

## Technical Bulletin

# JEFFSOL<sup>®</sup> Alkylene Carbonates

Huntsman Corporation is the world's largest producer of alkylene carbonates. The roots of Huntsman's carbonates experience date back to the 1950's. Huntsman currently produces its carbonate products in multiple manufacturing facilities and maintains inventory of the materials in various sites around the world.

The JEFFSOL<sup>®</sup> carbonates can be used as "safe" and environmentally friendly solvents, replacing harsh products such as methylene chloride, acetone, aromatic solvents, and other higher volatile and hazardous solvents. In addition, JEFFSOL<sup>®</sup> Glycerine Carbonate is bio-based and contains 76 wt% renewable carbon.

Carbonates can also be used as reactive intermediates, replacing ethylene and propylene oxides and ethylene and propylene glycols in many reactions. Where substitution occurs, use of the carbonates may allow for a more selective reaction, minimizing side reactions and contaminants.

## The Products

The JEFFSOL<sup>®</sup> carbonates are cyclic organic esters made from the reaction of ethylene oxide or propylene oxide with carbon dioxide.

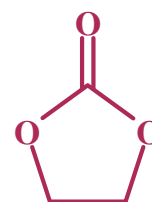
Primary products are

- JEFFSOL<sup>®</sup> Ethylene Carbonate (EC)
- JEFFSOL<sup>®</sup> Propylene Carbonate (PC)
- JEFFSOL<sup>®</sup> Glycerine Carbonate (GC).

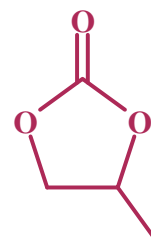
Blends of JEFFSOL<sup>®</sup> Ethylene and Propylene Carbonates are also available to provide liquid carbonates containing ethylene carbonate. By itself, ethylene carbonate is a solid at room temperature.

- JEFFSOL<sup>®</sup> EC-75 (75/25 blend of EC/PC)
- JEFFSOL<sup>®</sup> EC-50 (50/50 blend of EC/PC)
- JEFFSOL<sup>®</sup> EC-25 (25/75 blend of EC/PC)

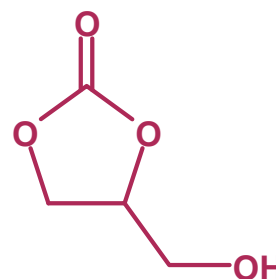
In addition, Huntsman produces electronics grade carbonates sold as ULTRAPURE<sup>®</sup> carbonates and continues to invest in specialty carbonates and carbamates.



Ethylene Carbonate



Propylene Carbonate



Glycerine Carbonate

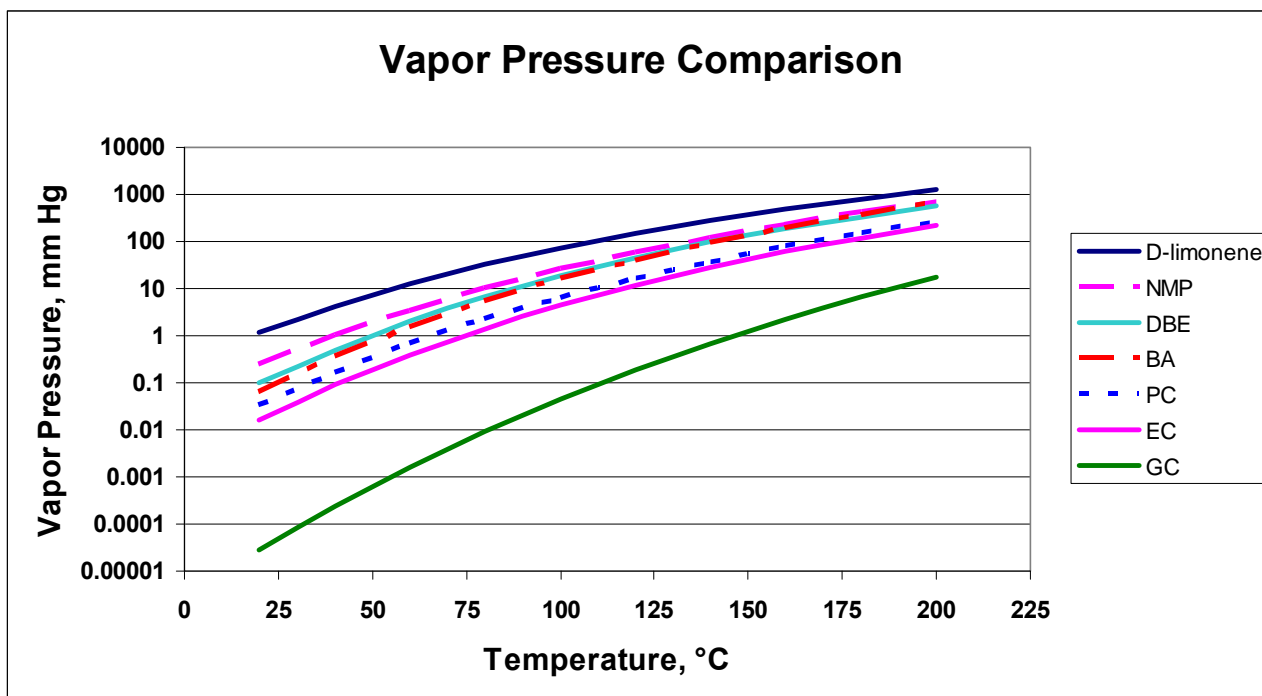
## Features and Benefits

- High boiling points
- High flash points
- Low evaporation rates
- Low toxicity
- Low odor
- Cost effective
- Not damaging to the atmosphere
- Readily biodegradable

The JEFFSOL<sup>®</sup> carbonate products are excellent polar solvents for many organic and inorganic materials. Their excellent solvency properties combined with their high flash points, high boiling points, low evaporation rates, low VOC, low toxicity, and low odor make the products particularly attractive choice for many solvent applications today.

Chart 1 illustrates the low volatility advantage of JEFFSOL<sup>®</sup> EC, PC and GC compared to several traditional solvents.

**Chart 1: Volatility**



NMP: N-Methyl-2-Pyrrolidone  
DBE: Dibasic Ester Mixture  
BA: Benzyl Alcohol  
EC: Ethylene Carbonate  
PC: Propylene Carbonate  
GC: Glycerine Carbonate

**Table 1: Volatile Organic Content**

Product	% VOC (110°C) by ASTM D-2369
JEFFSOL <sup>®</sup> EC	34
JEFFSOL <sup>®</sup> PC	VOC Exempt
JEFFSOL <sup>®</sup> EC-50	31
JEFFSOL <sup>®</sup> GC	To be determined
D-limonene	100
NMP	100
BA	100
DBE	100

**Table 2: Advantages in Using JEFFSOL<sup>®</sup> Carbonates**

Product	Flash Point, °F	Boiling Point, °C	Evap. Rate (n-BuAc = 1.0)	Overall Toxicity	Odor	Damaging to Atmosphere
JEFFSOL <sup>®</sup> EC	320	248	< 0.005	T	No	No
JEFFSOL <sup>®</sup> PC	275	242	< 0.005	None	No	No
JEFFSOL <sup>®</sup> GC	> 374	--	< 0.005	None	No	No
Benzyl Alcohol	213	205	0.007	N	Slight	No
Dibasic Ester Mixture	212	225	0.009	None	Yes	No
GBL	209	205	0.030	Slight	Slight	No
NMP	187	202	0.030	T	Yes	No
Isophorone	184	214	0.020	AC	Yes	Yes
DMF	136	153	0.200	T, liver damage	Yes	No
D-Limonene	119	176	0.253	T	Yes	No
MEK	26	80	4.030	T, N	Yes	No
Methylene Chloride	None	40	14.50	N, AC	Yes	Yes

AC = Animal Carcinogen

N = Neurotoxin

T = Teratogen

**Table 3: Typical Analyses of JEFFSOL<sup>®</sup> Carbonates**

	EC	PC	GC	EC-75	EC-50	EC-25
<b>Carbonate, wt%, by GLC</b>	99.8 – 99.95	99.8 – 99.95	93	99.8 – 99.95	99.8 – 99.95	99.8 – 99.95
<b>Glycol Content, wt%, by GLC</b>	0.005 – 0.02	0.02 – 0.10	1.5 – 3.0	0.03 – 0.10	0.03 – 0.10	0.03 – 0.10
<b>Water, wt%</b>	0.01 – 0.05	0.01 – 0.05	0.05	0.01 – 0.10	0.01 – 0.10	0.01 – 0.10
<b>Ash, wt%</b>	< 0.0002	< 0.0002	--	< 0.0002	< 0.0002	< 0.0002
<b>pH, 10% aqueous solution</b>	6.7 – 7.0	6.7 – 7.0	4.0 – 6.5	6.7 – 7.0	6.7 – 7.0	6.7 – 7.0
<b>Color, Pt-Co</b>	5 – 20	5 – 20	75	5 – 20	5 – 20	5 – 20

**Table 4: Typical Physical Properties of JEFFSOL<sup>®</sup> Carbonates**

	EC	PC	GC	EC-75	EC-50	EC-25
<b>Molecular Weight, g/mole</b>	88.1	102.1	118	91.2	94.6	98.2
<b>Normal Boiling Point, °C</b>	245.6	241.8	110 – 115 (0.1 mm Hg)	245.1	244.1	243
<b>Freezing Point, °C</b>	--	-49.5	-69.0**	22.2	4.0	-25.8
<b>Melting Point, °C</b>	36.3	--	--	--	--	--
<b>Flash Point, °F, PMCC</b>	320	275	> 374	305 - 310	295 - 300	285 - 290
<b>Evaporation Rate, °C (n-BuAc = 1.00)</b>	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
<b>Density, g/ml</b> 25°C 40°C	1.339* 1.321	1.199 1.183	1.398 1.385	1.304 1.286	1.269 1.251	1.235 1.217
<b>Viscosity, cP</b> 25°C 40°C	3* 2	3 2	84 34	3 2	3 2	3 2

\*Supercooled

\*\*Glass transition

## Solubility Characteristics

Tables 5 -7 provide typical solubility characteristics of the JEFFSOL<sup>®</sup> carbonates.

**Table 5: Solubility Characteristics of JEFFSOL<sup>®</sup> Carbonates**

Property	EC	PC	GC	EC-75	EC-50	EC-25
Hansen Sol Par, total (cal <sup>1/2</sup> cm <sup>-3/2</sup> )	15.3	13.5	16.7	14.0	13.9	13.5
Hansen Sol Par, dispersive (cal <sup>1/2</sup> cm <sup>-3/2</sup> )	9.0	8.3	8.8	9.5	9.6	9.7
Hansen Sol Par, polar (cal <sup>1/2</sup> cm <sup>-3/2</sup> )	11.3	7.7	9.5	10.1	9.8	9.2
Hansen Sol Par, hydrogen bonding (cal <sup>1/2</sup> cm <sup>-3/2</sup> )	5.1	4.4	10.5	2.3	2.2	2.1
Dipole Moment (Debye)	4.81	4.94	5.05	n.a.	n.a.	n.a.
Surface Tension (dyn/cm, 25°C)	41.9*	41.1	50.0	48.5	45.9	43.2
Surface Tension (dyn/cm, 40°C)	40.5	39.1	48.0	47.0	44.0	41.9

\* Supercooled

**Table 6: Solubility of Water in 100 Grams of JEFFSOL<sup>®</sup> Carbonates (25°C)**

Product	Grams of Water
JEFFSOL <sup>®</sup> EC carbonate	∞
JEFFSOL <sup>®</sup> PC carbonate	8.3
JEFFSOL <sup>®</sup> GC carbonate	∞
JEFFSOL <sup>®</sup> EC-75 carbonate	33.0
JEFFSOL <sup>®</sup> EC-50 carbonate	19.0
JEFFSOL <sup>®</sup> EC-25 carbonate	10.3

**Table 7: Solubility of JEFFSOL<sup>®</sup> Carbonates in 100 Grams of Water (25°C)**

Product	Grams of Water
JEFFSOL <sup>®</sup> EC carbonate	∞
JEFFSOL <sup>®</sup> PC carbonate	25
JEFFSOL <sup>®</sup> GC carbonate	∞
JEFFSOL <sup>®</sup> EC-75 carbonate	>100
JEFFSOL <sup>®</sup> EC-50 carbonate	48
JEFFSOL <sup>®</sup> EC-25 carbonate	33

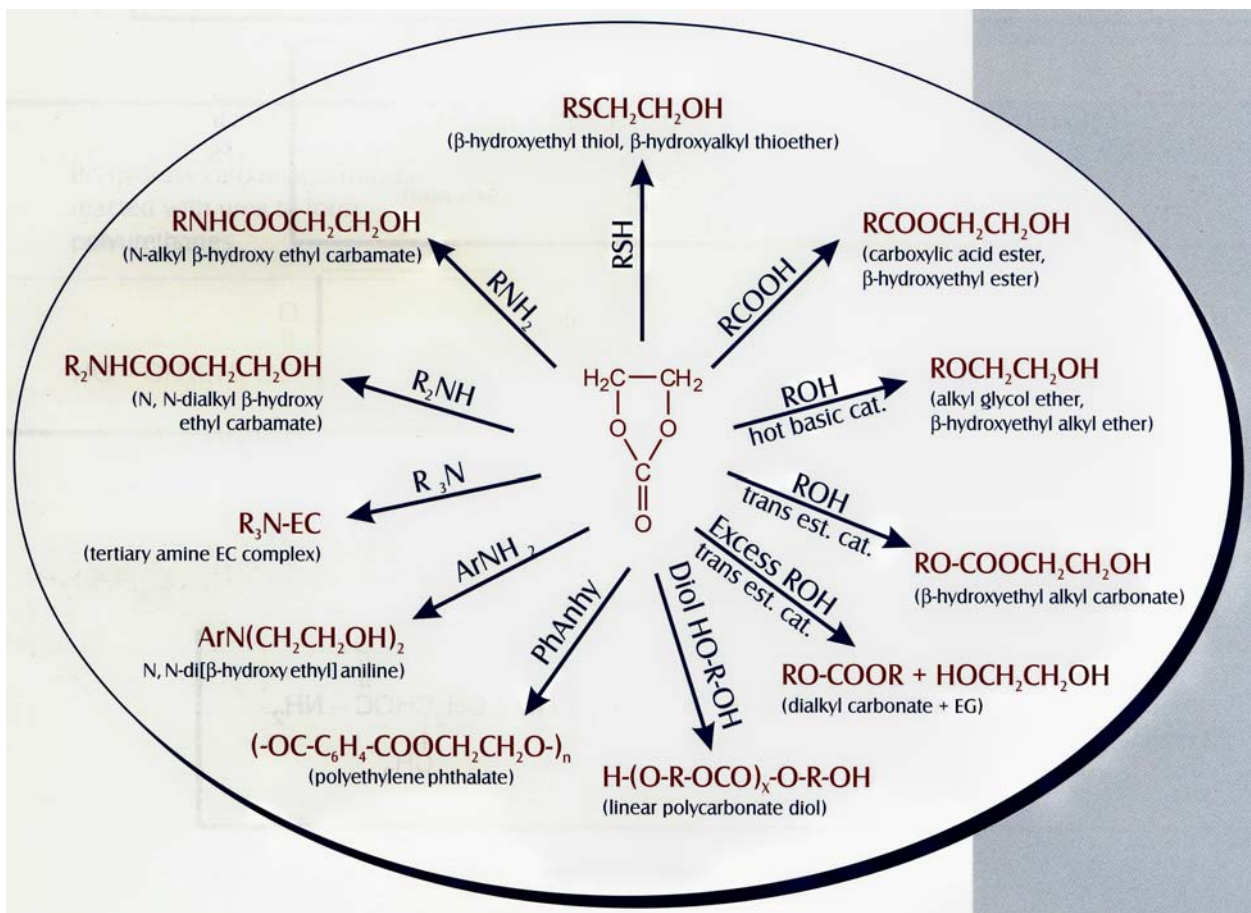
## Applications

JEFFSOL<sup>®</sup> carbonates are used in a wide spectrum of applications. The matrix below lists some of the more common applications.

Application	Ethylene Carbonate	Propylene Carbonate	Glycerine Carbonate	Carbonate Blends
<b>“Safe” Solvents</b>		✓		✓
• Electrochemical	✓	✓		✓
• Agrochemical		✓		✓
• Cosmetics & Personal Care		✓	✓	✓
<b>Cleaners / Degreasers</b>		✓		✓
• Industrial & Consumer		✓	✓	✓
<b>Paint Strippers / Removers</b>		✓		✓
<b>Chemical Intermediates</b>	✓	✓		✓
<b>Woodbinder Resins</b>	✓	✓		✓
<b>Urethane (Reactive Diluent)</b>	✓	✓	✓	✓
<b>Foundry Sand Binders</b>	✓	✓		✓
<b>Lubricants / Greases</b>		✓		✓
<b>Photochromic</b>		✓		✓
<b>Plasticizer</b>	✓	✓		✓
<b>Gas Treating</b>		✓		✓
<b>Epoxy Resins (Reactive Diluent)</b>	✓	✓		✓
<b>Water Scavenger</b>	✓	✓		✓
<b>Antipilling</b>	✓	✓		✓
<b>Textile Dyeing</b>	✓	✓		✓
<b>Superabsorbent Polymers</b>	✓	✓		
<b>Tail Solvent (Bake Enamels)</b>		✓		✓

## Applications – Chemical Intermediates

The JEFFSOL<sup>®</sup> carbonates can be used as reactive intermediates in numerous chemistries with the resulting products used as such or further reacted to produce other derivatives. The diagram below illustrates the versatility of the products using ethylene carbonate as an example.



## Toxicity and Safety

For additional information on the toxicity and safe handling of the JEFFSOL<sup>®</sup> carbonate products, consult the individual Material Safety Data Sheets prior to use of the products.

## FOR MORE LITERATURE OR INFORMATION

Please call the nearest Huntsman Corporation office

### Americas

Huntsman Corporation  
10003 Woodloch Forest Drive  
The Woodlands, Texas, 77380  
USA  
Tel.: 281-719-6000  
Fax: 281-719-6055

Research and Development  
Advanced Technology Center  
8600 Gosling Road  
The Woodlands, TX 77381  
Tel: 281-719-7780  
Fax: 281-719-7555

### Asia Pacific

Huntsman Performance Products  
150 Beach Road  
#37-00 Gateway West  
Singapore 189720  
Tel.: +65-6297-3363  
Fax: +65-6296-3368

### Australia

61 Market Road, Brooklyn  
Victoria, Australia, 3012  
Tel.: +61-3-9316-3646  
Fax: +61-3-9316-3647

### Brazil

Huntsman Quimica Brasil Ltda.  
Av. Professor Vicente Rao, 90  
04636-000 Sao Paulo SP  
Brazil  
Tel.: +55-11-55324278  
Fax: +55-11-55324412

### China

Level 45 Shanghai Maxdo Center  
8 Xing Yi Road, Chang Ning District  
Shanghai 200336, P.R. China  
Tel.: +86-21-2208-7500  
Fax: +86-21-2208-7588

### Europe, Africa and Middle East

Huntsman Performance Products  
Everslaan 45  
B-3078 Everberg  
Belgium  
Tel.: +32-2-758-9544  
Fax: +32-2-758-9946

### India

Research & Application House, Tax  
Centre,  
E -Wing, Saki Village  
Chandivali Farm Road, Andheri  
(East),  
Mumbai 400 072 India  
Tel : +91-22-4050-6565  
Fax : +91-22-4050-6300

### Japan

KIBC South Bldg., 6F, 5-5-2  
Minatojima Minaminachi, Chuo-ku,  
Kobe 650-0047 Japan  
Tel.: +81-78-304-3924  
Fax: +81-78-304-3970

### Korea

9<sup>th</sup> Fl. Dukmyung Bldg., 170-9  
Samsung-dong, Gangnam-gu  
Seoul, Korea  
Tel.: +82-2-3404-6800  
Fax: +82-2-556-3263

### Singapore (SEA)

150 Beach Road  
#37-00 Gateway West  
Singapore 189720  
Tel.: +65-6297-3363  
Fax: +65-6296-3368

### Taiwan

No. 19, Industrial Third Road  
Kuan Yin Industrial District  
Taoyuan, Taiwan  
Tel.: +886-3-483-8616  
Fax: +886-3-483-6412

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CHEMTREC  
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