

CONFIGURATION OF VARIOUS PROCEDURE INVOLVED IN PRODUCTION OF ETHYLENE DICHLORIDE

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 "A" grade by NAAC

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600119

MARCH 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Yogeshwaran.P (37190043)** and **ANAND.S (37190009)** who had done the Project work as a team. Who carried out the project entitled **"CONFIGURATION OF VARIOUS PROCEDURE INVOLVED IN THE PRODUCTION OF ETHYLENE DICHLORIDE"** under my supervision from October 2020 to March 2021

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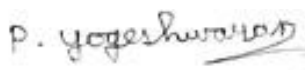
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Internal Examiner

External Examiner

DECLARATION

I **YOGESHWARAN.P (37190043)** hereby declare that the Project report entitled “Configuration of various procedure involved in the production of ethylene dichloride” done by me under the guidance of **Dr. Aravind kumar.J** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Chemical Engineering.


[P.YOGESHWARAN]

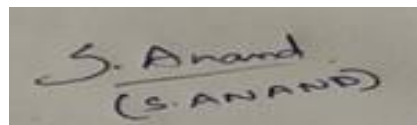
SIGNATURE OF THE CANDIDATE:

DATE: 20-03-2021

PLACE: Chennai

DECLARATION

I **ANAND.S (37190009)** hereby declare that the Project report entitled “Configuration of various procedure involved in the production of ethylene dichloride” done by me under the guidance of **Dr. Aravind kumar.J** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Chemical Engineering.

A photograph of a handwritten signature in black ink on a light-colored surface. The signature reads "S. Anand" in a cursive style, with "(S. ANAND)" written in a more formal, blocky font underneath it.

DATE:20-03-2021

PLACE: Chennai

SIGNATURE OF THE CANDIDATE:

ACKNOWLEDGEMENT

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ABSTRACT

A process of preparing Ethylene dichloride of 1000 TPA by direct chlorination in the liquid phase in the presence of ethylene. The ethylene is chlorinated in the liquid phase in plug flow reactor in the presence of ethylene and chlorine at a temperature of 60 – 120 deg Celsius and formation of by product like hydrochloric acid and Ethylene trichloride. The process of separation of HCl which makes damage to distillation column is removed in the neutralizer using sodium hydroxide. The detailed study in the process of separation of pure ethylene dichloride in the distillation column which remove the ethylene trichloride and crude from the mixture to form pure ethylene dichloride. The study of material balance and energy balance for production of 1000 TPA. Design of plug flow reactor and distillation column. The detailed cost estimation to calculate rate of return and payback period. The safety aspects for easy handling of chemical compound, first aid measures to follow and the efficient plant layout include site selection and safety measures to reduce the loss by increasing the profit. In this project we listed all the major aspects involved in the production of Ethylene dichloride of 1000 TPA by direct chlorination process.

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CHAPTER 1

1. INTRODUCTION:

Ethylene dichloride(EDC) is a chlorinated hydrocarbon. It is the fluid with a chloroform like scent. The widely recognized utilization of ethylene dichloride in the creation of polyvinyl chloride and vinyl chloride production also in the production of furniture and upholstery, divider covers, house wares, and car parts. Ethylene dichloride is likewise utilized by and large as a halfway for other natural substance compounds, and dissolvable also nature. It structures azoetrope with numerous different solvents, including water and other chlorocarbon. ethylene dichloride has been utilized as paint remover and degreaser yet is presently prohibited from use because of it harmfulness and conceivable carcinogenity. And also a valuable building block reagent and it is utilized as a moderate in the creation of different natural mixtures, for example, ethylenediamine. In the research facility it is once in a while utilized as wellspring of chlorine and disposal of chloride and ethylene. Through a few stages, ethylene dichloride is a forerunner to ethylene trichloride, which is utilized in the cleaning. Verifiably, Ethylene dichloride was utilized as an enemy of thump added substance in leaded powers to search lead from valve and chamber forestalling development. The expanding of the complete populace affects the expanding needs, including fabricating materials upheld. Ethylene dichloride (EDC) is an essential fixing in supporting assembling materials satisfaction, for example VCM- Vinyl chloride monomer crude materials, moderate in PVC polyvinyl chloride creation, utilized in Trichloroethane parts which blended as a antiknock agents, solvents for candles, oils and covering crude, and remover materials for perchlorate ethylene, ethylenediamine, ethylene trichloride and carbon tetrachloride. The world requirement for EDC expanded since 1986. This expansion in the accordance with expanding interest for polyvinyl chloride and vinyl chloride . In 1986, EDC creation in the Japan was 7x10⁵ tons, in USA 8x10⁹ tons, and Europe 2x126 tons. Untill the finish of 2007, India has all the while bringing in EDC from nations on the planet, India actually imported EDC of 3567868 tons from different nations on the planet. World Ethylene dichloride needs since 1976 expanded 7% each year; hence, it is assessed that in 20 years, the EDC needs will be 134893329 tons.

The development of the Ethylene dichloride process plant will be entirely productive in light of the fact that it decreases reliance on imports, regardless of whether homegrown requirements are met, India can trade it. Crude materials supply should likewise be carefully considered to guarantee plant coherence. In view of the depiction above and different contemplations in regards to the EDC sum needs at abroad and home plant limit, crude materials and limit range depend on writing considers. The assurance of ethylene dichloride plant limit in Ethylene dichloride plant predesigned from ethylene and chlorine is 1000 TPA.

CHAPTER 2

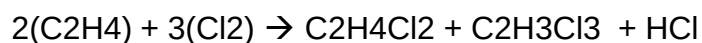
2.METHODS OF PRODUCTION :

Ethylene dichloride can be produced domestically by two processes:

- 1) Direct chlorination of ethylene and
- 2) Oxychlorination of ethylene by varying raw material ratios.

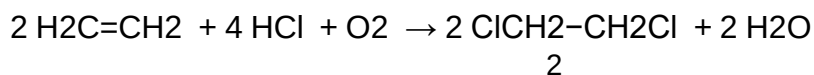
2.1. DIRECT CHLORINATION PROCESS :

Direct chlorination is acted in the fluid stage where fluid chlorine and unadulterated ethylene are responded . The response can be done at one or the other low (20-80°C) or high (100-120°C) temperatures. The low temperature measure has the upside of low result development yet requires more energy to recuperate the Ethylene dichloride. The high temperature measure uses the warmth of response in the refining of the Ethylene dichloride, prompting significant energy reserve funds.



2.2. OXYCHLORINATION PROCESS:

In the oxychlorination interaction, unadulterated ethylene and hydrogen chloride, blended in with oxygen, are responded at 200-300 deg C and 2-3 bar within the sight of an impetus, generally cupric chloride. The response happens in either a fixed bed or liquid bed reactor, the last being liked as it is simpler to control the temperature.



2.3. PROCESS SELECTION & DESCRIPTION

2.3.1. Selection of methods:

Ethylenedichloride (EDC) is presently delivered by either direct chlorination or oxychlorination of ethylene. It can be created independently or as a co result of ethylenetrichloride (ETC), by changing crude material proportions. Ethylenedichloride was once fabricated dominantly by the chlorination of acetylene.

Notwithstanding, in light of the significant expense of acetylene, Ethylene chlorination turned into the favored technique for creating Ethylene dichloride. High temperature direct chlorination measure that professes to have altogether better returns and immaculateness

2.4. PHYSICAL & CHEMICAL PROPERTY:

Ethylene dichloride colorless, sweet smelling, nonflammable liquid at normal temperature and pressure.

Density	-	1.253 g/ml
Melting point	-	-35°C
Boiling Point	-	84°C
Molecular weight	-	98.95
Vapor pressure (20°C)	-	75 mmHg
Heat of formation, liquid	-	-125.4 KJ/kg mol
Heat capacity	-	77.5 J/mol K
Heat of fusion	-	8.8 KJ/kg mol
Heat of combustion	-	-1241 KJ/kg
Surface tension	-	40.05 mN/m

2.5. PHYSICAL PROPERTIES OF HCL

1. It is a colorless acid.
2. It has sharp irritating smell.
3. It has sour taste.
4. It is heavier than air.
5. It gives fumes in must air.
6. It turns blue utmost to red

2.6. USES OF EDC:

- Ethylene dichloride is an effective solvent for a variety of organic material.
- EDC has been used as a solvent in the metal cleaning , textile industry and adhesive industry.
- 1,2-dichloroethane was utilized as an enemy of thump added substance in leaded energizes to rummage lead from chambers and valves forestalling development
- It has also been used as a dry-cleaning solvent
- It is utilized as a middle in the creation of different natural mixtures, for example, ethylenediamine
- In the research facility it is once in a while utilized as a wellspring of chlorine, with disposal of ethylene and chloride
- EDC is used in the manufacture of range of fluorocarbon refrigerant.

2.7. PROCESS FLOW DIAGRAM FOR EDC PRODUCTION:

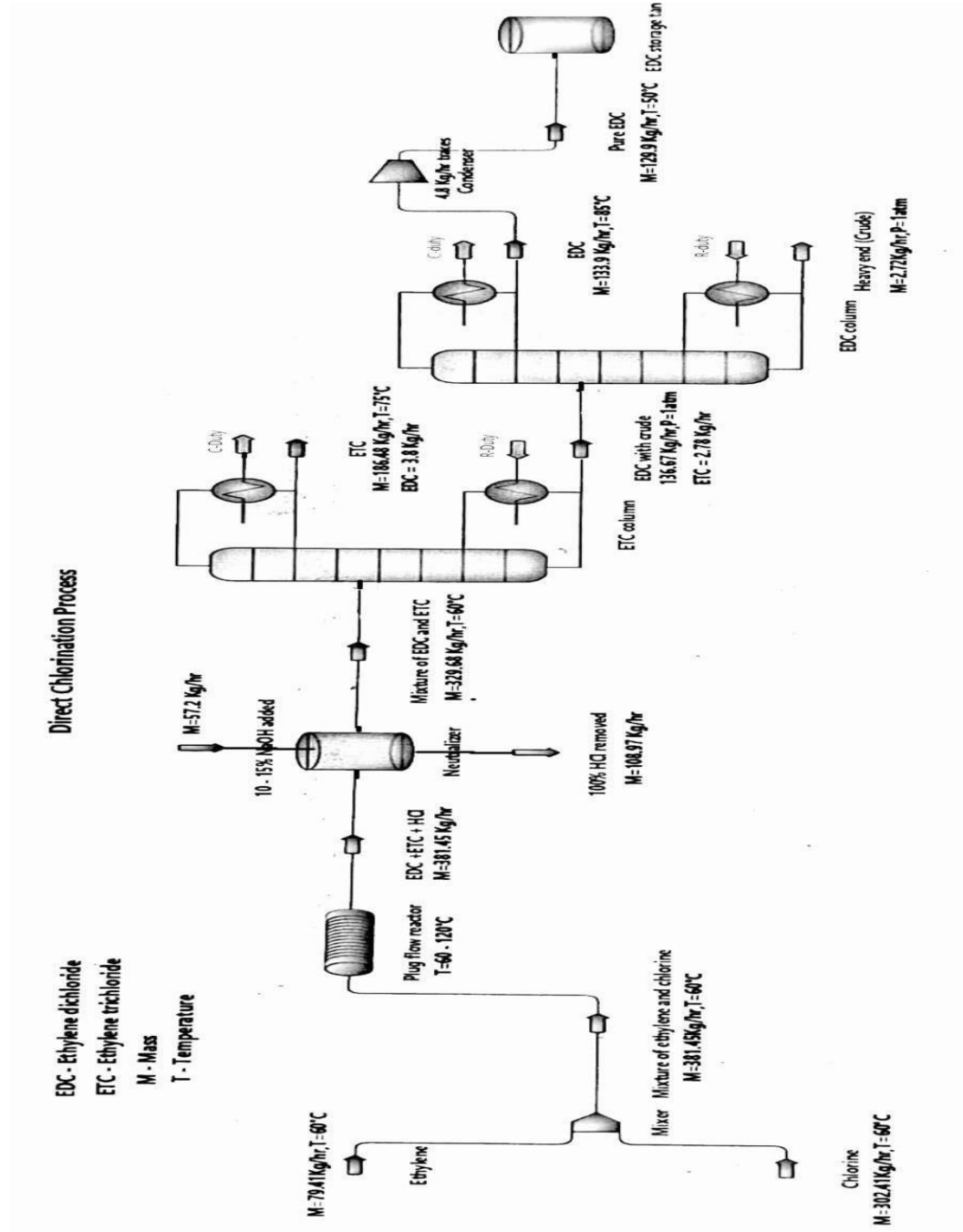


Fig.1.1: Ethylene dichloride Production Process

CHAPTER 3

3.1. MATERIAL BALANCE:

Manufacturing of Ethylene dichloride($C_2H_4Cl_2$) by Chlorination Process

Manufacturing of Ethylene dichloride($C_2H_4Cl_2$) by Chlorination Process – 1000 TPA

Basis: 1000TPA

No of Working days : 330 days

Reaction: $2(C_2H_4) + 3(Cl_2) \rightarrow C_2H_4Cl_2 + C_2H_3Cl_3 + HCl$

2(28) 3(71) 99 133.5 36.5

Table 3.1 : Component Molecular weight

Component	Molecular weight (g/mole)
Ethylene (C_2H_4)	28
Chloride(Cl_2)	71
Ethylene dichloride – EDC - $C_2H_4Cl_2$	99
Ethylene trichloride – ETC- $C_2H_3Cl_3$	133.5
Hydrochloric acid – HCl	36.5

Reactant : Ethylene and chlorine

Product : Ethylene dichloride

By Product : Ethylene trichloride

Reactor : Plug flow reactor

Reactor Temperature : 60 – 125 deg celcius

Basis : 1000 TPA

Working days : 330 days + 35 (Maintenance)

Amount = $(1000 * 1000)/(330 * 24) = 126.6$ Kg/hr

3.1.1. Assumption:

- Limiting reactant is chlorine (Cl_2)
- 100% conversion of limiting reactant
- The conversion rate of EDC is 92%

3.2. REACTOR:

Assuming 100% conversion

126.6 Kg/hr of EDC formed = 92% of EDC formed

'x' Kg/hr of EDC formed = 100% of EDC formed

$$x = 126.6 \times 100 / 92$$

$$x = 137.6 \text{ Kg/hr of EDC formed}$$

3.2.1. Reactant :

Amount of Ethylene and Chloride required

As per stoichiometric :

99 g/mole of EDC required = 56 g/mole of Ethylene

137.6 Kg/hr of EDC required = 'x' kg/hr of Ethylene

$$x = 56 \times 137.6 / 99$$

$$x = 77.83 \text{ Kg/hr}$$

According to PFR the conversion rate is 98%

77.83 Kg/hr of Ethylene = 98% conversion

'x' Kg/hr of Ethylene = 100% conversion

$$x = 77.83 \times 100 / 98 = 79.41 \text{ Kg/hr}$$

Ethylene required = 79.41 Kg/hr

Total amount required :As per stoichiometric:

56 g/mole of EDC required = 269 g/mole of Total reactant

79.41 Kg/hr of EDC required = 'x' kg/hr of Total reactant

$x = 381.45$ Kg/hr of Total reactant

Amount of Cl_2 required = (Total amount of Total reactant) –

(Amount of ethylene)

$= 381.45 - 79.41$

Amount of Cl_2 required = 302.04 Kg/hr

Table 3.2 : Amount of reactant

Component	Amount (Kg/hr)	Amount (g/mole)
Ethylene	302.04	213
Chlorine	79.41	56
Total	381.45	269

3.2.2 :Product:

Amount of Ethylene dichloride, Ethylene Trichloride and HCl

Total content of product – 269 g/mole

Ethylene dichloride EDC – 99 g/mole

Ethylene Trichloride ETC – 133.5 g/mole

HCl – 36.5 g/mole

Amount of EDC formed:

As per stoichiometric :

99 g/mole of EDC required = 269 g/mole of Total content

'x' Kg/hr of EDC required = 381.45 kg/hr of Total content

$$x = 99 * 381.45 / 269$$

$$x = 140.38 \text{ Kg/hr}$$

Amount of ETC formed:

As per stoichiometric :

133.5 g/mole of EDC required = 269 g/mole of Total content

'x' Kg/hr of EDC required = 381.45 kg/hr of Total content

$$x = 133.5 * 381.45 / 269$$

$$x = 189.2 \text{ Kg/hr}$$

Amount of HCl formed:

As per stoichiometric :

36.5 g/mole of EDC required = 269 g/mole of Total content

'x' Kg/hr of EDC required = 381.45 kg/hr of Total content

$$x = 36.5 * 381.45 / 269$$

$$x = 51.73 \text{ Kg/hr}$$

Assuming the amount of unreacted = 0.1 Kg/hr

Amount of Crude = 0.04 Kg/hr

Amount of EDC formed = 140.38 Kg/hr

Amount of ETC formed = 189.2 Kg/hr

Amount of HCl formed = 51.73 Kg/hr

Table 3.3 : Amount of Product Formed

Component	Amount (Kg/hr)	Amount(g/mole)
Ethylene dichloride	140.38	99
Ethylene Trichloride	189.2	133.5
HCl	51.73	36.5
Unreacted Ethylene	0.1	-
Crude	0.04	-
Total	381.45	269

Table 3.4 : Reactor Material balance

Component	Input		Output	
	Kg/hr	g/mole	Kg/hr	g/mole
Chlorine	302.04	213	-	-
Ethylene	79.41	56	-	-
Ethylene dichloride	-	-	140.38	99
Ethylene Trichloride	-	-	189.2	133.5
HCl	-	-	51.73	36.5
Total	381.45	269	381.45	269

3.3. NEUTRALIZER:

In Neutralizer NaOH required to get neutralize excess HCl formed in the reaction. As well this NaOH acts a purifier the impurities occur in reaction

10-15 % of NaOH required to remove HCl and 100% of HCl is Neutralized = 57.2 Kg/hr

Table 3.5 : Inlet Stream - Neutralizer

Component	Kg/ hr
Mixture of components EDC, ETC&Hcl	381.45
NaOH (Sodium Hydroxide)	57.2
Total	438.65

Table 3.6 :Outlet Stream - Neutralizer

Component	Kg/ hr
Mixture of EDC and ETC	329.68
Nacl (Sodium chloride)	108.97
Total	438.65

3.4. DISTILLATION COLUMN:

3.4.1. Material balance for Preliminary distillation column:

Boiling point of Ethylene trichloride = 75 deg celcius

Boiling point of Ethylene dichloride = 85 deg celcius

Table 3.7 : Inlet stream – ETC Distillation column

Component	Amount (Kg/hr)	Mole basis(g/mole)
Ethylene dichloride – EDC	140.38	1.414
Ethylene Trichloride – ETC	189.2	1.417
Total	329.68	

Mass fraction of EDC in Feed – 0.42

Mass fraction of ETC in Feed – 0.58

Material balance:

$$F = D + W \Rightarrow 329.68 = D + W$$

Component material balance for ETC:

$$F x_f = D x_D + W x_W$$

98% distillation occurs in simple distillation column, Therefore

$$x_D = 0.98$$

$$x_W = 0.02$$

Mass fraction of ETC, $x_F = 0.58$

$$F x_f = D x_D + W x_W$$

$$(329.68)(0.58) = D(0.98) + W(0.02)$$

On solving

$$D = 190.21$$

$$W = 139.46$$

Table 3.8 :Outlet stream – ETC Distillation column

Components	Top (Kg/hr)	Bottom (Kg/hr)	Total (Kg/hr)
EDC	3.8	136.67	140.38
ETC	186.4	2.78	189.2
TOTAL	190.21	139.46	329.68

3.4.2. Secondary distillation column:

Boiling point of Ethylene dichloride = 85 deg celcius

Table 3.9 : Inlet stream – EDC Distillation Column

Component	Mass (Kg/hr)
EDC	136.67
ETC	2.78
TOTAL	139.46

Overall Material balance:

$$F = D + W$$

$$139.46 = D + W$$

Component material balance for EDC:

$$F x_f = D x_D + W x_W$$

98% distillation occurs in simple distillation column, Therefore

$$x_D = 0.98$$

$$x_W = 0.02$$

Mass Fraction of EDC is $x_F = 0.98$

$$F x_f = D x_D + W x_W$$

$$(139.46)(0.98) = D(0.98) + W(0.02)$$

On solving

$$D = 133.98$$

W= 5.45

Table 3.10 : Outlet Stream – EDC Distillation column

Components	Top (Kg/hr)	Bottom (Kg/hr)	Total (Kg/hr)
Ethylene dichloride	133.93	2.73	136.67
ETC + Crude	0.05	2.72	2.78
Total	133.98	5.45	139.46

3.5 CONDENSER MATERIAL BALANCE:

Here 98 % condensation taking place in water cooled condenser, which removes traces of ETC and getting purity 100% of EDC

Table 3.11 : Inlet stream - Condenser

Component	Mass (Kg/hr)
EDC + traces of ETC+Crude	136.67

Table 3.12 : Outlet stream - Condenser

Component	Mass (Kg/hr)
Pure EDC	129.10
Traces of ETC + Crude	4.88
Total	133.98

CHAPTER 4

4.1 ENERGY BALANCE:

4.1.1. Objective

- Energy in
- Energy output
- Heat created
- Heatloss

During 1000TPA Ethylene dichloride production.

4.1.2. Specific Heat Capacity:

1. Chlorine = 0.48 KJ/Kg
2. Ethylene = 1.453 KJ/Kg
3. EDC = 0.297 KJ/Kg
4. ETC = 0.247 KJ/Kg
5. HCl = 0.4 KJ/Kg

4.1.3. Heat of formation:

1. Chlorine = 121.7 KJ/Kg
2. Ethylene = 52.4 KJ/Kg
3. EDC = -169.7 KJ/Kg
4. ETC = -136.5 KJ/Kg
5. HCl = -92.3 KJ/Kg

Heat of reaction = Heat formation of products – heat formation of reactants

$$= (-5.256) - (5.2)$$

$$= -10.456 \text{ KJ/Kg}$$

4.2 REACTOR:

4.2.1 Energy input:

Heat input by Chlorine:

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 302.0 \cdot 0.48 \cdot (65 - 25)$$

$$Q = 5799.168 \text{ kJ/hr}$$

Heat input by Ethylene:

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 79.41 \cdot 1.453 \cdot (65 - 25)$$

$$Q = 4615.30 \text{ kJ/hr}$$

4.2.2 Energy output:

Heat output by EDC

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 140.38 \cdot 0.29 \cdot (121 - 25)$$

$$Q = 4002.51 \text{ kJ/hr}$$

Heat output by ETC:

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 189.2 \cdot 0.247 \cdot (121 - 25)$$

$$Q = 4486.31 \text{ kJ/hr}$$

Heat output by HCl:

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 51.73 \cdot 0.385 \cdot (121 - 25)$$

$$Q = 1911.94 \text{ kJ/hr}$$

Heat output by Unreacted ethylene

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 0.1 \cdot 1.453 \cdot (121 - 25)$$

$$Q = 13.94 \text{ kJ/hr}$$

Table 4.1 :Reactor Energy Balance

Description	Energy Input				Energy Output			
	M(Kg/hr)	Cp (KJ/Kg)	Δt (°C)	Heat Consumed KJ/h	M(kg/hr)	Cp KJ/Kg	Δt °C	Heat Consumed KJ/h
Cl2	302.64	0.48	40	5799.168				
C2H4	79.41	1.453	40	4615.30				
EDC					140.38	0.29	96	4002.51
ETC					189.2	0.247	96	4486.31
HCl					51.73	0.385	96	1911.94
Unreacted C2H4					0.1	1.453	96	13.94
TOTAL				10414.168				10414.168

4.3. ENERGY BALANCE PRELIMINARY DISTILLATION COLUMN:

4.3.1 Energy input:

Heat input by EDC $Q = m \cdot c_p \cdot \Delta t$ $Q = 140.38 \cdot 0.29 \cdot (60 - 25)$

$$= 1424.8 \text{ kJ/hr}$$

Heat input by ETC

$$Q = m \cdot c_p \cdot \Delta t$$

$$Q = 189.2 \cdot 0.247 \cdot (60 - 25)$$

$$= 1635.634 \text{ kJ/hr}$$

Heat input by unreacted ethylene

$$Q = mcp\Delta t$$

$$Q = 0.1 * 1.453 * (60 - 25)$$

$$= 5.08 \text{ kJ/hr}$$

4.3.2 Energy Output:

Heat output by EDC:

$$Q = mcp\Delta t$$

$$Q = 140.38 * 0.29 * (75 - 25)$$

$$= 2035.51 \text{ kJ/hr}$$

Heat output by ETC :

$$Q = mcp\Delta t$$

$$Q = 189.2 * 0.247 * (75 - 25)$$

$$= 2336.62 \text{ kJ/hr}$$

Heat output by crude :

$$Q = mcp\Delta t$$

$$Q = 0.1 * 1.453 * (75 - 25)$$

$$= 7.265 \text{ kJ/hr}$$

Heat load = Energy output - Energy input

$$= 4379.395 - 3065.51$$

$$= 1313.885 \text{ kJ/hr}$$

Description	Energy Input				Energy Output			
	M (kg/hr)	Cp (KJ/Kg)	Δt °C	Heat Consumed KJ/h	M(kg/hr)	Cp KJ/Kg	Δt °C	Heat Consumed KJ/h
EDC	140.38	0.29	35	1424.8	140.38	0.29	50	2035.51
ETC	189.2	0.247	35	1635.634	189.2	0.247	50	2336.62
Unreacted C2H4	0.1	1.453	35	5.08	0.1	1.453	50	7.265
Heat load	-	-	-	1313.885	-	-	-	-
TOTAL				4379.395	4379.395			

Table 4.1 : Energy Balance for Preliminary Distillation Column

4.4 ENERGY BALANCE SECONDARY DISTILLATION COLUMN:

4.4.1 Energy input

Heat input by EDC

$$Q = mcp\Delta t$$

$$Q = 140.2 \times 0.29(75-25)$$

$$= 2032.9 \text{ kJ/hr}$$

Heat input by crude

$$Q = mcp \Delta t$$

$$Q = 4.3 \times 1.453(75-25)$$

$$= 312.39 \text{ kJ/hr}$$

4.4.2 Energy output:

Heat output by EDC

$$Q = mcp\Delta t$$

$$Q = 140.2 \times 0.29 \times (85 - 25)$$

$$= 2439.48 \text{ kJ/hr}$$

Heat output by crude

$$Q = mcp\Delta t$$

$$Q = 4.3 \times 1.453 \times (85 - 25)$$

$$= 374.874 \text{ kJ/hr}$$

Heat Load = Energy output - Energy input

$$= 2814.354 - 2345.29$$

$$= 469.064 \text{ KJ/hr}$$

Description	Energy Input				Energy Output			
	M (Kg/hr)	Cp (KJ/Kg)	Δt	Heat Consumed KJ/h	M(kg/hr)	Cp KJ/Kg	Δt	Heat Consumed KJ/hr
EDC	140.38	0.29	50	2032.9	140.38	0.29	60	2439.48
Crude	4.3	1.453	50	312.39	4.3	1.453	60	374.874
Heat load	-	-	-	469.064	-	-	-	-
TOTAL				2814.354				2814.354

Table 4.2 : Energy Balance for Secondary Distillation Column

4.5 CONDENSER:

Heat in by EDC

$$Q = mcp\Delta t$$

$$Q = 135.9 \times 0.29 \times (85-25)$$

$$Q = 2364.66 \text{ KJ/hr}$$

Heat out by EDC

$$Q = mcp\Delta t$$

$$Q = 126.9 \times 0.29 \times (75-25)$$

$$Q = 1840.05 \text{ KJ/hr}$$

Heat Load = Energy output- Energy input

$$= 1840.05 - 2364.66$$

$$= -542 \text{ KJ/hr}$$

Table 4.1 :Condenser Energy Balance

Description	Energy Input				Energy Output			
	M (Kg/hr)	Cp (KJ/Kg)	Δt °C	Heat Consumed (kJ/h)	M(kg/hr)	Cp (KJ/Kg)	Δt °C	Heat Consumed (kJ/h)
EDC	140.38	0.29	60	2364.66	140.38	0.29	50	1840.05
Heat Load	-	-	-	-542	-	-	-	-
TOTAL				1840.05				1840.05

CHAPTER 5

5.1. EQUIPMENT DESIGN:

Distillation Column Design

The parameters necessary for the design are,

- Vapour load
- Theoretical No of stages
- Feed stage
- Rectifying stages
- Stripping stages
- Actual number of stages
- Column height

5.1.1..Vapour load,

$$V = D(R+1) MV/3600 \cdot \rho_v$$

D = Number of moles of distillate

MV = Average molecular weight

ρ_v = Density of vapour

$$D = 140.38/98.96 = 1.418 \text{ moles}$$

Where, MV

Mole fraction:

$$M_v = 98.96 \cdot 0.98 + 133.4 \cdot 0.04$$

$$= 102.31 \text{ g/mole}$$

$$\rho = P M_{avg} / RT$$

$$\text{Operating pressure} = 101.3 \cdot 102.316 / 8.314 \cdot (275 + 75)$$

$$= (10364.6/2893.2) = 3.582 \text{ kg/m}^3$$

Vapour load,

$$V = 1.4185 \cdot (1+4) \cdot 102.316 / 3600 \cdot 3.582$$

$$V = 0.56 \text{ m}^3/\text{sec}$$

2. Minimum number of theoretical stages are calculated using McCabe – Thiele Method

Step 1: Convert the data in mole basis

$$\text{Amount of EDC} = 140.38 \text{ Kg/hr}$$

$$\text{Amount of ETC} = 189.2 \text{ Kg/hr}$$

$$\text{Total amount of feed entering the Distillation column} = 329.68 \text{ Kg/hr}$$

Mole Basis:

$$\text{Amount of EDC} = 0.42$$

$$\text{Amount of ETC} = 0.58$$

Step 2: Material Balance for Distillation column

$$F = D + W$$

$$F x_F = D x_D + W x_W$$

We calculated:

$$x_F = 0.58$$

$$x_D = 0.99$$

$$x_W = 0.1$$

Step 3: Determine VLE data

$$y = \alpha \cdot x / 1 + (\alpha - 1) \cdot x$$

$$\text{Relative volatility } \alpha = 5.68$$

$$x = 0.2$$

$$y = \alpha x / 1 + (\alpha - 1) x$$

$$y = (5.68 \cdot 0.2) / 1 + (5.68 - 1) \cdot 0.2$$

$$y = 0.587$$

Table 5.1 : VLE data

X	Y
0	0
0.1	0.387
0.2	0.587
0.3	0.709
0.4	0.791
0.5	0.85
0.6	0.895
0.8	0.958
1.0	1.0

Step 4: Plot a graph between x and y

Step 5: locating X_D , X_W , X_F on the diagonal line

Step 6 : From X_F draw the q line the q line is vertical here because the feed is in liquid state

Step 7: Joining X_D and the intercept point of q line and equilibrium curve and extent to Y axis

The Y intercept is $X_D / R_{min} + 1 = 0.88$

$$X_D = 0.99$$

$$X_D / R_{min} + 1 = 0.99 / R_{min} + 1 = 0.88$$

$$R_{min} = 0.13$$

$$R_{act} = 2.6(0.15) = 0.39$$

$$X_D / R_{act} + 1 = 0.99 / 0.39 + 1 = 0.71$$

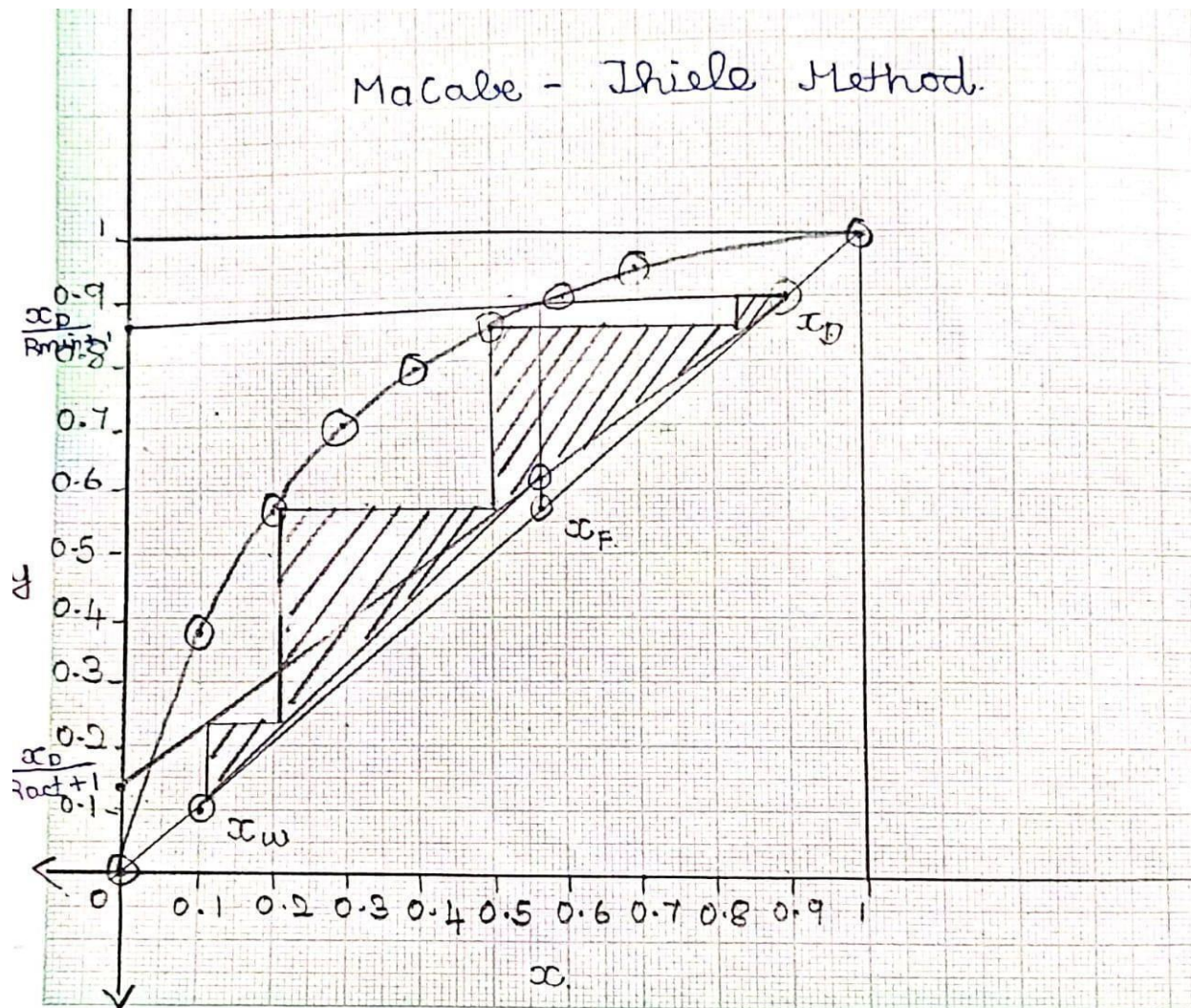


Fig 5.1 :MaCabe – Thiele Method

Equilibrium curve – The line joining the VLE data

Diagonal line – The line Joining the x_D , x_W , x_F

Q line is based on the feed condition(liquid)

5.1.2. Total number of stages:

Theoretical number of stages = 4

Feed stage location = 2

Number of Rectifying stage = 1

Number of stripping stages = 2

5.1.3. Actual number of stages:

.Actual no of stages = (theoretical no of trays – 1)/efficiency) +1

Efficiency = 98% = 0.98

Actual trays = (4 -1)/0.98)+1 = 5

Theoretical number of trays = 4

Actual number of trays = 5

Inlet stage location = 2

5.1.4. Column Height:

. Column Height = (N-1)P + 2P

Where, The plate spacing P = 0.4m

Column Height = (5-1)*0.4+2*0.4
= 2+1 = 3 m

5.1.5. Design summary for Distillation column:

Vapour load =0.66 m³/sec

Theoretical number of trays = 4

Actual number of trays = 5

Inlet stage location = 2

Column Hht = 3 m

5.2. PLUG FLOW REACTOR:

The performance equation of PFR is

$$V/F_a = \int dX_a / (-r_a)$$

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

The values of Arrhenius factor and activation energy were found to be

$$A = 1.1852 \times 10^6 \text{ s}^{-1} \text{ and } E_a = 65 \text{ Kcal/mol}$$

On solving, $k = 1.162 \text{ s}^{-1}$

We know that, $-r_a = k C_a^n$

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

$$C_a = M / V_{\text{mix}}$$

Where, M = molar flow rate of Ethylene

V_{mix} = volume of mixture

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

On solving

$$\begin{aligned} \rho_{\text{mix}} &= (2.898 \text{ kg/m}^3 \times 1/28.05 \text{ mol/g} \times 1000 \text{ g/kg}) + (1.282 \times 1000 / 70.9) \\ &= 103.31 + 18.08 \\ &= 121.39 \text{ kg/m}^3 \\ &= 2.898 + 1.282 = 4.18 \text{ Kg/m}^3 \end{aligned}$$

$$V_{\text{mix}} = 381.45 / 4.18$$

$$= 91.25 \text{ m}^3 / \text{hr}$$

Thus, $C_a = 7.091 \cdot 10^3 / 91.25$

$$= 77.70 \text{ kmol/m}^3$$

Thus, $-r_a = 1.162 \cdot 77.70$

$$= 90.28 \text{ kmol/m}^3 \text{ s}$$

The conversion rate is 92% of Ethylene to Ethylene Dichloride

From performance equation

$$V = (F/k C_{p0}) / \int dX_a$$

$$V = (381.45/90.28)/0.92$$

$$V = 4.592 \text{ m}^3$$

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

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

On simplifying $D = 0.836 \text{ m}$

$$L = 8.36 \text{ m}$$

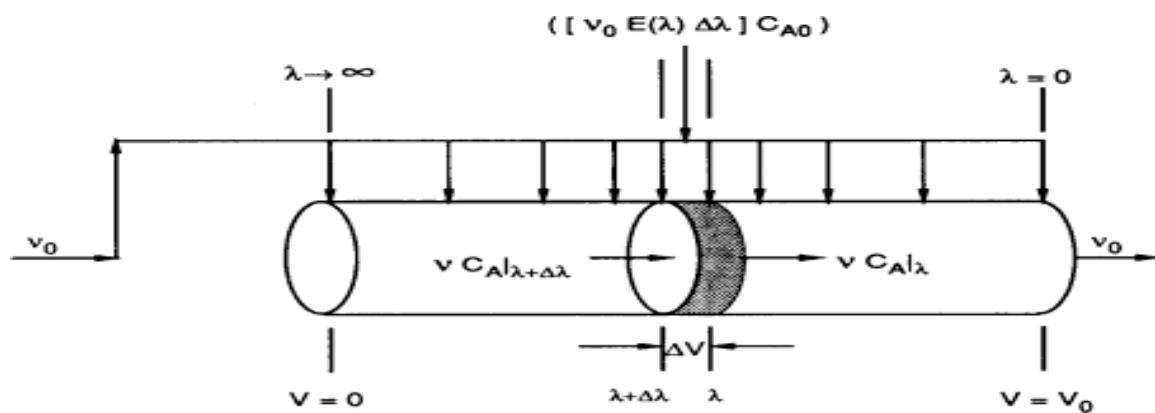


Fig 5.2 Plug flow reactor

CHAPTER 6

6.1 PROCESS ECONOMICS:

Total Equipment cost:

Table 6.1. Process Economics

Equipment	No of Equipments	Total cost in lakhs
Reactor	1	40
Storage Tank	2	8
Condenser	1	6
Neutralizer	1	4
Distillation column	2	24
Total	7	82

DETAILED COST ANALYSIS

6.2. DIRECT COSTS:

A. Installation, Piping, Painting, Insulation, Instrumentation

1. Total Equipment cost = 82 L
2. Installation including insulation and painting = $0.4 \times \text{Purchased Equipment cost}$
 $= 0.4 \times 82 = 32.8 \text{ L}$
3. Instrumentation and controls = $0.2 \times \text{Purchased Equipment Cost}$
 $= 0.2 \times 82 = 16.4 \text{ L}$
4. Piping = $0.4 \times \text{Purchased Equipment cost}$
 $= 0.4 \times 82 = 32.4 \text{ L}$
5. Electrical Costs = $0.25 \times \text{Purchased Equipment cost}$
 $= 0.25 \times 82 = 20.5$

B. Building process and auxillary = $0.50 \times \text{Purchased Equipment cost}$ $= 0.50 \times 82 = 41 \text{ L}$

$$\begin{aligned}\text{C. Land} &= 0.05 * \text{Purchased Equipment cost} \\ &= 0.05 * 82 = 4.1 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{Direct costs} &= A+B+C \\ &= 229.6 \text{ L}\end{aligned}$$

6.3.INDIRECT COSTS:

- Engineering and Supervision = $0.2 * \text{Direct costs}$
 $= 0.2 * 229.6 = 45.92 \text{ L}$
- Construction Expenses and Supervision = $0.2 * \text{Direct costs}$
 $= 0.2 * 229.6 = 45.92 \text{ L}$
- Contingency Costs = $0.25 * \text{Direct costs}$
 $= 0.25 * 229.6 = 57.4 \text{ L}$
- Indirect Costs = $A+B+C = 149.24 \text{ L}$

$$\begin{aligned}\text{Fixed Capital Investment} &= \text{Indirect costs} + \text{direct costs} \\ &= 229.6 + 140.24 = 378.84 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{Working Capital} &= 0.2 * \text{Fixed Capital Investment} \\ &= 0.2 * 378.84 = 75.768 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{Total Capital Investment} &= \text{Fixed} + \text{Working Capital Investment} \\ &= 454.608 \text{ L}\end{aligned}$$

6.4. FIXED CHARGES:

- Depreciation = 15% of FCI + 3% for building
 $= (0.15 * 378.84) + (0.03 * 378.84)$
 $= 68.19 \text{ L}$
- Local Taxes = 3% of FCI
 $= 11.36 \text{ L}$
- Insurance = 10% of FCI
 $= 37.88 \text{ L}$

$$\text{Total Fixed charges} = 117.43 \text{ L}$$

$$\text{Total Product cost} = \text{Total Fixed Charges}/0.2 = 117.43/0.2 = 587.15 \text{ L}$$

6.5 MANUFACTURING COSTS:

A. Direct Production Costs

- Raw Material = $0.15 * \text{Total Product cost}$
 $= 0.15 * 587.15 = 88.07 \text{ L}$
- Operating labor = $0.1 * \text{Total Product cost}$
 $= 0.1 * 587.15 = 58.71 \text{ L}$
- Direct supervisory and chemical labor = $0.1 * \text{Operating labor}$
 $= 0.1 * 58.71 = 5.87 \text{ L}$
- Utilities = $0.1 * \text{Total Product costs}$
 $= 0.1 * 587.71 = 58.7 \text{ L}$
- Maintenance and Repairs(MNR) = $0.05 * \text{Total Product cost}$
 $= 0.05 * 587.15 = 29.35 \text{ L}$
- Operating supplies, Laboratory Charges and Patents and royalties = $0.1 * \text{MNR}$
 $= 0.1 * 58.71$
 $= 2.935 \text{ L}$
- Direct Product Costs = sum of 1+2+3+4+5 = 243.646 L

B. Fixed Charges = $0.2 * \text{Total Product cost}$
 $= 0.2 * 587.15 = 117.43 \text{ L}$

C. Plant Overhead Costs = $0.1 * \text{Total Product cost}$
 $= 0.1 * 587.15 = 58.71 \text{ L}$

Manufacturing Costs = A+B+C
 $= 419.78 \text{ L}$

- . General Expenses = $0.25 * \text{Total Product Costs}$
 $= 0.25 * 587.15 = 146.78 \text{ L}$
- . Total Product Cost = Manufacturing Costs + General Expenses
 $= 566.62 \text{ L}$

- 4.Current price of Product:

Cost of Product = 120 Rs/kg

Total selling price per annum = 1200 L

1. Gross Earnings = Total Selling Price – Total Product Costs
= 633.35 L
2. Tax = 0.3 * Gross earnings
= 0.3 * 633.35 = 190.05 L
3. Net profits = Gross Earnings – Tax
= 443.3 L
4. Rate of Return = Net Profit / TCI
= 78.32%

6.6.PAY OUT TIME:

Calculation of Payout time :

$$\text{Pay out time} = -\log(1 - (\text{interest rate} * \text{TCI}) / R) / \log(1 + I)$$

Interest rate I = 10%

R = Net profit + Depreciation

$$= 443.3 + 68.19 = 511.49 \text{ L}$$

$$\text{Pay out time} = -\log(1 - (0.10 * 454.608) / 511.45) / \log(1.1)$$

$$= 0.801 / 0.404$$

Pay out time = 2 year

CHAPTER 7

7. SAFETY ASPECTS

7.1. GENERAL ASPECTS:

Almost all the chemicals handled in this plant as a raw material, intermediate or final products can cause injury to personnel if improperly handled. The administrators ought to be completely familiar with the risky properties of the multitude of synthetics took care of and it should be prepared in legitimate manners to deal with materials to decrease individual contact to a base. The general overview for handling these materials and protecting personnel are explained below. The potentially hazardous materials are listed below:

7.1.1. HANDLING HAZARDOUS MATERIALS:

By and large, it ought to be underlined that works ought to limit all actual contact with the synthetic compounds took care of in this plant by thinking about the accompanying standards

- Always Keep the chemical compound within closed container.
- Use appropriate defensive apparel and gear if the synthetic compounds can't be kept inside shut holders.

7.1.2. SAFETY IN PRESSURIZED VESSELS

All vessels should be completely drained, depressurized, purged and vented before opening and/or attending for inspection or maintenance. From an environmental, atmospheric aspect, vessels should preferably be drained to another vessel before opening. If this cannot be accomplished, the next most desirable procedure is to drain vessels to drums. If drained, full precaution should be taken to prevent sledge, atmospheric contamination and excessive flashing in the sewers. Vessels should be depressurized back to process if possible.

Once drained and depressurized, vessel entry procedures must be followed. The minimum requirements consisting of oxygen and combustible gas monitoring prior to vessel entry, disconnecting of all piping to the vessel, lock out of motors, equipment vessel entry personnel with safety harnesses and keeping fire watch and safety conservers on hand while personnel are in the vessel and maintaining constant communication with those inside.

7.1.3. SAFETY IN USE OF TOOLS AND STEAMHOSES

Powered tools, hand tools, should all be in good safe working condition. Electric cables grounding should be intact. Ropes and pulleys, slings should not be frayed. Ladders should be intact.

Be certain that all steam hoses are in acceptable condition and that all associations are made tight so that there is no way of a release that could cause burning of an administrator. Hoses ought to likewise be secured so they are unintentionally separated by vibration or other external specialists that the free hose end doesn't whip about. Break the steam valve from the start until all water in the hose is released and the hose is warmed up, to keep high speed planes of water from giving from the hose.

Since compacted air can't be seen, not many administrators appreciate the perils when utilizing it. Goggles ought to be worn when air is utilized for cleaning of garments as little particles of earth can get into the skin. When taking care of with steam hoses, precautionary measures ought to be taken to guarantee great conditions, tight associations and secure hoses on the off chance that they detach.

7.1.4. REPAIRING LEAKS:

Because of the hazardous nature of the chemicals handled in the plant, leaks should be repaired immediately, whenever possible. Leaks in the reactor feed or reactor effluent system must be repaired. Piping, vessels, heat exchangers and other equipment should be thoroughly drained, depressurized and purged before performing maintenance.

7.2. FIRST AID:

All administrators ought to be prepared to perceive the dangerous impact of the carious synthetic substances dealt with and to play out the essential first air strategy to limit work force injury.

The plant doctor ought to be made familiar with the carious synthetics being taken care of so he will be set up to make the fundamental clinical move immediately in case of genuine faculty openness.

7.2.1. PERSONAL PROTECTING EQUIPMENT:

Consistently administrators and other staff inside the plant ought to be completely dressed with long-sleeved shirts and long sleeved pants, caps, wellbeing glasses and security shoes. To diminish the chance of unsafe contacts with synthetic substances, administrators ought to be constrained to wear reasonable goggles where relevant.

Little fluid anhydrous NH_3 and Liquid alkali spills from channel or vent valves or pressing around valves can go unnoticed and can cause eye wounds.

All administrators ought to have a couple of work gloves to shield their hands from contact with synthetic substances when they are performing procedure on the cycle supplies. Since gas veils are of restricted an incentive for higher convergence of gases, it is attractive to have accessible independent air covers which will be stamped and effectively accessible in the work region. Getaway respirators ought to be conveyed by all work force in the working territories. Other traditional fire and security gear, for example, fire covers, quenchers, and so forth, ought to be promptly accessible to every single working help and upkeep staff. The plant security program ought to incorporate preparing and occasional boost preparing of all work force. In regard to safe utilization of the security and emergency treatment hardware, reaction groups ought to be set upto help laborers when they are in harm's way.

7.2.2. MAJOR HEALTH HAZARDS:

Respiratory plot aggravation, skin bothering, eye disturbance, focal sensory system discouragement, hypersensitive responses, malignant growth risk (in people)

7.2.3. PHYSICAL HAZARDS:

May polymerize. Holders may burst or detonate. May disintegrate on contact with air, light, dampness, warmth or capacity and use above room temperature.

Deliveries poisonous, destructive, combustible or unstable gases.

7.2.4. Other hazards:

This substance/blend contains no parts viewed as either relentless, bio collective and harmful , or diligent and very bio aggregate at levels of 0.2% or higher.

7.2.5. First aid measures

Depiction of emergency treatment estimates General guidance Consult a doctor. Show this wellbeing information sheet to the specialist in participation.

- If breathed in:

Whenever took in, move individual into natural air. If not breathing, give fake breath. Counsel a doctor.

- In instance of skin contact:

Wash off with cleanser and a lot of water. Counsel a doctor.

- In instance of eye to eye connection:

Flush altogether with a lot of water for at any rate 15 minutes and counsel a doctor.

7.3. LIKELY HEALTH EFFECTS INHALATION:

- SHORT TERM EXPOSURE: aggravation, changes in circulatory strain, queasiness, regurgitating, stomach torment, trouble breathing, unpredictable heartbeat, migraine, sleepiness, wooziness, bewilderment, mind-set swings, quakes, loss of coordination, visual unsettling influences, somewhat blue skin tone, lung clog, kidney harm, liver , harm, obviousness, trance like state
- LONG TERM EXPOSURE: same as impacts detailed in transient openness, loss of craving, weight reduction, blood problems, cerebrum harm, malignant growth

7.3.1. SKIN CONTACT:

- SHORT TERM EXPOSURE: disturbance, unfavorably susceptible responses.
- LONG TERM EXPOSURE: bothering, unfavorably susceptible responses, queasiness, loss of craving, weight reduction, trouble breathing, migraine, laziness, unsteadiness, joint agony, loss of coordination, visual unsettling influences loss of motion

7.3.2. EYECONTACT:

- SHORT TERM EXPOSURE: bothering (perhaps serious), obscured vision

- LONG TERM EXPOSURE: bothering (perhaps serious), eye harm

7.3.3. INGESTION:

- SHORT TERM EXPOSURE: same as impacts announced in transient inward breath
- LONG TERM EXPOSURE: same as impacts announced in long haul inward breath

7.4. FIRE FIGHTING MEASURES:

- FIRE AND EXPLOSION HAZARDS: Slight fire peril.
- EXTINGUISHING MEDIA: carbon dioxide, ordinary dry substance Large flames: Use standard froth or flood with fine water splash.

7.5. SAFTY MEASURES:

- INHALATION: If antagonistic impacts happen, eliminate to uncontaminated territory. Give counterfeit breath if not relaxing. Stand out enough to be noticed.
- SKIN CONTACT: Wash skin with cleanser and water for in any event 15 minutes while taking off tainted attire and shoes. Stand out enough to be noticed, if necessary. Altogether perfect and dry polluted apparel and shoes before reuse.
- EYE CONTACT: Flush eyes with a lot of water for at any rate 15 minutes. At that point stand out enough to be noticed.
- INGESTION: If heaving happens, keep head lower than hips to help forestall desire. In the event that individual is oblivious, go head to side. Stand out enough to be noticed right away.

7.6 ACCIDENTAL RELEASE MEASURES:

- AIR RELEASE: Reduce fumes with water splash. Gather overflow for removal as likely dangerous waste.
- SOIL RELEASE: Dig holding territory like tidal pond, lake or pit for control. Embankment for later removal. Retain with sand or other non-flammable material.
- WATER RELEASE: Absorb with initiated carbon. Eliminate caught material with pull hoses. Gather spilled material utilizing mechanical hardware. Subject to California Safe Drinking Water and Toxic Enforcement Act of 1986 . Keep out of

water supplies and sewers.

7.6.1. HANDLING & STORAGE:

- STORAGE: Store and handle as per every single current guideline and norms. Store in a cool, dry spot. Store in a very much ventilated territory. Dodge heat, flares, sparkles and different wellsprings of start. Keep isolated from contrary substances.
- EXPOSURE CONTROLS, PERSONAL PROTECTION:
- VENTILATION: Provide nearby fumes ventilation framework. Guarantee consistence with relevant openness limits.
- EYE PROTECTION: Wear sprinkle safe security goggles. Give a crisis eye wash wellspring and brisk douse shower in the prompt work zone.
- CLOTHING: Wear fitting compound safe dress.
- GLOVES: Wear fitting compound safe gloves.

7.6.2. RESPIRATOR:

The accompanying respirators and most extreme use focuses are drawn from NIOSH and OSHA. Any independent breathing mechanical assembly that has a full face piece and is worked in a pressing factor interest or other positive-pressure mode.

Any supplied-air respirator with a full face piece that is operated in a pressure-demand or other positive pressing factor mode in mix with a helper independent breathing device worked in pressure interest or other positive-pressure mode

CHAPTER 8

8. PLANT LAYOUT AND SITE SELECTION

8.1.SITE SELECTION:

Plant area is anyway perhaps the main piece of definite arranging. Choice of appropriate area of the plant is vital in light of the fact that accomplishment of the plant depends on this point.

The geological area of the last plant can impact the achievement of a modern endeavor. Much consideration should be practiced in picking the plant site, and a wide range of variables should be thought of. Basically, the plant ought to be found where the base expense of creation and circulation can be gotten, yet different components, like space for development and general day to day environments, are additionally significant.

A rough thought with respect to the plant area ought to be acquired before a plan project arrives at the nitty gritty gauge stage, and a firm area ought to be set endless supply of the itemized gauge plan. The decision of the last site should initially be founded on a total overview of the benefits and detriments of different topographical territory and, eventually, on the benefits and weaknesses of accessible land. The accompanying elements ought to be considered in picking a plant site:

- Water supply
- Markets
- Climate
- Labour supply
- Transportation facilities
- Raw materials
- Waste disposal
- Power and fuel
- Taxation and legal restrictions
- Community factors
- Flood and fire protection
- Site selection

The elements that should be assessed in a plant-area study demonstrate the requirement for an immense measure of data, both quantitative (factual) and subjective. **8.1.1. Raw materials:**

The wellspring of crude materials is quite possibly the main elements affecting the choice of a plant site. This is especially obvious if enormous volumes of crude materials are burned-through, in light of the fact that area close to the crude materials source grants impressive decrease in transportation and capacity charges. Consideration ought to be given to the bought cost of the crude materials, distance from the cause of supply, cargo or transportation costs, unwavering quality of supply, immaculateness of the accessible crude materials, and capacity necessities.

8.1.2. Market:

The area of business sectors or moderate dispersion places influences the expense of item conveyance and the time needed for delivery. Nearness to the significant business sectors is a significant thought in the choice of a plant site, on the grounds that the purchaser generally thinks that its profitable to buy from close by sources. It ought to be noticed that markets are required for results just as for the significant eventual outcomes

8.1.3. Power and fuel:

Force and steam prerequisites are high in most modern plants, and fuel is normally needed to supply these utilities. Thus, force and fuel can be joined as one central point in the decision of a plant utilizing electrolytic cycles are regularly situated close to enormous hydroelectric establishments. On the off chance that the plant requires huge amounts of coal or oil, area close to a wellspring of fuel supply might be fundamental for financial activity. The neighborhood cost of force can help decide if force ought to be bought or self-produced.

8.1.4. Climate:

In the event that the plant is situated in a chilly environment, expenses might be increment by the need for development of defensive sanctuaries around the cycle hardware, and exceptional cooling pinnacles or cooling gear might be required if the overarching temperatures are high. Unreasonable stickiness or boundaries of sweltering or chilly climate can seriously affect the monetary activity of a plant, and these variables

ought to be analyzed when picking a plant site.

8.1.5. Transportation:

Water, rail lines, and expressways are the basic methods for transportation utilized by mechanical concerns. The sort and measure of items and crude materials decide the most reasonable kind of transportation offices. Regardless, cautious consideration ought to be given to nearby cargo rates and existing railroad lines. The closeness to railroad focus and plausibility of channel, waterway, lake, or sea transport should be thought of. On the off chance that conceivable, the plant site ought to approach every one of the three kinds of transportation, and, positively, at any rate two sorts ought to be accessible. Compelling transportation offices for the plant laborers are fundamental.

8.1.6. Water supply:

The cycle enterprises utilize enormous amounts of water for cooling, washing, steam age, and as a crude material. The plant, in this way, should be found where a trustworthy stock of water is accessible. The temperature, mineral substance, residue or sand content, bacteriological substance, and cost for supply and purging treatment should likewise be viewed as while picking a water supply.

8.1.7. Waste Disposal:

As of late, numerous legitimate limitations have been put on the techniques for discarding waste materials from the interaction enterprises. The site chose for a plant ought to have sufficient limit and offices for right garbage removal. Despite the fact that a given zone has no limitations on contamination, it ought not be accepted that this condition will keep on existing. Garbage removal can be cultivated by water, land, or air dispersal. In picking a plant site, the reasonable resistance levels for the different techniques for garbage removal ought to be thought of, and consideration ought to be given to possible prerequisites for extra waste-treatment offices.

8.1.8. Labor supply:

The sort and supply of work accessible nearby a proposed plant site should be inspected. Thought ought to be given to winning compensation rates, limitations on number of hours worked each week, contending businesses that can cause disappointment or high turnover rates among the laborers, racial issues, and varieties in the expertise and knowledge of the specialists.

8.1.9. *Taxations and legal restrictions:*

State and nearby duty rates on property, pay, joblessness protection and comparable things shift starting with one area then onto the next. Additionally, neighborhood guidelines on drafting, building regulations, disturbance viewpoints, and transportation offices can impact the last decision of a land site.

8.1.10. *Site characteristics:*

The qualities of the land at a proposed plant site ought to be analyzed cautiously. The geography of the plot of land and the dirt design should be thought of, since they may pronouncedly affect development costs. The expense of the land is significant just as neighborhood building expenses and day to day environments. Future changes may make it alluring or important to extend the plant offices. Subsequently, despite the fact that no quick extension is arranged, another plant ought to be built at an area where extra space is accessible.

8.1.11. *Flood and fire protection:*

Numerous mechanical plants are situated along waterways or close to enormous waterways, and there are dangers of flood or storm harm. Prior to picking a plant site, the territorial history of common occasions of this sort ought to be inspected and the results of such events considered. In the event of a significant fire, help from outside local groups of fire-fighters ought to be accessible.

8.1.12. *Community factor:*

The character and facilities of a community can have quite an effect on the location of the plant. If a certain minimum number of facilities for satisfactory living of plant personnel do not exist, it often becomes a burden for the plant to subsidize such facilities. Cultural facilities of the community are important to sound growth. Churches, libraries, schools, civic theatres, concert associations, and other similar groups, If active and dynamic, do much to make a community progressive. The efficiency, character and history of both state and local government should be evaluated. The existence of low taxes is not in itself a favorable situation unless the community is already well developed and relatively free of debt.

8.2. PLANT LAYOUT IMPORTANCE:

Plant design alludes to the course of action of actual offices like hardware, gear, stockpiles, divisions and so forth inside the plant working in such a way in order to have fastest progression of material at the most minimal expense and with the most minimal expense preparing the item from the crude material to the completed item.

It encourages the creation cycle, limits material dealing with, time and cost, and permits adaptability of activities, simple creation stream, utilizes the structure, advances viable usage of labor, and accommodates representatives comfort, wellbeing, comfort at work, most extreme openness to characteristic light and ventilation.

It is additionally significant on the grounds that it influences the progression of material and cycles, work effectiveness, oversight and control, utilization of room and development prospects and so on

A productive plant format is one that can be instrumental in accomplishing the accompanying destinations:

- Proper and proficient use of accessible floor space
- To guarantee that work continues starting with one point then onto the next point without any delay
- Provide enough creation limit.
- Reduce material dealing with costs
- Reduce risks to work force
- Utilize work productively
- Increase business
- Reduce mishaps
- Provide for volume and item adaptability
- Provide simplicity of oversight and control
- Provide for worker security and wellbeing

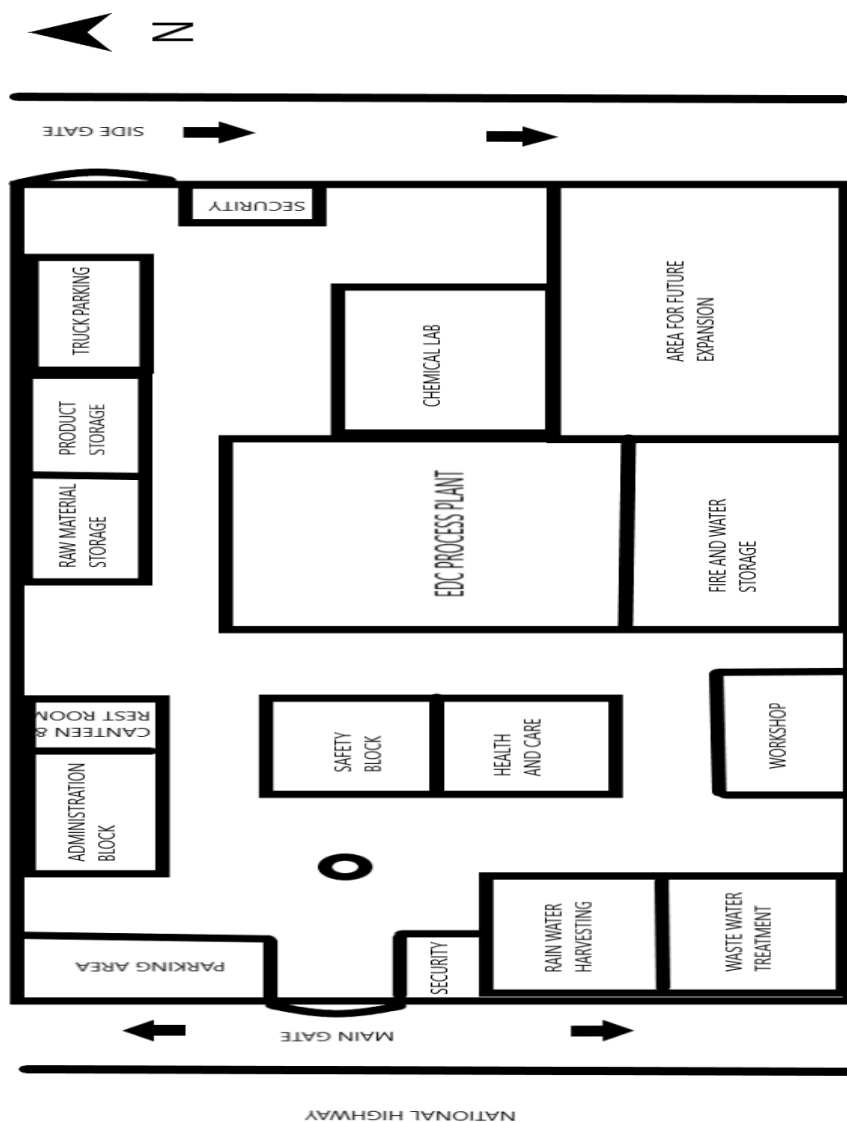


Fig 8.1: Plant layout

CHAPTER 9

9.1 PROCESS CONTROL AND INSTRUMENTATION

9.1.1 PROCESS DESCRIPTION:

Ethylene dichloride is produced from ethylene. The reaction takes place in a plug flow reactor. The reactor maintains at 120°C . Two side reactions also take place. The 1st is ethylene reacts with chlorine to give ethylene dichloride and the 2nd is chlorine reacts with ethylene dichloride to give ethylene trichloride.

Now the contents are sent to the distillation columns. In the first distillation column, the ETC comes out as the distillate and the remaining contents travel to the other distillation column where the EDC and crude are separated.

9.1.2 INPUT-OUTPUT STRUCTURE

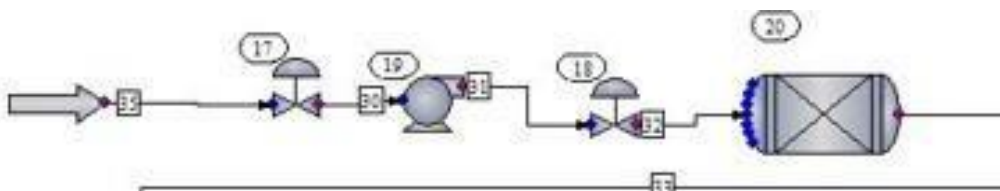


Fig 9.1 Instrumentation diagram of reactor

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.

9.2. NEUTRALIZER:

In Neutralizer NaOH required to get neutralize excess HCl formed in the reaction. As well this NaOH acts a purifier the impurities occur in reaction

10-15 % of NaOH required to remove HCl and 100% of HCl is Neutralized = 57.2 Kg/hr

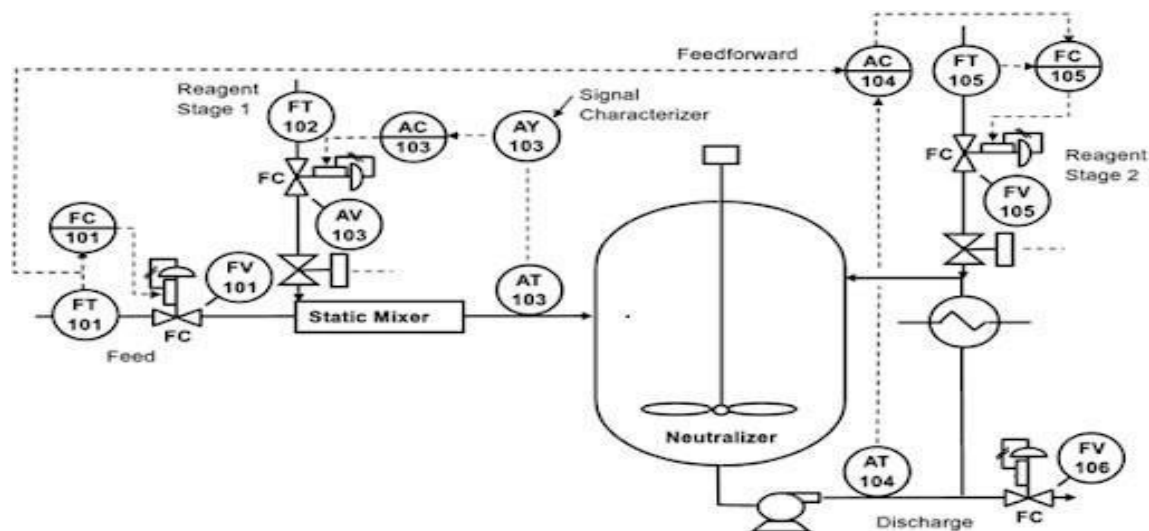


Fig 9.2: Neutralizer

9.1.3 SEPARATION SECTION

The control circles are generally standard for the refining segment 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. 75 deg celcius and 85 deg celcius at environmental pressing factor itself. In this manner, it is attainable 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 climate on the reflux drums

The Ethylene trichloride leaves from the highest point of the segment. That implies a quality regulator must be put here. That leaves the bubble up rate to control the level. The creation 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. Indeed, the distillate line must be utilized for stock purposes. In the event that some Ethylene trichloride gets conveyed to the following section, it essentially comes out from the lower part of that segment

The temperature in the section is controlled through the reboiler

9.2. INSTRUMENTS

The different instruments used in the P & I diagram generally are Flow meters, Level meters, Thermometers, Quality Analysis, Radiation measurement concentration meters, Pressure transmitters and Weight calculation. The instruments are used for indicating, recording and controlling purposes. The instruments are all identified by a code number. The first letter of the code refers to the property measured. For Example, F for Flow meters, T for thermometers and L for Level meters. The second letter is either I, R or C which indicates to indicating, recording and controlling respectively. Then the letters are followed by a number used to identify the instrument uniquely amidst a number of similar instruments.

9.3. Aim:

- To control the interaction factors that they are inside known safe working cutoff points.
- To keep up the item arrangements inside the predefined quality norms.
- To recognize risky circumstances and create caution and programmed shut-down frameworks.
- To work at most reduced conceivable creation cost accomplish the ideal item yield. •
- To accomplish the ideal item yield accomplish the ideal item yield. To accomplish the ideal item yield

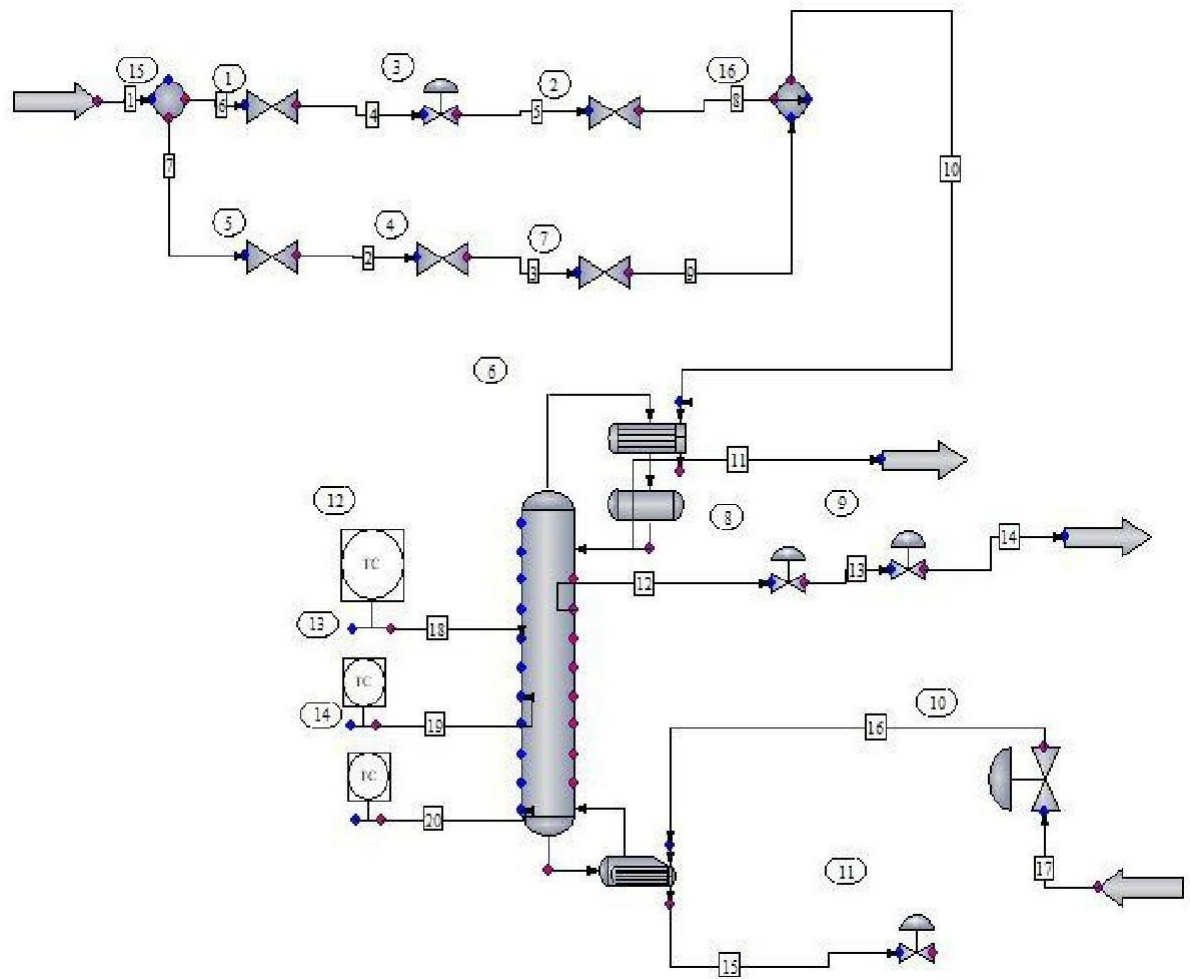


Fig 9.3 Instrumentation of distillation column

CHAPTER 10

10. CONCLUSION:

The various configuration involved for the production of Ethylene dichloride has been designed for the capacity of 1000 TPA. Ethylene dichloride is a very important product which is extensively used for the manufacture of Vinyl chloride and Polyvinyl chloride. Various aspects of safety, environment and application have been considered. The process is also cheap unlike the other processes, which is very good in an economic way. The cost economics of the plant has been detailed and the payback period account to 2 years. The design of reactor and distillation column carried out in this project.

The project based on manufacturing of ethylene dichloride of capacity 1000 tons per years it includes material balance and energy balance

Design of equipment such as

- Plug flow reactor
- Distillation column by McCabe- Thiele diagram

Cost estimation: Pay Back Period: 2 Years.

Efficient site selection and safety aspects are studied in this project

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