

CONFIGURATION OF VARIOUS PROCEDURES INVOLVED IN PRODUCTION OF PROPYLENE GLYCOL

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Technology degree in Chemical Engineering

By

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**DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

SEPTEMBER – 2020 to MARCH – 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ABIMANYU R (37190002)** and **DEEPAN RAAJ P (37190018)** who carried out the project entitled **“CONFIGURATION OF VARIOUS PROCEDURES INVOLVED IN PRODUCTION OF PROPYLENE GLYCOL”** under our supervision from September 2020 to March 2021.

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DECLARATION

I ABIMANYU R (Reg.No.37190002) hereby declare that the Project Report entitled "CONFIGURATION OF VARIOUS PROCEDURES INVOLVED IN PRODUCTION OF PROPYLENE GLYCOL" done by me under the guidance of Dr. J. ARAVIND KUMAR M.E., Ph.D., at Sathyabama Institute of Science and Technology, Jeppiaar nagar, Rajiv Gandhi Salai, Chennai-600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Chemical Engineering.

DATE : 22-03-2021

PLACE : CHENNAI



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DECLARATION

I DEEPAN RAAJ P (Reg.No.37190018) hereby declare that the Project Report entitled "CONFIGURATION OF VARIOUS PROCEDURES INVOLVED IN PRODUCTION OF PROPYLENE GLYCOL" done by me under the guidance of Dr. J. ARAVIND KUMAR M.E., Ph.D., at Sathyabama Institute of Science and Technology, Jeppiaar nagar, Rajiv Gandhi Salai, Chennai-600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Chemical Engineering.

DATE : 22-03-2021

PLACE : CHENNAI

A handwritten signature in blue ink, appearing to read 'P. Raj P.', is positioned above the signature label.

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Propylene glycol is a synthetic fluid substance that keeps water. Propylene glycol is likewise used to make polyester compounds, and as a base for deicing arrangements. Propylene glycol is used by the artificial, meals, and drug ventures a cycle of getting prepared propylene glycol of 10 TDP by way of hydration of propylene oxide to provide mono-propylene glycol and di-propylene and tri-propylene glycols as with the aid of gadgets. The hydrolysis is finished at temperatures of 50°C to 275°C, but preferably from 140°C to 205°C. The hydrolysis product thus obtained is distilled to recover the desired pure propylene glycol. The methods, material balance, energy balance, equipment design such as plug flow reactor and distillation column, instrumentation control is discussed for the production of propylene glycol. The cost estimation, plant layout and site location, process safety are also discussed.

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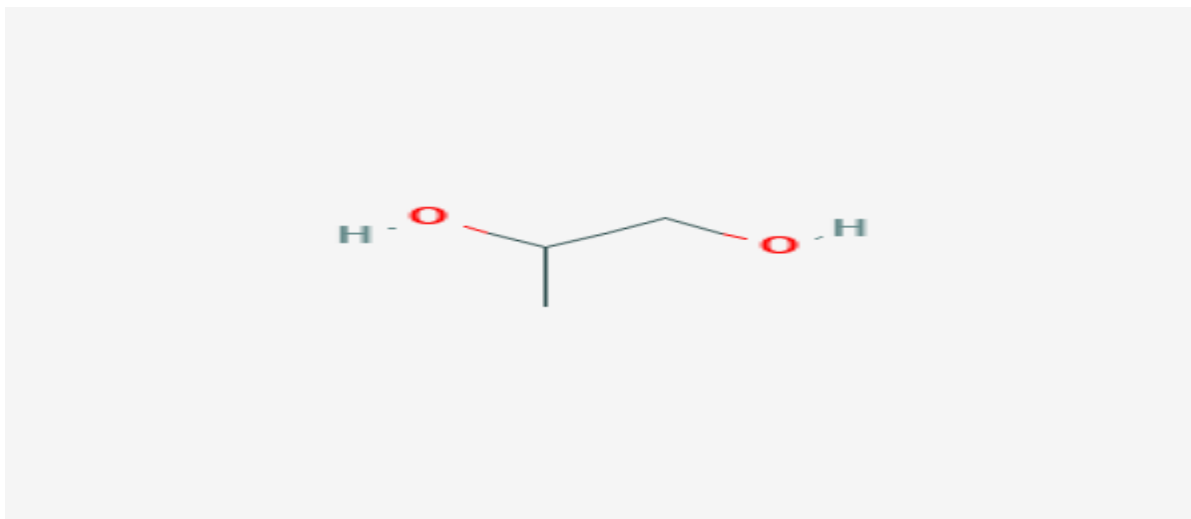
CHAPTER – 1

INTRODUCTION

Propylene glycol (PG) is a produced regular with synthetic equation $C_3H_8O_2$. It's far a thick, dull liquid which nearly unscented but has a weak sweet flavor. Artificially it classed as diol and with a sweeping volume of solvent, which includes water. Its miles made for a huge diploma and are on a very fundamental stage used in the formation of polymers, yet furthermore look use in food handling, and as a cycle fluid in low temperature heat-change applications. Within the ecu union, it has the e-wide variety e1520 for meals packages. for cosmetics and pharmacology, the range is e490. PG is similarly present in PG alginate which called e405. Compound is to a super extent called α -PG to don't forget the isomer propane 1-three diol, referred to as β -PG. PG has the sketchy honor by being named the yankee contact dermatitis society's allergen of the 12 months for 2018. PG is a produced Liquid substance that absorbs water. PG is moreover used for making polyester compounds, and as base for deicing courses of motion. PG is utilized by the synthetic, food, and remedy groups as a fluid impetus while spillage might incite touch with meals.

Food and drug administration (FDA) has masterminded PG as an additional substance this is "normally visible as ensured" to be used in food. it's far used to ingest extra water and preserve up sogginess in express remedies, enhancing professionals, or food matters. it is a dissolvable for meals tones and improves, and inside the paint and plastics ventures. PG, $C_3H_8O_2$ moreover referred to as as 1,2 propanediol or propane 1,2 diol, the compound is referred to as α -PG to don't forget it on the isomer propane 1,3 diol similarly known as β -PG. The PG gathering of sythetic compounds incorporates mono-pg (pg), di-pg (dpg) and tri-pg (tpg). dpg and tpg have multiple plans and stereo-chemical isomers. Propylene glycol changed into first installation in 1859. wurtz finished the hydrolysis of PG diacetate to get PG. In 1931, with the aid of carbide & carbon syntheic substances affiliation a comparable approach became promoted. in chlorohydrin degree, first propylene oxide become made and in addition it changed into ultimately hydrolyzed to PG. All the enterprise cooperation required excessive temperature; high squeezing element & non-catalytic hydrolysis of PG. Wealth water is

used for distinction in propylene oxide (PO) to PG.



2D Structure of PG

Fig. 1.1 Structure of PG

45% of PG produced is used as chemical feedstock for the formation of unsaturated polyester resin.

1.1 PROPERTIES OF PROPYLENE GLYCOL

PG is a practical, troubling and hygroscopic liquid. PG incorporates an off-beam carbon particle, so it exists in two enantiomers. The enterprise factor is a racemic mix. Unadulterated optical isomers may be gotten by way of hydration of optically unadulterated PO.

Edge of freeze over water is debilitate whilst jumbled in with PG, inferable with the outcomes of breaking down of a solute in a dissolvable (freezing gloom point). at the factor whilst everything is stated in carried out, glycols are non-ruinous, have low unusualness and outstandingly low noxiousness; regardless, the solidly associated ethylene glycol (a fundamental solving in fluid impetus) is hurtful to people and to numerous animals.

1.1.1 Physical properties

As shown by way of the fabric safety information sheet (msds) for PG, it is a horrid liquid with an insignificantly candy flavor and could be very greater gooey than water, suggesting that it streams bit by bit, like syrup. its conditioning factor is -73°F , and its cutoff is 360.8°F . it has a particular gravity of 1.035, inferring that it is genuinely to some diploma denser than water. its smoke pressure at traditional room temperature is immaterial, so PG does not disappear to any outstanding degree

1.1.2 Molecular properties

PG is a minute molecule containing 3 carbon molecules, 2 oxygen and 8 hydrogen molecules. Its sub-nuclear weight is 75.09 g/mol, in step with the CRC Handbook of physics and chemistry. the compound is little size & critical likeness to consuming alcohol makes it dissolvable in H_2O ; in all honesty, PG is hygroscopic, inferring that it pulls H_2O out of air and spoil down the water. Correctly, an example of PG left open to air will comfy volume after a while because it procures H_2O .

1.1.3 Chemical properties

The PG particle is quite steady and doesn't collapse as time is going on. it does not react with air, besides it's miles to a few diplomas ignitable at high temperature, in line with the msds. Because PG is each flammable and water dissolvable, H_2O is an off-base fire-manipulate approach; dry non-burnable powder is recommended for firefighting. A simple and vital substance assets of propylene glycol is that once it mixes in with H_2O , it disturbs the advancement of ice, which activates its radiator liquid utility. even as H_2O alone freezes at 32°F , 36% recreation plans of PG are liquid to 0°F , and greater amassed guides of motion freeze at lower temperatures nevertheless.

1.1.4 Biological properties

As demonstrated via the msds, PG is all fairness toxic to the pores and skin and eyes and is unfavorable in massive measurements at whatever point ingested. Of a few problem is that the compound is held thru the pores and skin, inferring that gigantic floor openings obtain indicators like those conveyed through ingestion. In particular, PG makes hurt the imperative tactile framework, which consolidates the psyche and spinal rope. there's in addition animal verification that has mutagenic residences, which implies it could provoke sickness, and that it's miles a teratogen, which means it reasons delivery deserts. even as significant section inner breath is wonderful due to the low unconventionality of PG, at whatever point warmed and took in it is able to cause respiratory pestering and central tactile Framework aggravation.

Table 1.1 Properties of PG

Chemical formula	C ₃ H ₈ O ₂
Molar mass	76.095g mol ⁻¹
Density	1.036g/cm ³
Melting point	-59°C
Boiling point	188.2 °C
Solubility in water	Miscible
Solubility in acetone	Miscible
Solubility in chloroform	Miscible
log p	-1.34
Thermal conductivity	0.34 W/m-K
Viscosity	0.042 Pa·s

1.2 APPLICATIONS

45% of pg conveyed is used as substance feedstock for the manufacturing of unsaturated polyester pitches. in such manner, PG reacts with a mix of unsaturated maleic anhydride and iso phthalic to present a copolymer. This generally unsaturated polymer goes via in addition cross linking to yield thermoset plastics. Associated with this software, PG reacts with PO to offer oligomers and polymers which might be used to deliver polyurethanes. Propylene glycol is utilized in water-primarily based acrylic underlying paints to increase dry time which it accomplishes by way of conserving the surface again from drying due to its all the greater slow dispersal charge seemed differently with regards to water. Propylene glycol is used as a humectant (e1520), dissolvable, and delivered substance in meals and for tobacco things. it is also one of the critical trimmings (<1–92%), close by vegetable glycerin (VG), of the e-liquid and cartridges used in digital cigarettes wherein it's miles aerolyzed in the atomizer. It's also utilized in version railroad and model boat packages to reenact steam or smoke, using a touch warming segment.

After a while, there has been a declared development in the usage of pg in up near and private notion things in the U.S.A in a 1994 prosperity exam, the beauty factor evaluate mentioned utilization of pg in 5676 matters recorded in the voluntary beauty registry; in the cosmetic element evaluate 2012 replace, this voluntary beauty registry Exposed 9094 matters containing pg.

PG is moreover utilized in various palatable things, as an instance, coffee-based liquids, liquid sugars, frozen yogurt, whipped dairy matters and dad. Vaporizers used for transport of medications or man or woman concept things habitually are a part of PG among the trimmings. In alcohol based totally hand sanitizers, its miles used as a humectant to maintain the pores and skin back from drying. propylene glycol is used as a dissolvable in numerous medicines, along with Oral, injectable and pores and skin subtleties, as an example, for diazepam and lorazepam which might be insoluble in water. positive subtleties of phony tears, as systane, use pg as a solving.

Like eg, PG can cut down the edge of freezing over of H₂O, subsequently it is used as

plane de-icing fluid. H₂O-pg mixes hued purple to reveal the combination is decently reliable are sold beneath the call of RV or marine fluid impetus. PG is mechanically used as Alternative for ethylene glycol in low noxiousness, innocuous to the environment auto fluid impetus. It is also used to winterize the strains structures in void plans. The eutectic affiliation/temperature is 60:40 pg: H₂O/ - 60 °c. The -50 °f/-40 °c business element is, regardless, water wealthy; a regular arrangement is 40:50.

PG is used in veterinary prescription as an oral treatment for hyperketonemia in ruminants. Glucose, which may be utilized in non-ruminants for this Expectation, is not effective due to its usage by way of the inhabitant microorganisms of the rumen. Propylene glycol is to some diploma prepared in the rumen to propionate which can be used as a gasoline supply. The rest of ingested into the course framework and utilized by the liver for gluconeogenesis.

1.3 USES

As a cream in prescriptions beautifiers, floss, mouthwash, and cigar items. In sanitizer, anti-bacterial moisturizer, & saline arrangements. As principle fixing in antiperspirant stick. As a blend specialist in Angostura & orange sharp flavoring. As dissolvable for food tone and flavoring. As a dissolvable for blending photographic synthetic compounds, for example, film designers. As a less-poisonous radiator fluid (contrasted and ethylene glycol)

CHAPTER - 2

MANUFACTURING PROCESS AND SELECTION

2.1 METHODS OF PRODUCTION

Various methods have been examined for the assembling of propylene glycol. Of these the accompanying has been utilized or genuinely considered for business creation

- 1) Hydrolysis of propylene oxide
- 2) Hydrogenolysis of glycerol
- 3) Hydrolysis of propylene carbonate with the assistance of an impetus
- 4) Reacting propylene with hydrogen peroxide to shape propylene oxide and thus structure propylene glycols
- 5) Hydrogenolysis of glycerol over Ru/C impetus

The principal strategy is the solitary financially used courses to glycol creation. Strategy 3 is completed under gentle conditions, there follows a disservice that unaltered alkylene carbonate joins with the response item to frame an azeotrope which delivers the separation of the created alkylene glycol troublesome. Strategy 2 includes the corrosive streams and the actual reactor. Administrators should be instructed on corrosive consume safety measure and treatment methodology because of the acidic prerequisites of the stream. The response runs at a high pressing factor and given the exothermic idea of the response. Technique 4 and 5 are infrequently utilized because of its significant expense of creation.

2.2 PROCESS DESCRIPTION

2.2.1 Hydrolysis of propylene oxide

The most essential technique is hydration of PG to give mono-PG, di-PG and tri-PG as by items

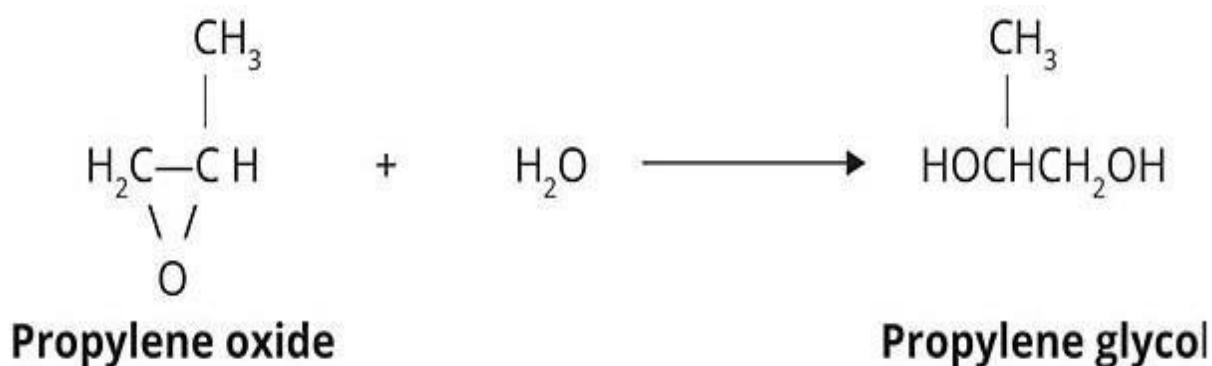


Fig 2.1 Reaction between propylene oxide to form propylene glycol

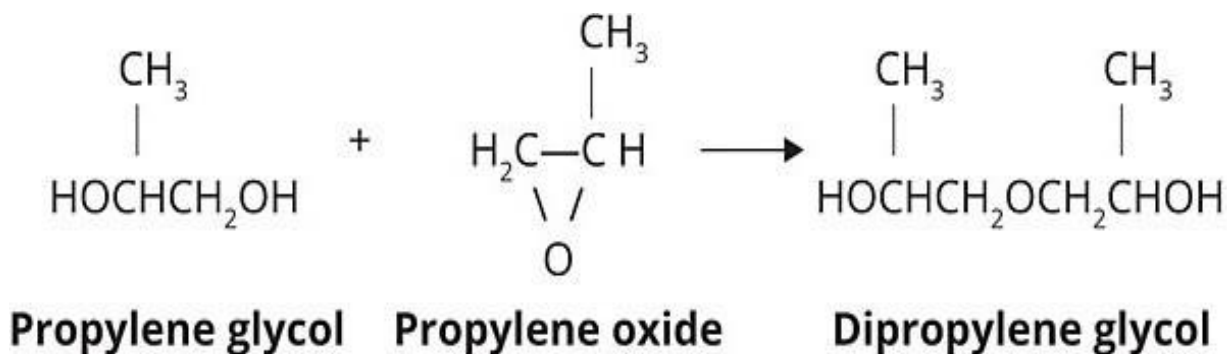


Fig 2.2 Reaction between propylene glycol to form di-propylene glycol

In this strategy the propylene oxide is hydrolyzed to pg alongside di-PG and tri-PG. For the high part, a hydrolysis is completed at temperatures of 50° C to 275° C however, ideally from 140° C to 205°C. The hydrolysis item consequently got is refined to

recuperate the ideal unadulterated propylene glycol. The refining segment utilized for eliminating the mono-propylene glycol may reasonably be worked at reboiler temperatures of 125° C to 240° C. also, 0.2 to 15 p.s.i.a., and ideally 180° C to 210° C. what's more, 1.7 to 5.8 p.s.i.a.; that for the di-glycol reasonably at reboiler temperatures of 140° C. to 270° C and head pressing factor of 0.2 to 15 p.s.i.a. what's more, ideally 145°C to 200° C. what's more, 0.75 to 2.0 p.s.i.a.

2.2.2 Hydrolysis of propylene carbonate with catalyst

Another strategy for creating alkylene glycols. For instance, to a technique which contains causing a comparing alkylene carbonate to respond with water of a sum marginally in overabundance of the stoichiometric sum under the state of 120°C - 200° C of temperature within the sight of a carbonate of an antacid metal, for example, potassium carbonate. In the response utilizing such an impetus as referenced above, notwithstanding, the response speed is low to the point that the response temperature should be raised to speed up the response by reason of economy of activity. The height of the response temperature has a chance of the warmth unfavorably influencing the nature of the alkylene glycol which is acquired by refining the response arrangement.

2.2.3 Hydrogenolysis of glycerol

Hydrogenolysis of biomass-surmised glycerol is a non-compulsory direction to possible production of PRG. Cu–ZnO stimuli have been set up by means of co-precipitation with an extent of copper or zinc atomic quantity (0.6–3.0) and examined in glycerol hydrogenolysis to pg at 453–523 K & 4.3 mpa H₂

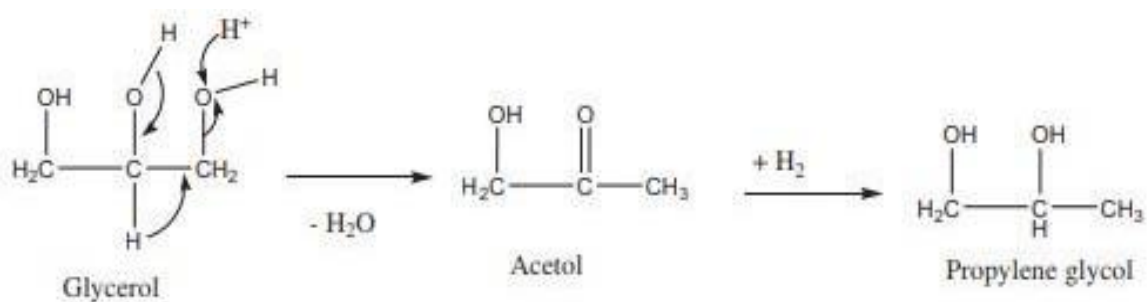


Fig 2.3 Reaction of glycerol to propylene glycol

Financial investigation has demonstrated that the undertaking as it is profoundly productive in spite of the fact that there are some current natural and security concerns. The current arrangement includes consuming a gushing stream in which the key segments are hydrogen, ethylene glycol and some unsaturated fats. For this situation an investigation should be done in to decide the degree of the harm to the nearby air and if sanitization is essential.

CHAPTER - 3

PROCESS METHODOLOGY

3.1 PROCESS FLOW DIAGRAM

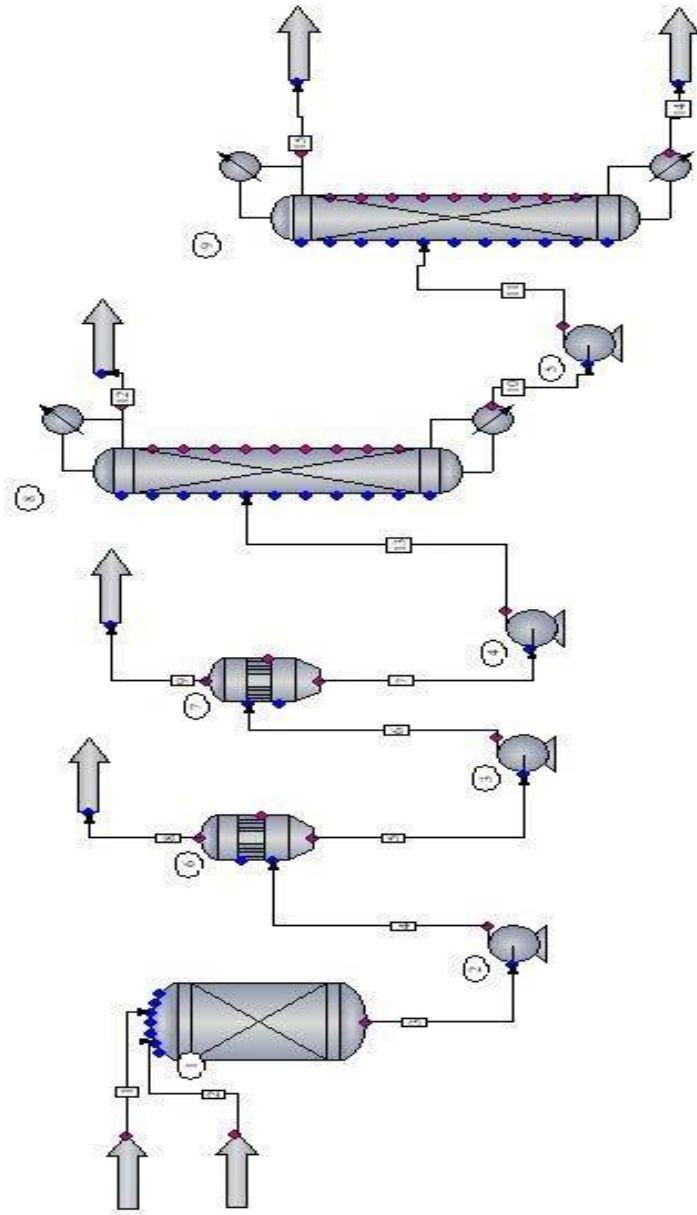


Fig 3.1 Flow sheet of propylene glycol

Input 1- propylene oxide

Input 2- water

Equipment 1- reactor

Equipment 2, 4, 6, 8- pump

Equipment 3, 5- multiple effect evaporator

Equipment 7, 9- distillation columns

Output 1- propylene glycol (PG)

Output 2- di-PG

Output 3- tri-PG

In this interaction, Propylene oxide is hydrolysed to form propylene glycol alongside a couple of other side-effects, for example, di-PG and tri-PG.

Initially, reactants for example propylene oxide and water which are in the proportion of 1:5 are shipped off an attachment stream reactor where response between them happens to shape the items in particular PG, di-PG and tri-PG. The reactor is set at 120°C for ideal conditions. The pressing factor is air pressure.

Next the substances are shipped off a various impact evaporator where the overabundance water is taken out and concentrate the arrangement. The temperature is set at pretty much the limit of water; practically 99% of the water is eliminated from the item

At last, to isolate the substance from the item, the substances are shipped off a pressed bed refining section where propylene glycol is isolated from the other two parts. The reboiler temperature is set to 190°C and air pressure which yields practically 99% of propylene glycol in the distillate. The reflux proportion is 2.5. The bottoms are shipped

off another refining section where di-propylene glycol is isolated from tri-propylene glycol. The reboiler temperature is set at 240°C and environmental pressing factor which yields 99% of di-propylene glycol in the distillate

3.2 MATERIAL BALANCE

BASIS

10 tons per day of propylene glycol

ASSUMPTIONS

- 1) 100% conversion of the limiting reactant to product is taking place
- 2) Propylene oxide is limiting reactant, so we have to send water in excess (1:5 ratio)
- 3) The conversion rates are
- 4) 80% propylene glycol
- 5) 12% di-propylene glycol
- 6) 8% tri-propylene glycol

3.2.1 Material balance of reactor

Assuming 100% conversion takes place

10 tons of MPG formed per day = 80% of MPG formed

'x' tons of MPG formed per day = 100% of MPG formed

On simplifying, 12.5 tons of MPG is formed per day or 416.66 kg/hr

Thus, amount of DPG and TPG formed are

$$\text{DPG} = (12.5 \times 12) / 100$$

$$= 1.5 \text{ tons per day or } 62.5 \text{ kg/hr of DPG}$$

$$\text{TPG} = (12.5 \times 8) / 100$$

$$= 1 \text{ ton per day or } 41.66 \text{ kg/hr of TPG}$$

Amount of PO and H₂O required are

$$58 \text{ g/mol of PO reacted} = 192 \text{ g/mol of TPG formed}$$

$$'x' \text{ kg/hr of PO reacted} = 41.66 \text{ kg/hr of TPG formed}$$

Thus, 12.58 kg/hr of PO is reacted to form TPG

$$58 \text{ g/mol of PO reacted} = 134 \text{ g/mol of DPG formed}$$

$$'x' \text{ kg/hr of PO reacted} = 91.575 \text{ kg/hr of DPG formed}$$

Thus, 39.63 kg/hr of PO is reacted to form DPG

$$58 \text{ g/mol of PO reacted} = 96 \text{ g/mol of MPG formed}$$

$$'x' \text{ kg/hr of PO reacted} = 468.59 \text{ kg/hr of MPG formed}$$

Thus, 357.608 kg/hr of PO is reacted to form MPG

Thus, total PO reacted = 409.818 kg/hr and water is 2049.09 kg/hr

Table 3.1 Material balance of reactor

COMPONENT	INPUT		OUTPUT	
	kg/hr	kmol/h	kg/hr	kmol/h
PROPYLENE OXIDE	409.847	7.066	-	-
WATER	2049.237	113.846	1938.251	107.68
MONO- PROPYLENE GLYCOL	-	-	416.66	5.482
DI-PROPYLENE GLYCOL	-	-	62.5	0.466
TRI- PROPYLENE GLYCOL	-	-	41.66	0.217
TOTAL	2459.084		2459.084	

3.2.2 Material balance of evaporator

99% of water is getting removed from the output of the reactor

Amount of feed entering the evaporator $F=2459.084$ kg/h

Mole fraction of MPG in feed $X_F=0.1695$

Mole fraction of MPG in top $X_V=0$

Mole fraction of MPG in bottom $X_B=0.7711$

Table 3.2 Material balance of evaporator

COMPONENT	INPUT	OUTPUT		
	kg/hr	TOP	BOTTOM	
		kg/hr	kg/hr	kmol/h
WATER	1938.251	1918.868	19.38	1.082
MONO- PROPYLENE GLYCOL	416.66	-	416.66	5.482
DI-PROPYLENE GLYCOL	62.5	-	62.5	0.466
TRI- PROPYLENE GLYCOL	41.66	-	41.66	0.217
TOTAL	2459.084	1918.868	2459.084	

By writing the material balance we get

$$F = B + V$$

$$2459.084 = B + V \rightarrow (1)$$

$$F X_F = V X_V + B X_B$$

$$(2459.084 \times 0.1695) = (0.7711 \times B) \rightarrow (2)$$

On solving

$$V = 1918.582 \text{ kg/hr}$$

$$B = 540.32 \text{ kg/hr}$$

3.2.3 Material balance of Distillation column - 1

Amount of feed entering the column $F = 7.242 \text{ kmol/h}$

Mole fraction of MPG in feed $X_f = 0.7712$

Mole fraction of MPG in distillate $X_d = 0.997$

Mole fraction of MPG in residue $X_b = 0.003$

By writing the material balance, we get

Table 3.3 Material balance of distillation column - 1

COMPONENT	INPUT	OUTPUT			
	kmol/h	TOP		BOTTOM	
		kg/hr	kmol/h	kg/hr	kmol/h
WATER	1.0768	-	-	19.38	1.076
MONO- PROPYLENE GLYCOL	5.482	415.416	5.466	0.0164	1.25
DI-PROPYLENE GLYCOL	0.466	-	-	0.466	62.5
TRI-PROPYLENE GLYCOL	0.217	-	-	0.217	41.66
TOTAL	7.242		5.466		1.776

$$F = D + W$$

$$7.242 = D + W \rightarrow (1)$$

$$F X_f = D X_d + W X_w$$

$$(7.242 \times 0.7712) = (0.997 \times D) + (0.003 \times W) \rightarrow (2)$$

On solving

$$D = 5.466 \text{ kmol/h}$$

$$W = 1.776 \text{ kmol/h}$$

3.2.4 Material balance of Distillation Column - 2

Amount of feed entering the column $F = 1.776 \text{ kmol/h}$

Mole fraction of DPG in feed $X_f = 0.500$

Mole fraction of DPG in distillate $X_d = 0.997$

Mole fraction of DPG in residue $X_b = 0.003$

By writing material balance we get

$$F = D + W$$

$$1.776 = D + W \rightarrow (1)$$

$$F X_f = D X_d + W X_w$$

$$(1.776 \times 0.500) = (0.997 \times D) + (0.003 \times W) \rightarrow (2)$$

On solving

$$D = 0.465 \text{ kmol/h}$$

$$W = 1.311 \text{ kmol/h}$$

Table 3.4 Material balance of distillation column - 2

COMPONENT	INPUT	OUTPUT			
	kmol/h	TOP		BOTTOM	
		kg/hr	kmol/h	kg/hr	kmol/h
WATER	1.0768	-	-	19.38	1.076
MONO- PROPYLENE GLYCOL	1.25	-	-	0.0164	1.25
DI-PROPYLENE GLYCOL	0.466	62.312	0.465	0.187	0.0013
TRI-PROPYLENE GLYCOL	0.217	-	-	0.217	41.66
TOTAL	1.776		0.465	1.311	

3.3 ENERGY BALANCE

Data for energy balance

Boiling points

Propylene oxide = 84° C

Water = 100° C

Mono-propylene oxide = 188.2° C

Di-propylene oxide = 230.5° C Tri-

propylene oxide = 272.77° C

Specific heat capacities

Propylene oxide = 2.156 J/g K

Water = 4.18 J/g K

Mono-propylene oxide = 2.498 J/g K

Di-propylene oxide = 2.075 J/g K

Tri-propylene oxide = 1.96 J/g K

Enthalpy values

Propylene oxide = -145 kJ/mol

Water = -285.83 kJ/mol

Mono-propylene oxide = -486 kJ/mol

Di-propylene oxide = -614.41 kJ/mol

Tri-propylene oxide = -813.83 kJ/mol

3.3.1 Energy balance of Reactor

Table 3.5 Energy balance of reactor

COMPONENT	INPUT kJ/hr	OUTPUT kJ/hr
PROPYLENE OXIDE	-1.022×10^6	-
WATER	-1.762×10^6	-
MONO-PROPYLENE OXIDE	-	-2.666×10^6
DI-PROPYLENE OXIDE	-	-2.863×10^6
TRI-PROPYLENE OXIDE	-	-1.757×10^6

$$\Delta H_r = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$$

$$= [-(2.666 + 2.863 + 1.757) \times 10^6] - [-(1.022 + 1.762) \times 10^6]$$

$$= -3.42 \times 10^5 \text{ kJ/h}$$

3.3.2 Energy balance of Evaporator

Assume it is a multiple effect evaporator of two stages both working at equal conditions

Food flow rate = 2459.084 kg/hr

Mole fraction of MPG in feed = 0.1695

Mole fraction of Mpg in bottom of evaporator 2 = 0.7711

Overall heat transfer coefficients $U_1 = 1952 \text{ kcal/hm}^2\text{°C}$

Overall heat transfer coefficients $U_2 = 1220 \text{ kcal/hm}^2\text{°C}$

Let P_2 be the final product

$$F X_f = P_2 X_{P2}$$

$$P_2 = 540.32 \text{ kg/hr}$$

So, $E = 1918.868 \text{ KH/HR}$

Now, $E_1 = E_2 = 959.4339 \text{ kg/hr}$ (2 stage evaporator)

Enthalpy of streams of first effect

$$H_{E1} = 635.7 \text{ kcal/kg}, \lambda_{E1} = 544.8 \text{ kcal/kg}$$

Enthalpy of streams of second effect

$$H_{E2} = 634.3 \text{ kcal/kg}, \lambda_{E2} = 546.8 \text{ kcal/kg}$$

Now, $H_{p1} = -3635.7 \text{ kcal/kg}$

$$H_{p2} = 3750 \text{ kcal/kg}$$

$$H_f = -975.44 \text{ kcal/kg}$$

Thus, energy balance for 1st evaporator

$$F H_f + S \lambda_s = E_1 H_{E1} + P_1 H_{P1}$$

Energy balance for 2nd evaporator

$$P_1 H_{P1} + E_1 \lambda_{E1} = E_2 H_{E2} + P_2 H_{P2}$$

On solving

$$S = 1991.24 \text{ kg/hr}$$

Now, $m_s = H_{p1} / \lambda_s$

Thus, the mass of steam entering the evaporator is 0.394 kg/hr

3.3.3 Energy balance of Distillation column - 1

Feed temperature = 61.5 °C

Distillate temperature = 180 °C

Residue temperature = 190 °C

Latent heat of vaporization = 712 kJ/kg

Distillate from column = 415.416 kg/hr

Reflux ratio = 2.5

Water inlet temperature = 25 °C

Water outlet temperature = 35 °C

$$Q_s = 712 \times (3.5) \times 415.416$$

$$= 287259.76 \text{ J/s}$$

$$Q_c = Q_s + F H_f - (D H_D + W H_W)$$

$$= 287259.9 \text{ J/s}$$

$$M_s = Q_s / \lambda_s$$

$$= 470.061 \text{ kg/hr}$$

Thus, steam required is 470.061 kg/hr

$$M_w = Q_c / C_{pw} \Delta T_w$$
$$= 47.006 \text{ kg/hr}$$

Thus, cooling water required is 47.006 kg/hr

3.3.4 Energy balance of Distillation column - 2

Feed temperature = 190 °C

Distillate temperature = 230 °C

Residue temperature = 240 °C

Latent heat of vaporization = 400 kJ/kg

Distillate from column = 62.3125 kg/hr

Reflux ratio = 2.5

Water inlet temperature = 25 °C

Water outlet temperature = 35 °C

$$Q_s = 400 \times (3.5) \times 62.3125$$
$$= 73998.82 \text{ J/s}$$
$$Q_c = Q_s + F H_F - (D H_D + W H_W)$$
$$= 73998.81 \text{ J/s}$$

$$M_s = Q_s / \lambda_s$$
$$= 33.63 \text{ kg/hr}$$

Thus, steam required is 33.63 kg/hr

$$M_w = Q_c / C_{pw} \Delta T_w$$
$$= 3.363 \text{ kg/hr}$$

Thus, cooling water required is 3.363 kg/hr

3.4 EQUIPMENT DESIGN

3.4.1 Design of Plug flow reactor

The performance equation of PFR is

$$V/F_{PO} = (1/-r_{PO}) \int dx / (1-X_{PO})$$

To calculate the volume of the reactor we can use the performance equation along with the Arrhenius equation

The Arrhenius equation is

$$k = A \exp(-E_a/RT)$$

where k = rate of reaction

A = Arrhenius factor

E_a = activation energy

values of Arrhenius factor and activation energy were found to be

$$A = 2.7911 \times 10^9 \text{ s}^{-1} \text{ \& } E_a = 32400 \text{ BTU/lbmol}$$

On solving

$$K = 0.3802 \text{ s}^{-1}$$

We know that, $-r_{PO} = k C_{PO}^n$

Since the concentration of water is too large, it is taken as constant and it becomes a pseudo-first order reaction

$$C_{PO} = M_{PO} / V_{mix}$$

Where M_{PO} = molar flow rate of propylene oxide

V_{mix} = volume of mixture

$$V_{mix} = M_{mix} / \rho_{mix}$$

On solving

$$\begin{aligned} \rho_{mix} &= (0.057 \times 830) + (0.943 \times 1000) \\ &= 990.31 \text{ kmol/m}^3 \end{aligned}$$

$$V_{\text{mix}} = 120.91/990.31$$

$$= 0.122 \text{ m}^3/\text{hr}$$

$$\text{Thus, } C_{\text{PO}} = 7.066/0.122$$

$$= 57.92 \text{ kmol/m}^3$$

$$\text{Thus, } -r_{\text{PO}} = 0.308 \times 57.92$$

$$= 17.83 \text{ kmol/m}^3\text{s}$$

The conversion rate is 80% of propylene oxide to mono-propylene glycol

From performance equation

$$V = (F/k C_{\text{po}}) / (\ln 0.2 - \ln 1)$$

$$V = (120.912 \times 1.609) / 17.83$$

$$V = 10.911 \text{ m}^3$$

The diameter and length of the PFR is assumed to be in the ratio of 1:10

$$V = (\pi D^2 L) / 4$$

On simplifying

$$D = 11.7 \text{ m}$$

$$L = 1.17 \text{ m}$$

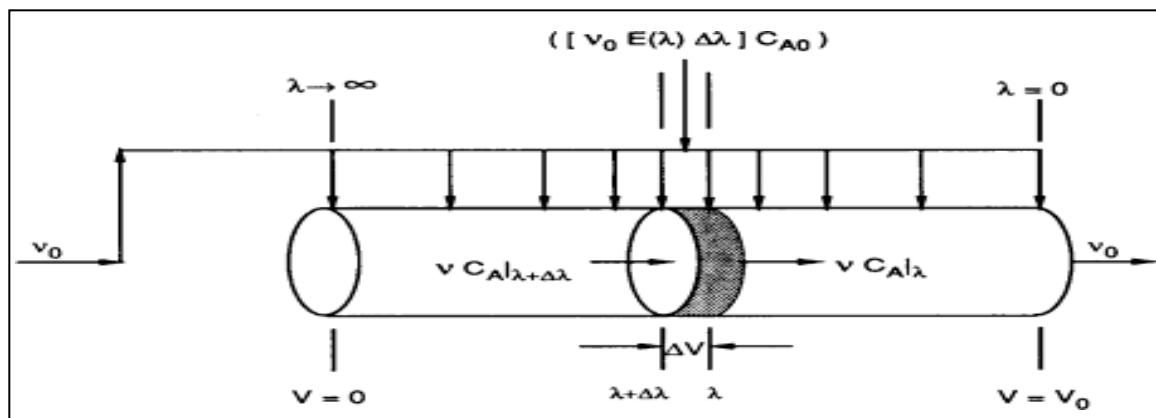


Fig 3.2 Plug flow reactor

3.4.2 Design of Distillation column

The packed column is made up of Raschig rings of diameter 50 mm and critical surface tension of 61 dyne/cm

To find the HTU, the diffusion coefficients of liquid and vapour can be used

$$HTU = (V_v/k_v a_e) + \lambda (V_L/k_L a_e)$$

Where, k_L = mass transfer coefficient of liquid

K_v = mass transfer coefficient of vapour

V_v = volumetric flow rate of vapour

V_L = volumetric flow rate of liquid

$$\text{Now, } k_L = 3.72 \times 10^{-3} (\mu_L g / \rho_L)^{0.333} (Re_L \cdot a_p / a_w)^{0.667} S_{CL}^{-0.5} (a_p \cdot d_p)^{0.4}$$

Where, Re_L = Reynolds number of liquid

S_{CL} = Schmidt number

a_p = packing surface area

a_w = area of wetted packing

$$a_w = a_p \{1 - \exp [-1.45 \cdot Re_L^{0.1} Fr_L^{-0.05} We_L^{0.2} (\sigma / \sigma_c)]\}$$

Where, σ = surface tension

On simplifying, $k_L = 10.058 \text{ m/s}$

$$\text{Similarly, } k_v = (0.119 \cdot a_p \cdot D_v \cdot Re_v^{0.7} \cdot S_{CL}^{0.333}) / (a_p \cdot d_p)^2$$

$$= 2.435 \text{ m/s}$$

$$HTU = (V_v/k_v a_e) + \lambda (V_L/k_L a_e) \quad (a_e = 2.5 \text{ m}^2, \lambda = 0.5)$$

$$= 10.144 \text{ m}$$

$$\text{Now, } NTU = \int_{y_2}^{y_1} \frac{dy}{(y-y^*)}$$

$$= 3$$

$$Z = HTU * NTU$$

$$= 10.144 * 3$$

$$= 30.432 \text{ m}$$

$$HETP = HTU * (\ln \lambda / (\lambda - 1))$$

$$= 14.06 \text{ m}$$

$$\text{Volume of packed column} = 20.2 \text{ m}^3$$

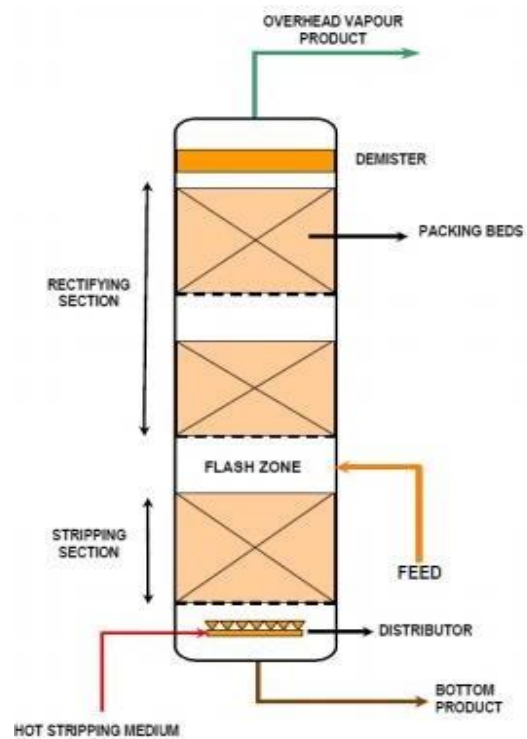


Fig 3.3 Packed bed distillation column

CHAPTER - 4

ECONOMICS OF PLANT

4.1 COST ESTIMATION

Palatable plant setup should gift a cooperation that is good for working below conditions, with a purpose to carry advantage back. In view that net advantage tactics general well worth much less all costs, it is essential that the substance engineer consider the wide scope of types of cost recalls for the amassing measures. Capital should allocate for the set off, plant charges like the ones for unrefined material, work and stuff other than direct expenses diverse different extraordinary fees are prompted, and These need to be consolidated if an all out evaluation of the total cost is to be gotten. more than one instances of these underhanded costs are administrative pay, thing allotment price and price for interplant correspondence. a capital enterprise is a required for every mechanical connection and affirmation of essential hypothesis is a massive piece of plant design degree. the whole undertaking for any verbal exchange incorporate constant capital principle for realistic system and workplaces inside the plant as Nicely as running capital, which have to be open to pay rates, hold tough substances and things handy , and manage different uncommon matters requiring the short price design.

Right while the fee for a business cycle is to be settled, best precision should be obliged robust choice. There are numerous additives impacting journey and creation fee.

They are:

1. Source of equipment
2. Price fluctuation
3. Company policy
4. Operating & rate of production
5. Governmental policy

Earlier a mechanical plant may be placed into movement, a gigantic degree of cash must accept to buy and gift the most important contraption and stuff. Land and employer offices must be gotten, and the plant ought to be raised really with all channeling,

controls and groups. The capital anticipated to deliver the widespread accumulating and plant offices is called the fixed capital hypothesis, at the same time as that essential for the action of the plant is known as the operating Capital. The degree of the fixed capital speculation and the operating is known as no doubt the capital undertaking. Normally, the working capital entirety 20 – 30% of the total scale capital theory. Following is the breakdown of the fixed capital speculation for a compound cycle.

Direct cost

1. Purchased equipments
2. Purchased equipment installation
3. Instrumentation and control
4. Piping
5. Electrical equipment and material
6. Building
7. Yard improvement
8. Land

Indirect cost

1. Engineering supervision
2. Construction process
3. Contractor's fees
4. contingency

Estimation of present plant cost

From operation cost and economic analysis,

Consider,

The present plant cost can be given as 10 tons per day of the propylene glycol is
 $\Rightarrow \text{Rs } 500 \times 10^6$

4.1.1 Direct cost

A Direct cost = Purchased equipments + Purchased equipment installation + Instrumentation and control + Piping + Electrical equipment and material + Building + Yard improvement + Land

1) Purchased cost equipment (15-30% of fixed capital investment):

Consider 30% of fixed capital investment

$$\Rightarrow \text{Rs } 150 \times 10^6$$

2) Installation cost, including insulation and painting (25-45% of purchased cost)

Consider 40% of purchased cost

$$\Rightarrow \text{Rs } 60 \times 10^6$$

3) Instrumentation cost and control cost (6-25% of purchased cost)

Consider 13% of purchased cost =

$$\Rightarrow \text{Rs } 19.5 \times 10^6$$

4) Piping installation cost (10-75 % of purchased cost)

Consider 45% of purchased cost =

$$\Rightarrow \text{Rs } 67.5 \times 10^6$$

5) Electrical cost (10-30 % of purchased cost)

Consider 15% of purchased cost =

$$\Rightarrow \text{Rs } 22.5 \times 10^6$$

6) Building process and auxiliary (10-70 % of purchased cost)

Assume 40% of purchased cost =

$$\Rightarrow \text{Rs } 60 \times 10^6$$

7) Service facilities (30-80 % of purchased cost)

Assume 50% of purchased cost =

$$\Rightarrow \text{Rs } 75 \times 10^6$$

8) Yard improvement (10-15 % of purchased cost)

Assume 12% of purchased cost =

$$\Rightarrow \text{Rs } 18 \times 10^6$$

9) Land (4-8 % of purchased cost)

Assume 6% of purchased cost =

$$\Rightarrow \text{Rs } 9 \times 10^6$$

DIRECT COST $\Rightarrow \text{Rs } 481.5 \times 10^6$

4.1.2 Indirect cost

An Indirect cost = engineering and supervision + construction expenses contractor fees + contingency

1) Engineering and supervision (5-30 % of direct cost)

Assume 15% of purchased cost

$$\Rightarrow \text{Rs } 72.25 \times 10^6$$

2) Construction expenses & contractors feed (6-30 % of direct cost)

Assume 10% of purchased cost =

$$\Rightarrow \text{Rs } 48.15 \times 10^6$$

3) Contractor fee (2-7 % of direct cost)

Assume 4 % of purchased cost =

$$\Rightarrow \text{Rs } 19.26 \times 10^6$$

4) Contingency costs (5-15 % of present cost)

Assume 12 % of present cost =

$$\Rightarrow \text{Rs } 57.78 \times 10^6$$

$$\text{INDIRECT COST} \Rightarrow \text{Rs } 197.415 \times 10^6$$

4.1.3 Total capital investment

FIXED CAPITAL INVESTMENT = DIRECT COST + INDIRECT COST

$\Rightarrow$

Working capital (10-20 % of fixed capital investment)

Assume 15% of fixed capital investment =

$$\Rightarrow \text{Rs } 678.915 \times 10^6$$

TOTAL CAPITAL INVESTMENT = TOTAL FIXED CAPITAL+ WORKING CAPITAL INVESTMENT

$$\Rightarrow \text{Rs } 780.752 \times 10^6$$

4.1.4 Manufacturing cost

FIXED COST

1) Depreciation:

10% of fixed capital investment for machinery and 3% of building value for Building => $\text{Rs } 69.691 \cdot 10^6$

2) Local taxes:

3-4% of fixed capital investment

Assumed value, 0.6% of fixed capital investment

=> $\text{Rs } 27.156 \cdot 10^6$

3) Insurances:

0.4 -1% of fixed capital investment

=> $\text{Rs } 4.07 \cdot 10^6$

4) Rent:

8-12% of the rented land and building

=> $\text{Rs } 6 \cdot 10^6$

Fixed charges 18% of the product cost = $\text{Rs } 19.24 \cdot 10^6$

TOTAL PRODUCT COST = $\text{Rs } 106.921 \cdot 10^6$

4.1.5 Direct production

1) Raw materials: 10-50% of total product cost

Assumed value, 30% of total product cost =

=> $\text{Rs } 32.07 \cdot 10^6$

2) Operating labour:

10-20% of total product cost

Assumed value, 15% of total product cost = Rs 16.038×10^6

3) Direct supervisory and electrical labour:

10-20% of operating labour

Assumed value, 12% of total product cost =

=> Rs 19.24×10^6

4) Utilities:

10-20% of total product cost

Assumed value, 13% of total product cost =

=> Rs 13.89×10^6

5) Maintenance and repairs:

2-10% of fixed capital investment

Assumed value, 0.8% of fixed capital investment

=> Rs 54.313×10^6

6) Operating supplies:

10-20% of cost of maintenance and repair

Assumed value, 15% of total product cost =

=> Rs 8.14×10^6

7) Laboratory charges:

15% of operating labour

Assumed value, 15% of operating labour = Rs 24.05×10^6

8) Patents and royalties:

2-6% of total product cost

Assumed value, 5% of total product cost = Rs 5.34×10^6

Direct production cost = sum of 1+2+3+4+5+6+7+8
=> Rs 134.151*10⁶

9) Plant overhead costs

60-70% of operating labour + direct supervisory + maintenance cost

Considering 60%, overhead plant cost = Rs 43.36*10⁶

Total manufacturing cost => Rs 284.43*10⁶

4.1.6 General expenses

1) Administration cost

60-70% of operating labour cost

Considering 50% the administration cost = Rs 8.01*10⁶

2) Distribution cost

2-20% of total product cost

Assumed value, 10% of total product cost = Rs 1.06*10⁶

3) Research and development cost

Assuming 3% of the production cost = 3.20*10⁶

General expenses = Rs 21.91*10⁶

4.1.7 Total product cost and other expenses

= manufacturing cost + general expenses

=> Rs 306.357*10⁶

1) Current selling price

Cost of propylene glycol= Rs 188.29/kg

Total selling price per annum=

$$\Rightarrow \text{Rs } 564.87 \times 10^6$$

2) Gross earning

$$= \text{total selling price} - \text{total product cost}$$

$$\Rightarrow \text{Rs } 258.51 \times 10^6$$

3) Tax

Assume the local tax rate 30%

$$\text{Tax on the gross earning} = \text{Rs } 90.47 \times 10^6$$

4) Net profit

$$= \text{gross earning} - \text{tax}$$

$$\Rightarrow \text{Rs } 168.03 \times 10^6$$

5) Rate of return

$$= (\text{net profit} / \text{fixed capital investment}) \times 100$$

$$\Rightarrow 24.75\%$$

6) Payback period = total capital investment/ net profits

$$= 4.6 \text{ years}$$

CHAPTER - 5

INSTRUMENTATION

5.1 PROCESS CONTROL AND INSTRUMENTATION

5.1.1 Process description

Mono-propylene glycol is delivered from propylene oxide. The response done in an attachment stream cylindrical reactor. The reactor is run at 120° C. Two side responses additionally occur. The first is propylene oxide responds with mono-pg to give di-PG and the second is propylene oxide responds with di-PG to give tri-PG.

Water is utilized in abundance and must be taken out in the multistage evaporator. The evaporator is working at simply the limit of water to eliminate essentially all the water from the reactor item.

Presently the substances are shipped off the refining segments. In the main refining section, the MPG comes out as the distillate and the excess substance travel to the next refining segment where the DPG and TPG are isolated.

5.1.2 Input-Output structure

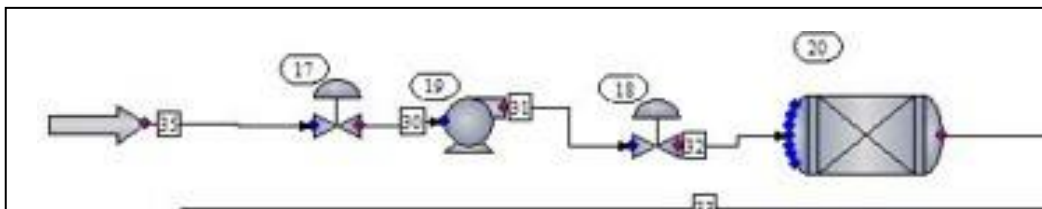


Fig 5.1 Instrumentation diagram of reactor

This was acquired by taking a gander at the conditions. Control circles that can be added at this stage are truly just to do with the feed. The two things that we need to do here are control the stream pace of propylene oxide and afterward set the stream pace of water as the proportion of this

5.1.3 Functional block

In the practical square, the multistage evaporator is available. Both accomplish a similar work of eliminating water from the item stream

The control of this segment is that the second evaporator eliminates a similar measure of fume as the first evaporator. The flow rate of feed additionally should be controlled to guarantee proficient vanishing

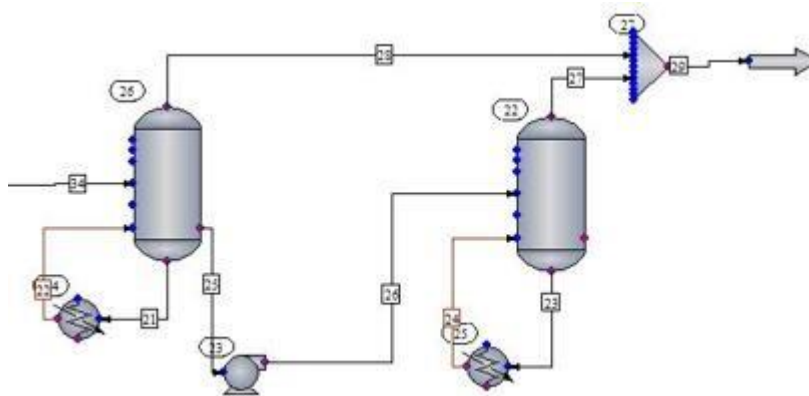


Fig 5.2 Instrumentation of multi-stage evaporator

5.1.4 Separation section

The control circles are generally standard for the refining section for example fume stream for pressure and other two yields to control the degrees of interface

The main thing to take a gander at is the pressing factor. The highest points of the segments are approx. 180K and 230K at climatic pressing factor itself. Accordingly, it is possible to utilize cooling water as the chilly liquid and there is no genuine requirement for an adjustment in pressure. This implies that the pressing factor can be constrained by utilizing vents to air on the reflux drums

The mono-propylene glycol leaves from the highest point of the segment. That implies a quality regulator must be set here. That leaves the bubble up rate to control the level. The piece at the highest point of the segment isn't so significant so the valve to control

the temperature can be set on the reflux line. Truth be told, the distillate line must be utilized for stock purposes. Assuming some mono-propylene glycol gets conveyed to the following section, it essentially comes out from the lower part of that segment

The temperature in the column is operated through the reboiler

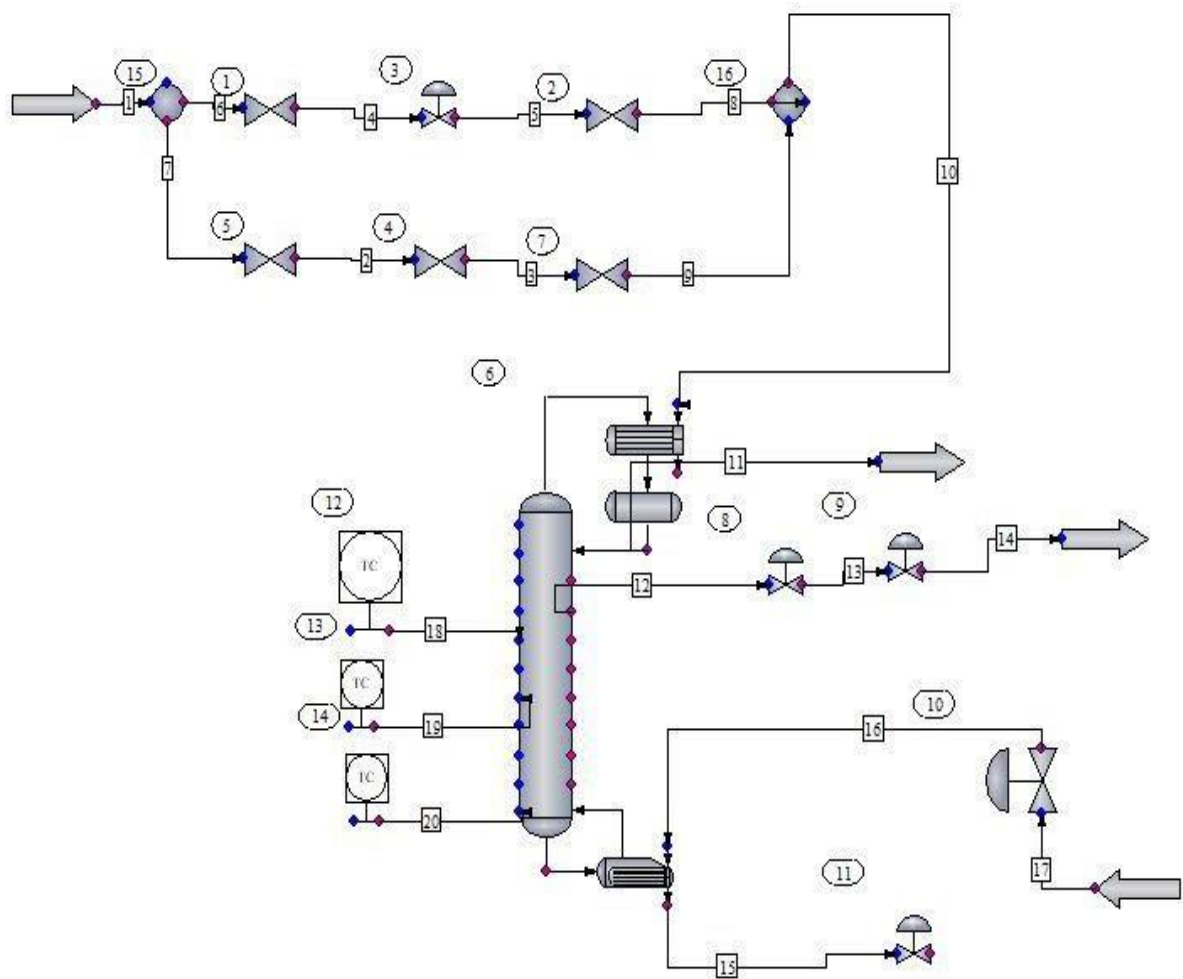


Fig 5.3 Instrumentation of distillation column

CHAPTER - 6

SITE LAYOUT

6.1 PLANT LAYOUT

6.1.1 Principles of Plant layout

6.1.1.1 Storage layout

Storerooms for crude materials, intermediates and completed items might be situated in disconnected zones or in connecting territories. Perilous materials become a concluded threat to life and property when put away in enormous amounts and ought to thusly be detached. Masterminding materials sources to encourage rearranging of taking care of is additionally a highlight be considered in plan. Where it is feasible to siphon a solitary material to a rise so the resulting dealing with can be cultivated by gravity to moderate response and capacity tanks. Fluids can be put away in little holders, barrels, horizontals or verticals tanks and tanks, either inside or outside.

6.1.1.2 Equipment layout

In making a design, abundant space ought to be relegated to each piece of gear. Availability is a significant factor in upkeep. Except if a cycle is very much prepared, it won't be feasible to foresee how the different units are acclimated to be congruity with one another. This is particularly obvious if the interaction is being scaled up from pilot plant plan. It is notable that in produce units measure which give off an impression of being sound after a sensible measure of examination in the pilot plant stage.

The activities that establish a cycle are a progression of unit tasks that might be continued all the while. Since these tasks are rehashed a few times in the progression of materials, it ought to be feasible to orchestrate a similar sort of hardware into a solitary gathering. Such a design will make the division of working work conceivable so a couple of administrators can be itemized about the situation of gear and their embellishments. Despite the fact that gravity stream is generally best, it isn't by and

large essential since fluids can be shipped by passing up siphoning and solids can be moved by mechanical methods for transport and support. The space ought to be accommodated fix and substitution units like cranes and forked trucks, and snow evacuation hardware, just as for access way like entryways and underground brings forth.

6.1.1.3 Safety

A lot of preparation is administered by neighborhood and public security and fire code prerequisites. Fire assurance comprising of reservoirs, mains, hydrants, hose houses, fire, siphon, sprinkles in structures, blast hindrances and directional steering of blast powers to clear regions, and embankments for flammable item stockpiling tanks should be joined to secure the plant speculation and decrease protection rates.

6.1.1.4 Plant Expansion

Extension should be consistently be remembered. The topic of duplicating the quantity of units or expanding the size of the predominant units or units justifies more examination than it very well may be given here. Consequently, it is adequate to say that one should practice designing decisions that as a punishment for awful judgment, one may lose a lot of his venture "shut down for retrofitting may in voice more noteworthy deficiency of cash than the dismissed hardware. In any case, the expense of progress should at times to borne, as the financial matters of bigger units may in the end make substitution basic.

6.1.1.5 Floor space

It might be a main consideration in the plan of the plant. The estimation of land will be extensive thing. The designing ought to, adhere to the standard of wealth of floor area with great cleaning in plant with the legitimate thought gave to the line stream of material, admittance to gear, space to allow chipping away at parts of hardware that need continuous adjusting and security and solace of the administrators.

6.1.1.6 UTILITIES SERVICING

The dispersion of gas, air, water, steam, force and power is consistently a significant thing. A little respect for the legitimate arrangement of every one of these administrations, rehearsing great plan, helps in every one of activity, deliberateness and decrease in expenses of upkeep. No lines ought to be laid on the floor or between the floor and the 7 feet level, where the administrator of the plant. The adaptability of standard pipefitting and force transmission instruments simplifies this issue

6.1.1.7 Building

After a total investigation of the quantitative variables, the choice of the structure or structures should be thought of. Standard manufacturing plant structures are to be wanted however in the event that none can be palatable to deal with the space and interaction necessity of the substance engineer, at that point an equipped draftsman ought to be counseled to plan a structure around the cycle. It is crucial in synthetic designing businesses that the structures ought to be worked around the interaction, rather than the cycle being made to fit inside the customary plan of structures

Much of the time just the control region requires lodging with the interaction's gear raised outside. This is known as outside development and such formats ought to be considered for little kinds of plants. The thought that should be given to building relies on the conditions. In the event that the fashioner should adjust his plan to find a way into an old structure or structures space previously raised. The choice of the plan of another structure to meet the prerequisites of the cycle is more logical. For this situation, one finds before him basically a wide range of standard structure, inherent units, interlocking or something else, prepared for shipment and erection

All through synthetic industry much idea should be given to the removal of waste alcohols, exhaust, cleans and gases. Ventilation rage end and waste may require the establishment of additional gear. The establishment of much hardware when required pays in better help from administrators, less uneasiness, more noteworthy creation and a preferred spirit over when such conditions are left to nature

It is perceived that there isn't just arrangement of the issue of the format of the gear. There are numerous normal plans. Which intend to receive should be settled on after extract of designing judgment and in the wake of finding some kind of harmony of the benefits and disservices of every conceivable decision

6.1.1.8 Materials handling equipment

Thought of gear for materials taking care of is just a minor factor as a rule of plan, inferable from the variety of accessible material taking care of gadgets. Notwithstanding, where this activity is foremost in an interaction, genuine idea should be given to it. Once more, it ought to be assistant that designing judgment should be worked out. At whatever point conceivable, one should exploit the geography of the site area, if such will serve to advantage simultaneously

6.1.2 Selection of Plant size

The main considerations in the determination of plant size are

- 1) raw materials
- 2) markets
- 3) energy supply
- 4) transportation offices
- 5) water supply

For starter review the initial four variables ought to be resolved. Subsequently, based on crude materials, markets, energy supply and environment worthy area can for the most part be decreased to a couple of general topographical areas.

In the subsequent stage the impacts of transportation offices and water supply are considered. Considering every one of the variables that have impact on plant area can diminish these zones further

As a last advance, a point-by-point investigation of the leftover destinations can be made. Precise information on things, for example, work conditions, charge rates, cost of land and general nearby conditions can be acquired. The different locales can be investigated and evaluated based on every one of the variables affecting a ultimate conclusion

Ordinarily, benefits of finding another plant ashore or close to different offices previously claimed by the worry for example building the new plant exceed the hindrances of the specific area. Regardless, anyway an official conclusion on choosing the plant size should contemplate every one of the elements that can influence a definitive accomplishment of the general activity

6.1.3 Plant location

The area of a plant crucially affects the general productivity of a venture and the extension for future development. Numerous components should be viewed as when choice an appropriate plant site. financial development and activity of a cycle unit will rely upon how the plant gear indicates on interaction stream sheet & spread out.

6.1.3.1 Costs

Expense on development can limited by receiving a design which gives most brief run of associating pipes among gear and embracing minimal measure of primary steel work. Notwithstanding, this won't really be the best course of action for activity and upkeep

6.1.3.2 Process equipment

All the necessary gears must be set appropriately inside measure. Indeed, even the establishment of the assistants ought to be done so that it will consume the least space

6.1.3.3 Operation

Gear that necessities to have continuous activity ought to be found helpful to control room. Test focuses and values ought to have situated at advantageous area and stature. Adequate work space should give to permit simple admittance for hardware

6.1.3.4 Maintenance

Warm temperature exchangers ought to site so the chamber packs may be without difficulty eliminated for cleaning and chamber alternative. vessels that require ceaseless substitute of impulse or squeezing need to be arranged ostensibly of the design. Gear that requires destroying for support, for example, blowers and enormous siphons ought to be set under cover

6.1.3.5 Safety

Impact dividers might be expected to seclude possibly unsafe hardware and keep the impacts of a blast. In any event two break courses for administrator should be given from each level in the process

6.1.3.6 Plant expansion

Gear ought to be found so it very well may be helpfully attached with and future development of the interaction. Space ought to be left on pipe rear entryways for future necessities, administration pipes larger than usual to consider future prerequisites

6.1.3.7 Modular construction

These days, there has been a transition to acquire segments of the plant at the maker website online. those modules contain the equipment, underlying steel, funneling & instrumentation. the modules at that factor moved to the plant by using street or ocean

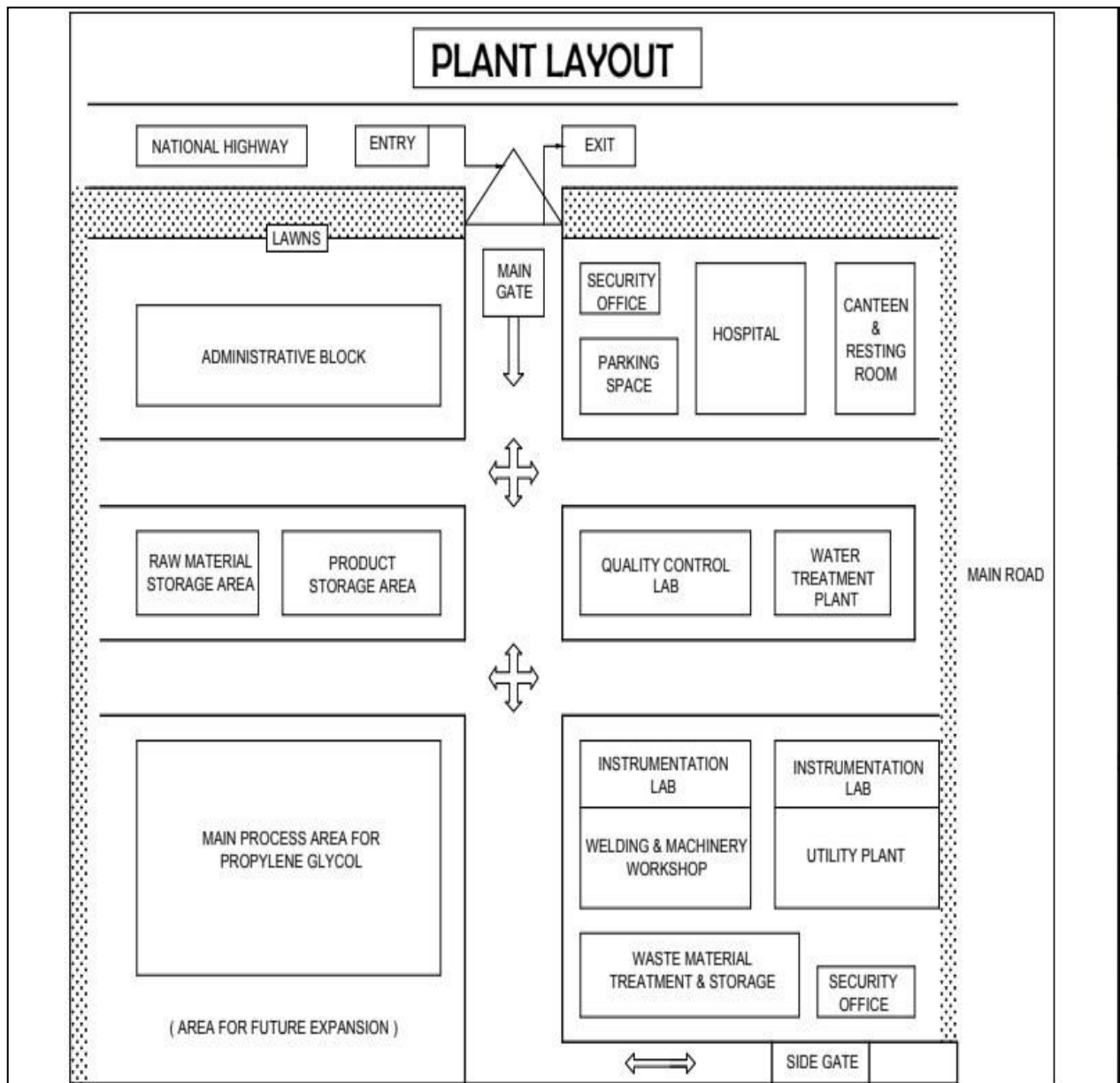


Fig 6.1 Plant layout of propylene glycol industry

CHAPTER - 7

SAFETY

7.1 CAUSE AND EFFECT

7.1.1 Animals

PG is an asserted meal introduced substance for dog and sugar lightweight flyer food beneath the order of animal feed and is generally seen as secure for dogs, with a LD_{50} of 8 ml/kg. The LD_{50} is higher for maximum examination workplace animals (30 ml/kg). Regardless, its miles refused for use in sustenance for cats as a result of associations with Heinz body sickliness.

7.1.2 Allergic reaction

Folks who can't suffer propylene glycol experience excited dry pores and skin in the facial area, or minimal red spots on body. propylene glycol has the sketchy honor of being named the yank contact dermatitis society's allergen of the year for 2017. estimates on the normality of propylene glycol affectability variety from 0.7% (10% propylene glycol in watery response for) 2.5% (35% propylene glycol in liquid answer). the North American touch dermatitis institution (NACDG) statistics from 1995 to 2008 Showed that the maximum widely perceived website for propylene glycol contact dermatitis turned into the face (24.9%), observed by means of a summarized or scattered version (22.6%). investigators acknowledge that the occasion of excessively touchy touch dermatitis to propylene glycol may be more conspicuous than 3% in sufferers with skin infection or infectious pollutions, which might be very critical in international locations with lesser solar transparency and lower-than-conventional supplement D changes. thusly, propylene glycol Severe touchiness is greater usual in the one's nations.

7.1.3 Environmental

PG is known to apply verifiable levels of BOD during corruption in surface of the water. This cooperation can negatively impact land and water proficient life on eating up O₂ needed by maritime natural substances for perseverance. Enormous measures DO in the water section are eaten up when microbial masses deteriorate pg.

CHAPTER - 8

SUMMARY AND CONCLUSION

Propylene glycol is a vital item which is widely utilized for the assembling of co-polymer to yield indoor regulator plastics. It is additionally utilized as additive for nourishments and tobacco items. There is an incredible interest for this item on the lookout. Among the various strategies for assembling of propylene glycol, Hydrolysis of Propylene Oxide is discovered to be the most financial and practical technique as it doesn't include any superfluous side items and acidic streams in its interaction. The cycle is additionally modest not at all like different cycles which is awesome in a monetary manner. The compensation period was discovered to be 4.6 years at a loan fee of 24%

CHAPTER - 9

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