



Product Highlights and Technical Information



SUSTAINABLE | ENVIRONMENTALLY BENIGN | ENERGY EFFICIENT | HYGIENICALLY SAFE



Better Products. Better for the Environment.





BLOWING AGENT TECHNOLOGY



Environmentally friendly blowing

Ecomate® blowing agent technology was born from the innovation of the FSI Chemistry Department. The advent of Ecomate® technology and its evolution has become yet another benchmark in FSI's history of formulating superiority and proves once again *Success Through Innovation.*



End Use Applications

Rigid Foams	Appliances/White Goods
Spray Foams	Automotive
Integral Skin Foams	Boardstock & Continuous Panel Mfg.
Flexible Foams	Commercial Foodservice
Reaction Injection Molding	Refrigerated Transportation
Roto-Mold Applications	SIPS & Discontinuous Panels
Pour-in-Place Applications	U.S.C.G. Marine/Flotation



1998

FSI begins search for next generation blowing agent.

2001

Ecomate® system successfully passes initial Class 1 (UL E-84) testing.

2002

Original Ecomate® worldwide patent application filed. Additional patents granted in 2006, 2007, 2008, 2009, 2010.

2003

95% of FSI HCFC customers successfully converted to Ecomate®.

2004

E.P.A. SNAP listed and granted VOC-Exempt Status.

FSI achieves UL E84 certification with Ecomate® system on panels ranging from 1.5–6 in (38.1–152.4 mm) with a density of 1.98–2.64 pcf (31.7–42.3 kg/m³).

2005

International presence established in Australia, Brazil and UK.

International partnerships grown in China, India, MEAF, South Africa and South Korea.

agent and family of polyurethane systems.

Ecomate® is the *Swiss Army Knife of Blowing Agents*

Ecomate® is a true liquid blowing agent designed for use in rigid insulating foams, spray foams, integral skin foams, and various flexible foams. FSI and the Ecomate® worldwide distribution team are constantly finding new uses for this versatile blowing agent.

Is Your Product Headed in the Right Direction?

Environmentally benign blowing agent Ecomate® and its systems are non-GWP, non-ODP, and VOC exempt, with good mechanical and thermal properties. Ecomate® fulfills current and future regulatory requirements and is both U.S. EPA and SNAP approved to replace HCFCs, HFCs, and SMOG producers such as hydrocarbons (HCs). No other blowing agent can match Ecomate's® sustainability. Be kind to our environment and your customers. Choose Ecomate.®

Open to Change? Your Customers Are.

Ecomate® offers users of HCFCs, HFCs, and HCs the unique option to “leap frog” and eliminate the need for additional changes due to current and future environmental regulation. Ecomate® allows OEMs to continue delivering on the increasing demands (improved thermal efficiency, adhesion, even density distribution, GRAS Approval to name a few) of the end consumer.

The Superior Choice. A Sea of Possibilities Awaits with Ecomate.®

Since 2000, Ecomate® has been field proven to deliver excellent solubility, processing and foam properties. Most importantly ecomate's® superior qualities have proven to be cost effective, offering an economical choice for those utilizing HCFCs, HFCs, and HCs. Ecomate® requires little to no equipment, plant, facility or production changes. As the world moves toward reducing the threat of ozone depletion, global warming, smog and other dangers to human life, every sector of manufacturing will be affected. Ecomate® ensures that you will keep ahead of the ever-changing regulatory and consumer trends.

2006

FSI discontinuous panel producer achieves Factory Mutual (FM) approval using Ecomate® Class 1 system.

2007

United States Coast Guard approves an Ecomate® system for use in Life Rings.

2008

FSI customer exceeds Energy Star standards by 23.7% utilizing Ecomate® technology.

Ecomate® receives Environmental Innovation Award at IBEX Trade Show.

2009

GRAS (Generally Regarded As Safe) Status achieved.

2010

85% of all FSI customers have successfully converted to Ecomate® technology.

Significant McDonald's supplier converts all foaming locations to Ecomate.®

EU and India Patent Rights granted. FSI now has patent rights in the three largest emerging economies: Brazil, China and India.

2011

FSI opens office in New Dehli, India

2012

International partnerships added in Turkey, Philippines, Malaysia and other locations.

FAST FACTS

- In one year alone, FSI customers reduced CO₂ emissions by 549,817 mt. Three times greater than the closest competitor.
- Ecomate® is not petro-chemical based.

PHYSICAL PROPERTIES

Ecomate®		
Chemical Name	Ecomate®	
Formula	HCOOCH ₃	
Molecular Weight (g/mol)	60.05	
Boiling Point (at 101.3 kPa, 14.69 psi)	31.5°C	88.7°F
Vapor Pressure (Bar at 20°C, psi at 68°F)	0.62	9
Specific Gravity (20°C, 68°F)	0.98	
Thermal Conductivity of Vapor (25°C/77°F) (mW/m ² ·°K, BTU/(hr.ft ² ·°F))	10.7	0.074
Solubility in water (23°C/73.4°F)	330 g/kg	33 wt%
Density of Vapor (20°C/68°F) (Air=1)	2.07	
Viscosity (25°C/77°F)	0.355 cps	
Electrical Conductivity (ps/m)	1.92x10 ⁸	
Refractive Index	1.343	

BLOWING AGENT ENVIRONMENTAL IMPACT

Blowing Agent	ODP	GWP	VOC	Atmospheric Lifetime, Years	MWt	†ratio	‡CO ₂ e
Ecomate®	0	0	Exempt	0.02	60	1.00	1
CFC-11	1	4750	Exempt	45	137.4	2.29	10878
CFC-12	1	10900	Exempt	100	120.9	2.02	22018
HCFC-22	0.055	1810	Exempt	12	86.5	1.44	2606
HCFC-141b	0.11	725	Exempt	9.3	117	1.95	1414
HCFC-142b	0.065	2310	Exempt	17.9	100.5	1.68	3881
HFC-134a	0	1430	Exempt	14	102	1.70	2431
HFC-152a	0	124	Exempt	1.4	66.05	1.10	136
HFC-227ea	0	3220	Exempt	34.2	170.3	2.84	9145
HFC-245fa	0	1030	Exempt	7.6	134	2.23	2297
HFC-365mfc	0	794	Exempt	8.6	148	2.47	1961
n-C5	0	<25	YES	0.008	72	1.20	29
c-C5	0	<25	YES	0.008	70	1.167	28

Data from US EPA.

†Ratio = MW/60, showing extra blowing agent for same density foam.

‡Carbon Dioxide equivalents [=GWP * Ratio].

	Ecomate®	141b	365mfc	n-C5	c-C5
Caradol 585	100	100	32	5	11
Castor Oil	100	100	18	47	100
DEG	100	35	*	*	*
Ethylene Glycol	10	4	3	1	1
IXOL M125	50	37	5	2	5
FM550	100	100	*	*	*
Stepanpol 3152	100	33	30	6	7
Stepanpol 2352	100	30	*	*	*
Terol 256	100	10	*	*	*
Arcol LHT240	100	100	*	*	*
TCPP	100	100	100	10	100
PPG 2000	100	100	*	*	*
Teracol A350	100	100	100	36	100
Teracol RF55	100	100	100	4	18
Voranol RA640	100	100	100	20	100
Jeffol R315X	100	100	*	*	*
Voranol 360	100	100	*	*	*
Poly G70-600	100	75	*	*	*
Multranol 8114	100	100	43	9	27

* Not Determined

MISCIBILITY

Ecomate® is an extremely miscible blowing agent. Ecomate® is compatible with all current blowing agents, most organic solvents, surfactants, and catalysts.



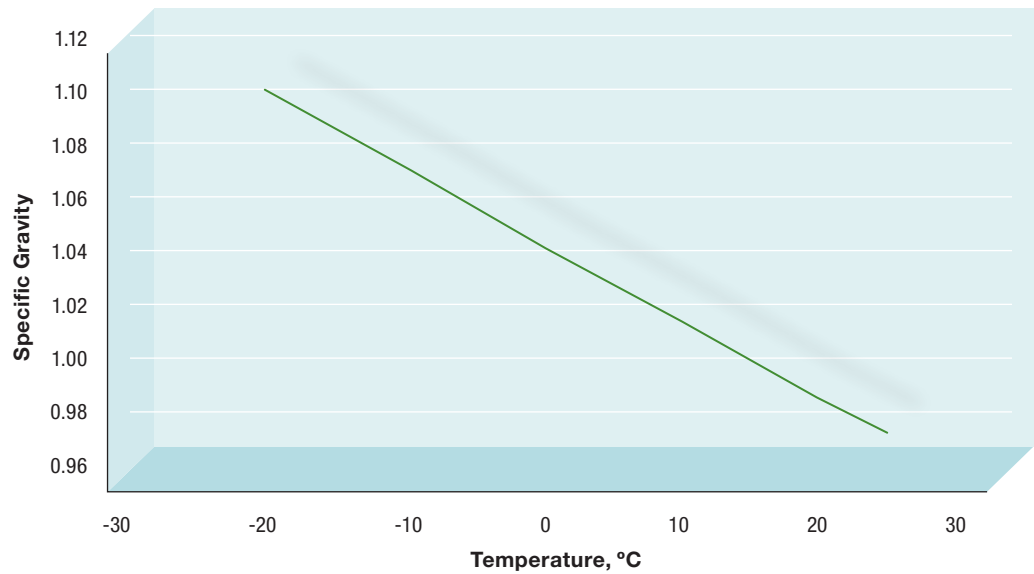
MATERIALS COMPATIBILITY

SEALS

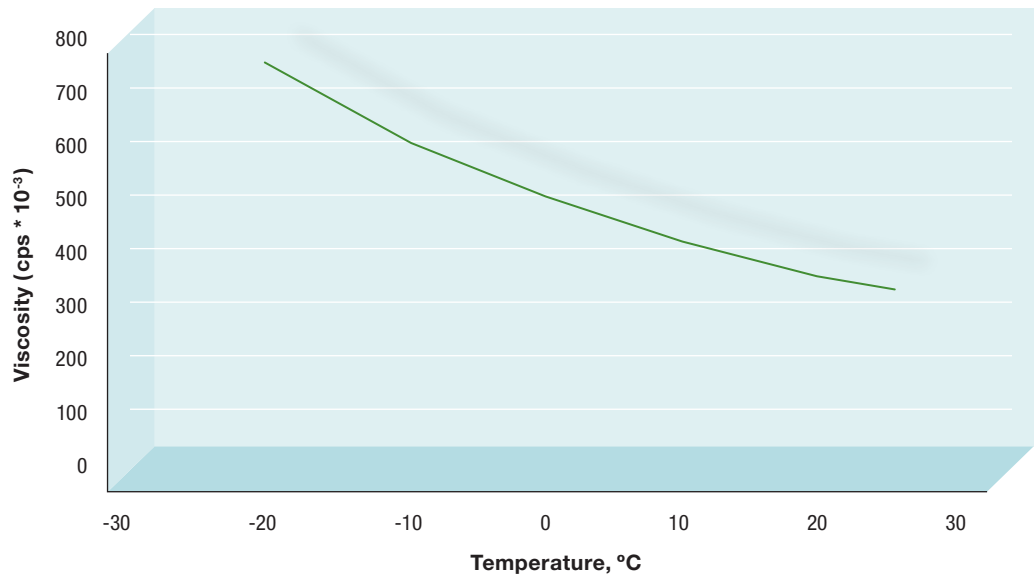
PTFE and Kalrez are the recommended seal materials for neat Ecomate®. EPDM is acceptable. For Polyol/Resin PU systems with ~5% Ecomate®, PTFE, Kalrez, EPDM, Butyl, Viton, Neoprene and Silicone have proven acceptable. Buna-N and Santoprene showed fair results. Isocyanate systems with Ecomate® had similar results to the Polyol/Resin systems. Each PU system is different and it is recommended that compatibility be tested. Consult with an FSI representative for further clarification.

SUBSTRATES AND ADHESION

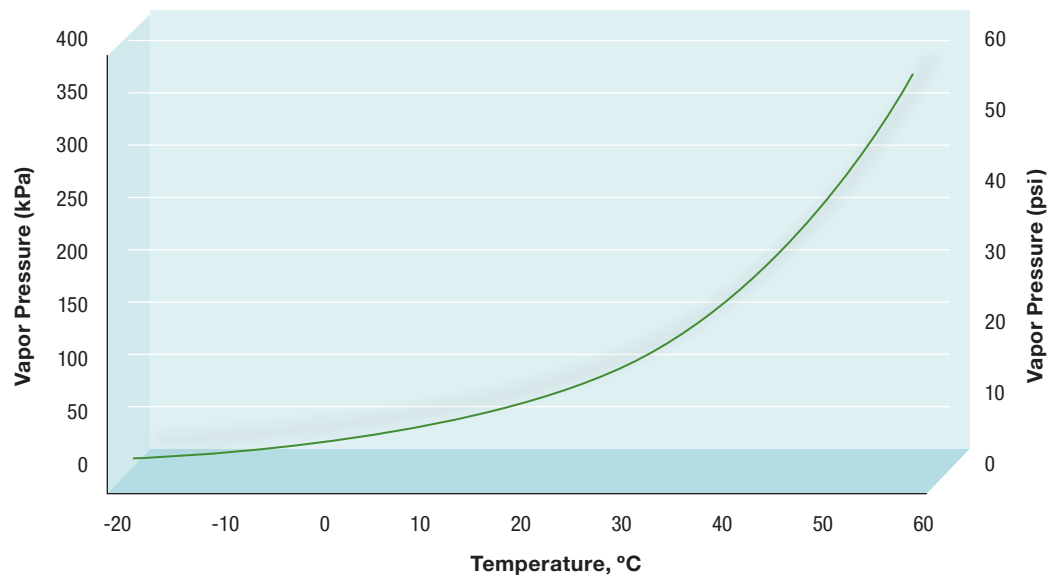
Ecomate® PU systems have been tested and are currently used with HIPS, ABS, PP, PE, PMMA, PVC, Polycarbonate and other various thermoplastics with favorable results. Compared to legacy PU systems, Ecomate® systems have demonstrated excellent — and in most cases, improved — adhesion to a broad range of plastic, metal and wood substrates.



LIQUID DENSITY
At 20°C / 68°F the specific gravity is 0.98



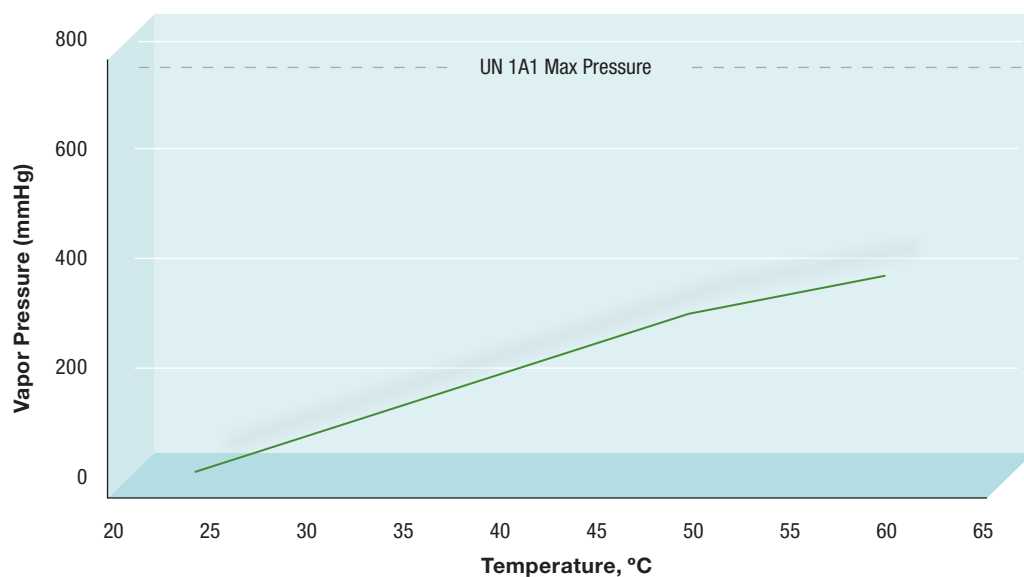
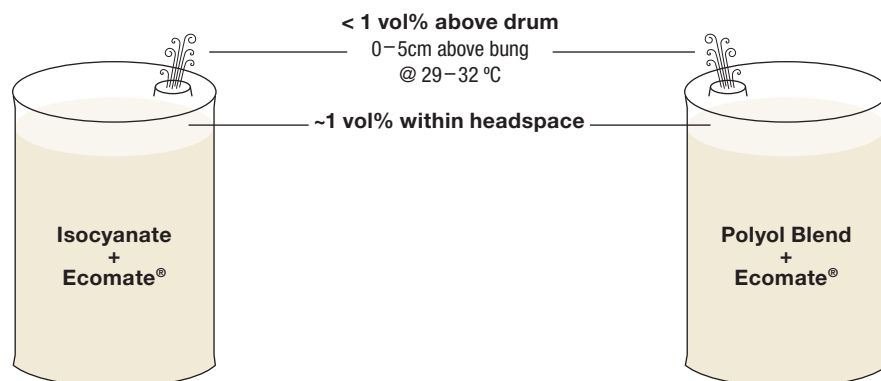
VISCOSITY
Ecomate® versus temperature



VAPOR PRESSURE OF NEAT ECOMATE®
Ecomate® versus temperature

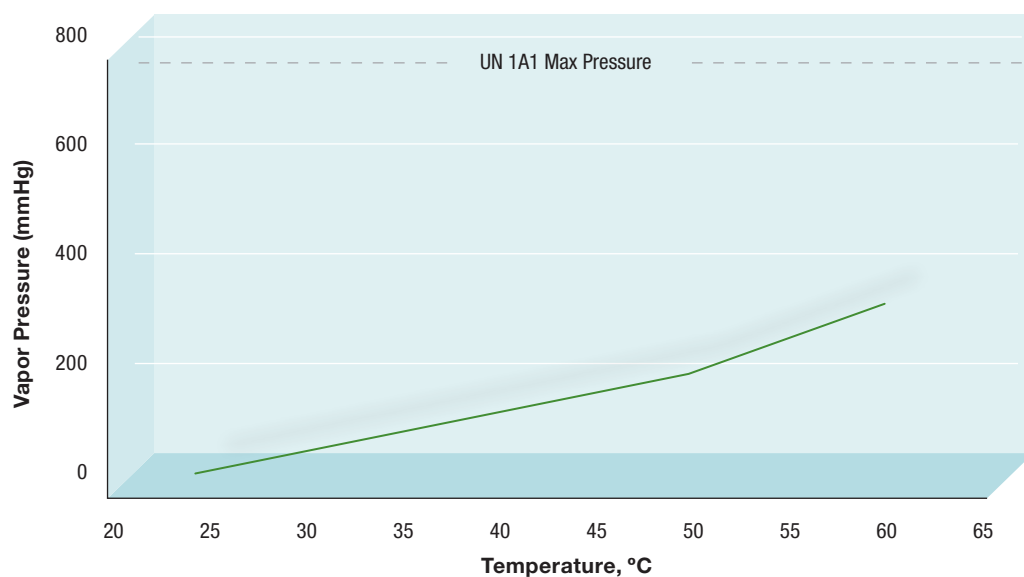
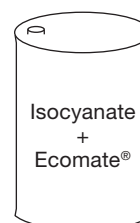
ECOMATE® SYSTEMS EMISSIONS

Stored systems in drums / totes



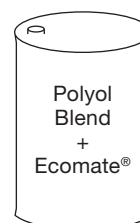
VAPOR PRESSURE OF STORED ECOMATE® BLENDS

(ASTM D2879, typical data)
Blowing Agent / Isocyanate System
eco3-95-1.7



VAPOR PRESSURE OF STORED ECOMATE® BLENDS

(ASTM D2879, typical data)
Blowing Agent / Polyol System
eco3-95-1.7



HANDLING AND STORAGE

Thoroughly review the Ecomate® Material Safety Data Sheet, Technical Data Sheet, and Product Handling Guide before handling the product. Ecomate® can be stored in small containers and larger bulk-type containment. Small containers should be kept in a cool, dry, well-ventilated area. Keep containers closed when not in use and open slowly to allow any excess pressure to vent. Keep away from heat, sparks, flame, or other sources of ignition.

Use proper grounding and bonding procedures when loading, unloading, and transferring. Use spark resistant tools and only use dry nitrogen to pressurize containers. Consult an FSI representative for the various options for bulk containment. Chemical stability of Ecomate® is excellent and is similar to that of HCFC-141b. It should not be exposed to strong alkaline compounds or alkali metals. PU formulations have been observed to be stable in excess of six months.

PACKAGING

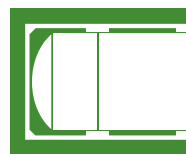
Ecomate® is available in the following containers.



NON-PRESSURIZED



PRESSURIZED



ISO-TANK



ROADTANKER

ENVIRONMENTAL

Today Ecomate® is the only physical blowing agent on the market which is zero ODP, zero GWP and a VOC exempt compound.

	ODP	GWP	VOC
Ecomate®	0	0	Exempt
HCFC-141b	0.12	725	Exempt
HFC-245fa	0	1030	Exempt
HFC-365mfc	0	794	Exempt
c-C5	0	11	Yes

FLAMMABILITY

Data below is on neat blowing agent. Isocyanates and Polyols/Resins can be blended with Ecomate® so the flash point is high enough to not require use of “red label”.

Lower Flammable Limit (Vol %)	5.0
Upper Flammable Limit (Vol %)	23.0
Flash Point (closed cup)	-19°C/-2°F
Auto Ignition Temp	465°C/869°F
Heat of Combustion (kJ/g / BTU/lb)	-16.2/6965
Min Ignition Energy (mJ / BTU)	0.5/4.74 x 10 ⁻⁷

STABILITY IN SOLUTION

Ecomate® systems are very stable. Unlike other blowing agents, Ecomate® mixes in readily and easily and does not separate like “oil & water” as many other blowing agents do. Blending of Ecomate® does not require sophisticated mixing equipment and/or emulsification equipment and agitators.

TOXICITY

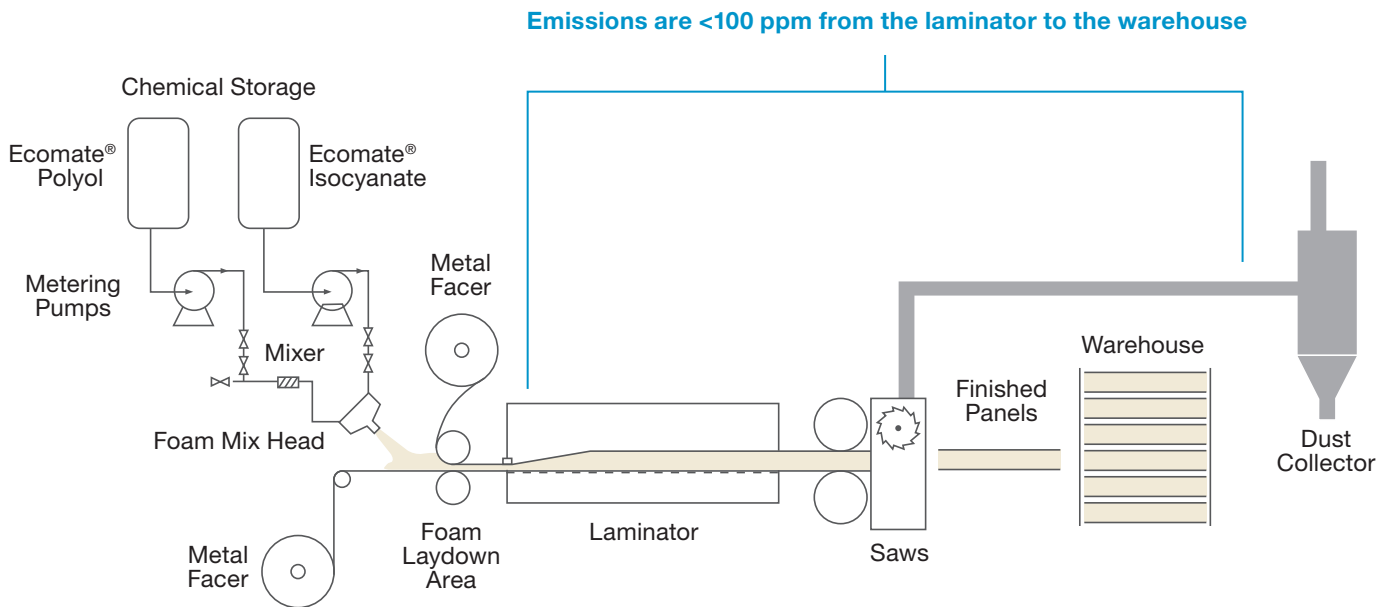
Long term evaluation of Ecomate® has shown no toxic concerns. Ecomate® has achieved GRAS (Generally Recognized As Safe) Approval for use in domestic appliances. Ecomate® is registered with REACH (EINECS No. 203-481-7). Refer to the MSDS and Technical Data Sheet for more specific toxicology information.

TLV (ACGIH) = 100 ppm
 STEL (ACGIH) = 150 ppm
 PEL (OSHA) = 100 ppm

<https://fsi.co/category/technical-documents/>

MANUFACTURING EMISSIONS

Because of its excellent solubility, Ecomate® emissions are very low throughout the manufacturing processes, including “3rd-Stream” applications.



SPRAY FOAM EMISSIONS

Spray Foams are “worst case” scenarios for emissions. Multiple third party emissions and hygiene testing on Ecomate® spray systems have proven very favorable.

Low Pressure injection equipment

PPM at Injection point	600 mm (23.62 in) from head
2.85	0.59
3.00	0.71
2.95	0.73
2.26	0.63

Spray equipment sampling taken indoors ~61 cm (2 ft) from point of application

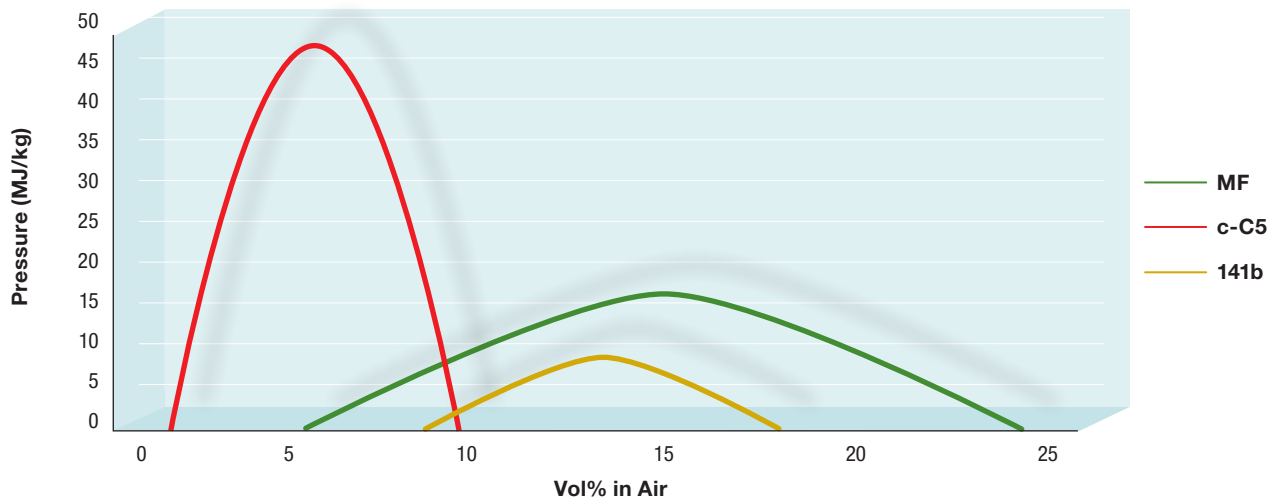
PPM over the foaming area	At the spray head
23	10
23	12
20	10



Sample Data below was taken from nominal 25–27 kg/m³ (1.56–1.69 lb/cu³) foam without use of ventilation.
Ventilation is a requirement for use of isocyanates.

PRESSURE GRAPH

The burning of Ecomate® gives off less pressure (*is less explosive*).



FLASH POINTS

Ecomate® systems have been reported and proven by multiple third party Testing Agencies to exhibit Flash Points well above 35°C/95°F per ASTM D93-02, thus not requiring “red label” via U.S. DOT regulations.

COMBUSTION

Ecomate® systems have been proven to not sustain combustion per ASTM D4206. This has been reported by multiple third party testing agencies.

Koehler
INSTRUMENT COMPANY, INC.

To: Foam Supplies, Inc.
4337 North Rider Trail
Earth City, MO 63045-1103
ATTN: Mark Schulte
TEL: 314-344-3330
FAX: 314-344-3331

The following liquid samples were sent in for Pensky-Martens Closed Cup Flash Point tests (D93) by Foam supplies, Inc. on August 4, 2009. The samples were tested and the results are filed.

Results for D93

Sample ID	Initial Dip (°F)	First Dip (°F)	Flash Point (°F)	Comments
I	68	70	73	Not true flash point, vapor may due to stirring
J	66	68	80	Not true flash point, vapor may due to stirring
K	66	68	109	
L	68	70	152	
M	66	68	141	
N	68	70	189	
O	68	70	127	
P	68	70	117	

Based on customer's requirement, the tests were performed using ASTM D93, the Standard Test Method for Flash point by Pensky-Martens Closed Cup Tester, procedure A. The instrument used is manufactured by Koehler Instruments Co. with part number K16200, PMCC Tester, 115V, with serial number R61091350.

The tests started at Room temperature, which is around 66-68 °F. Due to low flash point of the samples, flame was applied before the heating and stirring started for each sample test to insure none of them flashes at room temperature.

Post-Net Fax Note 7671 Date 8/7/09
To Mark Schulte From Koehler
Co. Attn: Foam Supplies Co. Koehler
Phone # 314.344.3331 Fax #
Selina Shi Date: 8/7/09
Application and Testing Engineer
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FAX NO. 773-772-3778

Phoenix Chemical Laboratory, Inc.
FUEL AND LUBRICANT TECHNOLOGISTS
3953 SHAKESPEARE AVENUE
CHICAGO, ILL. 60647-3497
May 15, 2002

RECEIVED FROM Foam Supplies, Inc.
4387 North Rider Trail
Earth City, MO 63045-1103
Attn: Mark Schulte

SAMPLE OF System 01B24 Part B

LABORATORY NO. 02 5 8 12

MARKED

Sustained Combustibility (ASTM D4206)
Triplicate Determinations

Target Flash Point, 120°F
(119°F after correction for barometric pressure)
Heating Time: 60 seconds

- 1) No ignition, sustained combustion or flashing before test flame moved into the test position.
- 2) No ignition, sustained combustion or flashing while the test flame was in the test position for 15 seconds and returned to off position.

Arthur A. Krawetz

ECONOMIC EFFICIENCY

In general, it takes the same molar concentration of any blowing agent to blow the same density of foam. There are however two potential mitigating factors of the blowing agent: high volatility (low boiling point temperature) and poor solubility. Both factors will cause more of the blowing agent to escape. Ecomate® combats effects of these factors through its low volatility and high solubility.

Ecomate® has excellent solubility in most polyols and in both sides of A+B systems. It is also soluble with most other blowing agents including HCFC, HFC and HCs. By blending it with the various products available it is easy to customize your product design.

The chart below illustrates how Ecomate® uses less material, and is less expensive at equal density.

Blowing Agent	Relative Price / Weight ¹	MW	Weight Factor ²	Relative Cost to Ecomate® ³
Ecomate®	**	60	Ref	Ref
HCFC-141b	**	117	1.95	1.95
HFC-245fa	*****	134	2.23	7.82
HFC-365/227	*****	149	2.48	9.44
n-C5	**	72	1.20	1.20
c-C5	**	70	1.17	1.46

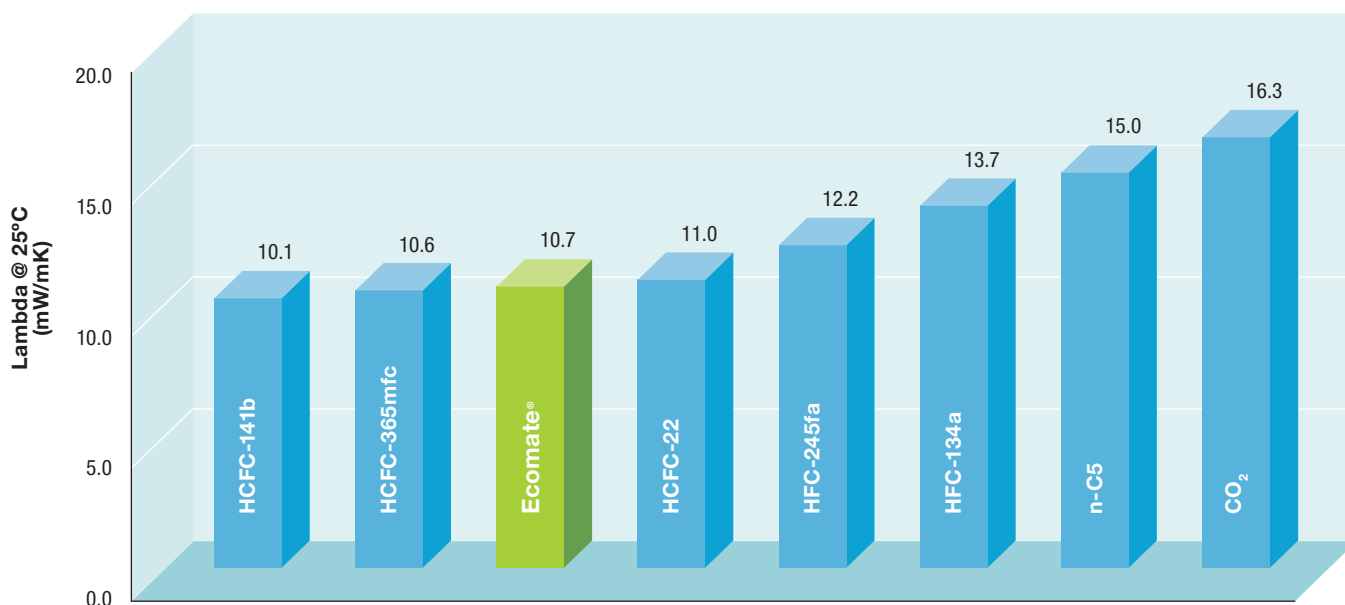
¹ Relative Price per unit of weight [ie, \$/lb or €/kg].

² Wt Factor [MW/60] illustrates extra blowing agent necessary for same density foam.

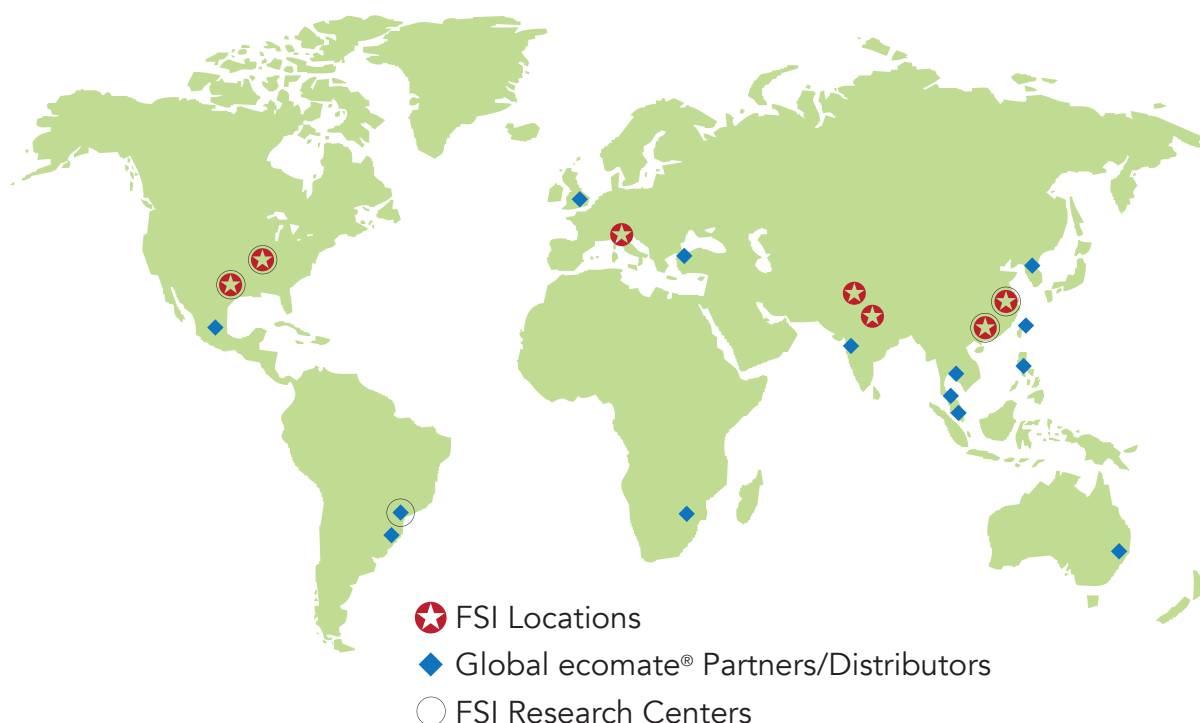
³ Cost relative to Ecomate® for same density of foam.

THERMAL EFFICIENCY

The low lambda value of neat Ecomate® allows production of foams with excellent thermal efficiency. In various side by side comparison tests against 141b products, Ecomate® has proven to perform nearly the same. FSI recommends end product, side by side comparison to eliminate deceiving or inaccurate reported lab results.



ecomate® systems and blowing agent technology is in use around the world.



Ecomate® is available worldwide through our network of global partners. For a complete list, visit ecomatetechnology.com or scan the code at right.



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