

# DMSO

## Dimethyl Sulfoxide (DMSO) Solubility Data

Bulletin # 102B

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### Introduction

DMSO, one of the strongest organic solvents, has been used commercially for **over forty years**. It is an effective solvent for a wide array of organic materials, including many polymers. DMSO also dissolves many inorganic salts, particularly transition metals nitrates, cyanides and dichromates. DMSO is miscible with water and most organic liquids.

This bulletin summarizes solubility of the following materials in DMSO:

Organics (pages 2-3)  
Active pharmaceutical Ingredients (pages 4-6)  
Resins and polymers (pages 8-10)  
Inorganics (pages 10-11)  
Gases (page 12)  
Pharmaceutical Excipient Solubility Data (pages 16-17)  
**New!** DMSO Gel Preparation Data (pages 18-19)

Data related to the solvent properties of DMSO are given in tables on the following pages:

Relative Hansen Solubility Parameter Data (page 12)  
Suggested DMSO Formulations for Industrial Solvent Replacement (page 14)  
Hansen Solubility Parameter Data for Selected Polymers (page 14)  
Solubility of Selected Polymers in DMSO / Tetralin mixtures (pages 14-15)  
Solubility of Selected Polymers in DMSO / MIBK mixtures (page 15)  
Appendix: Using Three Component Solubility Parameter Methodology in Formulating Industrial Solvent Mixtures (Page 16)

*Gaylord Chemical Company, L.L.C. (GCC) is the world's leading provider of Dimethyl Sulfoxide (DMSO) solutions. Beginning in the early 1960's, GCC has been dedicated to the development of new uses for DMSO. In order to meet customer-specific needs, GCC has pioneered the development of multiple grades of DMSO, including DMSO USP.*

*Gaylord Chemical's solutions-based approach has contributed to the development and growth of industries including pharmaceuticals, hydrocarbons, electronics, polymers, coatings, agricultural chemicals, and industrial cleaners.*

*Gaylord Chemical's headquarters are located in Slidell, Louisiana with manufacturing, research, and development facilities in nearby Bogalusa, Louisiana. GCC remains the only producer of DMSO in the Western Hemisphere.*

**Gaylord Chemical Company, L.L.C.**  
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Table 1  
**Solubility of Organic Materials in DMSO**

Material	Solubility Grams/100 cc DMSO		Material	Solubility Grams/100 cc DMSO	
	20-30°C	90-100°C		20-30° C	90-100°C
Acetic acid	Miscible	-	p-Dichlorobenzene	Very Soluble	
Acetone	Miscible	-	S-Dichlorodiphenyltrichloroethane	4	100
Acrawax	< 1	> 1	Dicyandiamide	40	
Acrawax B	Insoluble	4	Dicyclohexylamine	4.5	
Aniline	Miscible	-	Diethanolamine	Miscible	
Anthracene	2	-	Diethylamine	Miscible	
Beeswax	-	< 1	Diethyl ether	Miscible	
Benzene	Miscible	-	bis-(2-ethylhexyl)amine	0.7	
Benzidine	Soluble		Diethyl sulfide	Miscible	
Benzidine methane			Di-isobutyl carbinol	Miscible	
Sulfonate	Insoluble	-	Di-isobutylene (0.6% DMSO is soluble in di-isobutylene)	3.3	
Bromoethane	Miscible		Disopropyl ether	11	
Butenes	2.1		Dimethyl ether	4.4	
n-Butyl acetate	Miscible		Dimethyl formamide	Miscible	
Butly carbitol	Miscible		Dimethyl sulfide	Miscible	
Calcium methyl sulfonate	Soluble		Dimethyl sulfone	33.9	Miscible
Camphor	Soluble	Soluble	Dioxane	Miscible	
Candelilla wax		< 1	Diphenyl	Very soluble	
Carbon	Insoluble		Dipentene	10	
Carbon disulfide	90		Dodecanol	>100	
Carbon tetrachloride	Miscible		n-Dodecane	0.38	
Carbowax 600	Miscible		Dodecylbenzene (Neolene 400)	3.5	
Carbowax 6000	Insoluble	8	Dye- Burnt Sugar	Soluble	
Carnauba wax		< 1	Dye- FD&C Blue	Soluble	
Castor oil	Miscible		Dye- Pistachio Green B	Soluble	
Ceresin wax		< 1	1-Eicosanol	Insoluble	
Chloroform	Miscible		Ethyl benzoate	Miscible	
Chlorosulfonic acid	Reacts		Ethyl alcohol	Miscible	
Citric acid	> 70		Ethyl bromide	Miscible	Reacts
Coconut oil (Misc.@160°C)	0.3	1.3	Ethyl ether	Miscible	
Cresylic acid	Miscible		Ethylene dichloride	Miscible	
Cumene	Miscible		Formalin (37%)	Miscible	
Cyclohexane	4.67		Formamide	Miscible	
Cyclohexene	Miscible		Formic acid	Miscible	
Cyclohexylamine	Miscible		Glucose	54	
Decalin	4.5		Glycerine	Miscible	
n-Decane	0.7		Glycine	< 0.05	0.1
Di-n-butylamine	11	-	Hexane	2.9	
o-Dichlorobenzene	Miscible		4-Hydroxy benzoic Acid	24	

Table 1, Continued  
**Solubility of Organic Materials in DMSO**

Material	Solubility Grams/100 cc DMSO		Material	Solubility Grams/100 cc DMSO	
	20-30°C	90-100°C		20-30°C	90-100°C
Hy-Wax 120		< 1	Phosphoric acid	Miscible	
Imidazole	80		Phosphorus trichloride	Reacts vigorously	
Isophthalic acid	68	76	Phthalic acid	90	
Isoprene	Miscible		Picric acid	Soluble	
Kerosene	0.5		Pyridine	Miscible	
Lanolin, hydrous		11 (gets cold)	Pyrogallol	50	
Lauryl amide (Armid 12)	10	> 20	Rosin	> 100	
			Rosin soap (Hercules Dresinate X)	Slightly soluble	0.9
Lorol 5	Miscible		Sevin	50	
Lubricating oil	0.4		Silicon tetrachloride	Reacts vigorously	
Methionine	0.1	0.3	Sorbitan sesquioleate	2.5	
Methyl borate	Miscible		Sorbitan trioleate	Miscible	
Methyl caprate		Miscible	Sorbitol	60	> 180
Methyl iodide	Miscible	Reacts	Soybean oil	0.6	
Methyl isobutyl ketone	Miscible				
Methyl laurate	7	Miscible			
Methyl mercaptan	40 (Reacts)		Succinic acid	30	
N-methyl morpholine	Miscible		Sugar (sucrose)	30	100
Methyl palmitate	Immiscible	Misc. 130-180°C	Sulfamic acid	40	
Methyl salicylate	Miscible		Sulfuric acid	Miscible	
Methyl sulfonic acid	Miscible		Tallow	Insoluble	1.9
			Tallow amide, hydrogenated (Armour Armide HT)	Insoluble	> 40
Methylene chloride	Miscible		Terephthalic acid	26	33
Microcrystalline wax		< 1			
Morpholine	Miscible		Tetra hydrophthalic anhydride	50	
Naphthalene	40	Miscible	Tetralin	Miscible	
Neoprene	Insoluble	Insoluble	Tetrapropylene	1	
Nitrobenzene	Miscible		Thiourea	40	85
Oleic acid	Miscible		Toluene	Miscible	
Ouricuri wax		1	Toluene di-isocyanate	Miscible	
Oxalic acid	38				
Palmitic acid	100		Tributylamine	0.9	
Paraffin	Insoluble		Tricresyl phosphate	Miscible	
Paraformaldehyde	Insoluble	Slightly soluble	Triethanolamine laurylsulfate	Soluble	
Paradichlorobenzene	56		Triethanolamine	Miscible	
Pentaerythritol	5-10	30	Triethylamine	10	
n-Pentane	0.35		Trinitrotoluene	Soluble	
Pentene 1 & 2	7.1		Turpentine	10	
Perchloric acid	Reacts violently		Urea	40	110
Petroleum ether (DMSO soluble 0.3-0.5% in petro- leum ether)	3		Xylene	Miscible	
Phenol	>100				



Table 2  
**Solubilities of Active Pharmaceutical Ingredients in DMSO**

Pharmaceutical Nomenclature	CAS Number	Solubility g/100ml DMSO@25°C	Solubility g/100g DMSO@25°C	Solubility g/100ml Solution@25°C
Acetaminophen	103-90-2	84.3	77.0	43.5
Acetyl-D-Glucosamine	10036-64-3	4.9	4.5	4.3
Acyclovir USP	59277-89-3	15.4	14.0	12.3
Albuterol Sulfate		0.6	0.5	0.5
Aloe Vera Powder Freeze Dried 200:1	N/A	20.4	18.6	15.7
Amitriptyline Hydrochloride USP	549-18-8	25.4	23.2	18.8
Amphotericin B USP (Oral Grade)	1397-89-3	0.0	0.0	0.0
Androstendione	63-05-8	5.5	5.0	4.8
Baclofen	1134-47-0	0.0	0.0	0.0
Beclomethasone Dipropionate USP	1134-47-0	38.5	35.1	26.0
Beta Glucan (1,3) FG	N/A	0.0	0.0	0.0
Betamethasone Dipropionate USP	5593-20-4	89.6	81.8	45.0
Biotin (D) USP (Vitamin H)	58-85-5	23.4	21.4	17.6
Budesonide	51333-22-3	49.9	45.6	31.3
Bupivacaine Hydrochloride USP	18010-40-7	11.6	10.6	9.6
Capsaicin Synthetic	2444-46-4	19.3	17.6	15.0
Capsicum Oleoresin USP (Liquid)	8023-77-6	25.7	23.5	19.0
Carbamazepine USP	298-46-4	6.9	6.3	5.9
Cephalexin USP	15686-71-2	0.0	0.0	0.0
Chloroquine Diphosphate	50-63-5	0.0	0.0	0.0
Chondroitin Sulfate	9007-28-7	0.0	0.0	0.0
Clindamycin phosphate	24729-96-2	22.4	20.5	17.0
Clobetasol Propionate USP	25122-46-7	40.5	37.0	27.0
Clonidine Hydrochloride USP		5.6	5.1	4.8
Clotrimazole USP	23593-75-1	5.4	4.9	4.7
Colchicine USP	64-86-8	42.6	38.9	28.0
Cyclobenzaprine USP		10.2	9.3	8.5
Cyclosporin (A) USP	59865-13-3	46.1	42.0	29.6
Deoxy-D-Glucose (2)	154-17-6	19.0	17.4	14.8
Dexamethasone USP	50-02-2	60.6	55.3	35.6

Table 2, Continued  
**Solubilities of Active Pharmaceutical Ingredients in DMSO**

Pharmaceutical Nomenclature	CAS Number	Solubility g/100ml DMSO@25°C	Solubility g/100g DMSO@25°C	Solubility g/100ml Solution@25°C
Dextromethorphan		70.9	64.7	39.3
Dichlofenac Sodium		54.7	49.9	33.3
Dihydroepiandrosterone	53-43-0	61.2	55.8	35.8
Diiodohydroxyquin (Iodoquinol) USP	83-73-8	9.9	9.0	8.3
Dimercatopropanesulfonic Acid Na Salt (2,3)	4076-02-2	92.6	84.5	45.8
Dimercaptosuccinic Acid	N/A	91.8	83.8	45.6
Edetate Disodium USP	6381-92-6	9.3	8.5	7.8
Ergoloid Mesylate USP	8067-24-1	0.0	0.0	0.0
Erythromycin USP	114-07-8	21.6	19.7	16.5
Estradiol USP (E2)	50-28-2	100.3	91.6	47.8
Estradiol Cypionate USP	313-06-4	90.7	82.8	45.3
Estradiol Valerate USP	979-32-8	97.1	88.7	47.0
Estriol USP (E3)	50-27-1	0.0	0.0	0.0
Estrone USP (E1)	53-16-7	7.9	7.2	6.7
Fluorouracil-(5 FU) USP	51-21-8	17.3	15.8	13.7
Glucosamine Hydrochloride (D)	66-84-2	9.5	8.7	8.0
Guaifenesin USP	93-14-1	131.2	119.8	54.5
Haloperidol USP	52-86-8	0.0	0.0	0.0
Hydrocortisone Acetate USP	50-03-3	24.5	22.4	18.3
Ketamine Hydrocortisone USP	50-23-7	39.3	35.9	26.4
Hydroxyprogesterone Caproate USP	630-56-8	11.6	10.6	9.6
Ibuprofen USP	15687-27-1	412.1	376.2	79.0
Indomethacin USP	53-86-1	119.2	108.8	52.1
Itraconazole	84625-61-6	0.0	0.0	0.0
HCl USP CIII	1867-66-9	4.0	3.6	3.5
Ketoconazole USP	65277-42-1	3.4	3.1	3.1
Ketoprofen	22071-15-4	54.2	49.5	33.1
Levamisole HCl USP (Vet Use)	16595-80-5	5.2	4.7	4.5



Table 2, Continued  
**Solubilities of Active Pharmaceutical Ingredients in DMSO**

Pharmaceutical Nomenclature	CAS Number	Solubility g/100ml DMSO@25oC	Solubility g/100g DMSO@25oC	Solubility g/100ml Solution@25oC
Lidocaine USP	137-58-6	163.0	148.8	59.8
Lipoic Acid, DL-alpha (DL-Thiotic Acid)	1077-28-7	311.8	284.6	74.0
Loperamide Hydrochloride USP	34552-83-5	7.2	6.5	6.1
Lorazepam USP Civ NDC: 51927000502	846-49-1	10.8	9.9	9.0
Manganese Chloride Tetrahydrate USP	13446-34-9	0.0	0.0	0.0
Mebendazole USP	31431-39-7	6.3	5.7	5.4
Medroxyprogesterone Acetate	71-58-9	2.2	2.0	2.0
Megestrol Acetate USP	595-33-5	4.3	4.0	3.8
Methimazole USP	60-56-0	93.7	85.5	46.1
Methotrexate USP	59-05-2	20.2	18.5	15.6
Metronidazole		8.6	7.9	7.3
Miconazole Base USP	22916-47-8	37.5	34.2	25.5
Naproxen USP	22204-53-1	37.7	34.4	25.6
Niacinamide USP	98-92-0	7.9	7.2	6.7
Nifedipine USP	21829-25-4	47.8	43.7	30.4
Nystatin USP	1400-61-9	7.6	6.9	6.5
Panthenol		15.2	13.9	12.2
Pentoxifylline	6493-05-6*	36.1	32.9	24.8
Phenytoin USP (Diphenyl Hydantoin)		94.8	86.6	46.4
Piroxicam USP	36322-90-4	5.8	5.3	5.0
Prednisolone	50-24-8	23.2	21.2	17.5
Prednisolone USP	53-03-2	42.8	39.1	28.1
Pregnenolone	145-13-1	2.4	2.2	2.2
Prochlorperazine dimaleate		7.6	7.0	6.5
Progesterone USP	57-83-0	4.4	4.1	3.9

Table 2, Continued  
**Solubilities of Active Pharmaceutical Ingredients in DMSO**

Pharmaceutical Nomenclature	CAS Number	Solubility g/100ml DMSO@25oC	Solubility g/100g DMSO@25oC	Solubility g/100ml Solution@25oC
Promethazine Hydrochloride USP	58-33-3	24.9	22.7	18.5
Propranolol Hydrochloride	318-98-9	53.5	48.8	32.8
Pyracetam	7491-74-9	22.1	20.2	16.8
Riboflavin-5-Phosphate Sodium USP		0.0	0.0	0.0
Riboflavin-5-Phosphate Sodium USP	130-40-5	0.0	0.0	0.0
Rifampin USP	13292-46-1	20.6	18.8	15.8
Silver Sulfadiazine USP	22199-08-2	0.0	0.0	0.0
Tamoxifen Citrate USP	54965-24-1	10.8	9.9	9.0
Terazosin Hydrochloride Dihydrate	70024-40-7	10.6	9.6	8.8
Testosterone		30.2	27.6	21.6
Tetracaine USP	94-24-6	369.9	337.6	77.2
Tetracycline USP	60-54-8	19.0	17.4	14.8
Thiabendazole USP	148-79-8	10.8	9.9	9.0
Thymol Iodide Purified	552-22-7	3.0	2.8	2.7
Tranilast	53902-12-8	41.1	37.6	27.3
Triamcynilone		17.2	15.7	13.6
Urea USP	57-13-6	45.2	41.2	29.2
Vancomycin Hydrochloride	N/A	11.5	10.5	9.5
Verapamil Hydrochloride USP	152-11-4	19.5	17.8	15.1
Vitamin A Palmitate (18,000 U/mL)	79-81-2	11.9	10.9	9.8
Vitamin B12 USP (Cyanocobalamin)	68-19-9	0.0	0.0	0.0
Vitamin D3 (2400 U/mL)	67-97-0	0.0	0.0	0.0
Vitamin E	10191-41-0	0.0	0.0	0.0
Yohimbine Hydrochloride	65-19-0	0.0	0.0	0.0
Zinc Pyrithione (48% Min. Aq. Dis.)	13463-41-7	0.0	0.0	0.0



Table 3  
**Solubility of Resins and Polymers in DMSO**

Material	Solubility, Grams/100cc DMSO		
	20-30°C	90-100°C	Comments
<b>Aminoplasts</b>			
Melamine Formol	Soluble		
Urea formol	Soluble		
<b>Polyacrylics</b>			
Orlon (DuPont)	-	20	Viscous soln.
Acrlan (Monsanto)	>25		
Verel (Eastman)	>5		25 at 130°C with some decomposition
Creslan (Am. Cyanamid)	5		25 at 130°C
<b>Polyamides</b>			
Nylon 6	-	Insoluble	40 at 130°C
Nylon 6/6	-	Insoluble	25 at 150°C
Nylon 6/10	-	Insoluble	40 at 150°C
Nylon 11 Rilsan (Elf Ato)	-	Insoluble	-
Nylon 12 Oryasol (Elf Ato)	-	Insoluble	Soluble @ 140°C
<b>Polyimides</b>			
Bismaleimide copolymers		Insoluble	
Kermid 353 (Rhone-Poulenc)	Swells		
Kermid 711 (Rhone-Poulenc)	Soluble		
Polyamino bis maleimide Kermid 601(Rhone poulenc) I		-	
Polyamideimide Torton 4203L (Amoco)		Insoluble	
Polyetherimide Ultem 100 (G.E.)		Swells	
<b>Cellulose</b>			
Cellulose triacetate	10	20	
Viscose rayon	-	<1	
Cellophane	-	Insoluble	
Carboxymethyl cellulose	-	Insoluble	
Nitrocellulose	-	10	
<b>Chlorinated Resins</b>			
Butaclor MC30 (Distugil)	Swells		
CM3630 (Bayer)			
Hypalon DH70 (DuPont)	Swells		
<b>Epoxies</b>			
Epikote 1004 (Shell)	Soluble		
Epon 1001 (Shell)	50		
Epon 1004 (Shell)	50		
Epon 1007 (Shell)	50		



Table 3, Continued  
**Solubility of Resins and Polymers in DMSO**

Material	Solubility, Grams/100cc DMSO		
	20-30°C	90-100°C	Comments
<b>Fluorinated Resins</b>			
Polyvinylidene fluoride Forafion (Atochem)	Swells		
<b>Elastomers</b>			
Viton DF801 (DuPont)	Swells		
Viton DF809 (DuPont)	Swells		
Kalrez 4079 (DuPont)	Insoluble		
Teflon (DuPont)	Insoluble	Insoluble	
<b>Methacrylates</b>			
Lucite 41, 45 (DuPont)	-	<1	
Plexiglas (Rohm & Haas)	-	<1	
<b>Phenoplasts</b>			
Modified Novalac R7522 (Ceca)	Soluble		
R7550 (Ceca)	Soluble		
Norsophen Resin PH 13 (CDF Chime)	Soluble		
<b>Polycarbonates</b>			
Lexan (General Electric)	-	>5	
<b>Polyesters</b>			
Dacron (DuPont)	-	>1	Dissolves at 160°C; ppts at 130°C
CX 1037 (Goodyear)	-	7	
Atlac (ICI-America)	-	50	
Poly(ethylene terephthalate)	-	-	-
Poly(butylene terephthalate)	-	-	-
Hytrel (DuPont)	-	-	-
<b>Silicones</b>			
Dow Corning 803 soln.	Miscible	-	
Dow Corning 805 soln.	Miscible	-	
Dow Corning "Sylkyd 50"	Miscible	-	
Dow Corning Z6018 (flake)	70	-	
<b>Sulfur Resins</b>			
Polyphenylene sulfide Ryton V107 (Philips)	Swells		
<b>Polyethersulfone</b>			
Victrix 660P (ICI)	Soluble		
Ultrason E3000 (BASF)	Soluble		
Udel (Amoco)	Soluble		
<b>Urethanes</b>			
Vithane (Goodyear)	-	100	



Table 3, Continued  
**Solubility of Resins and Polymers in DMSO**

Material	Solubility, Grams/100cc DMSO		
	20-30°C	90-100°C	Comments
<b>Vinyle-Polymers &amp; Co-polymers</b>			
Butvar B-76 (Monsanto)	-	20	Very viscous
Formvar 7/70 E Monsanto)	-	42	Very viscous
Elvanol 51-05 (DuPont)	-	90	Viscous
Elvanol 52-22 (DuPont)	-	15	Viscous
Elvanol 71-24 (DuPont)	-	30	Viscous
Polyvinyl pyrrolidone (GAF)	30	>100	
Geon 101 (PVC Goodrich)	-	10	
Vynlite WHH (Union Carbide)	2	30	
Teslar (DuPont)	-	-	Partially sol. at 160-170°C
<b>Vinylidenes</b>			
Darvan (Goodrich)	5	-	Soln. cloudy and viscous
Saran film (Dow)	-	30	
Geon 200 x 20 (Goodrich)	-	20	
DNA (Goodrich)	>5	-	25 at 130°C
<b>Other Resinous Materials</b>			
Melmac 405 (Am. Cyanamid)	70	-	-
Neoprene	Insoluble	Insoluble	
Polyetherether ketone (PEEK)	Insoluble		
Polyethylene	Insoluble	Insoluble	
Polypropylene	Insoluble	Insoluble	
Polystyrene	-	-	Sol. at 150°C; ppts at 130°C
Rosin (Hercules)	>100	-	
Penton chlorinated polyether (Hercules)	-	5	
Vinsol (Hercules)	50	>100	

Table 4  
**SOLUBILITY OF INORGANIC MATERIALS IN DMSO**

Material	Solubility, Grams/100cc DMSO		Material	Solubility, Grams/100cc DMSO	
	25°C	90-100°C		25°C	90-100°C
Aluminum sulfate (18H <sub>2</sub> O)	Insoluble	5	Ammonium nitrate	80	
Aluminum chloride	Reacts		Ammonium thiocyanate	30	
Ammonium borate (3H <sub>2</sub> O)	10		Barium nitrate	1	
Ammonium carbonate(H <sub>2</sub> O)	1		Beryllium nitrate(4H <sub>2</sub> O)	10	
Ammonium chloride	Insoluble	10	Bismuth trichloride	1	
Ammonium chromate	1		Boric acid <sup>a</sup>	45	
Ammonium dichromate <sup>c</sup>	50		Bromine	Reacts	

Table 4, Continued  
**SOLUBILITY OF INORGANIC MATERIALS IN DMSO**

Cadmium chloride <sup>b</sup>	20		Potassium chloride	0.2	
Cadmium iodide	30		Potassium cyanide	1	2
Calcium chloride	Insoluble		Potassium hydroxide	0.013	
Calcium dichromate(3H <sub>2</sub> O) <sup>c</sup>	50		Potassium iodide	20	20
Calcium nitrate(4H <sub>2</sub> O)	30		Potassium nitrate	12	
Ceric ammonium nitrate	1		Potassium nitrite	2	
Cobaltous chloride (6H <sub>2</sub> O)	30	Misc. m.p.	Potassium perchlorate <sup>c</sup>	38	
Cupric acetate(H <sub>2</sub> O)	Insoluble	6	Potassium thiocyanate	20	50
Cupric bromide <sup>b</sup>	1	20 @150°C	Silver chloride	<0.01	
Cupric chloride(2H <sub>2</sub> O)	Insoluble	27	Silver iodide	<0.01	
Cupric sulfate(5H <sub>2</sub> O)	<0.01		Silver nitrate	130	180
Cuprous iodide	1 at 30°C		Sodium sulfate	<0.01	
Ferric ammonium sulfate	Insoluble	Misc. m.p.	Sodium azide	<1.0	1.6
Ferric chloride(6H <sub>2</sub> O)	30	90	Sodium chloride	0.4	
Ferrous chloride(4H <sub>2</sub> O)	30	90	Sodium cyanide	1	10
Gold chloride	5		Sodium dichromate(2H <sub>2</sub> O) <sup>c</sup>	12	
Iodine	>100		Sodium hydroxide	0.035	
Lead chloride <sup>b</sup>	10		Sodium iodide	30	
Lead nitrate	20	60	Sodium nitrate	20	
Lithium bromide	31.4		Sodium nitrite	20	
Lithium chloride	10.2		Sodium perchlorate <sup>c</sup>	24.2	
Lithium dichromate(2H <sub>2</sub> O) <sup>c</sup>	10		Sodium thiocyanate	1	
Lithium iodide	41.1		Stannic chloride	25	
Lithium nitrate	10		Stannous chloride(2H <sub>2</sub> O)	40	
Lithium perchlorate <sup>c</sup>	31.5		Strontium bromide(6H <sub>2</sub> O)	5	
Magnesium chloride(6H <sub>2</sub> O)	1.0		Strontium chloride(2H <sub>2</sub> O)	10	
Magnesium nitrate (6H <sub>2</sub> O)	40		Sulfur dichloride	Reacts violently	
Manganous chloride (4H <sub>2</sub> O)	20		Sulfur monochloride	Reacts violently	
Mercuric acetate	100		Tungsten hexachloride	5	
Mercuric bromide	90		Uranyl nitrate (6H <sub>2</sub> O)	30	
Mercuric iodide	100		Vanadium chloride		1
Mercuric sulfate	<0.01		Zinc acetate	>100	
Molybdenum bromide	1		Zinc chloride <sup>b</sup>	30	
Nickel chloride(6H <sub>2</sub> O)	60		Zinc nitrate(6H <sub>2</sub> O)	55	
Nickel nitrate (6H <sub>2</sub> O)	60		Zinc sulfate	<0.01	
Potassium bromide	6.5				

a) @20.3° b) possible reaction c) not recommended due to safety considerations



Table 5  
Solubility of Gases in DMSO (At Atmospheric Pressure, 20°C)

	Grams Gas/ 100 Grams Solution	Gas Volume/ Volume of DMSO
Acetylene	2.99	28.1
Ammonia	2.6	40.0
Butadiene	4.35	31.0
Butane		4.8
Butylenes (mixed)	2.05	
Carbon dioxide	.05	2.86
Carbon monoxide	<0.01	
Ethane	$6.85 \times 10^{-2}$	0.56
Ethylene	.32	2.8
Ethylene oxide	60.0	306.0
Freon 12	1.8	3.7
Helium	$1.46 \times 10^{-4}$	$0.89 \times 10^{-2}$
Hydrogen	$1.95 \times 10^4$	$2.39 \times 10^{-2}$
Hydrogen sulfide	0.5 (reacts)	
Isobutylene	2.5-3.0	
Methane	$7.92 \times 10^{-3}$	
Nitric oxide (NO)	0.00	
Nitrogen	$2.99 \times 10^{-3}$	0.6
Nitrogen dioxide(NO <sub>2</sub> ,N <sub>2</sub> O <sub>4</sub> )	Miscible (possible reaction)	
Oxygen	$6.44 \times 10^{-3}$	0.049
Ozone	Reacts	
Propane		1.8
Propyne		58.2
Sulfur dioxide	57.4 (reacts)	

Table 6  
Relative Hansen Solubility Parameter Data

Solvent	$\delta_d$	$\delta_p$	$\delta_h$	$\delta_t$
<b>DIMETHYL SULFOXIDE (DMSO)</b>	<b>9.0</b>	<b>8.0</b>	<b>5.0</b>	<b>13.0</b>
Butyrolactone	9.3	8.1	3.6	12.8
Dimethylacetamide (DMAC)	8.2	5.6	5.0	11.1
Dimethylformamide (DMF)	8.5	6.7	5.5	12.1
N-Methyl-2-pyrrolidone (NMP)	8.8	6.0	3.5	11.2
Propylene Carbonate	9.8	8.8	2.0	13.3
Sulfolane	9.0	7.4	5.3	12.8

The units for solubility parameters in this table are (cal /cm<sup>3</sup>)<sup>1/2</sup>. SI units (J/ cm<sup>3</sup>)<sup>1/2</sup> can be obtained by multiplying by 2.0455.

Table 7  
**Suggested DMSO Formulations for Industrial Solvent Replacement**

Solvents to Be Replaced				Theoretical Replacement Mixture			
	$\delta_d$	$\delta_p$	$\delta_h$	Weight %	$\delta_d$	$\delta_p$	$\delta_h$
Acetone	7.6	5.1	3.4	65% DMSO 35% Aromatic 150	8.8	5.0	3.6
Butyl cellosolve	7.8	2.5	6.0	10% DMSO 30% Aromatic 150 60% Isopropyl alcohol	8.0	2.7	5.9
Butyrolactone	9.3	8.1	3.6	100% DMSO	9.0	8.0	5.0
Cellosolve	7.9	4.5	7.0	33% DMSO 67% Butyl alcohol	8.1	4.2	7.0
Cyclohexanone	8.7	3.1	2.5	40% DMSO 60% Aromatic 100	8.9	3.2	2.4
Dimethyl acetamide	8.2	5.6	5.0	67% DMSO 33% Amyl acetate	8.6	5.3	5.0
Dimethyl formamide	8.5	6.7	5.5	80% DMSO 20% 2-methyl butanol	8.6	6.6	5.4
Ethyl amyl ketone	8.0	2.5	2.1	30% DMSO 70% Aromatic 100	8.9	2.5	2.0
Ethylene glycol butyl ether acetate	8.1	2.8	6.7	20% DMSO 60% Butyl alcohol 20% Amyl acetate	8.0	3.3	6.6
Isophorone	8.1	4.0	3.6	50% DMSO 40% Aromatic 100 10% n-Butanol	8.9	4.1	3.5
Methyl ethyl ketone	7.8	4.4	2.5	20% DMSO 80% MIBK	7.8	3.8	2.5
Dimethyl acetamide	8.2	5.6	5.0	67% DMSO 33% Amyl acetate	8.6	5.3	5.0
Dimethyl formamide	8.5	6.7	5.5	80% DMSO 20% 2-methyl butanol	8.6	6.6	5.4
Ethyl amyl ketone	8.0	2.5	2.1	30% DMSO 70% Aromatic 100	8.9	2.5	2.0
Ethylene glycol butyl ether acetate	8.1	2.8	6.7	20% DMSO 60% Butyl alcohol 20% Amyl acetate	8.0	3.3	6.6
Isophorone	8.1	4.0	3.6	50% DMSO 40% Aromatic 100 10% n-Butanol	8.9	4.1	3.5
Methyl ethyl Ketone	7.8	4.4	2.5	20% DMSO 80% MIBK	7.8	3.8	2.5
Methylene chloride	8.9	3.1	3.0	40% DMSO 60% Aromatic 150	8.7	3.1	2.7
Nitrobenzene	9.8	4.2	2.0	45% DMSO 55% Toluene	8.9	3.6	2.6



Table 7, Continued

<b>Suggested DMSO Formulations for Industrial Solvent Replacement</b>							
Solvents to be Replaced				Theoretical Replacement Mixture			
NMP	8.8	6.0	3.5	70% DMSO 30% Aromatic 100	8.9	5.4	3.6
Pentoxone (discontinued)	7.3	4.2	2.8	50% DMSO 50% Aromatic 100	8.9	3.9	2.8
Propylene carbonate	9.8	8.8	2.0	100% DMSO	9.0	8.0	5.0
Sulfolane	9.0	8.1	3.6	100% DMSO	9.0	8.0	5.0

Table 8

<b>Hansen Solubility Parameter data for Selected Polymers</b>				
Polymer	$d_d$	$d_p$	$d_h$	Radius
Polymethylmethacrylate Rohm & Haas	9.1	5.1	3.7	4.2
Epoxy - "Epicote" 1001 Shell Chemical	10.0	5.9	5.6	6.2
Polystyrene BASF	10.4	2.8	2.1	6.2
Polyvinyl acetate "Mowilith" 50 Farbwerke Hoechst	10.2	5.5	4.7	6.7
Nitrocellulose 1/2 sec. H 23 A. Hagedorn	7.5	7.2	4.3	5.6
Cellulose acetate "Cellidora" A. Bayer A.G.	9.1	6.2	5.4	3.7
Polyester "Desmophen" 850 A. Bayer A.G.	10.5	7.3	6.0	8.2
Polyvinyl chloride "Vipla"KR Montecatini	8.9	3.7	4.1	1.7

Tables 9 and 10 illustrate how the solvency of a mixture for selected polymers can be related to the composition of the mixture. Predicted solvencies of mixtures of DMSO and tetralin or DMSO and methyl isobutyl ketone for these eight polymers are tabulated. A solvency value of 100 was assigned to mixtures at the center of the HSP envelope and a value of 0 to mixtures at the envelope boundary. These tables also show how solvency changes with the composition of the mixture, with ratio of the solvents selected, and show the composition of maximum solvency for each polymer and solvent pair.

Table 9

<b>Solubility of Selected Polymers in DMSO/Tetralin Mixtures</b>								
Polymer	Solvency <sup>(1)</sup> Versus Mixture Composition							
	DMSO %	100	80	60	50	40	20	0
	Tetralin%	0	20	40	50	60	80	100
Polymethylmethacrylate Rohm & Haas		42	87	99	93	80	38	ns
Epoxy - "Epicote" 1001 Shell Chemical		77	85	81		60	32	ns
Polystyrene BASF		ns	35	70		87	91	84

Table 9, Continued								
Solubility of Selected Polymers in DMSO/Tetralin Mixtures								
Polymer	Solvency <sup>(1)</sup> Versus Mixture Composition							
	DMSO %	100	80	60	50	40	20	0
	Tetralin%	0	20	40	50	60	80	100
Polyvinyl acetate "Mowilith" 50 Farbwerke Hoechst		73	86	89	84	77	57	28
Nitrocellulose 1/2 sec. H 23 A. Hagedorn		67	65	65	-	4	ns	ns
Cellulose acetate "Cellidora" A. Bayer A.G.		74	89	61		0	ns	ns
Polyester "Desmophen" 850 A. Bayer A.G.		85	83	74		57	35	5
Polyvinyl chloride "Vipla" KR Montecatini		ns	ns	ns	68	ns	ns	ns

*If Solvency <0, rating is "ns" indicating not soluble.*

Table 10								
Solubility of Selected Polymers in DMSO/MIBK Mixtures								
Polymer	Solvency <sup>(2)</sup> Versus Mixture Composition							
	DMSO, % MIBK, %	100 0	80 20	60 40	40 60	20 80	0 100	
Polymethylmethacrylate		42	77	84	67	38	0	
Epoxy - Epicote® 1001, Shell Chemical		77	73	58	38	9	ns	
Polystyrene		ns	15	27	30	21	12	
Polyvinyl acetate Mowilith® 50, Farbwerke Hoechst		73	72	64	43	28	6	
Nitrocellulose 1/2 sec. H 23		67	83	82	69	51	27	
Cellulose acetate		74	81	54	0	ns	ns	
Polyester- Desmophen® 850, Bayer MaterialScience		85	74	58	39	16	ns	
Polyvinyl chloride		ns	ns	ns	ns	ns	ns	

*MIBK-methyl isobutyl ketone*  
*If Solvency <0, rating is "ns" indicating not soluble.*



Table 11

**Pharmaceutical Excipient Solubility Data**

Excipient	Brand Name (Supplier)	Solubility Description
Butyl and other patch adhesives	Duro-TAK® (National Starch)	practically insoluble/insoluble
Carnauba Wax	Carnauba wax, No. 1 (Aldrich)	practically insoluble/insoluble
Carrageenan NF	Gelcarin® GP 911NF (FMC)	practically insoluble/insoluble
Cetyl Alcohol NF	Crodacol® C-95 NF (Croda)	practically insoluble/insoluble
Ethanol (absolute)	Ethanol (Aldrich)	very soluble
Ethylcellulose NF	Ethocel® Standard 4 (Dow)	sparingly soluble
Hydroxypropyl cellulose	Klucel® LF (Aqualon)	sparingly soluble
Hypromellose USP	Methocel® E3 Premium LV (Dow)	sparingly soluble
Lactose	β- & D- Lactose	freely soluble
Lanolin	Medilan® Ultra (Croda)	slightly soluble
Lecithin	Lecithin, refined (Alfa Aesar)	practically insoluble/insoluble
Light Mineral Oil NF	Drakeol® 5 (Penreco)	<b>practically insoluble/insoluble</b>
MgStearate NF	Mg Stearate (Ferro)	practically insoluble/insoluble
Mineral Oil USP	Drakeol®19 (Penreco)	practically insoluble/insoluble
Oleic Acid	Oleic acid (Aldrich)	very soluble
PEG 300 NF	Carbowax® Sentry® 300 (Dow)	very soluble
PEG 50 Stearate	Ritox® 53 (Rita)	very slightly soluble
PEG 8000 NF	Carbowax® Sentry® 8000 (Dow)	practically insoluble/insoluble
Poloxamer NF	Lutrol® F127 NF (BASF)	practically insoluble/insoluble
Poly (L-lactide)	Resomer® L210 S (Boehringer Ingelheim)	practically insoluble/insoluble
Poly (DL-lactide-co-glycolide)	Resomer® RG502 H (Boehringer Ingelheim)	freely soluble
Polymethacrylates	Eudragit® E 100 (Rohm Pharma)	practically insoluble/insoluble



Table 11 (continued)

**Pharmaceutical Excipient Solubility Data**

Excipient	Brand Name (Supplier)	Solubility Description
Polyoxyl 35 Castor Oil NF	Cremophor® EL (BASF)	very soluble
Polysorbate 80 NF	Tween® 80 (Uniqema)	very soluble
Polyvinyl Alcohol	PVA, fully hydrolyzed (JT Baker)	practically insoluble/insoluble
Povidone USP	Kollidon® 90 F and 17 PF (BASF)	freely soluble
Propylene Glycol (USP)	Propylene Glycol (Dow)	very soluble
Sorbitan Monopalmitate	Span® 40 (Uniqema)	insoluble
Soybean Oil NF	Super Refined® Soybean Oil NF (Croda)	practically insoluble/insoluble
Starch Pregelatinized NF	Starch 1500 (Colorcon)	practically insoluble/insoluble
Stearic Acid	Stearic acid, Grade I (Aldrich)	sparingly soluble
Sucrose	Sucrose (Domino)	freely soluble
Water	Water	very soluble
White Petrolatum USP	Super White PET USP (Penreco)	practically insoluble/insoluble

Descriptive Term	Parts of Solvent Required for 1 Part of Solute
Very Soluble	Less than 1
Freely Soluble	From 1 to 10
Soluble	From 10 to 30
Sparingly Soluble	From 30 to 100
Slightly Soluble	From 100 to 1000
Very Slightly Soluble	From 1000 to 10000
Practically Insoluble Or Insoluble	10,000 or over

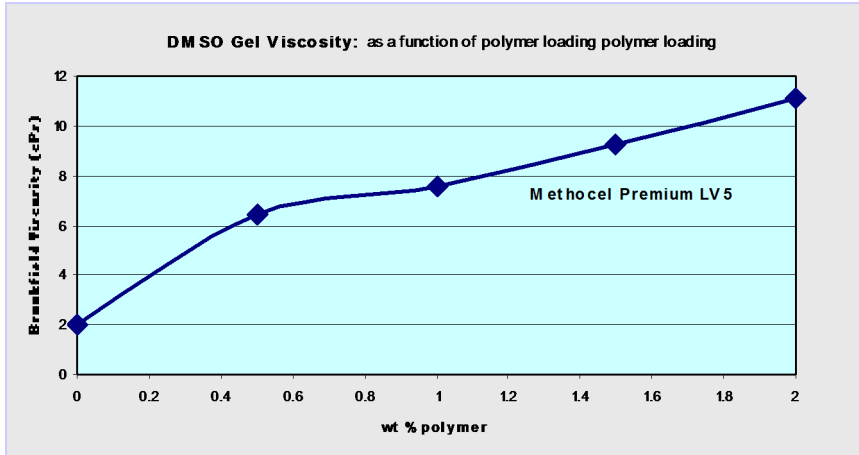
Adapted from USP 28 / NF 23 (2005) p. 9. All measurements were performed at room temperature (ca. 21°C)



Table 12

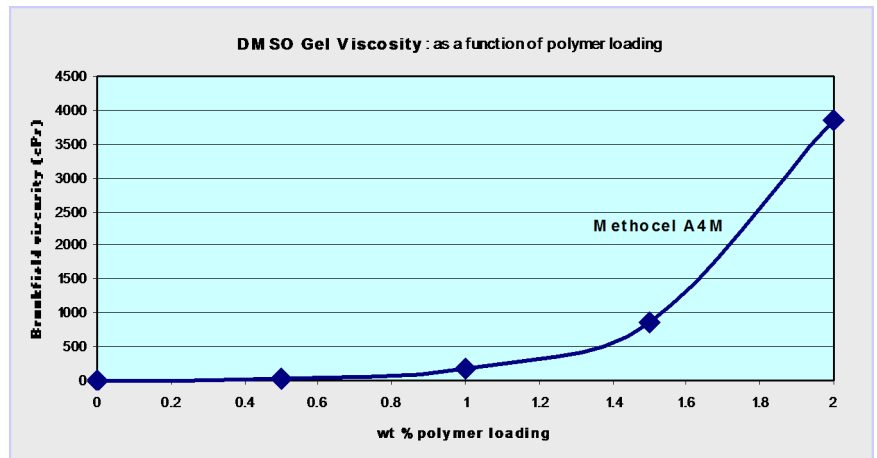
### DMSO Gel Preparation Data

Pharmaceutically acceptable gelling agents suitable for the formulation of topical / transdermal DMSO products were evaluated to understand the effect of polymer loading on formulation viscosity. Methocel® is a trademark of the Dow Chemical Company.

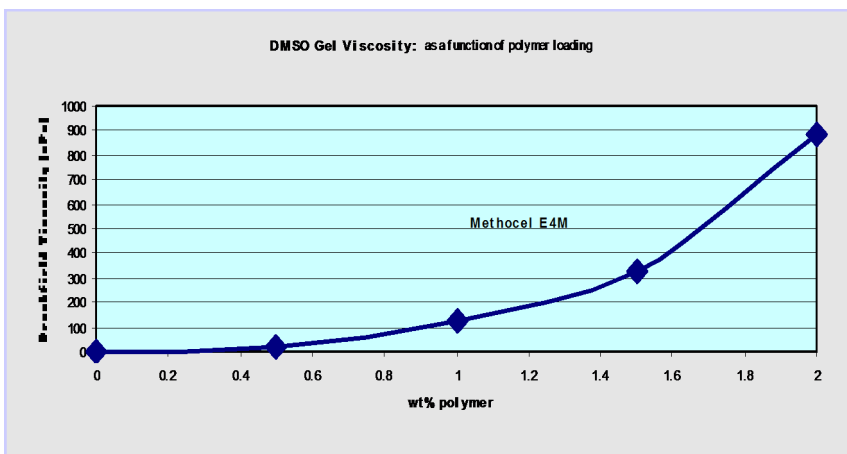


All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer, using spindle 61 at 100 rpm. Gels were measured at 73°F (23°C). The diameter of the measurement vessel was 8 cm.

Methocel A4M: All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer, using spindle 61 for measurements at 0.5, 1.0 and 1.5 % polymer. Spindle 63 was used for the 2.0 % sample. Instrument settings of 100, 30, 6 and 100 RPM were used for samples containing 0.5, 1.0, 1.5, and 2.0 wt% polymer, respectively. Gels were measured at 73°F (23°C). The diameter of the measurement vessel was 8 cm.



Methocel E4M: All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer, using spindle 61. Instrument settings of 100, 30, 12 and 5 RPM were used for samples containing 0.5, 1.0, 1.5, and 2.0 wt% polymer, respectively. Gels were measured at 73°F (23°C). The diameter of the measurement vessel was 8 cm. Formulation included 1.0 wt% triethanolamine.

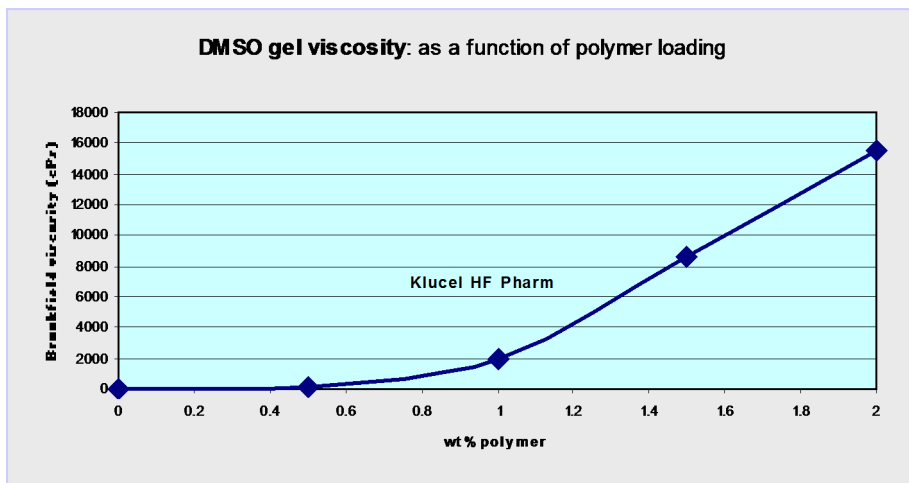


**Other Dow rheology modifiers currently under evaluation include:**  
Polyox® WSR N10 NF, Methocel E5 LV, Ethocel® Standard 4 NF and Ethocel Standard 10

Table 12 (continued)

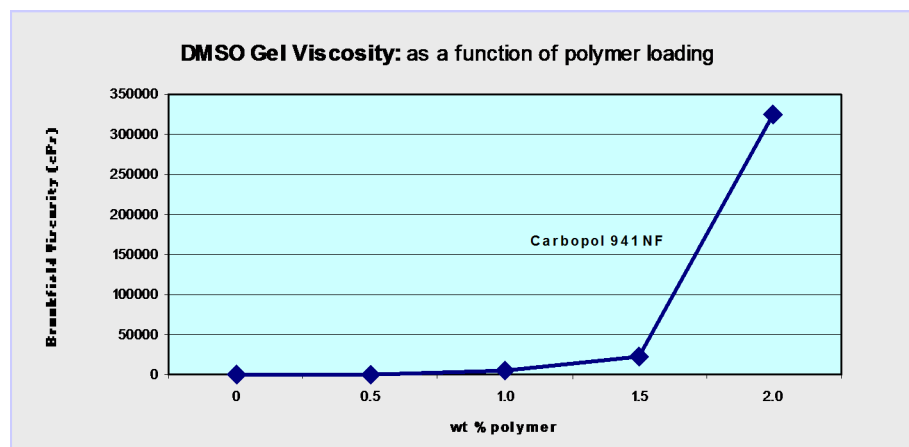
### DMSO Gel Preparation Data

Pharmaceutically acceptable gelling agents suitable for the formulation of topical / transdermal DMSO products were evaluated to understand the effect of polymer loading on formulation viscosity. **Klucel® is a trademark of Hercules Aqualon.** Carbopol® is a trademark of Noveon Corporation.



**Klucel HF:** All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer. using spindle 61 for measurements at 0.5, 1.0 and 1.5 % polymer. Spindle 64 was used for the 2.0 % sample. Instrument settings of 60, 2.5, 0.6 and 20 RPM were used for samples containing 0.5, 1.0, 1.5, and 2.0 wt% polymer, respectively. Gels were measured at 73°F (23°C). The diameter of the measurement vessel was 8 cm.

**Other Hercules Aqualon rheology modifiers currently under evaluation include:** Klucel GF, HFX, LF, MF, EF, JF.



**Carbopol 941 NF :** All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer. using spindle 64 for measurements at 1.5 % and 2.0% polymer. Spindle 61 was used for the 0.5 % sample and spindle 62 for the 1.0% sample. Instrument settings of 30, 1.0, 100 and 0.3 RPM were used for samples containing 0.5, 1.0, 1.5, and 2.0 wt% polymer, respectively. Gels were measured at 73°F (23°C). The diameter of the measurement vessel was 8 cm.

**Other Noveon rheology modifiers currently under evaluation include:** Carbopol 940 NF, 934 NF, 980 NF, 934 NF, 981 NF, 1342 NF, 71G NF, 974 NF, Ultrez 10 NF, 971P NF

*General procedure for preparing DMSO-based gel products.* DMSO-based gels are prepared using methods similar to those described by manufacturers for water-based media. The additive is sifted with stirring into DMSO and allowed to disperse over 30-60 minutes. Warming the mixture at 50°C is helpful in dispersing the additive, and pH adjustment using suitable bases is often useful. In the case that less polar cosolvents are included, it may be best to form a pregel in DMSO, followed by slow addition of the less polar cosolvent. Recommended packaging materials for storage include HDPE, HDPP, or Teflon® PTFE.



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