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Industrial Products

SOLSTICE® PROPELLANT

Technical Bulletin

Solstice® Propellant

Solstice Propellant, is a new, nonflammable aerosol propellant that has an ultra-low global warming potential (GWP) and very low photochemical reactivity. Its full chemical name is trans- 1,3,3,3-tetrafluoroprop-1- ene, also known as HFO-1234ze. Its INCI name is tetrafluoropropene. The chemical structure is shown in Figure 1.

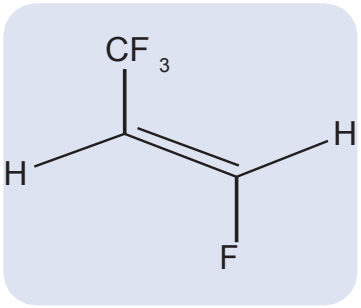

Figure 1.

Propellant Properties

Some of the physical properties of Solstice Propellant are shown in Table 1. Tables 2 and 3 show vapor pressures and liquid densities as a function of temperature, in English and SI units, respectively.

SOLSTICE PROPELLANT		
Molecular Formula	$CHF=CHCF_3$	
Molecular Weight	114	
Boiling Point	-2.2°F	-19°C
Vapor Pressure at 70°F/21°C at 130°F/54°C	49 psig 147 psig	3.4 bars 10 bars
Liquid Density at 70°F/21°C	1.17 g/cc	
Vapor Flame Limits (Vol.% in Air) Measured at 70°F	NONE	
Solubility of Water in 1234ze at 68°F/20°C	225 ppm	
Solubility of 1234ze in Water at 68°F/20°C	373 ppm	
Dipole Moment (debye)	1.44	
Dielectric Strength (Vapor at 1 atm.)	0.12 kV/mil	
Dielectric Strength (Vapor at 1 atm.)	0.12 kV/mil	
Heat of Combustion	4385 BTU/lb.	10.2kJ/g
Heat of Vaporization @NBP	84 BTU/lb.	195kJ/kg

Table 1.

F°	PSIA	Lbs/ft³	F°	PSIA	Lbs/ft³	F°	PSIA	Lbs/ft³
0	15.5	80.55	45	40.6	76.09	90	89.5	71.09
5	17.4	80.07	50	44.7	75.56	95	96.8	70.49
10	19.5	79.59	55	49.1	75.03	100	104.6	69.87
15	21.8	79.11	60	53.8	74.49	105	112.9	69.25
20	24.4	78.62	65	58.8	73.95	110	121.6	68.62
25	27.1	78.13	70	64.2	73.39	115	130.9	67.97
30	30.1	77.63	75	69.9	72.83	120	140.6	67.30
35	33.4	77.12	80	76.0	72.26	125	150.9	66.62
40	36.9	76.61	85	82.5	71.68	130	161.8	65.92

Table 2.

C°	MPa	kg/m³	C°	MPa	kg/m³	C°	MPa	kg/m³
-15	0.1200	1282.6	9	0.2980	1213.5	33	0.6308	1136.0
-12	0.1359	1274.3	12	0.3298	1204.3	36	0.6866	1125.6
-9	0.1534	1266.0	15	0.3642	1195.0	39	0.7460	1114.9
-6	0.1726	1257.5	18	0.4012	1185.6	42	0.8092	1104.0
-3	0.1936	1248.9	21	0.4410	1176.0	45	0.8764	1092.9
0	0.2165	1240.2	24	0.4837	1166.2	48	0.9476	1081.5
3	0.2414	1231.4	27	0.5295	1156.3	51	1.023	1069.8
6	0.2686	1222.5	30	0.5784	1146.3	54	1.103	1057.8

Table 3.

Flammability

Solstice Propellant does not exhibit vapor flame limits under standard test conditions. It is there- fore classified as nonflammable according to EC Testing Method A11: Flammability of Gases, as well as by the U.S. Department of Transportation (DOT) standard (tested according to ASTM E681). HFO-1234ze is nonflammable in the ASTM flame projection test. HFO-1234ze has also been tested and found to be nonflammable in the ignition distance test and the enclosed space ignition test (closed drum test).[1]

Miscibility

Solstice Propellant is miscible with the other liquefied gas propellants: 134a, 152a, DME, butane, isobutane and propane. It is also miscible with commonly-used solvents such as the lower alcohols, ketones, chlorinated solvents and hydrocarbons.

In some situations, it may be beneficial to blend HFO-1234ze with other propellants to optimize a formulation. For example, blends of HFO-1234ze with hydrocarbons or 152a might be useful in personal care formulations while blends with 134a might be used in certain technical aerosols. Vapor pressure data for blends of HFO-1234ze with other propellants are shown in tables 4a-5b.

	1234ze/134a		1234ze/152a		1234ze/DME	
Weight % 1234ze	70°F	130°F	70°F	130°F	70°F	130°F
80	71	177	70	175	62	155
60	76	189	73	182	65	161
40	80	199	75	186	69	169
20	83	207	76	189	73	178

Table 4a. *Vapor Pressure (PSIA)*

	1234ze/butane		1234ze/isobutane		1234ze/propane	
Weight % 1234ze	70°F	130°F	70°F	130°F	70°F	130°F
80	64	163	73	176	117	260
60	62	149	70	168	126	281
40	55	131	65	153	129	285
20	45	108	56	134	128	281

Table 4b. *Vapor Pressure (PSIA)*

	1234ze/134a		1234ze/152a		1234ze/DME	
Weight % 1234ze	21°C	54°C	21°C	54°C	21°C	54°C
80	4.9	12.2	4.8	12.0	4.3	10.7
60	5.2	13.0	5.0	12.5	4.5	11.1
40	5.5	13.7	5.2	12.8	4.8	11.7
20	5.7	14.3	5.3	13.0	5.0	12.2

Table 5a. *Vapor Pressure (Bars absolute)*

	1234ze/butane		1234ze/isobutane		1234ze/propane	
Weight % 1234ze	21°C	54°C	21°C	54°C	21°C	54°C
80	4.6	11.2	5.0	12.2	8.0	17.9
60	4.2	10.3	4.8	11.6	8.7	19.4
40	3.8	9.0	4.5	10.6	8.9	19.6
20	3.0	7.4	3.9	9.2	8.8	19.4

Table 5b. *Vapor Pressure (Bars absolute)*

Environmental Properties

In work done at the University of Copenhagen, the atmospheric lifetime of HFO-1234ze was determined to be approximately two weeks. The GWP, which is largely a function of atmospheric lifetime, was determined to be <1 versus CO_2 on a 100-year integrated time horizon[2]. In a companion study, also at the University of Copenhagen, it was determined that the atmospheric degradation products of HFO-1234ze have negligible impact on the environment[3].

Compounds with short atmospheric lifetimes often contribute to the generation of tropospheric, or ground-level, ozone which is one of the components of photochemical smog. That is not the case with HFO-1234ze. The MIR (maximum incremental reactivity) and POCP (photochemical ozone creation potential) values for HFO-1234ze have been determined to be 0.09[4] and 6.4[5], respectively. These very low values indicate that HFO-1234ze has very low photochemical reactivity and does not contribute in any significant way to tropospheric ozone generation. The U.S. EPA has recommended that HFO-1234ze be classified as a non-VOC.

Table 6 shows the environmental properties of HFO-1234ze compared to those of some commonly used propellants.

		1234ze	134a	152a	DME	Propane	Isobutane
GWP (versus CO_2, 100 year ITH)		<1	1300	138	<15	<15	<15
Photochemical Reactivity	MIR (g O_3/g VOC)	0.09	0.0007	0. 0175	0.93	0.57	1.23
	POCP	6.4	0.1	1	17.4	17.6	30.7

Table 6.

Compatibility

Solstice® Propellant exhibits good compatibility with plastics, elastomers and metals. In storage tests, it has been shown to be compatible with aluminum aerosol cans, tinplate cans and PET-lined cans. Solstice propellant has also been tested with aerosol valves and found to be compatible with common gasket materials including grades of butyl rubber, buna and neoprene. Since results may vary, it is always recommended that testing be done to confirm compatibility with specific package components and materials of construction. Valve compatibility tests have been run by Precision, Summit and Aptar Pharma. Contact information is available upon request.

Stability

HFO-1234ze has been shown to be thermally and hydrolytically stable. In one experiment, samples of HFO-1234ze, in the presence of water and metals, were stored at 392°F (200°C) for two weeks. There was no observed effect on the metals and analysis showed no indication of breakdown of the HFO-1234ze. Also, samples stored in steel cylinders for several years have been analyzed and found to be within the specification. It is always advisable to confirm the stability of any aerosol formulation containing a new propellant.

Toxicity

An extensive series of toxicity tests was carried out on HFO-1234ze with excellent results. The toxicity testing program included: acute exposure, repeat exposure, mutagenicity and developmental toxicity studies. The results of those tests support the conclusion that HFO-1234ze exhibits a very low order of toxicity. The American Industrial Hygiene Association has assigned a Workplace Environmental Exposure Level (WEEL) of 800 ppm (8-hour time weighted average) to this material. Of interest for medical and personal care applications, HFO-1234ze was found not to be an irritant in a human skin sensitization study.

Storage and handling

Honeywell's Solstice Propellant should be handled in a manner consistent with materials categorized as 'liquefied gases under pressure.' As illustrated by the vapor pressure data, HFO-1234ze is a moderate pressure gas and containers (bulk storage tanks or packages) should be rated for the pressure of HFO-1234ze.

Solstice Propellant, in approved containers, should be stored in a cool, well-ventilated area. HFO-1234ze containers should neither be punctured or dropped, nor exposed to open flames, excessive heat or direct sunlight. Container valves should be tightly closed after use and when the container is empty.

As with other fluorocarbons, HFO-1234ze should not be mixed with oxygen at elevated pressures. Applications necessitating pressurization – exceeding the vapor pressure of HFO-1234ze – should use dry nitrogen.

The Honeywell material safety data sheet (MSDS) contains the most current and comprehensive information on the health, safety and environmental aspects of HFO-1234ze.

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For more information

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2041 FP SOL A4 | December 2017

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