Honeywell
THE POWER OF CONNECTED

Blowing Agents

Honeywell Enovate® 245fa
TECHNICAL INFORMATION

Introduction

Honeywell Enovate® 245fa blowing agent (HFC-245fa, 1,1,1,3,3,-pentafluoropropane) is a liquid hydrofluorocarbon, which has been developed as a blowing agent for rigid insulating foams. It is a replacement for HCFC-141b and other fluorocarbon and non-fluorocarbon blowing agents. Enovate is a nonflammable liquid having a boiling point slightly below room temperature. It is non-ozone-depleting and it is Volatile Organic Compound (VOC) -exempt per the U.S. EPA. The physical properties of Enovate are summarized in Table 1 below.

Table 1: Physical Properties of Enovate		
Molecular Formula		$CF_3CH_2CHF_2$
Molecular Weight		134.0
Boiling Point	(ºF)	59.5
	(ºC)	15.3
Liquid Density	(g/cc) @ 20ºC	1.32
Freezing Point	(ºF)	<-160
	(ºC)	<-107
Vapor Pressure:	(psia @ 68ºF)	17.8
	(kPa @ 20ºC)	123
Vapor Thermal Conductivity*	(BTU in / ft²hrºF)@25 ºC	0.0832
	(mW/mK) @25	12.50
Water Solubility (in Enovate)		1600 ppm
Flash Point **		None
Vapor Flame Limits ***		None

*Source: Geller, Bivens, Yokozeki, "Transport Properties and Surface Tension of Hydrofluorocarbons HFC 236fa and HFC-245fa 20th International Congress of Refrigeration, IIR/IIF, Sydney, 1999.
**Flashpoint by ASTM D 3828-87; ASTM D 1310-86
***Flame Limits measured at ambient temperature and pressure using ASTM E 681-85 with electrically heated match ignition, spark ignition and fused wire ignition; ambient air.

Toxicity

Enovate® is currently listed on the U.S. EPA TSCA Inventory, the European EINECS Inventory, REACH, and the Japanese MITI Inventory. Extensive toxicity testing indicates that Enovate is of low toxicity. Overall results from a series of genetic studies indicate that Enovate is non-mutagenic and non-teratogenic. The American Industrial Hygiene Association has established a Workplace Environmental Exposure Level (WEEL) of 300 ppm. Anyone who uses or handles Enovate should carefully review the SDS and product label prior to use.

Table 2: Regulatory and Environmental Information on Enovate® 245fa	
CAS Number	460-73-1
ELINCS Number	419-170-6
Ozone Depletion Potential	0
U.S. VOC status	Exempt
Exposure Guidelines	
ACGIH TLV	None
OSHA PEL	None
WEEL (AIHA) TWA 8 hrs	300 ppm
TSCA Inventory Status	Listed
SNAP Approval	All Foam Applications
REACH	Registered

Environmental

Enovate® blowing agent is a fluorinated hydrocarbon. Follow all applicable regulatory guidelines when treating or disposing of wastes generated from the use of this product. Enovate is not considered a "hazardous waste" by the Resource Conservation and Recovery Act if discarded unused. Care should be taken to avoid releases into the environment.

Applications

Enovate has been evaluated in a variety of foam systems and applications. Its superior thermal insulating characteristics, physical properties and compatibility with other materials make it ideal as a blowing agent for rigid polyurethane foams. Enovate replaces HCFC-141b in rigid polyurethane foam applications. Foams formulated with Enovate generally have thermal properties equivalent to those of HCFC-141b foams and better dimensional stability and compressive strength properties. The U.S. EPA has given SNAP approval for the use of Enovate as a replacement in all foam applications.

It should be noted that on October 15, 2016, delegates to the Montreal Protocol agreed in Kigali, Rwanda to an historic amendment that adds high-GWP HFCs to the Protocol and establishes schedules for their phase down in developed and developing countries. The accord will further accelerate the adoption of HFC substitutes such as Honeywell's Solstice® blowing agents (based on HFO technology) used for aerosols, foam insulation, and air conditioning and refrigeration equipment.

Miscibility

As reflected in the statistics below, Enovate has exhibited acceptable miscibility in a wide range of polyols. To determine miscibility, a mixture containing 40 wt.% Enovate and 60 wt.% polyol is prepared in a calibrated miscibility tube. The mixture is thoroughly mixed at an elevated temperature. The tube is then placed in a constant temperature bath for 24 hours. The height of the polyol and the Enovate is measured and the miscibility is calculated.

Table 3: Miscibility of Enovate® in Polyols @70 °F (21 °C)	
Polyol	**% Miscible**
Polyethers	
(Sucrose)	
Dow Voranol® 360	>40
(Sucrose- Amine)	
Huntsman Rubinol® R 170	>40
Huntsman Rubinol® P 180	>40
(Aromatic-Amine)	
Huntsman Rubinol® R 144	>40
Huntsman Rubinol® R159	21
(TDA)	
BASF Pluracol® -824	35.4
Dow Voranol® 490	>40
Polyester	
Invista Terate® 2541	23.3
Invista Terate® 2541L	27.9
Invista Terate® 2031	18.8
Invista Terate® 2542	21.5
Invista Terate® 5521	23.0
Invista Terate® 254	23.4
Stepan Stepanol® 2352	32.3
Great Lakes PHT 4 Diol®	6.2

Stability

Laboratory tests indicate that Enovate® blowing agent has a high degree of thermal and hydrolytic stability. In sealed tube studies, the material showed no signs of decomposition after six weeks of exposure to temperatures ranging from 75°C to 200°C in the presence and absence of water (at 300 ppm), and in the presence and absence of metals (3003 aluminum and/or 316 stainless steel). A separate study was also conducted with cold rolled steel rod exposed to Enovate in the presence and absence of air and water for a period of two to six weeks at temperatures ranging from 25°C to 100°C. Again, Enovate did not show any signs of decomposition.

Compatibility

Enovate blowing agent is non-reactive and non-corrosive toward all commonly used metals in polyurethane processing equipment. This includes carbon steel, stainless steel, copper and brass. There is a concern with the use of aluminum in contact with any halogenated material, which includes Enovate, due to the reactive nature of aluminum. This is particularly so if aluminum fines are present and if the oxide layer on the surface of the aluminum is removed.

In general, Enovate is less aggressive toward plastics and elastomers than HCFC-141b. Gaskets and seals that were changed to accommodate HCFC-141b should be compatible with Enovate. Honeywell has evaluated plastics and elastomers for use

with Enovate. Table 3 below reports the findings of this study. Elastomers that may find application in both static conditions (for example, gasketing between flanges) versus dynamic conditions (for example, seals on rotating shafts) may have varying degrees of suitability in use.

Storage & Handling

Enovate® 245fa should be stored in a cool, well-ventilated area. The material should only be stored in an approved cylinder. Please consult Honeywell's Technical Service Department prior to storage of the material in anything other than its original shipping cylinder to ensure that the new container meets all safety requirements. The container and its fittings should be protected from physical damage. It should neither be punctured or dropped, nor exposed to open flames, excessive heat or direct sunlight. The container's valves should be tightly closed after use and when the container is empty.

Based on experience with other HFCs, Enovate should not be mixed with either air or oxygen at pressures above atmospheric pressure. If pressurization is required in your application, the use of nitrogen is recommended.

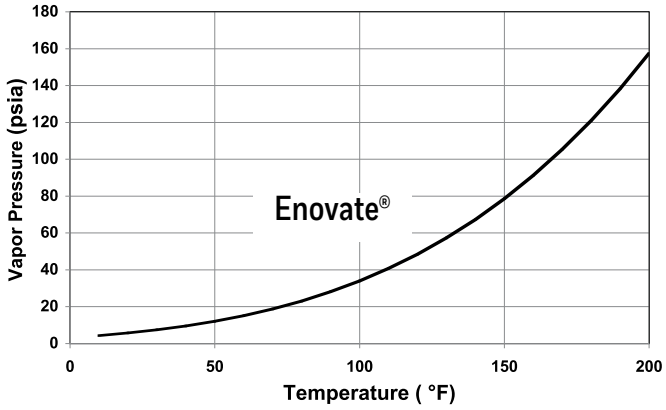
For additional information on the use of cylinders, please consult the appropriate handling, storage and unloading bulletin (available from a Honeywell Technical Service Representative).

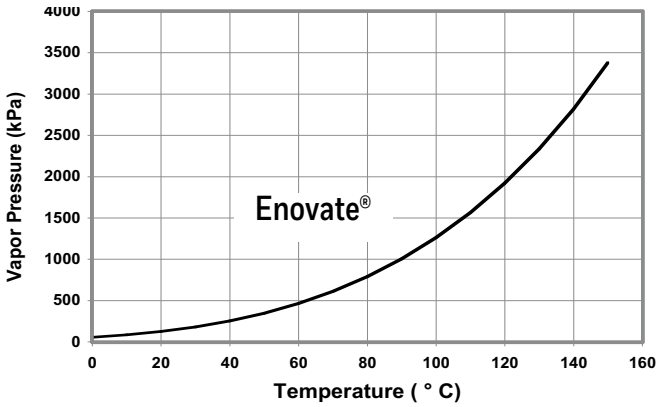
Table 3: Materials Compatibility

Plastics				
Application	**% Weight Delta**	**% Length Delta**	**% Width Delta**	**%Thickness Delta**
Acetal	Negligible	Negligible	Negligible	Negligible
Acrylic	Dissolving			
HDPE	Negligible	Negligible	Negligible	Negligible
Nylon	Negligible	Negligible	Negligible	Negligible
Polycarbonate	Negligible	Negligible	Negligible	Negligible
Polyetherimide	Negligible	Negligible	Negligible	Negligible
Polypropylene	Negligible	Negligible	Negligible	Negligible
PET	Negligible	Negligible	Negligible	Negligible
PVC	Negligible	Negligible	Negligible	Negligible
PVDF	Negligible	Negligible	Negligible	Negligible
PTFE	Negligible	Negligible	Negligible	Negligible
Elastomers				
Application	**% Weight Delta**	**% Length Delta**	**% Width Delta**	**%Thickness Delta**
Butyl Rubber	Negligible	Negligible	Negligible	Negligible
Fluoroelastomer	76.5	24.8	26.9	27.7
EPDM	Negligible	Negligible	Negligible	Negligible
Epichlorohydrin	10.4	3.7	3.4	25.5
EthylenePropylene	1.2	0.8	Negligible	Negligible
Neoprene	Negligible	Negligible	Negligible	Negligible
Nitrile Rubber	4.2	Negligible	Negligible	Negligible
Silicone	6.0	Negligible	Negligible	2.4
Urethane	20.5	2.3	5.0	9.1

Notes: Fluoroelastomer: "Viton A": Trademark of DuPont Dow Elastomers
Nitrile Rubber: "Buna N"
PTFE: "Teflon": Trademark of the E. I. du Pont de Nemours and Company
PVDF: "Kynar": Trademark of Arkema Inc.
Polyetherimide: "Ultem": Trademark of The General Electric Company

Temperature vs Pressure

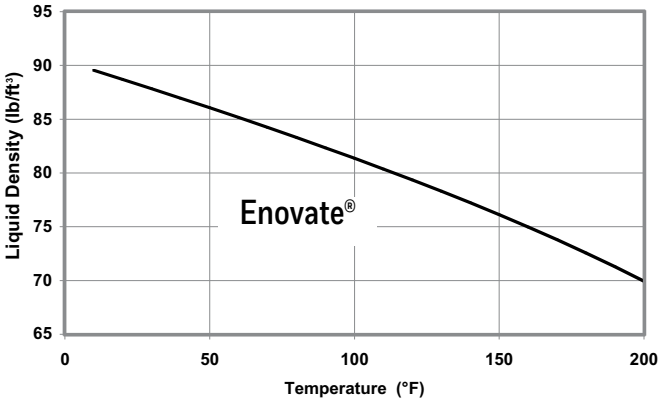


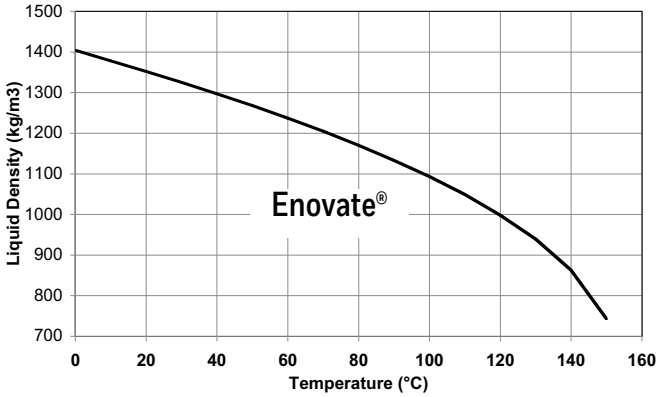


Temperature [°F]	Pressure [psia]	Temperature [°F]	Pressure [psia]
10	4.3	110	40.7
20	5.7	120	48.4
30	7.4	130	57.2
40	9.5	140	67.2
50	12	150	78.5
60	15.1	160	91.1
70	18.7	170	105.2
80	23	180	120.2
90	38.1	190	138.2
100	33.9	200	157.4

Temperature [°C]	Pressure [kPa]	Temperature [°C]	Pressure [kPa]
0	54	80	789
10	83	90	1004
20	124	100	1261
30	179	110	1565
40	252	120	1921
50	345	130	2335
60	464	140	2817
70	610	150	3380

Temperature vs Density



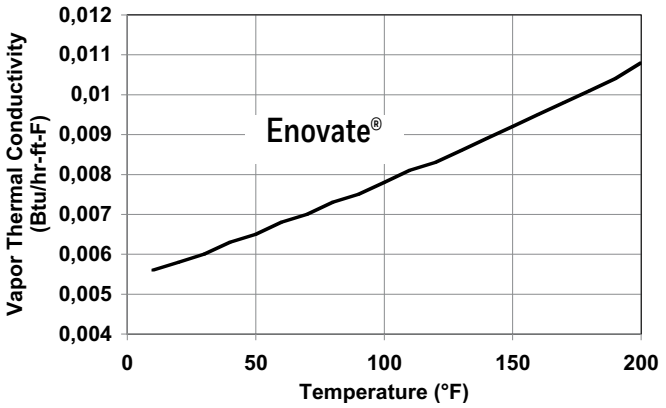


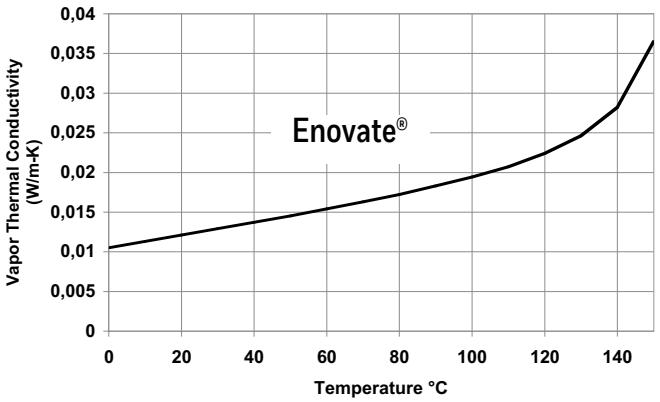
Temperature vs Density (cont.)

Temperature [°F]	Liquid Density [lb/ft³]	Temperature [°F]	Liquid Density [lb/ft³]
10	89.5	110	80.4
20	88.7	120	79.3
30	87.8	130	78.3.
40	86.9	140	77.2
50	86.1	150	76.1
60	85.2	160	75.0
70	84.2	170	73.8
80	83.3	180	72.6
90	82.3	190	71.3
100	81.4	200	69.9

Temperature [°C]	Liquid Density [kg/m]	Temperature [°C]	Liquid Density [kg/m]
0	1404	100	1093
10	1378	110	1049
20	1352	120	998
30	1325	130	939
40	1297	140	863
50	1268	150	743
60	1237		
70	1205		
80	1170		
90	1133		

Temperature vs. Vapor Thermal Conductivity





Temperature [°F]	Vapor Thermal Conductivity [Btu/hr-ft-F]	Temperature [°F]	Vapor Thermal Conductivity [Btu/hr-ft-F]
10	0.0056	110	0.0081
20	0.0058	120	0.0083
30	0.0060	130	0.0086
40	0.0063	140	0.0089
50	0.0065	150	0.0092
60	0.0068	160	0.0095
70	0.0070	170	0.0098
80	0.0073	180	0.0101
90	0.0075	190	0.0104
100	0.0078	200	0.0108

Temperature [°C]	Vapor Thermal Conductivity [W/m-k]	Temperature [°C]	Vapor Thermal Conductivity [W/m-k]
0	0.0105	80	0.0172
10	0.0113	90	0.0183
20	0.0121	100	0.0194
30	0.0129	110	0.0207
40	0.0137	120	0.0224
50	0.0145	130	0.0246
60	0.0154	140	0.0282
70	0.0163	150	0.0365

For more information:
Please call: +1-800-631-8138
www.honeywell-blowingagents.com

Honeywell Advanced Materials
115 Tabor Road
Morris Plains, NJ 07950

RESPONSIBLE CARE®
OUR COMMITMENT TO SUSTAINABILITY

470 FP BA v4 | December 2018

Honeywell