In-plant Training

Manufacturing:

- Propylene Oxide
- Propylene Glycol
- Propylene Glycol Mono Methyl Ether

NAME : C.Suraj Choudhary

INSTITUTION : SRM University Kattankalathur

COURSE : B.Tech Chemical Engineering

REG NO : RA2011007010046

ACKNOWLEDGMENT:

I take this opportunity to sincerely thank **Mr. M. Karthikeyan** WTD (Operations), Manali Petrochemicals Ltd for the encouragement he gave me during the course training. I express my sincere thanks to **Mr. T. Thangasagaran**, GM (HOG) Manali Petrochemicals Limited for giving me the support during the training.

I express my sincere thanks to **Mr.G.R.SRIDHAR (GM)** (Operations), Manali Petrochemicals Limited for giving me the support during the training.

I express my sincere thanks to **Mr. T.Muthukumarasamy**, DGM(TS & Mech) Manali Petrochemicals Limited for the encouragement he gave us during the course of training.

I express my sincere thanks to **Mr. A. R. Swamydurai**, AGM(Operations) Plant I who has taken care of us right from the beginning till the end of the training.

I am also grateful to **Ms. V. Husmitha**, Executive, Technical Service, for her unparalleled assistance, kind support and valuable suggestion during training.

We thank all the officials and colleagues of MPL and seniors in the control room who helped in several ways and for bestowing their kindness on us.

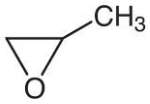
PROPYLENE OXIDE [PO]

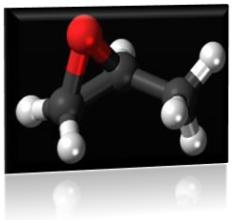
Appearance : Clear Liquid .

Colour : 10 Hazen with sweetish odour.

Chemical Formula : C3H6O

Structural Formula :





Acidity : 50 ppm (as acetic acid).

Non – Volatile Residue : 10mg/100ml.

Aldehyde Content: 50 ppm (as propanol)

200ppm (as water).

Molecular Weight : 58.1 g/mol.

Boiling Point : 34.2 celsius.

Melting Point : -112.1 celsius.

Critical Temperature : 209.1 celsius.

Critical Pressure : 50.2 kg/cm^2

RAW MATERIALS : Proplene

Chlorine

Milk of Lime .

PROCESS DESCRIPTION

Propylene Oxide (PO) is obtained by spanification of propylenic chlorhydrin with lime then recovered by distillation. This production way is particularly well suited to small and medium size unit.

This process is carried out by following stages :

1.Reaction section : Chlorine feed , Propylene feed, and water is injected in reactor under flow Control.

1.1 Chlorhydrin Production : Chlorine is dissolved in water and gives hypochlorous acid. Propylene react with hypochlorous acid , that gives chlorhydrin .

$$Cl2 + H2O \rightarrow ClH + ClOH$$

(Chlorine) (water) (hydrochloric acid) (hypochlorous acid)

$$ClOH + C3H6 \rightarrow ClC3H6OH$$

(hypochlorous acid) (Propylene) (Chlorhydrin)

Similtaneously side reaction takes place , especially DCP is formed , Direct contact between Propylene and chlorine in gaseous phase which gives product DCP.

$$C_3H_6 + Cl_2 \rightarrow C_3H_6Cl_2$$

(Propylene) (Chlorine) (DCP)

DCIPE also formed :

$$C_3H_6 + ClOH + ClC_3H_6OH \rightarrow (C_3H_6Cl)O + H_2O$$

(Propylene) (hypochlorous acid) (Chlorhydrin) (DCIPE) (Water)

Chlorhydrin solution from the reactor to the saponifier Buffer tank , then Chlorhydrin solution is pumped to saponification section under flow control .

2. Saponification of Chlorhydrin : Chlorhydrin solution is pumped fron the saponifier buffer tank pumps flow control . It is heated at 65-70 celsius in the plate exchanger and blended with milk of lime , which is injected under flow control.

Chlorhydrin and milk of lime are mixed in the ststic mixer and the mixture flows into sponifier which is very close to mixer Chlorhydrin is saponified and converted into PO which is quickly separated by stripping with very pressure steam.

$$2ClC_3H_6OH + Ca(OH)_2 \rightarrow 2C_3H_6O + CaCl_2 + 2H_2O$$

(Propylenic Chlorhydrin) (Lime) (Propylene Oxide gas) (Calcium chloride) (Water)

The waste lime solution flows from saponifier bottom to the waste water flash drum where steam is recovered by thermo compression.

3. Purification of Propylene Oxide: Propylene Oxide (PO) extracted by stripping from the sponifier contains water , DCP,DCIPE and impurities as aldehydes.

It is send to diatillation colume in which aldehyds are dimerized by injection of caustic soda as catalyst .

Propylene Oxide (PO) is recovered at top of the colume and condensed , it is send to stripping column in which the lights are separated .

4. Purification of DCP : DCP and other chlorinated organic derivatives are removed from aqueous effluent by decantation .

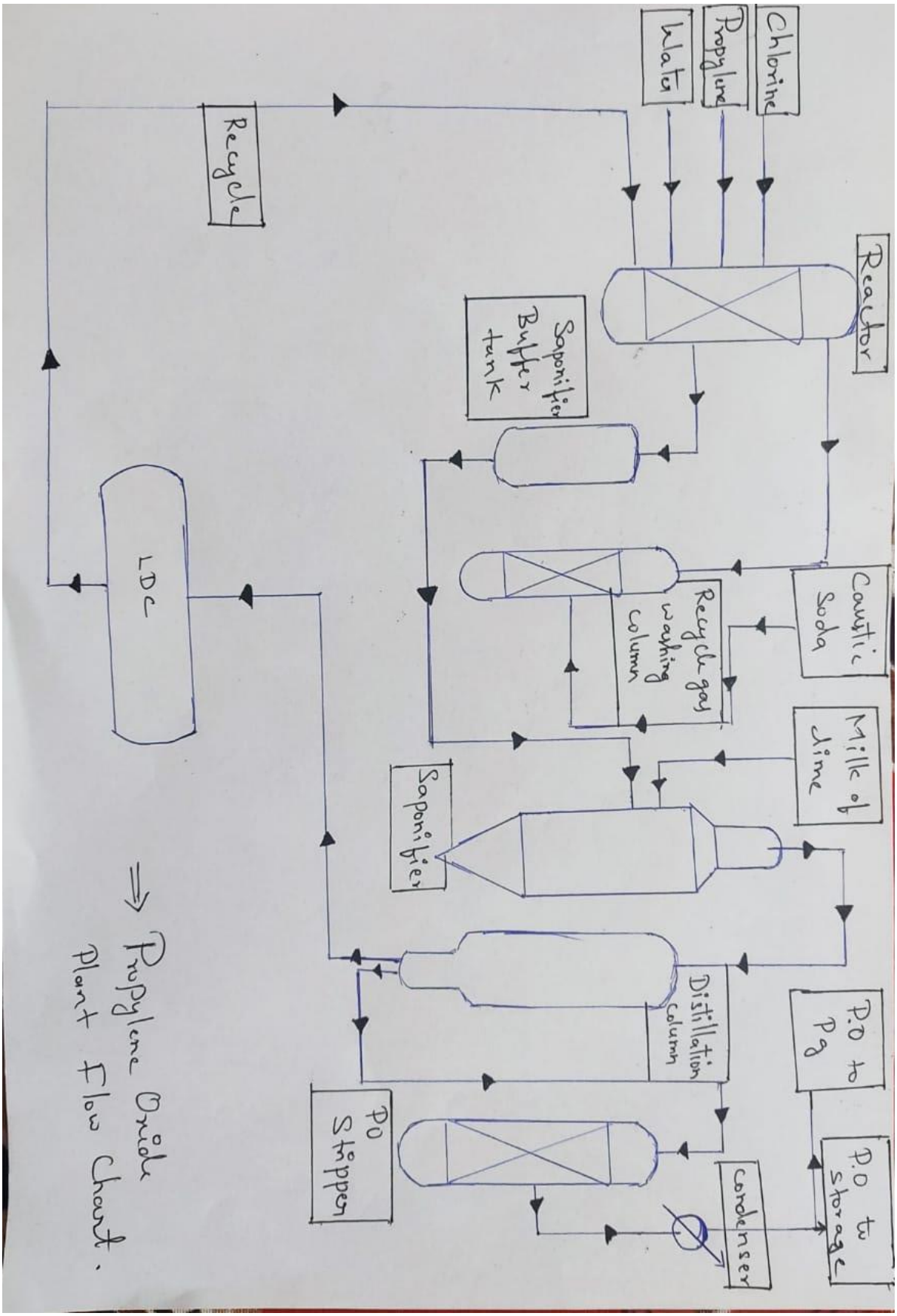
The organic phase is dried by azeotropic distillation and DCP is separated from DCIPE .

USES OF PROPYLENE OXIDE

- The major use of propylene oxide is in the production of polyethers (the primary component of polyurethane foams) and propylene glycol.

- Propylene oxide is also used in the fumigation of foodstuffs and plastics medical instruments and in the manufacture of dipropylene glycol and glycol ethers , as hericides , as solvents , and in the preparation of lubricants , surfactants, and oil demulsifiers.

FLOW CHART


Chlorine
Propylene
Water
Recycle
Reactor
Saponifier Buffer tank
LDC
Caustic Soda
Recycle gas washing column
Milk of lime
Saponifier
Distillation Column
P.O to Pg
P.O to storage
PO Shipper
Condenser
⇒ Propylene Oxide Plant Flow Chart.

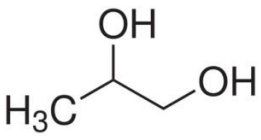
PROPLYENE GLYCOL (PG)

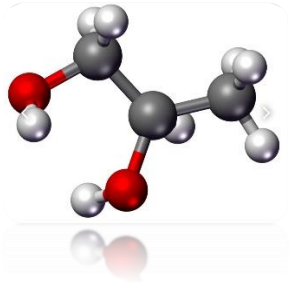
Appearance : Clear liquid.

Colour : 10 Hazen .

Chemical Formula : C3H8O2

Structural Formula :





Acidity : 20 ppm (as acetic acid)

1000 ppm (water)

Non-Volatile Residue : 10 ppm

Molecular Weight : 76.1 g/mol.

Boiling Point : 187.6 celsius.

Melting Point : -60.6 celsius.

Critical Temperature : 353 celsius.

Critical Pressure : 62.2 kg/cm^2.

RAW MATERIALS :

Propylene Oxide.

Water.

PROCESS DISCRIPTION

The process of production of propylene glycol by direct hydrolysis of propylene oxide in a reactor which produce crude propylene glycol that could further purified by means of distillation .

The reaction of propylene oxide with water is exothermic and realized in liquid phase .

$$CH_3\text{-}(CH\text{-}CH_2)O + H_2O \rightarrow CH_3\text{-}CHOH\text{-}CH_2OH$$

(Propylene Oxide) (Water) (Mono-Propylene glycol)

$$CH_3\text{-}(CH\text{-}CH_2)O + CH_3\text{-}CHOH\text{-}CH_2OH \rightarrow 2(CH_3\text{-}CHOH\text{-}CH_2OH)$$

(Propylene Oxide) (Monopropylene glycol) (Di-Propylene glycol)

$$CH_3\text{-}(CH\text{-}CH_2)O + 2(CH_3\text{-}CHOH\text{-}CH_2OH) \rightarrow \text{Tri-Propylene glycol} + \text{Residue}$$

(Propylene Oxide) (Di-Propylene glycol)

MPG,DPG,TPG Concentration is directly proportional to the water feed into reactor.

The aqueous mixture of Propylene glycol is concentrated by means of a triple effect evaporation .

The MPG and DPG is recovered through distillation .

The process is carried out by following stages :

1.Reaction section : The Propylene Oxide can be supplied from cooled storage and feeds the PO buffer drum. The Propylene oxide in mixed in the static mixer with the reaction water which comes under flowrate control from the process water recovery drum.

Afterwards , the aqueous mixture of 17% weight of propylene oxide is sent under reaction pressure into the reactor feed preheating train. The PO is quite converted into a mixture of Propylene glycol.

2. Glycols concentration : The reactor outlet effluents are flashed into the bottom section of the first evaporated column .This first evaporator is re-boiled by MP steam in the exchanger, and the column bottoms are flashed and sent under level control to the second effect evaporated.

The overheated vapors condensation permits to achieve the inter-reboiling of the third effect evaporated rectification section in the exchanger . the column bottoms are flashed and sent under level control to the third effect evaporator. The third effect evaporator is reboiled by MP steam in reboiler.

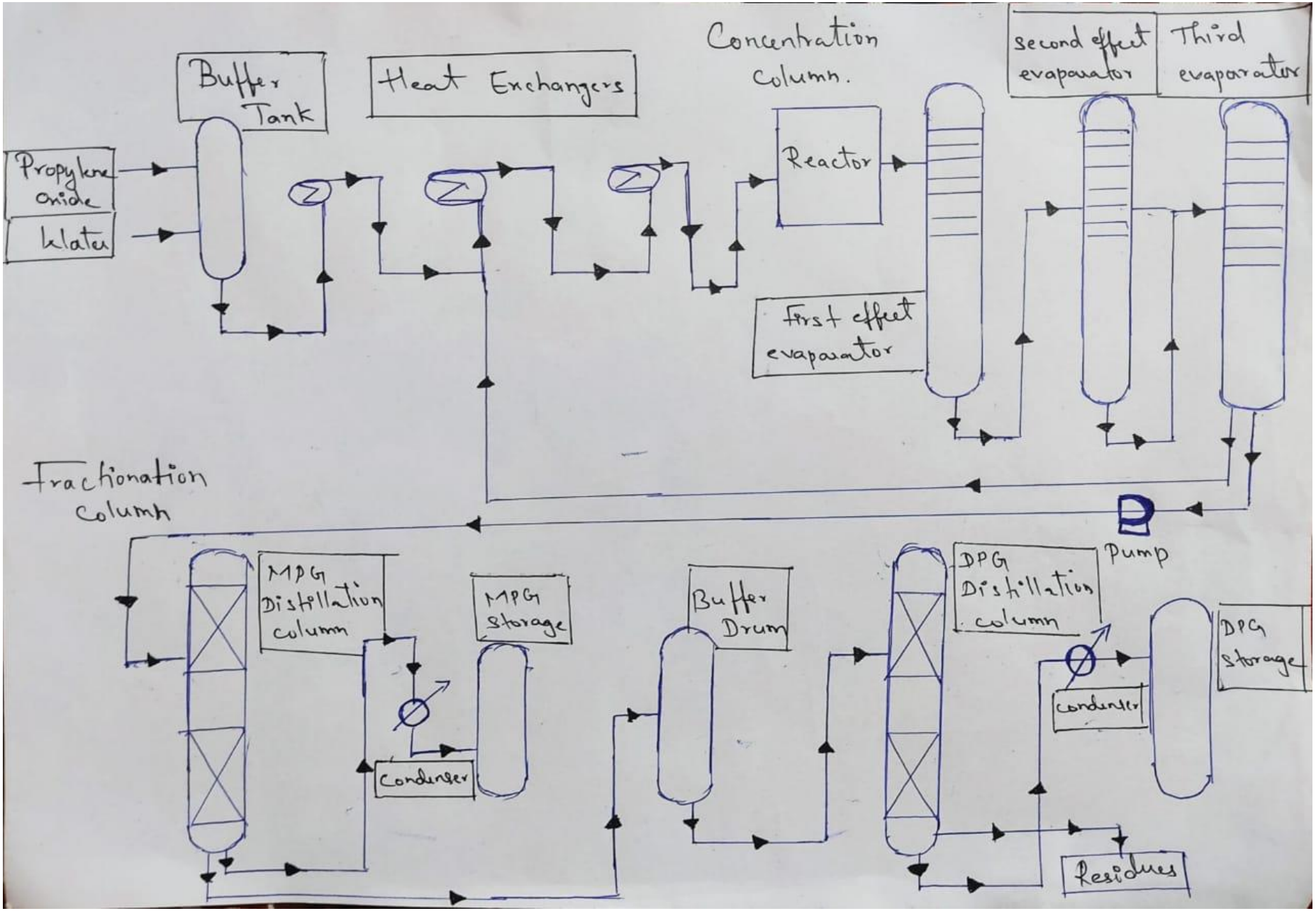
The glycol mixture is recovered from the bottom and sent by pump to the glycols fractionation section by flow rate control to ensure a steady feed of the MPG Distillation.

3. Glycols Fractionation : The MPG distillation column, is fed by the glycols mixture , free of water. The Mono propylene glycol is separated from the other glycols and recovered , after condensation by cooling water into the reflux drum.

The MPG distillation reboiling is achieved in the exchanger and the column bottoms are pumped by the reciprocating pumps under level control by action on the pumping stroke to the DPG column buffer tank. The buffer tank is maintained under pressure to feed the DPG fractionation obtained in second column which achieves the separation between Di propylene and heavier glycols.

The Di propylene glycol is recovered in the reflux drum after condensation.

4. MPG and DPG intermediate storages: MPG and DPG products are pumped respectively to intermediate storages , two storage drum are provider . The off spec product are recycled to the concentration section , and the on-spec products are sent , each 8 hours, to storage in battery limits by pumps.


Buffer Tank
Heat Exchangers
Concentration Column.
Second effect evaporator
Third evaporator
Propylene oxide
Water
Reactor
First effect evaporator
Fractionation Column
Pump
MPG Distillation column
MPG storage
Condenser
Buffer Drum
DPG Distillation column
Condenser
DPG storage
Residues

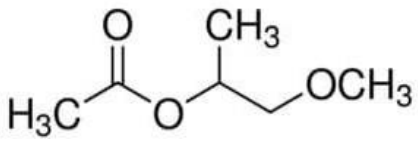
PROPYLENE GLYCOL MONO METHYL ETHER (PGMME)

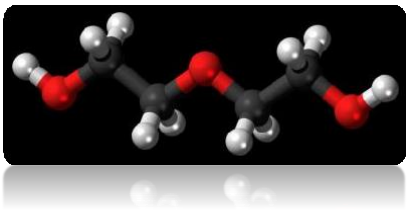
Appearance : Clear liquid , Hygroscopic , Volatile liquid.

Chemical name : 1 Methoxy 2 Propanol .

Molecular Formula : C4H10O2

Structural Formuls :





Odour : Mild alcoholic.

Density at 20 deg C : 0.920-0.923 g/cc.

Solubility in water : Freely mixable with water at room temperature .

Molecular weight : 90.122 g/mol

Melting Point : -97deg C

Boiling Point : 120 deg C.

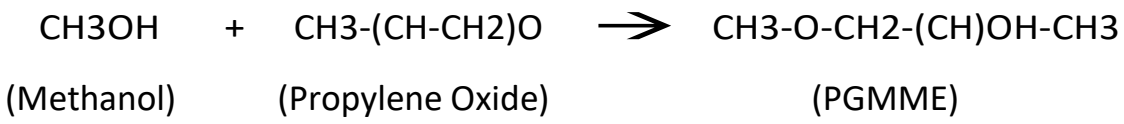
RAW MATERIAL : Methanol

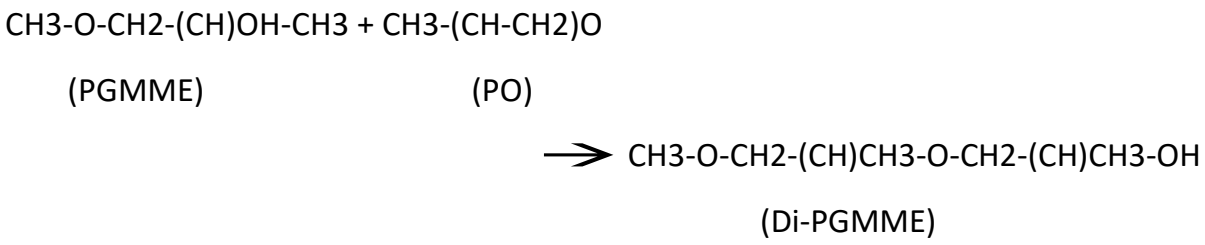
Propylene Oxide

Catalyst .

PROCESS DESCRIPTION

Reaction of Methanol and Propylene Oxide yields Propylene Glycol Mono Methyl Ether (PGMME).





1. **Buffer drum for Propylene Oxide and Methanol :** Raw materials Propylene oxide and Methanol are periodically transferred from the bulk storage to the buffer drum the required quantity the raw material is fed into the reactor for initiating reaction.

2. Reaction Section : The reaction section comprises of the catalyst addition , premixing , pre-heater and the reactor . The catalyst is injected to , the system as and when required to maintain the concentration around 2% in the reactor feed.

In order to ensure even mixing of the Propylene Oxide , Methanol , and the catalyst a static mixer is provided before entering the feed pre-heater.

The reaction is mildly exothermic and the raise the temperature will not be distinctly indicative.

$$CH3OH + CH3\text{-}(CH\text{-}CH2)O \rightarrow CH3\text{-}O\text{-}CH2\text{-}(CH)OH\text{-}CH3$$

(Methanol) (Propylene Oxide) (PGMME)

$$CH3\text{-}O\text{-}CH2\text{-}(CH)OH\text{-}CH3 + CH3\text{-}(CH\text{-}CH2)O \rightarrow CH3\text{-}O\text{-}CH2\text{-}(CH)CH3\text{-}O\text{-}CH2\text{-}(CH)CH3\text{-}OH$$

(PGMME) (PO) (Di-PGMME)

The outlet of the reactor is lead to the methanol distillation column.

3. Methanol Distillation Section : Methanol is used in excess in the process of manufacture of PGMME to minimize the production of byproducts. The excess methanol and catalyst are distilled in this column and recycled back to the reactor. Methanol is condensed in two stages using methanol distillation condenser with cooling water and methanol vent condenser using glycol water. The uncondensed vapour released from the methanol distillation reflux drum . Crude PGMME is withdrawn from the bottom of distillation column and is forwarded to PGMME distillation column.

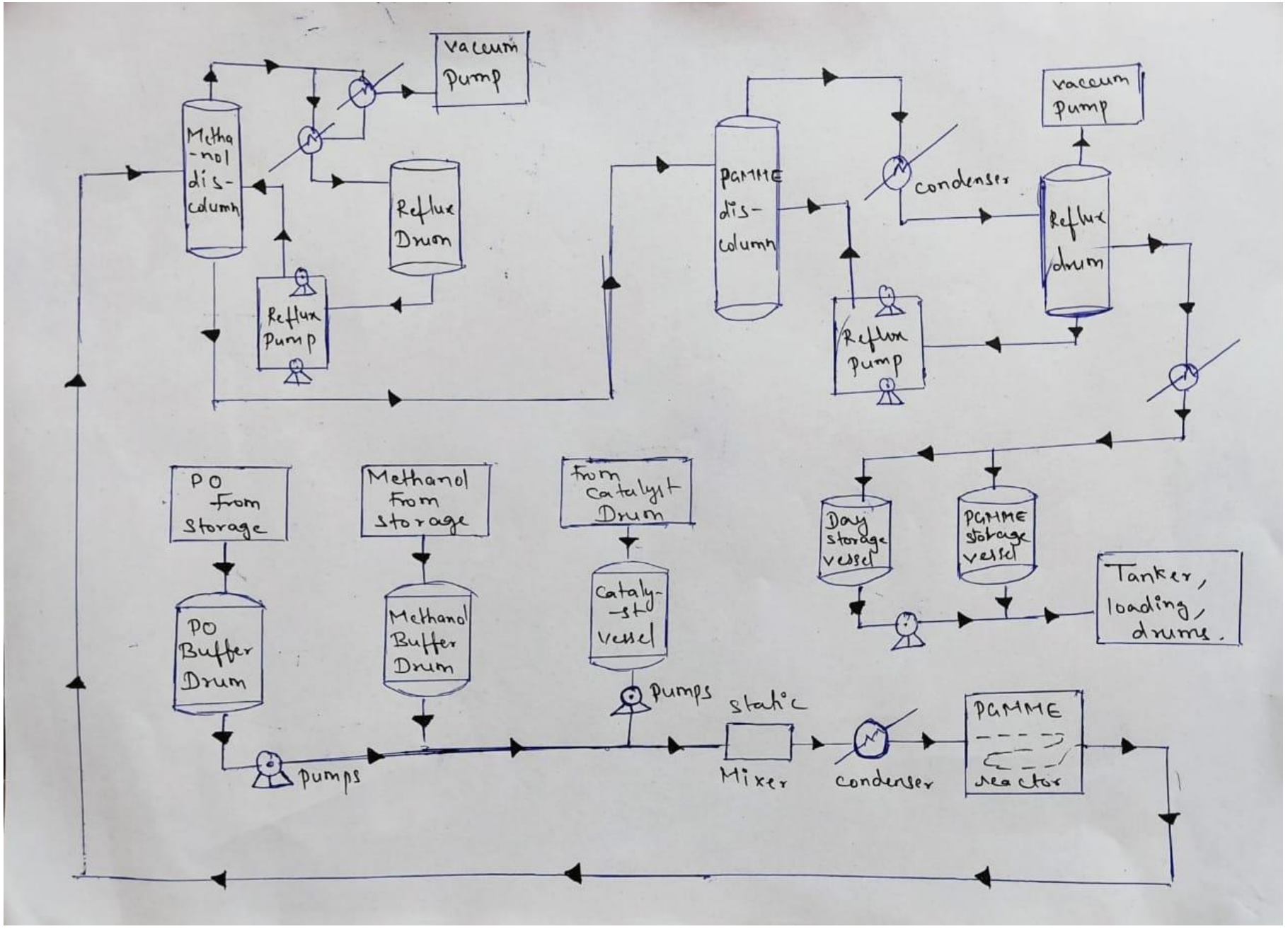
4. PGMME Distillation Section : Crude PGMME with byproduct like DPGMME and higher residue glycol ethers formed in the reactor is removed in this

section . The PGMME vapour are condensed in using cooling water and collected in the reflux drum . The DPGMME and higher glycol ethers are removed from the system as residue from the bottom of the column. The product is cooled in the exchanger and taken to product storage vessels.

5. Methanol Unloading Section : Bulk methanol is stored which has been planned as an underground storage vessel and comes under " Chief Controller of Explosives". Methanol received in bulk throught road tankers are unloaded by gravity into these vessels , from,where it is periodically pumped to the day storage tank through transfer pump. Methanol is a highly hazardous chemical .

USES OF PGMME

- The product is used as solvent in Paint and Ink industries and as a substitude for ethylene glycol based solvent due to eco-friendly nature.
- Washing and cleaning agents in polyester resin industry.
- Stabilization for trichloro ether and chloroform.
- Foaming agent in copper ore floatation.


Vacuum Pump
Metha -nol dis- column
Reflux Drum
Reflux Pump
PGMME dis- column
condenser
Vacuum Pump
Reflux drum
Reflux pump
PO From Storage
Methanol From storage
From Catalyst Drum
Day storage vessel
PGMME storage vessel
Tanker, loading, drums.
PO Buffer Drum
Methanol Buffer Drum
Catalyst vessel
Pumps
Static
PGMME
Pumps
Mixer
condenser
Reactor