

# DIMETHYL SULFOXIDE

## SOLUBILITY DATA

### DMSO



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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:

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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-Dichlorodiphenyltri- chloroethane	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 Sulfonate	Insoluble		Di-isobutyl carbinol	Miscible	
Bromoethane	Miscible		Diisobutylene (0.6% DMSO is soluble in di-isobutylene)	3.3	
Butenes	2.1		Disopropyl ether	11	
n-Butyl acetate	Miscible		Dimethyl ether	4.4	
Butly carbitol	Miscible		Dimethyl formamide	Miscible	
Calcium methyl sulfonate	Soluble		Dimethyl sulfide	Miscible	
Camphor	Soluble	Soluble	Dimethyl sulfone	33.9	Miscible
Candelilla wax		< 1	Dioxane	Miscible	
Carbon	Insoluble	< 1	Diphenyl	Very soluble	
Carbon disulfide	90		Dipentene	10	
Carbon tetrachloride	Miscible		Dodecanol	>100	
Carbowax 600	Miscible		n-Dodecane	0.38	
Carbowax 6000	Insoluble	8	Dodecylbenzene (Neo- lene 400)	3.5	
Carnauba wax		< 1	Dye- Burnt Sugar	Soluble	
Castor oil	Miscible	< 1	Dye- FD&C Blue	Soluble	
			Dye- Pistachio GreenB	Soluble	



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
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	
<i>n</i> -Decane	0.7		Glycine	< 0.05	0.1
Di- <i>n</i> -butylamine	11		Hexane	2.9	
<i>o</i> -Dichlorobenzene	Miscible		4-Hydroxybenzoic Acid	24	
Hy-Wax 120		< 1	Phosphoric acid	Miscible	
Imidazole	80		Phosphorus trichloride	Reacts vig- orously	
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 vig- orously	
Methionine	0.1	0.3	Sorbitan sesquioleate	2.5	



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
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	
<i>n</i> -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
Methylene chloride	Miscible		Tallow amide, hydrogenated (Armour Armide HT)	Insoluble	> 40
Microcrystalline wax		< 1	Terephthalic acid	26	33
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 diisocyanate	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	
<i>n</i> -Pentane	0.35		Trinitrotoluene	Soluble	



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
Pentene 1 &2	7.1		Turpentine	10	
Perchloric acid	Reacts violently		Urea	40	110
Petroleum ether (DMSO soluble 0.3- 0.5% in petroleum 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



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
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
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
Diiiodohydroxyquin (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



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
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
Lidocaine USP	137-58-6	163.0	148.8	59.8
Lipoic Acid, DL-alpha (DL-Thiolic Acid)	1077-28-7	311.8	284.6	74.0
Loperamide Hydrochloride USP	34552-83-5	7.2	6.5	6.1
Lorazepam USP	846-49-1	10.8	9.9	9.0



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
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
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





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
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 IU/ml		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 IU/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

Solubility, Grams/100cc DMSO			
Material	20-30°C	90-100°C	Comments
<b>Aminoplasts</b>			
Melamine Formol	Soluble		
Urea formol	Soluble		
<b>Polyacrylics</b>			
Orlon (DuPont)		20	Viscous soln.
Acrilan (Monsanto)	>25		
Verel (Eastman)	>5		25 at 130°C with some decomposition
Creslan	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		Insoluble	
Nylon 12 Oryasol		Insoluble	Soluble at 140°C
<b>Polyimides</b>			
Bismaleimide copolymers		Insoluble	
Kermid 353	Swells		
Kermid 711	Soluble		
Polyamino bismaleimide Kermid 601 I			
Polyamideimide Torlon 4203L		Insoluble	
Polyetherimide Ultem 100	Swells		
<b>Cellulose</b>			
Cellulose triacetate	10	20	
Viscose rayon		<1	
Cellophane		Insoluble	
Carboxymethyl cellulose		Insoluble	
Nitrocellulose		10	



Table 3 , continued			
Solubility of Resins and Polymers in DMSO			
Solubility, Grams/100cc DMSO			
Material	20-30°C	90-100°C	Comments
<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		
<b>Fluorinated Resins</b>			
Polyvinylidene fluoride Forafion	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		<1	
<b>Phenoplasts</b>			
Modified Novalac R7522	Soluble		
R7550	Soluble		
Norsophen Resin PH 13 (CDF Chime)	Soluble		
<b>Polycarbonates</b>			
Lexan (General Electric)		>5	



Table 3 , continued  
Solubility of Resins and Polymers in DMSO

Solubility, Grams/100cc DMSO			
Material	20-30°C	90-100°C	Comments
<b>Polyesters</b>			
Dacron (DuPont)		>1	Dissolves at 160°C; ppts at 130°C
CX 1037 (Goodyear)		7	
Atlac		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	Swells		
<b>Polyethersulfone</b>			
Victrax 660P	Soluble		
Ultrason E3000 (BASF)	Soluble		
Udel	Soluble		
<b>Urethanes</b>			
Vithane (Goodyear)		100	
<b>Vinyl polymers &amp; copolymers</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
Polyvinylpyrrolidone	30	>100	
Geon 101 (PVC)		10	
Vinylite WHH	2	30	
Teslar (DuPont)			Partially sol. at 160-170°C

Table 3, continued			
Solubility of Resins and Polymers in DMSO			
Solubility, Grams/100cc DMSO			
Material	20-30°C	90-100°C	Comments
<b>Vinylidenes</b>			
Darvan	5		Soln. cloudy and viscous
Saran film (Dow)		30	
Geon 200 x 20		20	
DNA	>5		25 at 130°C
<b>Other Resinous Materials</b>			
Melmac 405	70		
Neoprene	Insoluble	Insoluble	
Polyetheretherketone (PEEK)	Insoluble		
Polyethylene	Insoluble	Insoluble	
Polypropylene	Insoluble	Insoluble	
Polystyrene			Sol. at 150°C; ppts at 130°C
Rosin	>100		
Penton chlorinated polyether		5	
Vinsol	50	>100	

Table 4					
SOLUBILITY OF INORGANIC MATERIALS IN DMSO					
Solubility, Grams/100cc DMSO			Solubility, Grams/100cc DMSO		
Material	25°C	90-100°C	Material	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			Boric acid <sup>a</sup>	45	
Ammonium dichromate <sup>c</sup>	50		Bromine	Reacts	
Cadmium chloride <sup>b</sup>	20		Potassium chloride	0.2	
Cadmium iodide	30		Potassium cyanide	1	2



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

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	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	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	



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

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 x 10 <sup>-2</sup>	0.56
Ethylene	.32	2.8
Ethylene oxide	60.0	306.0
Freon 12	1.8	3.7
Helium	1.46 x 10 <sup>-4</sup>	0.89 x 10 <sup>-2</sup>
Hydrogen	1.95 x 10 <sup>4</sup>	2.39 x 10 <sup>-2</sup>
Hydrogen sulfide	0.5 (reacts)	
Isobutylene	2.5-3.0	
Methane	7.92 x 10 <sup>-3</sup>	
Nitric oxide (NO)	0.00	
Nitrogen	2.99 x 10 <sup>-3</sup>	0.6



Table 5, continued Solubility of Gases in DMSO (At Atmospheric Pressure, 20°C)		
Nitrogen dioxide(NO <sub>2</sub> ,N <sub>2</sub> O <sub>4</sub> )	Miscible (possible reaction)	
Oxygen	6.44 x 10 <sup>-3</sup>	0.049
Ozone	Reacts	
Propane		1.8
Propyne		58.2
Sulfur dioxide	57.4 (reacts)	

Table 6 Relative Hansen Solubility Parameter Data				
Solvent	δ <sub>d</sub>	δ <sub>p</sub>	δ <sub>h</sub>	δ <sub>t</sub>
DIMETHYL SULFOXIDE (DMSO)	9.0	8.0	5.0	13.0
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  $\left(\frac{\text{cal}}{\text{cm}^2}\right)^{1/2}$ . SI units  $\left(\frac{\text{J}}{\text{cm}^2}\right)^{1/2}$  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
Butyrolactone	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
Dimethylacetamide	8.2	5.6	5.0	67% DMSO 33% Amyl acetate	8.6	5.3	5.0
Dimethylformamide	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
Dimethylacetamide	8.2	5.6	5.0	67% DMSO 33% Amyl acetate	8.6	5.3	5.0
Dimethylacetamide	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



Table 7

### Suggested DMSO Formulations for Industrial Solvent Replacement

Solvents to Be Replaced				Theoretical Replacement Mixture			
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
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



Polymer	$\delta_d$	$\delta_p$	$\delta_h$	Radius
Poly (methylmethacrylate)	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	10.2	5.5	4.7	6.7
Nitrocellulose	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	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  
**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
Poly (methacrylate)		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
Polyvinyl acetate "Mowilith" 50		73	86	89	84	77	57	28
Nitrocellulose		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		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 %	100	80	60	40	20	0	
	MIBK %	0	20	40	60	80	100	
Poly (methacrylate)		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		73	72	64	43	28	6	
Nitrocellulose		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®	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 (Ashland)	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)	practically insoluble/insoluble
Mg Stearate 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 very slightly
PEG 50 Stearate	Ritox® 53 (Rita)	soluble practically
PEG 8000 NF	Carbowax® Sentry® 8000 (Dow)	insoluble/insoluble practically
Poloxamer NF	Lutrol® F127 NF (BASF)	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
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

Table 11  
**Pharmaceutical Excipient Solubility Data**

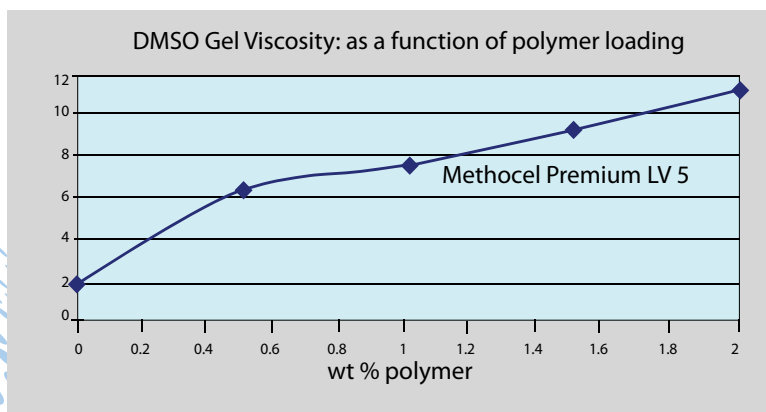
Excipient	Brand Name (Supplier)	Solubility Description
Sorbitan Monopalmitate	Span® 40 (Uniqema)	insoluble
Soybean Oil NF	Super Refined® Soybean Oil NF (Croda)	practically insoluble/insoluble
Starch Pregelatinized NF	Starch 1500 (Colorcon)	practically insoluble/insoluble
Stearic Acid	Stearic acid, Grade I (Aldrich)	sparingly soluble
Sucrose	Sucrose (Domino)	freely soluble
Water	Water	very soluble practically
White Petrolatum USP	Super White PET USP (Penreco)	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. 21oC)

## DMSO Gel Preparation Data

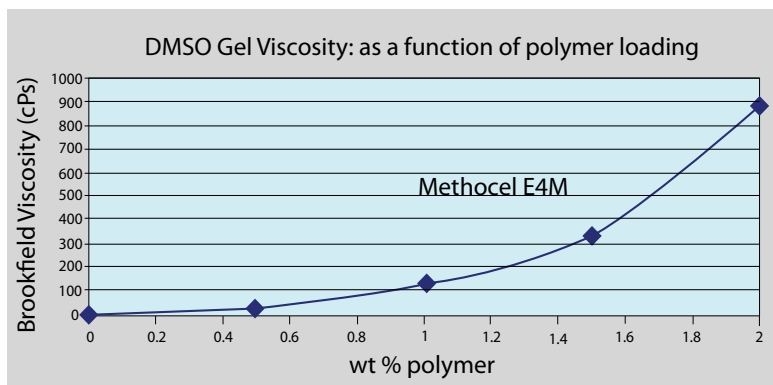
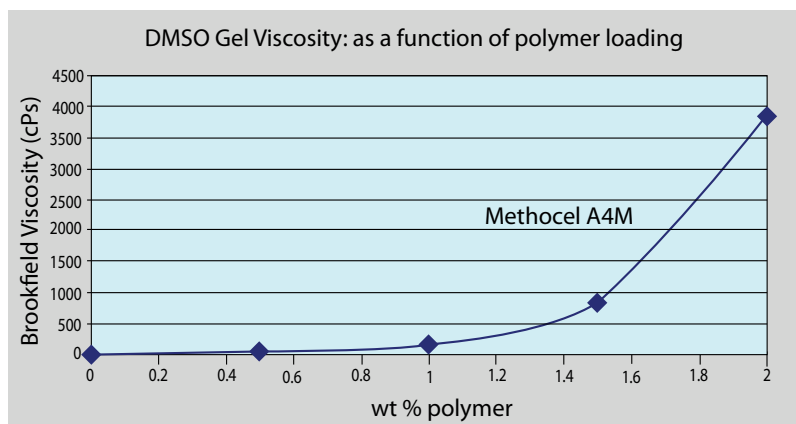
Pharmaceutically acceptable gelling agents suitable for the formulation of topical / transdermal DMSO products were evaluated to understand the effect of polymer loading on formulation viscosity. Methocel® is a trademark of the Dow Chemical Company.



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.

## DMSO Gel Preparation Data, continued

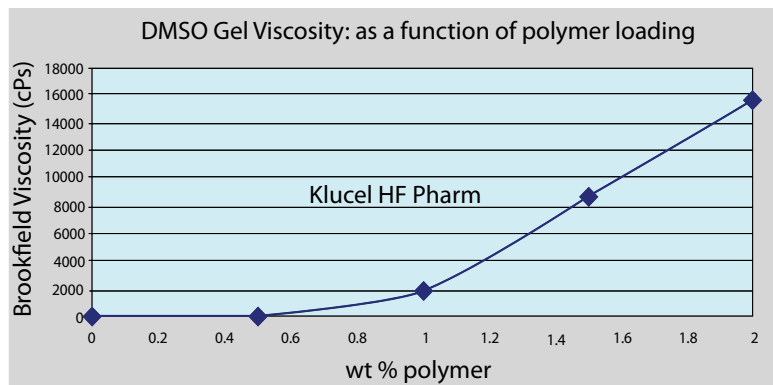
Methocel A4M: All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer using spindle 61 for measurements at 0.5, 1.0 and 1.5 % polymer. Spindle 63 was used for the 2.0 % sample. Instrument settings of 100, 30, 6 and 100 RPM were used for samples containing 0.5, 1.0, 1.5, 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<sup>®</sup> WSR N10 NF, Methocel E5 LV, Ethocel<sup>®</sup> Standard 4 NF and Ethocel Standard 10

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<sup>®</sup> is a trademark of Ashland. Carbopol<sup>®</sup> is a trademark of Noveon Corporation.

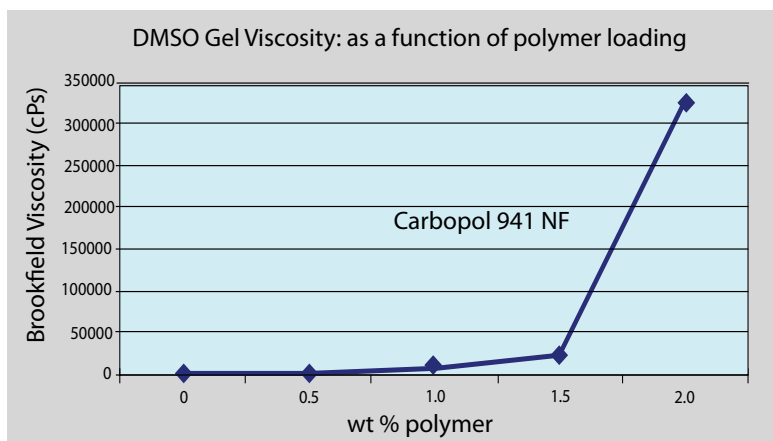


Klucel HF: All viscosity measurements were recorded using a Brookfield Model DV-E Digital Viscometer, using spindle 61 for measurements at 0.5, 1.0 and 1.5 % polymer. Spindle 64 was used for the 2.0 % sample. Instrument settings of 60, 2.5, 0.6 and 20 RPM were used for samples containing 0.5, 1.0, 1.5,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

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



## DMSO Gel Preparation Data, continued



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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