

PLANT DESIGN FOR THE MANUFACTURE OF GLUTAMIC ACID

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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DEPARTMENT OF CHEMICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Nikizhl P (37190029)** and **Rama Krishna Reddy K (371900025)** who had done the Project work as a team. Who carried out the project entitled **"PLANT DESIGN FOR THE MANUFACTURE OF GLUTAMIC ACID"** under our supervision from SEPTEMBER 2020 to MARCH 2021.

Internal Guide

Dr. A Annam Renita Ph.D.

Head of the Department

Dr. S. SATHISH (M.E., Ph.D.)

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We, **Nikizhl p (37190029)** and **Rama Krishna Reddy K (37190025)** hereby declare that the Project report entitled plant design for the manufacture of glutamic acid done by me under the guidance of **Dr. A Annam Renita** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Chemical Engineering.



SIGNATURE OF THE CANDIDATE

DATE:

PLACE:

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K. R. K. Reddy

SIGNATURE OF THE CANDIDATE

DATE:

PLACE:

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I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr.S. Sathish** and **Dr.D. Prabhu**, Head of the Department, Department of Chemical Engineering for providing me the necessary support and details at the right time during the progressive of reviews.

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ABSTRACT

A process of preparing glutamic acid of 1000 TPA by fermentation of micro-organism. The process flow diagram has been described and the study of material balance and energy balance for production of 1000 TPA. Design of batch reactor and crystallizer. 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 glutamic acid of 1000 TPA by fermentation process.

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CHAPTER 1

INTRODUCTION:

The microbiological strategies for delivering food varieties and refreshments were unwittingly applied by our progenitors. They made wine from natural product squeeze and heated bread with yeast. Today we actually utilize these strategies in creating numerous substances. This is on the grounds that the maturation technique is the most effortless method of delivering food varieties, drinks, and surprisingly more unpredictable mixtures, which we can't fabricate monetarily by manufactured strategies. Over the most recent twenty years maturation has extended its application to the creation of anti-microbials and amino acids. These new applications have added to the prosperity of humankind. Perhaps the best accomplishment in amino-corrosive creation by aging is the microbiological creation of L-Glutamic acid. Glutamic acid was found by Ritthausen in 1866. In 1908 teacher Ikeda tracked down that the material upgrading the flavor of ocean weed (tangle) soup came from the sodium salt of glutamic corrosive (monosodium glutamate). From that point forward, monosodium glutamate has been broadly utilized in both the food business and by the overall population as a flavor-upgrading specialist. The interest of glutamic corrosive has expanded quickly. Before 1956 glutamic corrosive was principally acquired by the hydrolysis of plant proteins, e. g. gluten. In 1956 Japanese agents revealed the chance of 2 creating glutamic corrosive by microbiological means, and started on a mechanical scale the creation of this amino corrosive. Due to their prosperity, this technique has been acknowledged by different countries and furthermore has animated agents to discover other miniature life forms and strategies to deliver glutamic corrosive all the more adequately. In spite of the fact that the new interest in the production of glutamic corrosive has moved to substance manufactured strategies, the microbiological technique for creating glutamic corrosive records for virtually the entirety of the glutamic corrosive utilized today. Notwithstanding the far-reaching utilization of the microbiological technique for the creation of glutamic corrosive little has been distributed up to this point on the conditions needed for its

creation. In this proposal, the creator read the conditions needed for the collection of glutamic acid by *Micrococcus glutamicus* in a glucose-ammonium medium and assessed the connection between the pace of oxygen consumption and the development of the miniature organic entity. pilot plant scale fermentor and the assistant gear were developed. The conditions contemplated were cell strain, medium arrangement, antifoam added substance fixations, air circulation, tumult, and aging time.

1.1 APPLICATION:

L-Glutamic Acid is an amino acid ordinarily utilized as a salt substitute, a dietary enhancement, a flavor enhancer, and furthermore utilized as a preventive specialist.

L-Glutamic Acid E620 is utilized as wholesome enhancement in food, for example, in prepared cheeses, handled natural products, handled meats, soups, wines, flavors, and yogurts, canned shrimps, crabs, and so on

L-Glutamic Acid E620 can be utilized as healthful enhancement in Agriculture.

1.2 PROPERTIES OF GLUTAMIC ACID:

Chemical names: 2-Aminopentanedioec Acid

1-Aminopropane-1 :3-dicarboxylic Acid

n-Aminoglutaric Acid

Chemical formula: $C_5H_9NO_4$

Molecular weight: 147.14

Density: 1.460

Melting point: 199°C

Boiling point: 205°C

CHAPTER 2

LITERATURE SURVEY:

In 1866, occupied with the investigation of different vegetable proteins, Ritthausen (1866) hydrolyzed wheat gluten with sulfuric corrosive. Toward the finish of the response, calcium hydroxide was included abundance to accelerate sulfate, oxalate in overabundance to encourage the calcium, lead carbonate in abundance to hasten oxalate, and hydrogen sulfide in abundance to hasten the lead. The last, clear filtrate was concentrated until gems of tyrosine blended in with another and more water-dissolvable substance isolated. On cautious treatment with warm water, the last was isolated and was saved from the chilled, watery concentrate in a glasslike structure. This ended up being another amino corrosive which, taking into account its source, Ritthausen named glutamic corrosive. In 1873, Hlasiwetz and Habermann {18 73} utilized hydrochloric corrosive rather than sulfuric corrosive as a specialist for the total hydrolysis of proteins and got a hydrochloric corrosive salt of L-Glutamic corrosive. Because of its insolubility in a hydrochloric corrosive arrangement which surpassed of some other amino corrosive hydrochloride, it was effectively disconnected from protein hydrolysates.

L-Glutamic acid and its subsidiaries exist broadly in nature. Nonetheless, just a little amount of D-glutamic corrosive is found in the free state, for example, in new milk; in human pee, and follows in plant organs.

CHAPTER 3

AIM AND SCOPE:

AIM:

To design the process for the manufacture of glutamic acid and plant design.

SCOPE:

Selective reduction of hydrogen on large scale

To achieve high yield of the glutamic acid

Safe process for the development of glutamic acid

Use of *Micrococcus glutamicus*

Reducing reaction time

Easy workup of the reaction in order to achieve the pure product.

Selective amination

To avoid any incident while performing the reaction

CHAPTER 4

METHODS AND ALGORITHMS USED:

4.1 PROCESS SELECTION:

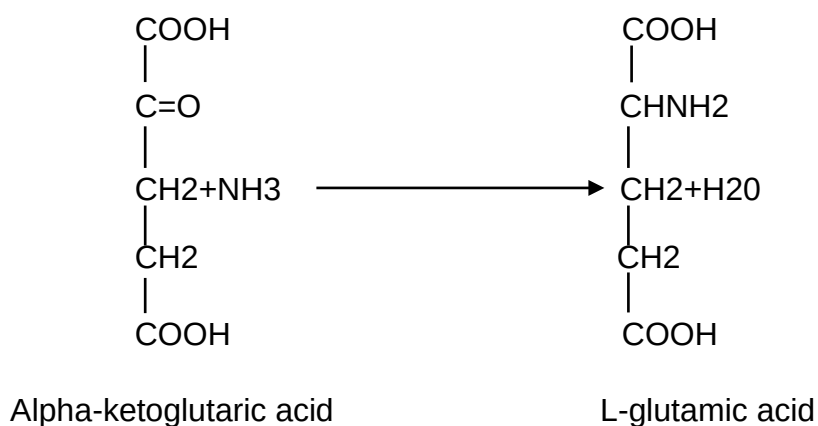
Two methods are utilized for the creation of glutamic acid are

- i) Hydrolysis of protein compounds.
- ii) Microbiological maturation.

In the first technique, the crude materials utilized in this the proteins are in glutamic corrosive, like gluten, soybean cake, or casein. The crude material is hydrolyzed by amassed hydrochloric corrosive in erosion safe pot for five to six hours at 11 0°C. At the point when the protein is totally hydrolyzed, the charcoal-like humus is eliminated by filtration. The filtrate is then packed in vacuo. The concentrated sweet fluid is chilled off to - 5°C for a few hours. During the way toward cooling the hydrochloric corrosive salt of L-Glutamic corrosive takes shape. The translucent glutamic corrosive is isolated from its mom fluid by mechanical methods. The glutamic corrosive hydrochloride is re-disintegrated in steaming hot water. Iron is eliminated from the salt arrangement and the arrangement is then de-colored with sodium sulfide and enacted charcoal. At last, the glasslike glutamic corrosive is acquired by changing the pH of the answer for its isoelectric point (PH 3. 2) and isolating the hasten.

In the second strategy, the typical culture mechanism for glutamic corrosive maturation contains sources like(glucose), the corrosive hydrolysate of starch, molasses, or a combination of these substances. A nitrogen source like urea and different synthetic compounds is available. The readied culture medium is cleaned in a fermentor by steam. At the point when the temperature of the medium chills off to 30°C, the miniature creature is added into fermentor in a legitimate inoculum of

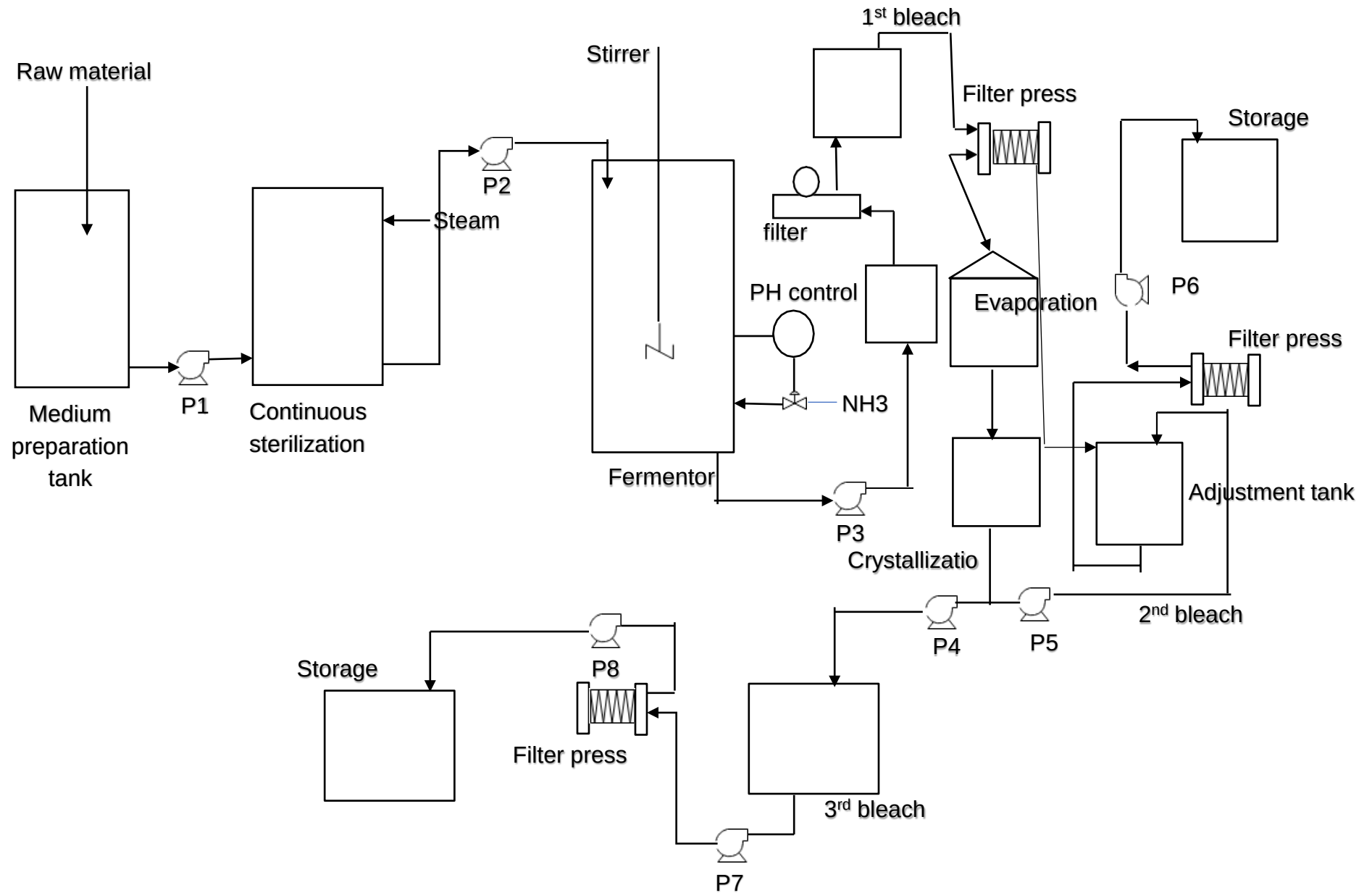
appropriate size. In this strategy, the miniature organic entity, *Micrococcus glutamicus*, or some other glutamic acid delivering miniature living beings are utilized the miniature living being is brooded for 1 ½ day and then the pH., temperature is controlled. And maturation takes and glutamic is accurized.



4.2. DESCRIPTION AND PROCEDURE:

The microbe's strain is filled in fermentor. The crude materials are incorporate sugar peptone, inorganic salts and Biotin fixation of that maturation impact the yield of glutamic corrosive. Aging finishes inside 2 to 4 days and, toward finish on the aging, it stock has glutamic corrosive as ammonium salt. In a commonplace following interaction, then the cells of bacteria are isolated & stock is gone that of an essential anion trade sap. Glutamic corrosive anions get on to the pitch and alkali is delivered. This alkali can be recuperated through refining and reused in the maturation. Elution to be performance to NaOH to straightforwardly frame monosodium glutamate (MSG) in the arrangement and to recover the essential anion exchanger. From the elute, MSG might be solidified straightforwardly followed by additional molding to be decolorization and serving to yield a food-grade nature of MSG.

4.1 Glutamic acid production process



CHAPTER 5

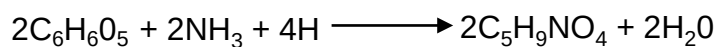
PERFORMANCE ANALYSIS

5.1 MATERIAL BALANCE

Manufacturing of glutamic acid by reductive amination process.

No of Working days: 300 days

Reaction



Basis 100 kg/hr.

INPUT=OUTPUT

Input

Alpha- ketoglutaric acid	292kg
Ammonia	34 kg
Hydrogen	4 kg
Total	330 kg

Output

L-glutamic acid	294 kg
Water	36 kg
Total	330 kg

INPUT=OUTPUT

Reactant: alpha-ketoglutaric acid, ammonia and hydrogen

Product: L-glutamic acid

By Product: Water

Reactor: Batch reactor

Basis: 1000 TPA

Working days: 330 days + 35 (Maintenance)

Weight basis = $(1000 \times 1000) / (300 \times 24) = 138.8 \text{ Kg/hr.}$

5.1.1. Assumption:

- Limiting reactant is ammonia.
- 100% conversion of limiting reactant
- The conversion rate of L-glutamic acid is 95%

5.2. REACTOR:

Assuming 100% conversion

138.8 kg/hr of L-glutamic acid formed = 95% of L-glutamic acid formed

x kg/hr of L-glutamic acid formed = 100% of L-glutamic acid formed

$$x = 138.8 \times 100 / 95$$

$$x = 146.1 \text{ kg/hr of L-glutamic acid}$$

5.2.1 Reactant:

Amount of Alpha-ketoglutaric acid and ammonia required

As per stoichiometric:

249 g/mole of L-glutamic acid = 292 g/mole of alpha-ketoglutaric acid

146.1 kg/hr of L-glutamic acid = 'x' kg/hr of alpha-ketoglutaric acid

$$x = 292 \times 146.1 / 249$$

$$x = 145.11 \text{ kg/hr}$$

According to reactor the conversion is 95%

145.11 kg/hr of alpha-ketoglutaric acid= 95% conversion

'x' kg/hr of alpha-ketoglutaric acid= 100% conversion

$$x = 100 \times 145.11 / 95 = 152.74 \text{ kg/hr}$$

Alpha-ketoglutaric acid required = 152.24 kg/hr

Total amount required: As per stoichiometric:

292 g/mole of Alpha-ketoglutaric acid = 330 g/mole of total reactant

152.75 kg/hr of Alpha-ketoglutaric acid= 'x' kg/hr of Total reactant

$$X = 330 \times 152.74 / 292 = 172.61 \text{ kg/hr of Total reactant}$$

294 g/mole of L-glutamic acid= 4 g/mole of hydrogen

146.1 kg/hr of L-glutamic acid = 'x' kg/hr of hydrogen

$$x = 4 \times 146.1 / 294 = 1.98 \text{ kg/hr}$$

Amount of hydrogen required = 1.98 kg/hr

Amount of ammonia = 172.61-152.74-1.98= 17.89 kg/hr

Amount of ammonia required = 17.89 kg/hr

5.2.2 Product:

Amount of L-glutamic acid, water required

Total content of product = 330 g/mole

Weight of L-glutamic acid = 294 g/mole

Weight of water = 36 g/mole

Amount of L-glutamic acid formed:

294 g/mole of L-glutamic acid= 330 g/mole of Total product

$$\begin{aligned}
 \text{'x' kg/hr of L-glutamic acid} &= 172.58 \text{ kg/hr of total product} \\
 \times &= 294 \times 172.58 / 330 \\
 &= 153.75 \text{ kg/hr}
 \end{aligned}$$

Amount of water formed:

As per stoichiometric:

$$\begin{aligned}
 36 \text{ g/mole of water required} &= 330 \text{ g/mole of total product} \\
 \text{'x' kg/hr of water required} &= 172.58 \text{ kg/hr of total product} \\
 \times &= 36 \times 172.58 / 330 \\
 &= 18.82 \text{ kg/hr}
 \end{aligned}$$

$$\text{Amount of L-glutamic acid formed} = 153.75 \text{ kg/hr}$$

$$\text{Amount of water formed} = 18.82 \text{ kg/hr}$$

Assuming the amount of unreacted ammonia = 0.1 kg/hr

Filter:

Input

Alpha- ketoglutaric acid	15.368 kg
Ammonia	1.7894 kg
Hydrogen	0.2105 kg
L-glutamic acid	294 kg
Water	36 kg

Output

	Filtrate	Residue
Alpha- ketoglutaric acid		15.368 kg
Ammonia	1.7894 kg	
Hydrogen	0.2105 kg	
L-glutamic acid		294 kg
Water	36 kg	
Total		306.368 kg

Material balance for crystallizer:

$$F = C + M$$

$$F x_f = C x_c + M x_m$$

$$F = 309.368 \quad x_f \Rightarrow 294/309.368 = 0.95$$

$$x_c = 1 \quad x_m = 0.008 \text{ (Solubility data of L-glutamic acid Acid)}$$

$$309.368 = C + M$$

$$309.368 \cdot x_f = C \cdot x_c + M \cdot x_m$$

$$C = 293.8667 \text{ Kg}$$

$$M = 15.5013 \text{ Kg}$$

5.3 ENERGY BALANCE:

5.3.1. Objective:

Energy in

Energy output

Heat created

Heatless

5.3.1 Specific heat capacity:

1. Alpha-keto glutaric acid = 3.377 kJ/kg
2. Ammonia = 2.2 kJ/kg
3. Hydrogen = 14.304 kJ/kg
4. L-glutamic acid = 1.19 kJ/kg
5. water = 4.2 kJ/kg

5.3.2 Heat of formation:

alpha- ketoglutaric = -1796.25 (KJ/ml) acid

ammonia = - 46.19 (KJ/ml)

hydrogen = 0 (KJ/ml)

L-glutamic acid = -1005.2 (KJ/ml)

Water = -285.82 (KJ/ml)

ΔH_r = (ΔH) products - (ΔH) reactants

$$= \{(-1005.2) + (-285.82)\} - \{(-1796.25) + (46.19) - (0)\}$$

$$= -1290.96 - (-1842.44) = 551.48 \text{ (KJ/m)}$$

5.4 REACTOR:

5.4.1 Energy input:

Heat input by Alpha-ketoglutaric acid:

$$Q = m \cdot c_p \cdot dt$$

$$Q = 152.74 \cdot 3.677 \cdot (65-25)$$

$$Q = 22466.554 \text{ KJ/hr}$$

Heat input by ammonia:

$$Q = m \cdot c_p \cdot dt$$

$$Q = 17.89 \cdot 2.2 \cdot (65-25)$$

$$Q = 1574.32 \text{ kJ/hr}$$

Heat input by Hydrogen:

$$Q = m \cdot c_p \cdot dt$$

$$Q = 1.98 \cdot 14.304 \cdot (65-25)$$

$$Q = 1132.87 \text{ kJ/hr}$$

5.4.2 Energy output:

Heat output L-glutamic acid:

$$Q = m \cdot c_p \cdot dt$$

$$Q = 153.75 \cdot 1.19 \cdot (121-25)$$

$$Q = 17564.4 \text{ KJ/hr}$$

Heat output by water:

$$Q = m \cdot c_p \cdot dt$$

$$Q = 18.82 \cdot 4.2 \cdot (121-25)$$

$$Q = 7588.224 \text{ KJ/hr}$$

Table 5.1: Reactor Energy Balance

Description	Input energy				Energy Output			
	M(Kg/hr)	Cp (KJ/Kg)	T(c)	Heat Consumed KJ/h	M(kg/hr)	Cp KJ/Kg	Δt °C	Heat Consumed KJ/h
Alpha-keto glutaric acid	152.74	3.677	40	22466.554				
Hydrogen	1.98	14.304	40	1132.87				
ammonia	17.89	2.2	40	1574.32				
L-glutamic acid					153.74	1.19	96	17564.4
water					18.82	4.2	96	7588.224
Unreacted ammonia					0.1	2.2	96	21.12
TOTAL				25173.744				25173.744

5.5 EQUIPMENT DESIGN

5.5.1 Batch reactor:

Basis: 400 L reactor

Diameter of the reactor = D

Height of the reactor = H

Volume of the reactor = 400 L = 0.4 m³

Volume of cylindrical shell V = $\pi/4 \cdot d^2 \cdot H$

Volume of elliptical head V = $\pi/24 \cdot d^3$

Assume H = 1.0 * diameter of vessel

Sub h in above we get V = $\pi/4 \cdot d^2 \cdot 1.0$

6 = $\pi/4 \cdot d^3 \cdot 1.0 + 2 \cdot \pi/24 \cdot d^3$

d³ = 0.4 / (1.0 * $\pi/4$ + $\pi/12$)

	d^3	$= 0.3827 \text{ m}^3$
	d	$= 1.789 \text{ m}$
	D	$= 1789 \text{ mm}$
Height of reactor	H	$= 1.0 * D = 1.0 * 1.789$
		$= 1.789 \text{ m}$
	H	$= 1789 \text{ mm}$

THICKNESS OF ELLIPTICAL HEAD

$$t = pDV/2fj$$

$$\text{stress factor} = 1/4 (2+k^2)$$

common value of k is 2

J – joint efficiency

f - Allowable stress

Assuming, efficiency	=	0.9
Atmospheric pressure	=	1 kg /cm ²
Design pressure	=	1.5 * atmospheric pressure
	=	1.5 kg/cm ²
Assuming	k	= 2.0
	V	= $\frac{1}{4} (2+(2.0)^2)$
		= 1.5
D- major axis of ellipse	=	1789 mm Assuming F allowable

Stress	= 1090 kg/cm ²
Thickness of elliptical head t	= $pDV/2fj$
Sub the values in above equ. T	= $1.5 \times 1327 \times 1.5 / (2 \times 1090 \times 0.9)$
	= 2.052 mm
Corrosion allowance	= 2 mm
Thickness of elliptical head t	= (2.052 + 2) mm
Thickness of elliptical head t	= 4.052 mm

THICKNESS OF THE BOTTOM SS PLATE

$$T_{\min} = pD_i / 2 \cdot f \cdot j - (pD_i)$$

Were,	T min	=minimum thickness for the sheet
	pDi	= internal pressure of the vessel
	f	= the allowable stress
	j	= the welding joint efficiency
Operating pressure	=	1.0 kg/cm ²
Design pressure	=	1.5*operating pressure
Allowable stress	=	1000kg/cm ²
Joint efficiency	=	90 %
Corrosion allowance	=	2 mm
Type of enclosure	=	Elliptical head

Calculation

$$\begin{aligned}T_{\min} &= p_{Di}/1 \cdot f \cdot j - (p_{Di}) \\T_{\min} &= 1.5 / 2 \cdot 1000 \cdot 0.9 - (1.5) \\&= 1.495 \text{ mm} \\ \text{Corrosion allowance} &= 2 \text{ mm} + 1.495 \text{ mm} \\T_{\min} &= 3.45 \text{ mm}\end{aligned}$$

DESIGN OF AGITATOR

$$\begin{aligned}\text{Diameter of the agitator } D_a &= 1/3 \cdot D_t \text{ Diameter of the tank} \\D_t &= 1789 \text{ mm} \\&= 1/3 \cdot 1789 \\&= 596.33 \text{ mm} \\ \text{Width of the blade } w &= 1/5 \cdot D_a \\ \text{Diameter of the agitator } D_a &= 119.266 \text{ mm} \\ \text{Width of the blade } w &= 265.4 \text{ mm} \\ \text{Length of the blade } L &= 1/4 \cdot D_a \\&= 1/4 \cdot 596.33 \text{ mm} \\&= 149.083 \text{ mm} \\ \text{Clearance between agitator} &= 1/3 \cdot D_a \\ \text{and bottom of reactor} &= 1/3 \cdot 596.33 \\&= 198.78 \text{ mm}\end{aligned}$$

$$\begin{aligned}\text{Thickness of the baffles } J &= 1/12 * Dt \\ &= 149.083 \text{ mm}\end{aligned}$$

POWER REQUIRED FOR AGITATOR

$$NRe = Da^2 * N * P / u$$

$$NRe = \text{Reynolds no.}$$

$$Da = \text{Diameter of the agitator}$$

$$N = \text{Speed of the agitator}$$

$$Q = \text{Density of liquid}$$

$$U = \text{viscosity of liquid}$$

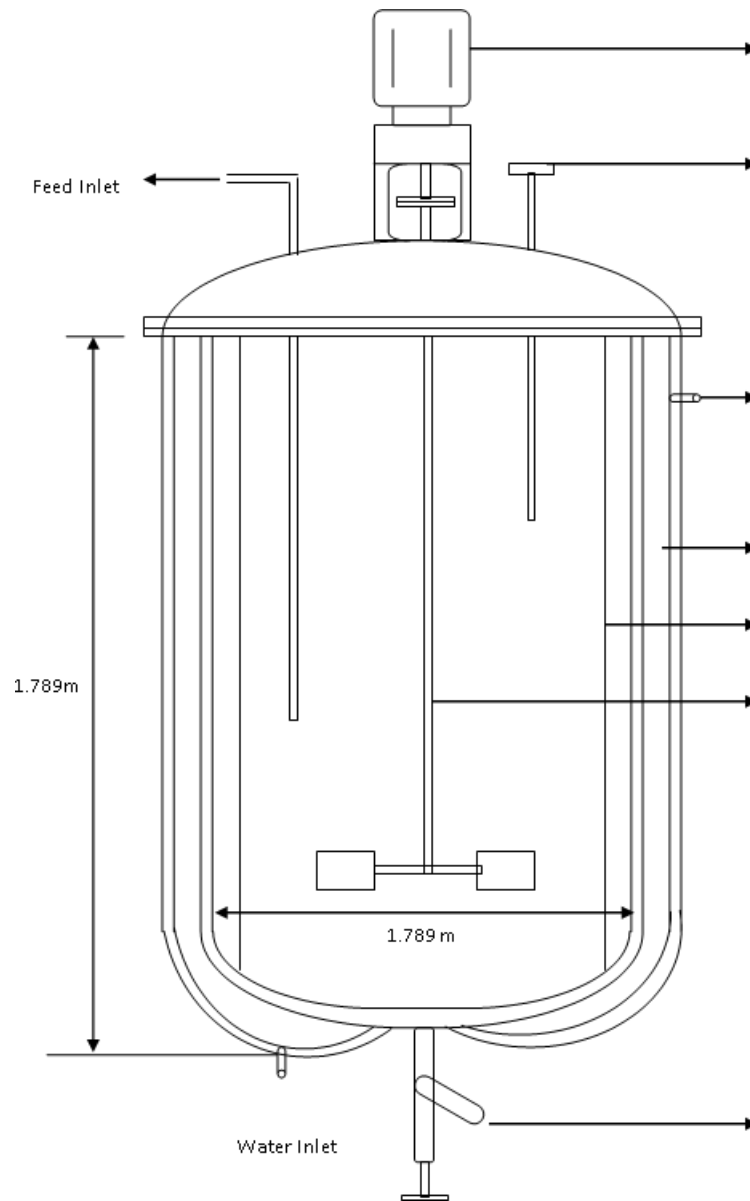
$$\begin{aligned}NRe &= (Da^2 * N * p / u) \\ &= (596.33/1000)^2 * (90/60) * 1840 / 2.4 * 10^{-2}\end{aligned}$$

$$NRe = 40,895.1$$

$$Np = 4.5$$

$$\begin{aligned}P &= Np * p * N^3 * Da^5 \\ &= 4.5 * (1840)^3 * (90/60)^3 * (596.33/1000)^5 \\ &= 21,010.53 \text{ W} \\ &= 21010.53 / 745.7 \\ &= 28 \text{ HP}\end{aligned}$$

Fig 5.5.1 Batch Reactor



5.5.2 DESIGN OF A CRYSTALLIZER

The diameter of the crystallizer is =1.627 m

The height of the crystallizer is =1.843m

Curved surface area is given by 2π

$$= 2\pi (1.627) \cdot (1.843)$$

$$= 18.84 \text{ m}^2$$

Surface area of the baffles

The height of the baffle is =1.659 m

width of the baffle is = 0.1627 m.

$$= 2 \cdot (4) \cdot (1.659) \cdot (0.1627)$$

$$= 2.16 \text{ m}^2$$

Total heat transfer area = 18.84+2.16

$$= 20.1 \text{ m}^2$$

Surface area for vaporization of water is determined from diameter of the vessel. For a diameter of 1.627m the vaporization area is given by;

Area, A = πr^2

$$= \pi (1.627/2)^2$$

$$= 2.08 \text{ m}^2$$

DESIGN PARAMETERS

Calculation of volume

Average density for compounds

Compounds	Average density
Alpha- ketoglutaric acid	400 kg/m ³
Ammonia	0.86 kg/m ³
Hydrogen	42 kg/m ³
L-glutamic acid	630 kg/m ³

$$V=m/d$$

$$\text{Volume of Alpha - ketoglutaric Acid} = 0.73 \text{ m}^3$$

$$\text{Volume of ammonia} = 39.53 \text{ m}^3$$

$$\text{Volume of Hydrogen} = 0.0952 \text{ m}^3$$

$$\text{Volume of L- Glutamic acid} = 0.466 \text{ m}^3$$

$$\text{Total Volume required} = 40.8579 \text{ m}^3$$

For Crystallizer the ratio of height to diameter is 1.1333:1 mixer height and diameter

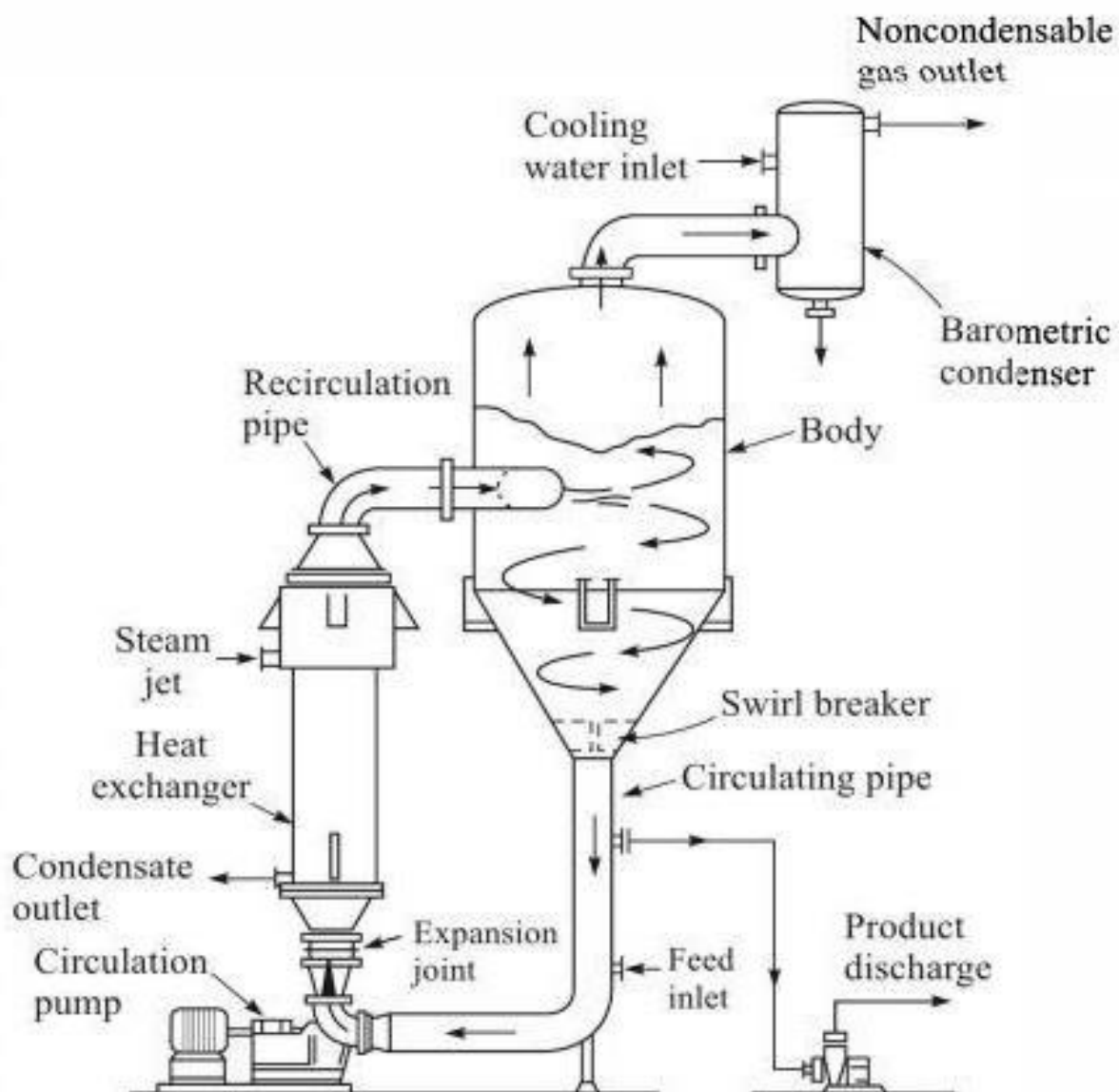
$$\text{Height} = 1.1333$$

$$\text{Volume} = r^2 h = h$$

$$\text{Substituting for V} = 40.8579 \text{ m}^3 r$$

$$= 6.0043 \text{ m}$$

Fig 5.5.2 Crystallizer



CHAPTER 6

PROCESS ECONOMICS

6.1 PROCESS ECONOMICS:

Plant Capacity = 400 kgs batch (2 batch/day) .

Cost Estimated based on the following factors for the above plant capacity.

1. Equipment Cost
2. Project Cost
3. Accessories
4. Raw material Cost

6.1.1 Equipment cost:

Table 6.1.1 Equipment cost:

S. No	List of Equipments	No. of Equipment	Total Cost (Rs. in lakhs)
1	Reactor	2	5
2	filter	1	1
3	Evaporator	1	1.5
4	Crystallizer	1	3
5	Adjustment tank	1	1
6	Storage Tank	2	1.5
7	Filter press	3	2.4
TOTAL (Rs. in lakhs)			15.4

6.1.2 Project cost:

Table
Project

S. No	Type	Total Cost (Rs. in lakhs)
1	Land Purchase	150
2	Drawing Preparation	1
3	Consultancy	5
4	Construction Charges	75
5	Erection & Start Up	25
TOTAL (Rs. in lakhs)		256

6.1.2
cost:

6.2 DIRECT AND INDIRECT COST:

6.2.1 Accessories Cost:

Table 6.2.2 Accessories cost:

S. No	Type	No. of Equipment	Total Cost (Rs. in lakhs)
1	Piping	-	30
2	Pumps	8	8.5
3	Valves	3	0.30
4	Instrumentation	-	20
5	Electrical	-	15
6	Service	-	20
TOTAL (Rs. in lakhs)			93.8

6.2.3 Raw material Cost

Table 6.2.3 Raw material cost

S. No	Raw Materials	Quantity (kg/day)	Cost / Kg	Total Cost (Rs. in Crores)
1	glucose	110	26	3
2	Inorganic salts	100	200	2
3	Biotin	500	200	10
4	Peptone	400	60	1.26
TOTAL				17.26

Man power expenses = 16 lakhs/ month

Running cost = 15 lakhs/ day

Amount of glutamic acid produced per year = 804709.152 KG/YEAR AVERAGE

Price of glutamic acid = 650 Rs/kg

Annual sales = 523060948 Rs

= 52.30 Cr

Total production cost = Manpower expenses + Raw material cost + Running cost
+Extra storage

Total profit before tax= 52.30-22.98 = 29.32

Tax = 15% =0.15*29.32

= 4398 L

=1.92 + 17.26 + 1.80 +2 = 22.98 Cr/YEAR

6.3 PAYBACK PERIOD:

$$\begin{aligned}
 \text{P.B. P} &= \frac{\text{Total Investment + Total Production Cost}}{\text{Profit after Taxes}} \\
 &= \frac{364.8 \text{ L} + 2298 \text{ L}}{4398 \text{ L}} \\
 &= 6 \text{ years}
 \end{aligned}$$

CHAPTER 7

PROCESS SAFETY

7.1 Plant wellbeing and climate:

All together of the components that impact the presentation of the gear and the plant there are components of vulnerability and the chance of blunder, including the error of actual information, essential relationships of conduct, for example, pipe rubbing (or) plate productivity (or) gas-fluid appropriation, vital approximations of plan strategies and counts not totally known practices of materials of development, the vulnerability of future stamped requests and changes in working execution with time.

7.2 Safety of Plant and Environment:

The plan of plant and gear should limit expected damage to faculty and public in the event of mishaps of which the fundamental driver is, Human Failure.

The disappointment of hardware and control instruments. The disappointment of supply of utilities and key interaction streams. Ecological occasions (wind, water, and so on).

Instances of regular safe practices are pressure help valves, vent frameworks, flare stacks, snuffing steam and firewater, get away from hatches in unstable regions, dams around tanks, putting away perilous synthetic, turbine drives as extras for electrical engines in the event of force disappointment and others. Well-being contemplations are principal in the design of the plant especially segregation of particularly dangerous tasks and availability for restorative activity at whatever point fundamentally.

In synthetic preparing plants of any size, counteraction survey is held intermittently by bunches that consistently incorporate an agent of the security division. Other staff on

a case-by-case basis by the specific circumstance are from assembling, support, specialized help, and potentially research, designing, and clinical gatherings.

7.3 Safety Factors:

An accomplished architect will apply security all through the plan of the plant. Exactly how much a wellbeing factor is to applied can't be expressed overall terms on the grounds that the conditions differ enormously, security variables ought not be utilized to stamp insufficient (or) indiscreet plan work

The plan ought to be that can be made in the time financially conceivable, and the wellbeing elements should gauge from a cautious thought of all elements going into the plan and the conceivable future deviations from the plan conditions.

Symbol	GHS07
Signal word	warning
Individual	Protective dust veil type N95 (us) Eye shields, gloves
Peril code	Xi
Danger statements	36/37/38

7.4 Analysis of the peril:

An examination should be made of the wellspring of risks are grouped into two significant classes.

Material Hazard:

They are because of the nature and the property of the material and the responses the materials are probably going to go through during their preparation.

Burnable solids, fluids, or gases. Unstable specialists.

Oxidizing materials.

Process Hazard:

Storage handling (or) physical change of the material such as transfer of flammable liquid or mixing in open container. Exothermic reaction where there is a strong possibility of the reaction going out of control.

Low pressure process where contaminants may leak into the process. High pressure process which may involve temperatures above flash point or the auto ignition point.

Dust or mist explosion hazards may arise in processes which involve handling of material that create dust.

Sparking of electric motor, switches or alarms. Hazards arising out of equipment or instrument failure.

Chapter 8

PLANT LAYOUT AND LOCATION

8.1 Plant layout:

A plant format study is a designing investigation used to break down various actual setups for a modern. The proficiency of creation relies on how well it is differentiating the machines, creation offices, and worker's conveniences are found.

Definition:

It alludes to the game plan of actual offices like apparatus, , within the plant it is working in that the snappiest progression of material at the most reduced expense and with minimal measure of taking care of in preparing the item from the receipt of material to the shipment of the completed item.

As "Riggs", the general target of plant format is to plan an actual course of action that most monetarily meets the yield and quality.

Significance:

It is a significant as it addresses long-haul responsibility. An ideal plant format ought to give the ideal relationship among yield, floor territory, and assembling measure. It encourages the creation interaction, limits material dealing with, time and cost and permits adaptability of tasks, simple creation stream, utilizes the structure advances viable usage of labor and accommodates representative's comfort, security, comfort at work, greatest openness to normal light and ventilation. It is additionally significant on the grounds that it influences the progression of material and cycles work proficiency, oversight and control, utilization of room and development prospects, and so on,

8.2 Steps associated with planning a plant format

Since choices with respect to format configuration have an impressive effect on the proficiency and productivity of a firm it requires cautious thought. Coming up next are the means engaged with planning a format:

1. Collection of the required information

Information about the size of the plant, the sort of items to be delivered, a technique for creation to be embraced, degree of the room accessible, degree of motorization, and so forth are to be gathered.

2. Preparation of outline for the floor plan

In light of the information assembled, a blueprint must be ready for the floor plan. Care ought to be taken to guarantee, that the design accommodates unhindered development of men and materials with least conceivable exertion and time.

3. Preparation of cycle graph and stream chart

The cycle graph and stream chart portraying the different exercises to be performed and the linkages between them must be readied.

4. Preparation of draft format

A draft design should be arranged unmistakably portraying the situating of men and materials and the cycle stream. The draft design ought to be circled and conversations held with workers welcoming ideas for development. Blemishes called attention to should be amended and ideas got fused after due conversations.

5. Test run

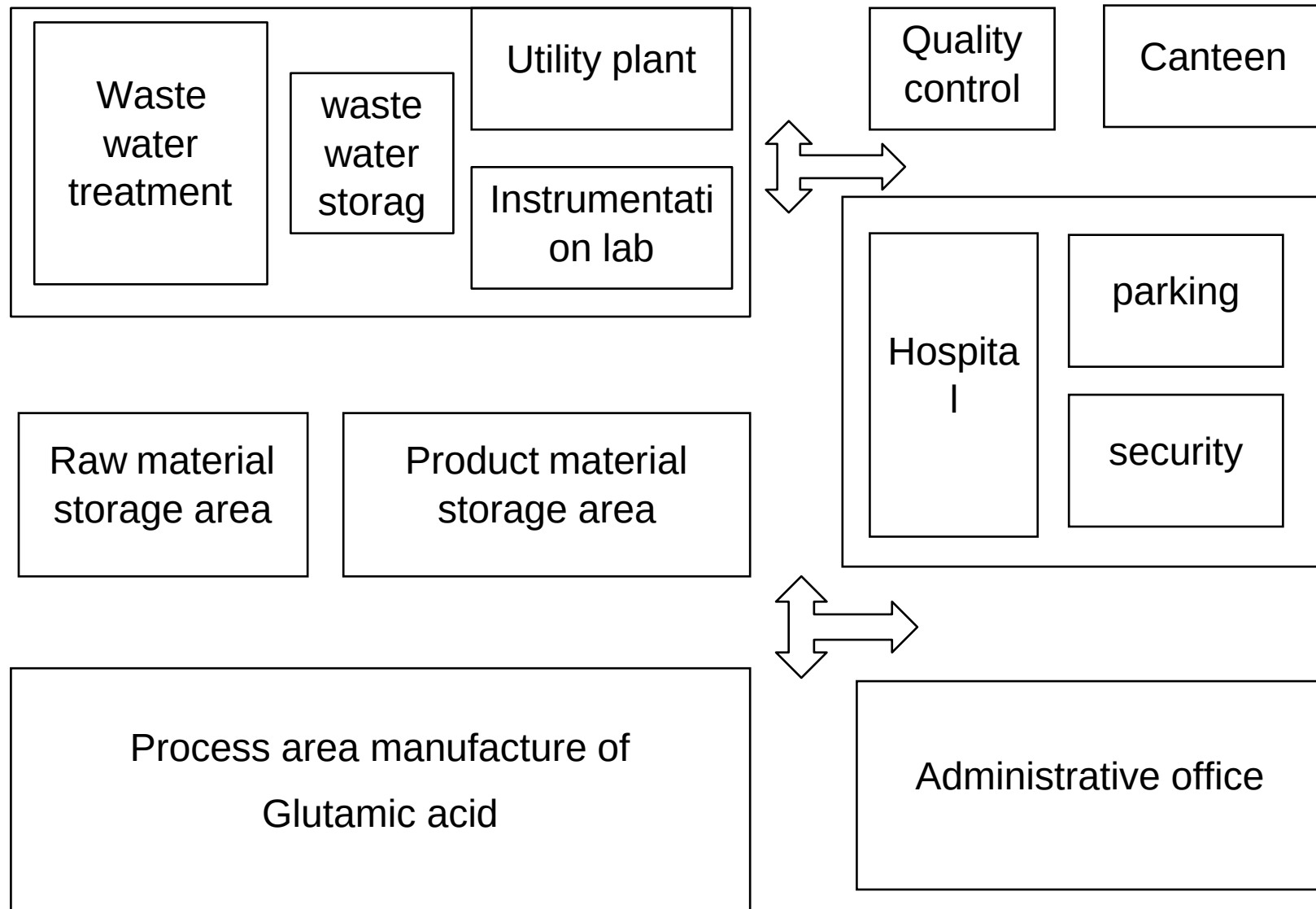
A trial is essential to comprehend the proficiency of the format in an ongoing workplace. Issues that do not saw in the previous stages can happen at this stage. The underlying issues saw should be changed and trials ought to be proceeded for in any event a couple of times to guarantee that the format can encourage the greatest creation at least expense.

Fundamentals:

An effective plant format is one that can be instrumental in accomplishing the accompanying targets:

- point
- 1) proper use of floor space
 - 2) work continues starting with one point then onto the next
 - 3) having enough creation limit.
 - 4) Reduction of material that dealing with cost.
 - 5) danger to the workforce should be reduced.
 - 6) Utilize work proficiently.
 - 7) representative spirit should be increased.
 - 8) mishaps should be reduced.
 - 10) Provide for volume and item adaptability.
 - 11) simplicity of management and control should be provided.
 - 12) Provide for representative wellbeing and wellbeing.
 - 13) simplicity of the support will be allowed.
 - 14) high machine (or) hardware use should be allowed.
 - 15) profitability should be improved

Plant Layout 8.1



CHAPTER 9

INSTURMENTATION AND CONTROL

9.1 INTRODUCTION:

Sensors to gauge measure conditions and valves to impact measure activities are fundamental for all parts of designing practice. Architects need to plan and work measures that stay in safe conditions, produce the ideal measures of top-notch items and are beneficial. Thusly, engineers should give estimating gadgets to key factors and valves (or different gadgets, like variable speed electric engines) to impact of "steer" the interaction. This site gives instructive material on sensors and valves for use in the process ventures.

While sensors and valves are significant taking all things together parts of designing, they accept most noteworthy significance in the investigation of programmed control, which is named measure control when applied in the process enterprises. Interaction control manages the guideline of cycles by applying the criticism standard utilizing different registering gadgets, mainly computerized calculation. Cycle control requires sensors for estimating factors and valves for executing choices. Accordingly, the introduction of this material is intended to supplement other learning subjects in measure control.

Sensors Valves

Signal transmission for measure control

Instrumentation security

Control hardware cost

Interaction Drawings

Wording

9.1.1 Sensors:

Sensors are utilized for measure checking and for measure control. These are fundamental components of protected and beneficial plant activity that can be accomplished just if the appropriate sensors are chosen and introduced in the right areas. The significant issues in sensor determination are summed up in the accompanying. The overall significance of each issue relies on the particular application; for instance, one application may require great exactness, while another might require just moderate precision, however high dependability. By and large, we track down that the more noteworthy the prerequisites for great execution, the higher the expense for buy and upkeep. Thusly, we should track down the appropriate equilibrium of execution and cost, as opposed to consistently determine the best performing sensor.

9.1.2 Valves:

Valves are utilized broadly for influencing the interaction; we regularly say that qualities are the "handles" by which we work a cycle. We have numerous objectives in affecting the interaction; along these lines, we utilize the stream and valve standards in numerous applications. There are numerous sorts of valves. The four most unmistakable sorts of valves are summed up beneath.

9.1.3 Signal transmission for measure control:

Most interaction control frameworks include a construction of disseminated gear, with sensors and valves at the cycle hardware and the control estimations and showcases situated in a far off, unified office. Thusly, estimations of key factors should be imparted between the sensors, counts and valves (or other last components).

9.1.4 Instrumentation wellbeing:

Normally, we should securely achieve estimation, control computations, and interaction balance through changing the last component. Control frameworks add to safe interaction activity through essential control plan, valve disappointment positions, cautions, wellbeing interlock frameworks, and pressing factor alleviation frameworks (e.g., Marlin, 2000; AIChE, 1993; Lees, 1996). This part tends to one significant unsafe condition, fire and blast that is influenced by the plan and execution of control and transmission gear. The material in this segment is pertinent to a wide scope of cycles and ventures utilizing either simple or computerized transmission.

9.1.5 Control gear:

Financial matters are consistently an issue in designing practice. In a run of the mill project, we bring about costs and obtain incomes over the long haul, and we face the test of deciding

the best undertaking choices, where best methods accomplishing the most elevated net benefit. Luckily, strategies for financial investigation are promptly accessible. These strategies consider the time-estimation of cash and give fitting proportions of productivity, like net present worth (NPV). This segment presents some helpful data for assessing the expense of control gear. We should perceive the expense incorporates the accompanying segments.

Purchase

Transportation from supplier to user Installation

and documentation Calibration

Maintenance over the equipment lifetime

9.1.6 Process Drawings:

Architects report their work utilizing numerous corresponding strategies. Surely, composed documentation is significant. Nonetheless, drawings play a similarly significant spot in the documentation on account of the intricacy of the frameworks being reported and the exact and effortlessly read nature of cycle drawings.

9.1.7 Terminology:

A couple of the most much of the time utilized terms are introduced here.

Precision:

Degree of conformance of an incentive to a perceived, acknowledged standard worth. Precision is communicated as the greatest positive and negative deviation from the norm for explicit conditions, typically communicated as the incorrectness as a percent of the worth, instrument reach, or full-scale esteem. It incorporates reasons for incorrectness, including linearity, repeatability, and hysteresis.

Dead Band: The reach through which info can be, endless supply of course, without causing an impact in the yield signal.

Float: An undesired change in yield throughout some stretch of time that is irrelevant to the information and working conditions.

Hysteresis: The property that the yield relies upon the historical backdrop of the info and current bearing of progress.

Linearity: The closeness of the alignment bend to a straight line. It is communicated as the most extreme deviation of the alignment bend and the predetermined straight-line trademark.

Reach The locale inside which worth is estimated, gotten, or sent, communicated as lower and upper reach esteems.

Repeatability: The closeness of understanding among sequential estimations of the yield for similar estimation of the contribution under similar working conditions and drawing nearer from a similar bearing. It is normally revealed as non-repeatability in percent of length and does exclude hysteresis.

Reproducibility: The closeness of the yield perusing for similar estimation of contribution throughout some undefined time frame drawing closer in the two ways. It is typically detailed as non-reproducibility as a percent of length and incorporates hysteresis, float, repeatability and dead band.

Reaction Time: Time needed for a yield to arrive at a predefined level of its last incentive because of a stage change in input.

Length: The contrast between the upper and lower cutoff points of reach.

CHAPTER 10

CONCLUSION

The various process is involved for the production of glutamic acid designed for the 1000 TPA. Glutamic acid is used in the manufacture of many products in various sectors. 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 4.5 years. The project based on manufacturing of glutamic acid of capacity 1000 tons per years it includes material balance and energy balance. The design of reactor and crystallizer are carried out in this project.

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