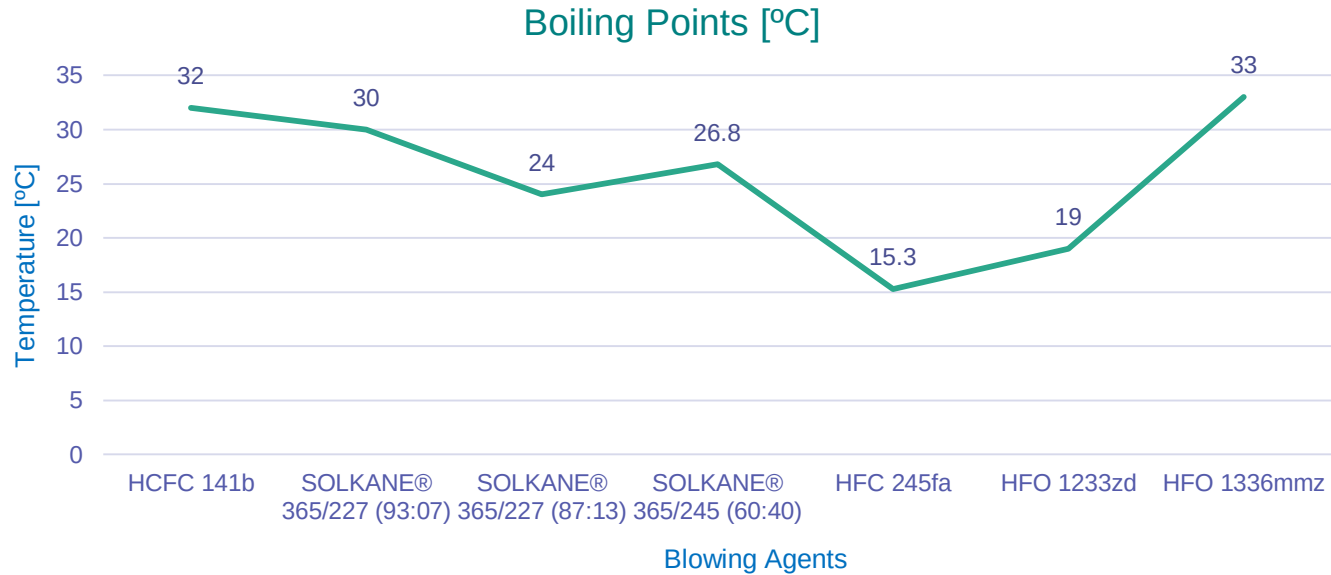


Comparison of Molecular Weights



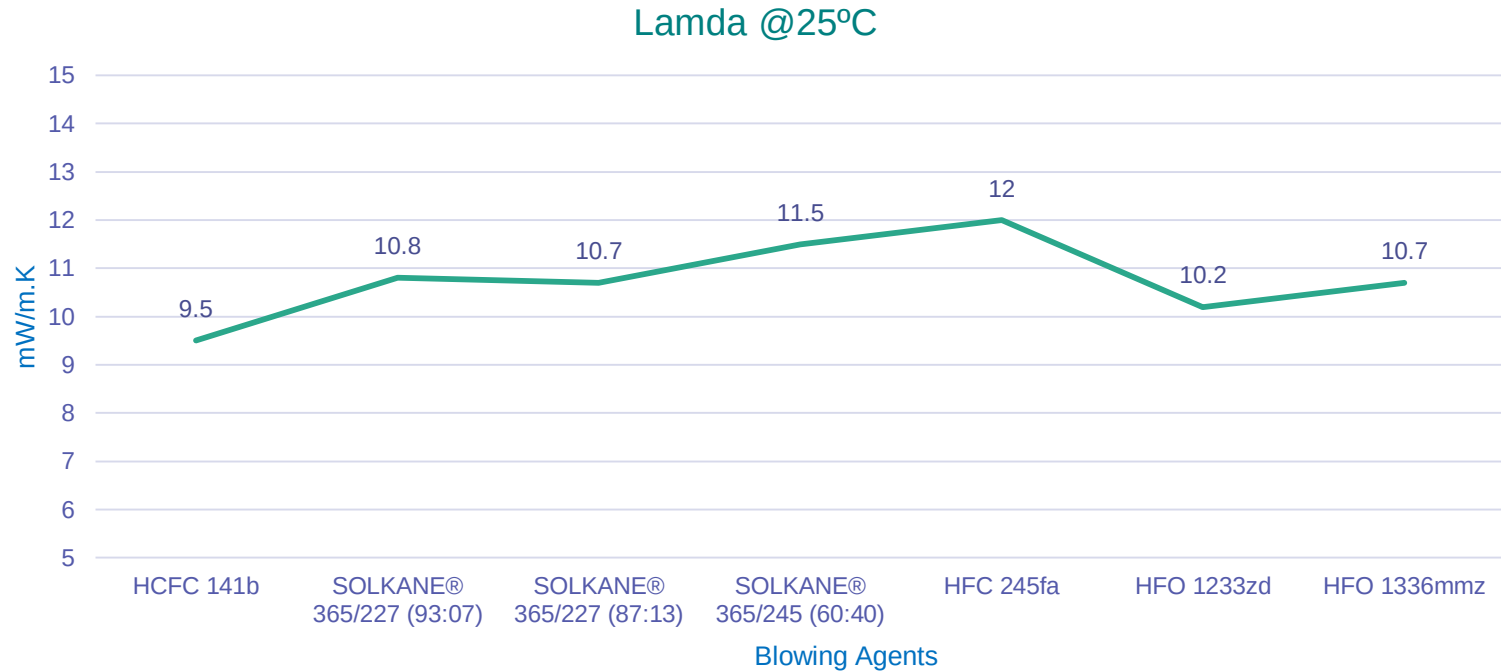


Comparison of Boiling Points



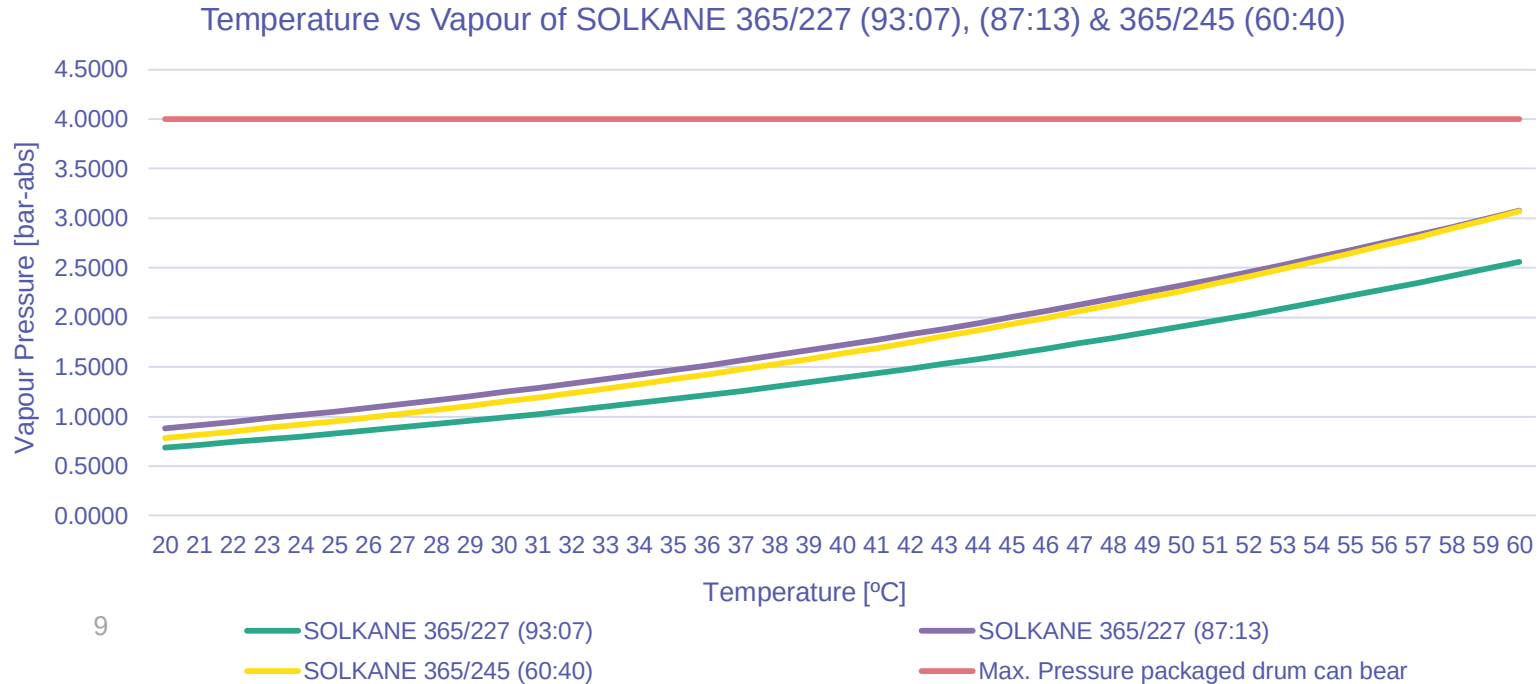


Comparison of Lambda of Blowing Agents





Temperature vs Vapour Pressure of SOLKANE Blends



SOLKANE® 365/227 Blend(s) are easy to handle



SOLKANE® 365/227 Blends are
Easy & Safe to Handle:

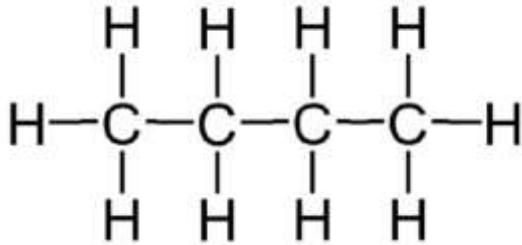
1. Non Flammable Liquid
2. Favourable Boiling Point & Vapour Pressure
3. High MIE: >>1000 mJ
4. Packaged in Standard Drums
5. No additional cost while replacing HCFC 141b



SOLKANE® 365/227 Blend

Structural Formula

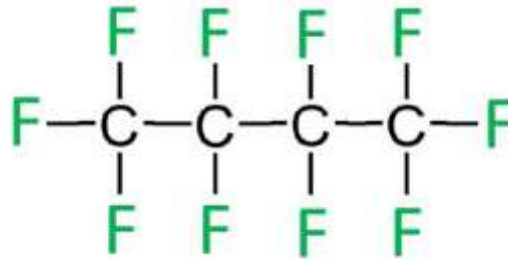
Butane



Flammable

Used as a fuel

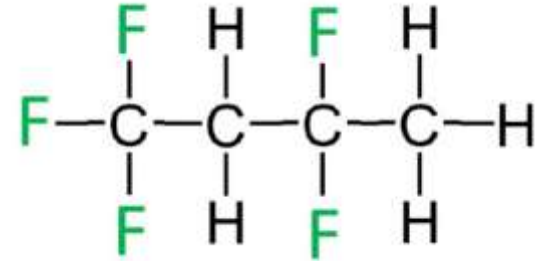
Decafluoro Butane



Non-flammable

Used as a Fire
Extinguisher

Pentafluoro Butane



Used as a Blowing
Agent in PUR
Foams

Flammability of alkanes & halogenated-alkanes



Material	Mol. Formula	No. of Carbon Atoms	No. of Halogen Atoms	No. of Hydrogen Atoms	Ratio of H/H	Flammability
Methane	CH ₄	1	0	4	0	Flammable
Fluoromethane	CH ₃ F	1	1	3	0,33	Flammable
Difluoromethane	CH ₂ F ₂	2	2	2	1	Flammable
Methylene Chloride	CH ₂ Cl ₂	2	2	2	1	Non-Flammable
Fluoroform	CHF ₃	1	3	1	3	Non-Flammable
CFC R11	CCL ₃ F	4	4	0	4	Non-Flammable
Propane	C ₃ H ₈	3	0	8	0	Flammable
Heptafluoropropane	C ₃ HF ₇	3	7	1	7	Non-Flammable
Butane	C ₄ H ₁₀	4	0	10	0	Flammable
Perfluorobutane	C ₄ F ₁₀	4	10	0	10	Non-Flammable
Pentafluorobutane	C ₄ H ₅ F ₅	4	5	5	1	Non-Flammable

➤ SOLKANE 227ea

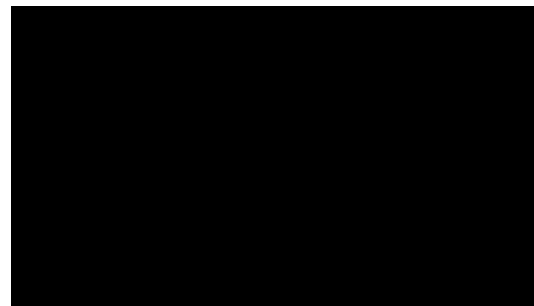
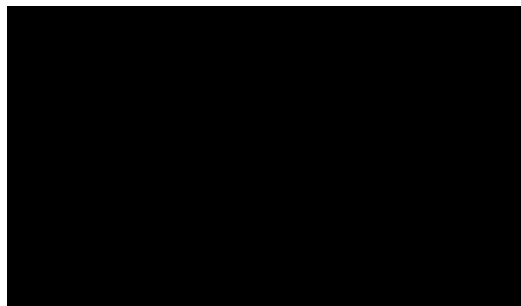
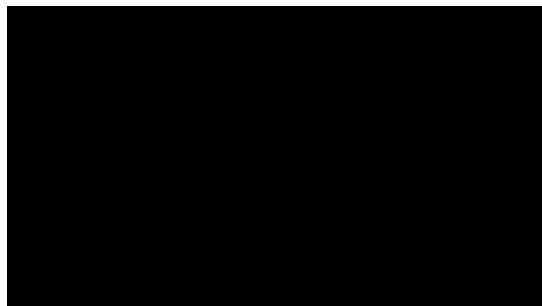
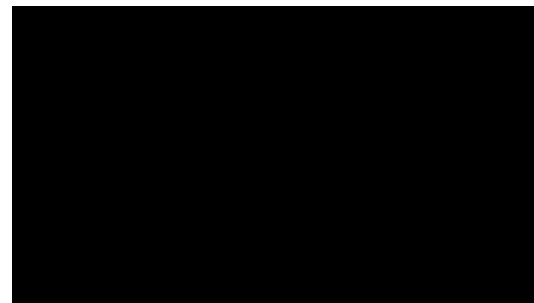
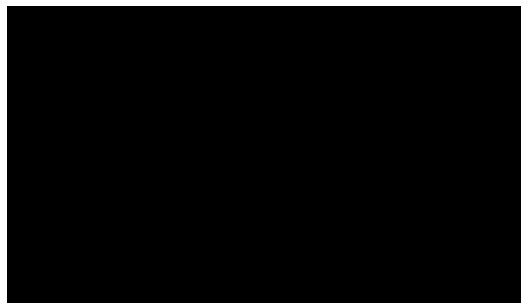
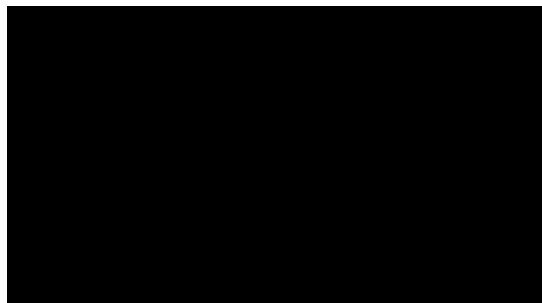
➤ SOLKANE® 365mfc

- SOLKANE® 365mfc exhibit **no flashpoint** as per Japanese test standard
- But as per ISO EN 13736 or ISO 1523 test standard it has a flashpoint -27C

Flammability of Blowing Agents



Videos



- SOLKANE® 365mfc exhibit no flashpoint as per Japanese test standard
- But as per ISO EN 13736 or ISO 1523 test standard it has a flashpoint -27C

Flammability of SOLKANE® 365mfc



- ❑ **Flashpoint:** The lowest temperature at which a liquid in a specified apparatus will give off sufficient vapor to ignite momentarily on application of a flame.

Normally a material catch fire, it continues to burn further this is what understood by many.

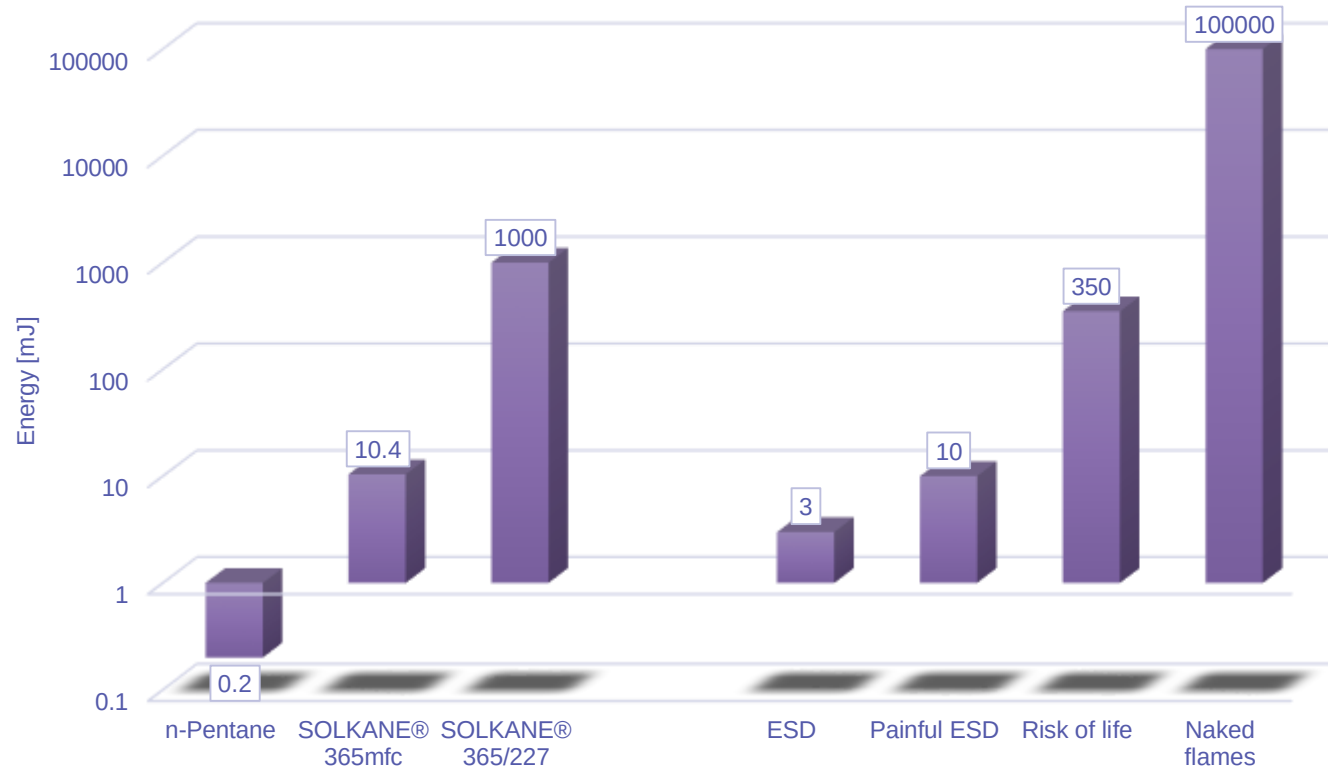
How do we classify chemicals whether are they flammable or non flammable?

- ❑ Flammable which has a flash point
- ❑ Non-flammable which does not have a flashpoint.

If you look at the flammability of SOLKANE® 365mfc deeply, you will find and be convinced that there are a few materials that behave differently and pose challenges to the classification to make them fit in either of the categories.

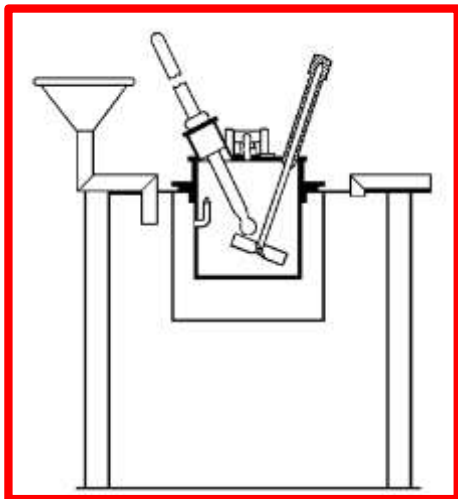
- ❑ **Firepoint:** The lowest temperature at which a volatile combustible substance continues to burn in air after its vapors have been ignited (as when heating is continued after the flash point has been determined)

Min. Ignition Energy (MIE) & Sources of Ignition



EDS: Electro static discharge from a surface

Recommended Test Method for Flashpoint Test

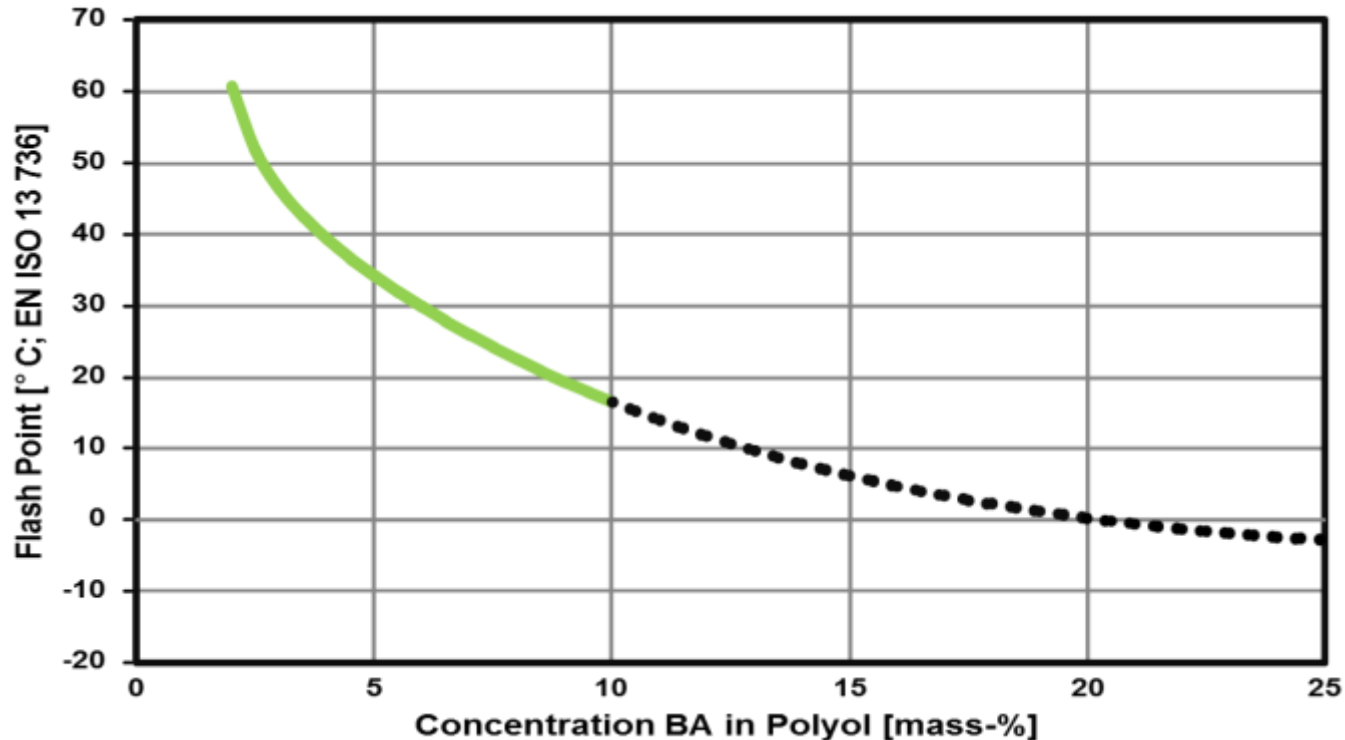


- “Abel”
- Closed cup
- Non equilibrium method in the **temperature range from -30 to 70 °C**
- Heating rate 1°C/min
- Slow stirring (30 rpm)
- For standard polyol systems with SOLKANE® 365/227 Blends **ISO EN 13736 or ISO 1523** are the recommended test methods

The **ASTM 93D** test method covers the determination of the flash point of petroleum products in the **temperature range from 40 to 360°C** by a manual Pensky-Martens closed-cup apparatus or an automated Pensky-Martens closed-cup apparatus.



SOLKANE® 365/227 Concentration vs Expected Flashpoint



The expected flashpoint is of SOLKANE® 365mfc in the absence of insufficient amount of SOLKANE® 227 in the Polyol blend(s)

Flashing behaviour during flashpoint test



Fig.-1: Taking Fire Phenomenon
(for the sample: 365 mfc)



Fig.-2: Taking Fire Phenomenon
(usual flash point measurement)

Solubility Comparison



S. No.	Polyols & other Components	HCFC 141B	SOLKANE 365® mfc	n-Pentane	c-Pentane
Polyether Polyols					
1.	Daltolac 585-8	100	32	4.5	11
2.	IXOL B251	3	0.3	1.4	2.2
3.	IXOL M125	37	5.3	2.1	5.6
4.	Tercarol A 350	100	100	36	100
5.	Tercarol RF 55	100	100	4.5	18
6.	Voranol RA 640	100	100	20	100
7.	Daltolac R 130	100	100	6.1	14.7
8.	Daltolac R 470X	100	48.6	13	100
9.	Desmophen T460	100	45.7	6.4	23
10.	Terol XO12009	36.7	11.8	26.6	89.3
11.	Wallbase B480T	100	9.7	25.3	100
Polyester Polyols					
1.	Repol 201-28	57	21	2.7	5.4
2.	Stepanpol PS 3152	34	31	6.5	6.6
3.	Terate 203	32	18	1.3	-
4.	Sepanpol PS 2520	93	23.4	2.7	5.8
5.	Sepanpol PS 3021	36.5	18.7	0.8	1.0
6.	Terate 5100	36.7	18.0	2.4	3.8
7.	Terate 5500	81.4	19.8	0.9	3.9
8.	Terol 305	45.3	16.4	13.1	3.9
Miscellaneous					
1.	TCPP	100	100	10	100
2.	Desmodur 44V20L	100	12	4.1	6.6
3.	Di-propylene Glycol	100	100	13	36

Pour in place formulations (Cost effective)



Formulations	#1 (Reference)	#2 - PAN	#3 - PAN	#4 - PAN
SOLKANE® 141b	15,00			
SOLKANE® 365/227 (87:13)		18,90	12,70	9,50
Daltolac R130	11,60	11,10	11,70	12,50
Syncopol GT150	6,50	6,20		
Syncopol GT690	12,00	11,40	18,00	21,00
Voranol RH 360	43,20	41,20	43,10	42,30
Water	1,50	1,42	2,40	2,65
TCP	7,00	6,70	9,00	8,80
PMDETA	0,20	0,20	0,20	0,20
Polycat 9	1,30	1,20	1,30	1,30
Surfactant B 8465	1,70	1,60	1,70	1,70
TOTAL	100,00	100,00	100,00	100,00

Physical FBA (mol)	0,13	0,13	0,09	0,06
Chemical FBA (mol)	0,08	0,08	0,13	0,15
Total FBA (mol)	0,21	0,21	0,21	0,21
Ratio of physical FBA (%)	60	60	40	30

Index	115	115	115	115
MDI Lupranat M20S (pbw)	112	107	112	118

Pour in place formulations (Cost effective)



Formulations	#1 (Reference)	#2 - PAN	#3 - PAN	#4 - PAN
Blowing Agent	SOLKANE® 141b	SOLKANE® 365/227 (87:13)	SOLKANE® 365/227 (87:13)	SOLKANE® 365/227 (87:13)
Flashpoint of system	no	no	no	no

Free rise density (kg/m ³)	26,5	26,5	26,5	27,5
Core mold (kg/m ³)	35,6	35,6	35,1	35,4
Overall (kg/m ³)	41,8	41,9	41,2	41,4
Closed Cells (%)	92,1	91,8	92,2	94,2

Compressive Strength (kPa)

Y (Height)	133	169	160	178
X	139	177	174	187
Z	157	161	147	166

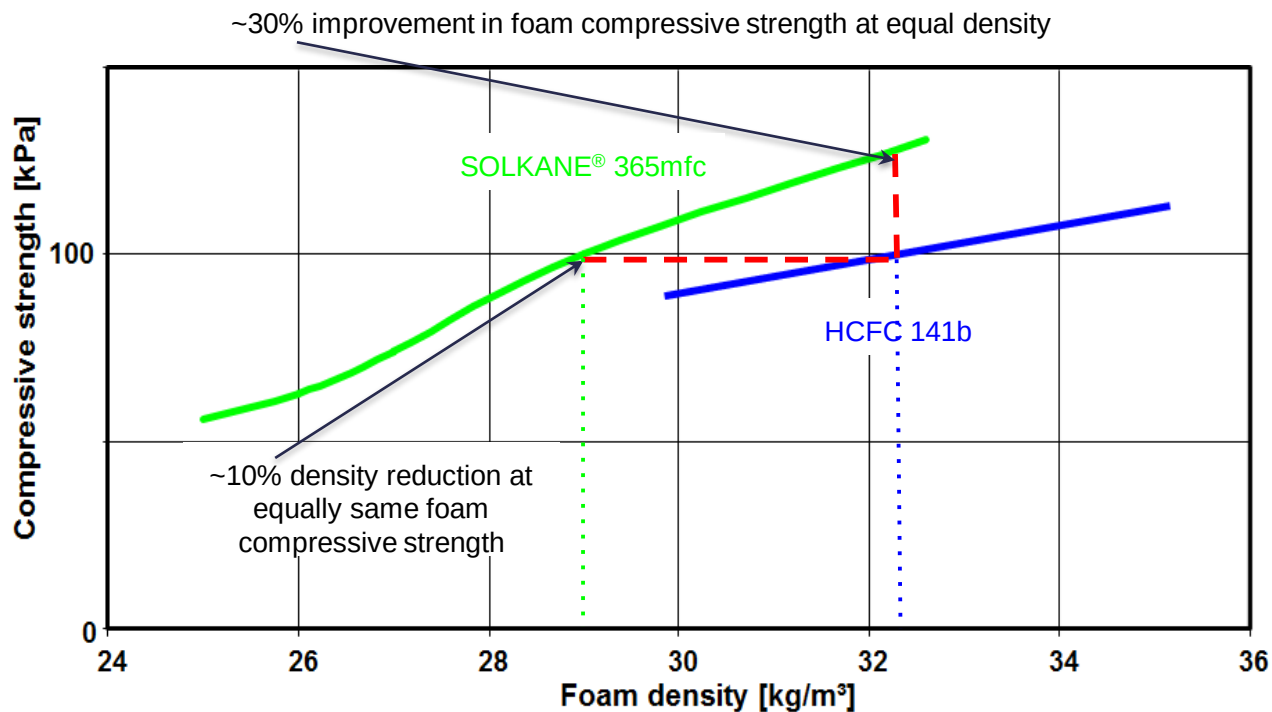
Lambda, initial (mW/m.K; 25 °C)	21,1	21,5	22,4	23,5
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Dimensional stability (1 week, %)

Length (-20 °C)	-0,2	0	-0,3	0
Width (-20 °C)	0,1	0	-0,2	0
Height (-20 °C)	-0,4	-0,1	-0,2	-0,1

Length (70 °C)	-0,2	-0,2	-0,1	-0,7
Width (70 °C)	0,3	0	-0,5	-0,2
Height (70 °C)	0	-0,3	-0,5	-0,4

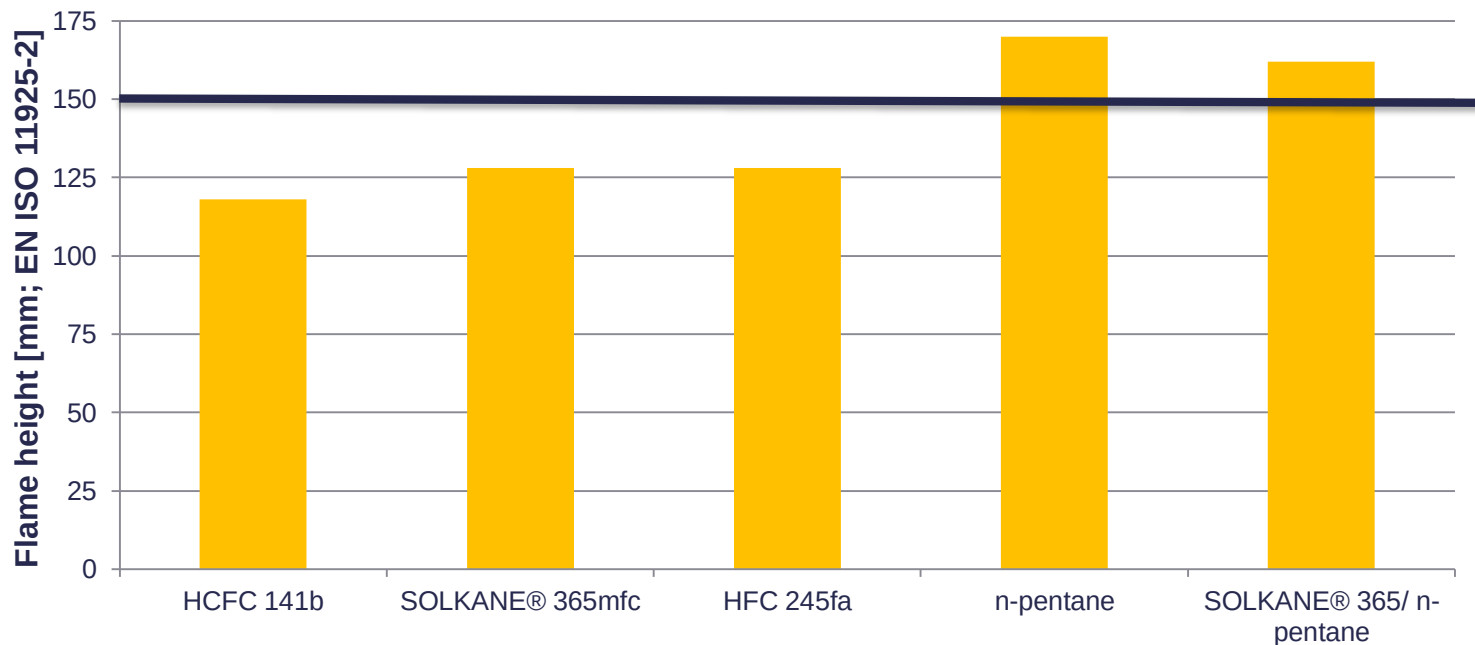
10% Reduction in Foam Density



Comparison of Ignitability Tests

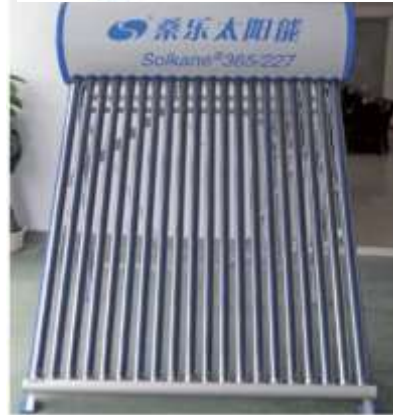


Ignitability Test (Euroclass E) of PU Foams



SOLKANE® 365mfc shows comparable ignitability test results to HCFC 141b
SOLKANE® 365/227 Blends would certainly be better!

Applications of SOLKANE® 365/227 Blend(s)



Metal Panels (Continuous Line)

SOLAR Water Heaters

Discontinuous Panels

Spray Foam

IXOL® High Performance Flame Retardant



IXOL® B251

flame retardant polyol for
Elements for construction
(steel sandwich)
Spray / Pour-in-place systems

IXOL® M125

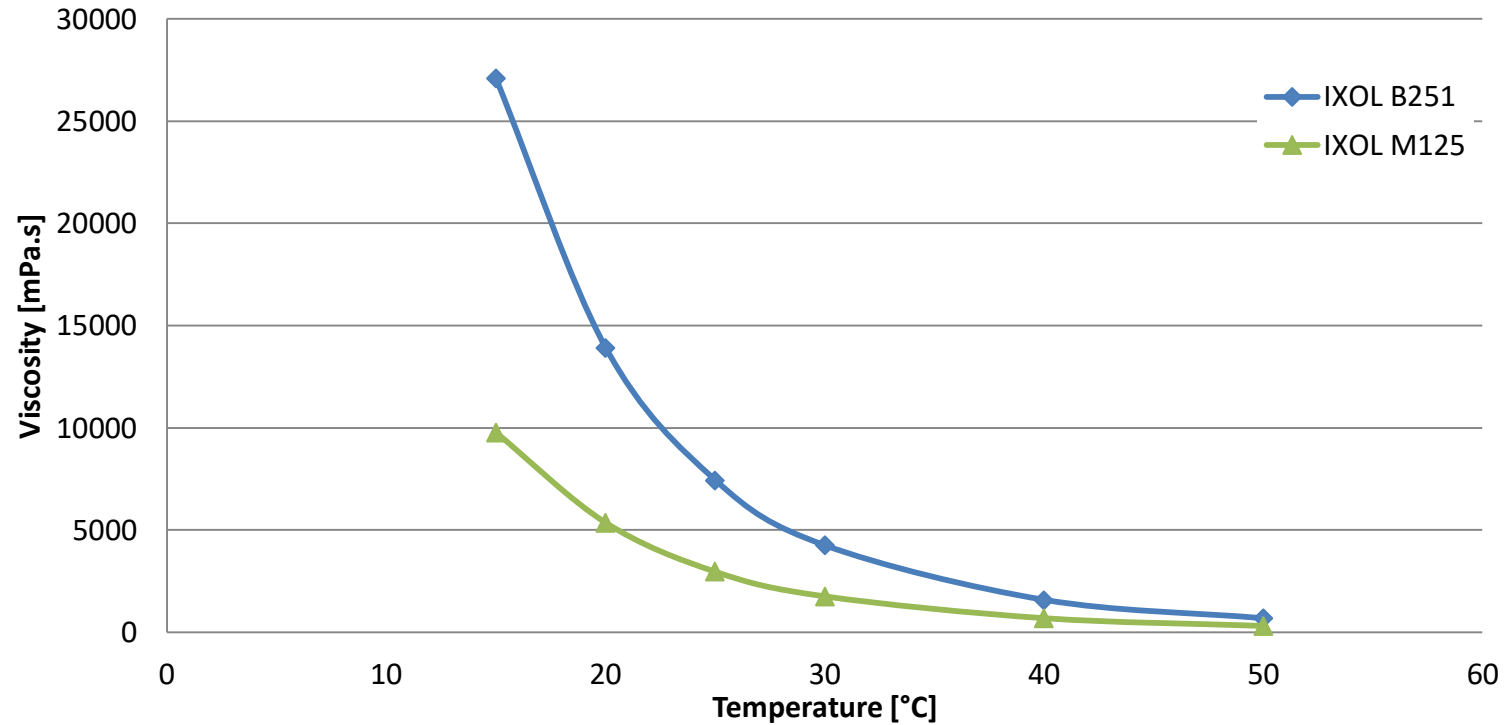
flame retardant polyol for
1 component foams (OCF)
PIR laminates (limited)

Specifications of IXOL B251 & M125



Parameter		Unit	IXOL B251	IXOL M125
Density	(25 °C)	[kg/m ³]	1580	1570
Viscosity	(25 °C)	[mPa.s]	7000	2900
OH-Value		[mg KOH/g]	330	240
Water		[mass-%]	< 0.2	< 0.2
Chlorine		[mass-%]	6.9	7.0
Bromine		[mass-%]	31.5	32.0
Acidity		[mg KOH/g]	< 0.3	< 0.3
Iron		[ppm]	-	< 4
Functionality			~ 3	~ 2

Viscosity > Easy Processing



IXOL® B 251 & M 125 - Main Product for



IXOL® B125 in one-component PUR foams
PIR foams blown with HFCs &/or pentanes,
Adhesives

IXOL® B251 can optimize
fire properties vs mechanical properties of the foam due to its
higher functionality



High Performance Reactive Flame Retardant

2K PU – Adhesive Systems with fire rated IXOL® M 125



In adhesives for
Mineral - Wool
EPS
XPS
Sandwich
Panels



Summary



Versatility SOLKANE® 365/227 (Blends) & IXOL® Products is great

- ✓ SOLKANE® 365/227 Blends are non-flammable liquids & Packaged in standard drums
- ✓ Easy to move on from HCFC 141b blown systems
- ✓ Better mechanical strength when compared with HCFC 41b blown foams
- ✓ Brominated Polyether Polyol(s) IXOL B251 & M125 are reactive fire retardants which also contribute mechanical strength to the foams.

Q & A



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- All statements or suggestions concerning the possible uses of HFC's and blends thereof are made without any representations and/or warranties whatsoever that any such use is free of legal constraints.
- Brochures and case studies are online available from the below link: <https://www.solvay.com/en/products/brands/solkane>



Thanks for your kind attention!

Abdulmalik Mohammad

Manager Technical Marketing

GBU Special Chem

SOLVAY Fluor GmbH

Hans-Boeckler-Allee 20

30173 Hannover/Germany

Email: abdulmalik.mohammad@solvay.com

Mobile: +491743460215

www.solvay.com