



## Process Description Report

**Process:** Dow's (Wolf, Bolnitz, 04) Prep of Alkali Cellulose Slurry, HP Ethn w/ MC & PO in Excess MC (MC/Cell=2) in 1 Train Autoclave Reactor, Steam/Water Stripping, 2 Hot Water Washings w/ Membrane Filtn Walocel HM F/P (DS=1.8, MS=0.15, AI=95%)

**Product:** Hydroxypropyl Methylcellulose (HPMC, Premium)  
[93.3-96.65%, DS=1.5-1.9, MS=0.25-0.3, Mw=0.8-0.9 MM]

### Process Section 1

Cellulose Preparation, Shredding and Slurrying

Etherification

Neutralization

Etherification

Temperature: 122 - 167 F

Pressure: 280.0 psig

Reaction Time: 5.0000 hr

Reactor Desc.: 5 parallel autoclave reactors,  
each

jacketed and agitated

Inlet Stream	lb/lb	reaction yield	overall yield
Raw Material(s)			
Cellulose, Wood Pulp	0.8427	100.0%	98.15%
(Water)	0.04300		
Hydrochloric Acid, 33%	0.0415		
(Water)	0.08430		
Methyl Chloride	1.5963	47.0%	39.50%
Propylene Oxide, Major Consumer	0.2020	23.6%	22.00%
Sodium Hydroxide, 50%, Major Consumer	0.7972		
(Water)	0.96700		
Outlet Stream	lb/lb		
Intermediate (outflow) (s)			
Dimethyl Ether	0.1341		
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051		
Hydroxypropyl Methylcellulose	1.0400		
Methyl Chloride	0.5691		

## Process Description Report

Methyl Alcohol	0.1245
Propylene Glycol Methyl Ether	0.0733
Propylene Glycol, Major Consumer	0.1225
Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.1656
Water	1.2936

**Process Section 2**

Steam Stripping

Separation

Cellulose Ether Washing

Separation

Cellulose Ether Washing

Filtration, membrane in two stages

Separation

Recovery

Temperature: 149 F

Pressure: 66.0 psig

Reactor Desc.: Membrane filtration is carried out  
at 66 and 78 psi

	lb/lb	reaction yield	overall yield
Inlet Stream			
Raw Material(s)			
Polyether Sulphone Membrane	0.0020		
Solvent(s)			
Steam	3.9400		
Water	14.8500		
Secondary Solvent(s)			
Water	124.0000		
Intermediate (inflow) (s)			
Dimethyl Ether	0.1341		
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051		
Hydroxypropyl Methylcellulose	1.0400		
Methyl Chloride	0.5691		
Methyl Alcohol	0.1245		
Propylene Glycol Methyl Ether	0.0733		
Propylene Glycol, Major Consumer	0.1225		

**Process Description Report**

Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.1656
Water	1.2936
Outlet Stream	lb/lb
Recycled Raw Material(s)	
Methyl Chloride	0.4228
Recycled Secondary Solvent(s)	
Water	123.0000lb/Mlb
Recovered Byproduct(s)	
Methyl Alcohol	0.1245
Intermediate (outflow)(s)	
Dimethyl Ether	0.0030
Hydroxypropyl Methylcellulose	1.0000
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Sodium Chloride	0.0036
Water	0.8800
Waste Product(s)	
Dimethyl Ether	0.1311
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051
Hydroxypropyl Methylcellulose	0.0400
Methyl Chloride	0.1410
Methyl Alcohol	0.0030
Propylene Glycol Methyl Ether	0.0733
Propylene Glycol, Major Consumer	0.1225
Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.1656
Water	20.2936

**Process Section 3**

Drying, Rotary

Product Finishing and Packaging

Drying, Rotary

Temperature: 194 F

Inlet Stream	lb/lb	reaction yield	overall yield
Solvent(s)			

## Process Description Report

Air	110.0000
Intermediate (inflow) (s)	
Dimethyl Ether	0.0030
Hydroxypropyl Methylcellulose	1.0000
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Sodium Chloride	0.0036
Water	0.8800
Outlet Stream	lb/lb
Final Product(s)	
Hydroxypropyl Methylcellulose	1.0000
(Sodium Chloride)	0.00360
(Water)	0.03100
Waste Product(s)	
Air	110.0000
Dimethyl Ether	0.0030
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Water	0.8490

**Solvents**

Steam  
Water  
Air

**Utilities**

	units/lb
Steam	10.8000 lb
Cooling Water	105.0000 G
Process Water	1.9000 G
Electricity	0.7000 kWh
Inert Gas	0.1000 SCF

**Liquid Waste Stream**

	lb/lb
Liquid Waste Flow:	2.6700 G/lb
Acid (H <sub>2</sub> SO <sub>4</sub> eq)	0.0260
Biological Oxygen Demand (BOD)	0.2120
Theoretical Oxygen Demand (ThOD)	0.5400

## Process Description Report

Total Organic Carbon (TOC)	0.2100
Organic Chlorine	0.0147
 Liquid Waste Products	
Dimethyl Ether	0.040000
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.005100
Hydroxypropyl Methylcellulose	0.040000
Methyl Chloride	0.021000
Methyl Alcohol	0.003000
Propylene Glycol Methyl Ether	0.073300
Propylene Glycol, Major Consumer	0.122500
Propylene Oxide, Major Consumer	0.024700
Sodium Chloride	1.165600
Water	20.022600

### Gas Waste Stream

Gas Flow: 32.0000 SCF/lb  
 Heat of Combustion: 2500 Btu/lb  
 lb/lb

### Gaseous Waste Products

Air	2.260000
Dimethyl Ether	0.100000
Methyl Chloride	0.122300
Propylene Oxide, Major Consumer	0.002400
Water	0.030000

### Solid Waste Stream

Landfill: 0.012778 cu ft/lb  
 lb/lb

### Solid Waste Products

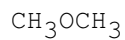
Organic Materials (cu ft/lb)	0.012800
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### Chemical Formulas

Cellulose, Wood Pulp  
 $[-C_6H_7O_2(OH)_3-]_N$

Dimethyl Ether

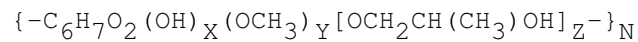
## Process Description Report



Hydrochloric Acid, 33%



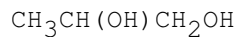
Hydroxypropyl Methylcellulose



Methyl Chloride



Propylene Glycol, Major Consumer



Propylene Oxide, Major Consumer



Sodium Chloride



Sodium Hydroxide, 50%, Major Consumer



Water



### References

USP 5360902

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### Process Section 1

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Reaction Time: 5.0000 hr

Reactor Desc.: 5 parallel autoclave reactors,  
each

jacketed and agitated

Inlet Stream	lb/lb	reaction yield	overall yield
Raw Material(s)			
Cellulose, Wood Pulp	0.8129	100.0%	98.15%
(Water)	0.04300		
Hydrochloric Acid, 33%	0.0415		
(Water)	0.08430		
Methyl Chloride	1.5963	47.0%	39.50%
Propylene Oxide, Major Consumer	0.3248	23.6%	22.00%
Sodium Hydroxide, 50%, Major Consumer	0.9096		
(Water)	0.96700		
Outlet Stream			
	lb/lb		
Intermediate (outflow) (s)			
Dimethyl Ether	0.1341		
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051		
Hydroxypropyl Methylcellulose	1.0400		
Methyl Chloride	0.5692		

## Process Description Report

Methyl Alcohol	0.1489
Propylene Glycol Methyl Ether	0.1256
Propylene Glycol, Major Consumer	0.1969
Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.3308
Water	1.2936

**Process Section 2**

Steam Stripping

Separation

Cellulose Ether Washing

Separation

Cellulose Ether Washing

Filtration, membrane in two stages

Separation

Recovery

Temperature: 149 F

Pressure: 66.0 psig

Reactor Desc.: Membrane filtration is carried out

at 66 and 78 psi

	lb/lb	reaction yield	overall yield
Inlet Stream			
Raw Material(s)			
Polyether Sulphone Membrane	0.0020		
Solvent(s)			
Steam	3.9400		
Water	14.8500		
Secondary Solvent(s)			
Water	124.0000		
Intermediate (inflow) (s)			
Dimethyl Ether	0.1341		
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051		
Hydroxypropyl Methylcellulose	1.0400		
Methyl Chloride	0.5692		
Methyl Alcohol	0.1489		
Propylene Glycol Methyl Ether	0.1256		
Propylene Glycol, Major Consumer	0.1969		



### Process Description Report

Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.3308
Water	1.2936
Outlet Stream	lb/lb
Recycled Raw Material(s)	
Methyl Chloride	0.4014
Recycled Secondary Solvent(s)	
Water	123.0000lb/Mlb
Recovered Byproduct(s)	
Methyl Alcohol	0.1459
Intermediate (outflow)(s)	
Dimethyl Ether	0.0030
Hydroxypropyl Methylcellulose	1.0000
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Sodium Chloride	0.0036
Water	0.8800
Waste Product(s)	
Dimethyl Ether	0.1311
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.0051
Hydroxypropyl Methylcellulose	0.0400
Methyl Chloride	0.1520
Methyl Alcohol	0.0030
Propylene Glycol Methyl Ether	0.1256
Propylene Glycol, Major Consumer	0.1969
Propylene Oxide, Major Consumer	0.0300
Sodium Chloride	1.3272
Water	20.2936

**Process Section 3**

Drying, Rotary

Product Finishing and Packaging

Drying, Rotary

Temperature: 194 F

Inlet Stream	lb/lb	reaction yield	overall yield
Solvent(s)			

### Process Description Report

Air	110.0000
Intermediate (inflow) (s)	
Dimethyl Ether	0.0030
Hydroxypropyl Methylcellulose	1.0000
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Sodium Chloride	0.0036
Water	0.8800
Outlet Stream	lb/lb
Final Product(s)	
Hydroxypropyl Methylcellulose	1.0000
(Sodium Chloride)	0.00360
(Water)	0.03100
Waste Product(s)	
Air	110.0000
Dimethyl Ether	0.0030
Methyl Chloride	0.0020
Propylene Oxide, Major Consumer	0.0030
Water	0.8490

**Solvents**

Steam  
Water  
Air

**Utilities**

	units/lb
Steam	11.0000 lb
Cooling Water	105.0000 G
Process Water	1.9000 G
Electricity	0.7000 kWh
Inert Gas	0.1000 SCF

**Liquid Waste Stream**

	lb/lb
Liquid Waste Flow:	2.6700 G/lb
Acid (H <sub>2</sub> SO <sub>4</sub> eq)	0.0260
Biological Oxygen Demand (BOD)	0.2870
Theoretical Oxygen Demand (ThOD)	0.6900

## Process Description Report

Total Organic Carbon (TOC)	0.2100
Organic Chlorine	0.0147
 Liquid Waste Products	
Dimethyl Ether	0.021000
Di, Tri & Higher Propylene Glycols and Propylene Glycol Methyl Ethers	0.005100
Hydroxypropyl Methylcellulose	0.040000
Methyl Chloride	0.021000
Methyl Alcohol	0.003000
Propylene Glycol Methyl Ether	0.125600
Propylene Glycol, Major Consumer	0.196900
Propylene Oxide, Major Consumer	0.024700
Sodium Chloride	1.330800
Water	20.022600

### Gas Waste Stream

Gas Flow: 31.0000 SCF/lb  
 Heat of Combustion: 2500 Btu/lb

lb/lb

### Gaseous Waste Products

Air	2.260000
Dimethyl Ether	0.113100
Methyl Chloride	0.131000
Propylene Oxide, Major Consumer	0.002400
Water	0.030000

### Solid Waste Stream

Landfill: 0.016463 cu ft/lb

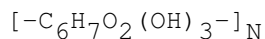
lb/lb

### Solid Waste Products

Organic Materials (cu ft/lb)	0.016500
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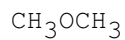
### Chemical Formulas

Cellulose, Wood Pulp



Dimethyl Ether

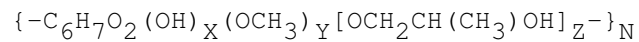
## Process Description Report



Hydrochloric Acid, 33%



Hydroxypropyl Methylcellulose



Methyl Chloride



Propylene Glycol, Major Consumer



Propylene Oxide, Major Consumer



Sodium Chloride



Sodium Hydroxide, 50%, Major Consumer



Water



### References

USP 5360902