Process Description Report

Process: Dow's (Wolf, Bolmitz, 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

Inlet Stream	lb/lb	reaction yield	overall yield
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_2SO_4 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

Gaseous Waste Products

	lb/lb
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

Solid Waste Products

	lb/lb
Organic Materials (cu ft/lb)	0.012800

Chemical Formulas

Cellulose, Wood Pulp

$[-C_6H_7O_2(OH)_3-]_N$

Dimethyl Ether

Process Description Report

CH_3OCH_3

Hydrochloric Acid, 33%

HCl

Hydroxypropyl Methylcellulose

$\{-C_6H_7O_2(OH)_X(OCH_3)_Y[OCH_2CH(CH_3)OH]_Z-\}_N$

Methyl Chloride

CH_3Cl

Propylene Glycol, Major Consumer

$CH_3CH(OH)CH_2OH$

Propylene Oxide, Major Consumer

C_6H_6O

Sodium Chloride

NaCl

Sodium Hydroxide, 50%, Major Consumer

NaOH

Water

H_2O

References

USP 5360902

Process Description Report

Process: Dow's (Wolf, Bolmitz, 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 Food (DS=1.9, MS=0.25, 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

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Etherification

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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

Inlet Stream	lb/lb	reaction yield	overall yield
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_2SO_4 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

Gaseous Waste Products

	lb/lb
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

Solid Waste Products

	lb/lb
Organic Materials (cu ft/lb)	0.016500

Chemical Formulas

Cellulose, Wood Pulp

$[-C_6H_7O_2(OH)_3-]_N$

Dimethyl Ether

Process Description Report

CH_3OCH_3

Hydrochloric Acid, 33%

HCl

Hydroxypropyl Methylcellulose

$\{-C_6H_7O_2(OH)_X(OCH_3)_Y[OCH_2CH(CH_3)OH]_Z-\}_N$

Methyl Chloride

CH_3Cl

Propylene Glycol, Major Consumer

$CH_3CH(OH)CH_2OH$

Propylene Oxide, Major Consumer

C_6H_6O

Sodium Chloride

NaCl

Sodium Hydroxide, 50%, Major Consumer

NaOH

Water

H_2O

References

USP 5360902