SOLKANE® 365
LNG/LPG Storage Tank Insulation

SOLKANE®

LNG, a liquefied natural gas and LPG, liquefied petrolium gas are becoming more and more important as a fossil fuel to compete with crude oil all over the world. Gathered in warmer regions like Qatar it has to be transported over greater distances by sea. The natural gas (cooled for transport to – 162 °C) is shipped in LNG/LPG tankers, which are specifically equipped for this kind of overseas transport. The standards for insulation at cryogenic temperatures are demanding.

The highest priority is given to keeping low storage temperatures and to minimizing expensive losses during transport. LNG/LPG storage tanks are insulated with polyurethane foam (PUF) and cargo containments are often insulated with glass fiber reinforced polyurethane foams (R-PUF).
In the beginning CFC 11 was used as a blowing agent, followed by HCFC 141b, which in turn has been substituted by SOLKANE®.

Blowing Gas	CFC11	HCFC 141b	SOLKANE® 365/227 93:7	Carbon Dioxide
Formula	CCl_3F	$CCl_2\ FCH_3$	$CF_3\ CH_2\ CF_2\ CH_3$	CO_2
Mol. Wt.	128	117	148	44
Boiling Point [30 °C]	23.8	32.1	40.2	subt. –78.5
Heat Conductivity of Vapor [mW/m.K, 25 °C]	8.8	9.5	10.7	16.6
ODP	1	0.11	0	0
GWP [1]	4,750	725	964 [2]	1

Table 1: Properties of various blowing agents

[1] GWP (ITH 100 y), Source IPCC 4th Assessment Report issued in 2007 (International Panel on Climate Change), [2] Based on weighted average (1,1,1, 3,3-pentafluorobutane: 93 %, 1,1,1,2,3,3,3-heptafluoro-propane 7 %)

Large temperature differences of up to 190°C (between –160°C and +30°C) cause high strain due to the LNG/LPG's static pressure, sloshing etc. Different PU densities are required to fulfill the dimensional and compressive stability requirements; table 2 shows the very similar mechanical data when HCFC 141b is compared to 3rd generation SOLKANE® 365/227.

Mechanical Properties of PUFs and R-PUF

Unit [MPa]		SOLKANE® 365/227				HCFC 141b			Water
		A	E	I	R-PUF	A	E	I	R-PUF
Density (dev.) [kg/m³]	**Mea**	41.5 (0.16)	82.7 (0.15)	110.0 (0.31)	125.38 (0.77)	42.0 (0.50)	84.0 (0.72)	118.0 (2.32)	123.47 (0.58)
	Req ≤	46.0	85.02	118.0	130.0	46.0	85.0	118.0	130.0
Comp. strength (dev.) z-dir.	**Amb.**	0.34 (0.018)	0.84 (0.005)	1.33 (0.003)	1.26 (0.027)	0.27 (0.023)	0.77 (0.010)	1.28 (0.095)	1.31 (0.046)
	Req ≤	0.17	0.53	0.87	1.2	0.17	0.53	0.87	1.2
	Cryo.	0.84	1.13	1.95	1.43	0.53	1.69	2.52	1.45
	Req ≥	0.22	0.69	1.23	*	0.22	0.69	1.23	*

Table 2: Mechanical properties in comparison

Notes: Mea. = measured value; Amb. = ambient temperature (23°C), Cryo. = cryogenic temperature; Req. = required value

Solvay Fluor GmbH
Postfach 220
30002 Hannover
Germany
Phone +49 511 857-2444
Fax +49 511 817338

Solvay Chemicals (shanghai) Co. Ltd.
3966 Jindu Rd.
Xinzhuang Industrial Zone
Shanghai 201108 · China
Phone +86 21 23501607
Fax +86 21 23501114

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

SOLVAY
asking more from chemistry®

Contact us: solkane.foamingagents@solvay.com
More Information: www.solkane.com

Another main criterion to achieve the expected and required properties, besides mechanical strength, is high performance insulation. As shown in table 3, the λ-value of SOLKANE® 365/227 is almost as good as that of HCFC 141b.

Fresh/initial Thermal Conductivity of PUFs and R-PUF

Unit [MPa]		SOLKANE® 365/227				HCFC 141b			Water
		A	E	I	R-PUF	A	E	I	R-PUF
Fresh/initial λ-value [W/m/K]	**Amb. (23°C)**	0.021	0.0225	0.0244	0.0261	0.0208	0.0222	0.0238	0.0374
	Req ≤	0.0213	0.0229	0.0251	-	0.0213	0.0229	0.0251	-

Table 3: Thermal conductivities

Notes: Amb. = ambient temperature; Req. = required value

Conclusion

It is evident from table 2 that the compressive strength at both ambient and cryogenic temperatures shows no remarkable differences between SOLKANE® 365/227 and HCFC 141b foam systems. This is also valid for the tensile and shear strengths, which can be reviewed in the proceedings[1].

The initial thermal conductivity of PUFs did not show any significant differences between SOLKANE® 365/227 and HCFC 141b syst ems.

All results for PUFs and R-PUF discussed in this paper show good thermal stabilities at cryogenic temperatures.

Based on these test results it is possible to substitute HCFC 141b with SOLKANE® HFC 365/227 as a blowing agent in the LNG/LPG industry. Besides, R-PUF blown with SOLKANE® HFC 365/227 seems to be a better selection as a new insulator for LNG/LPG cargo containment than R-PUF blown with water in the current situations.

[1] Proceedings of 5th (2005) International Offshore and Polar Engineering Conference, Seoul, Korea, June 19–24 (477–481)

SOLVAY asking more from chemistry®

35/240/08.14/007/1.000