

+Nature of Invention: Process design

Applicant: Catalysta Industries Pvt. Ltd.

Inventors:

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Chemical Formula: C₁₄H₁₈N₂O₅

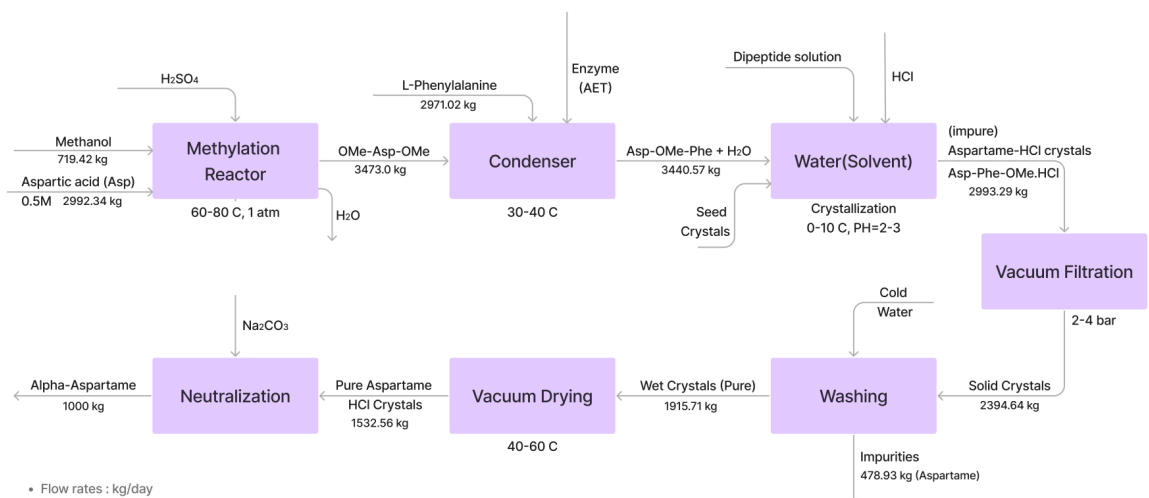
Chemical Name: Aspartame

Process Title: Production of Aspartame Through enzymatic and chemical synthesis

Process Description:

- a. Give the block diagram for the feasible process (as determined in the market analysis report). List all unit operations and process conditions.

ans:



- b. Give the material balance for a scaled-up process plant with 1000 kg/day capacity. (If needed, simplify the calculations by stating assumptions)

Ans:

- 1) Balance for Neutralization efficiency = 65%

$$(65/100) \times (\text{input}) = 1000 \text{ Kg}$$

$$\text{input} = 1532.56 \text{ Kg}$$

- 2) Vacuum Drying Efficiency = 80%

$$(80/100)*(x) = 1532.56 \text{ Kg}$$

$$x = 1915.71 \text{ Kg}$$

3) Washing Efficiency = 80%

$$(80/100)*(y) = 1915.71 \text{ Kg}$$

$$y = 2394.64 \text{ Kg}$$

4) Aspartame washed out (unreacted / impurities) = $2394.64 - 1915.71 \text{ Kg} = 478.9 \text{ Kg}$

5) Vacuum Filtration efficiency = 80%

$$(80/100)*(z) = 2394.64 \text{ Kg}$$

$$z = 2993.29 \text{ Kg}$$

6) Condenser efficiency = 65%

Acc. to balance reaction,

$$\text{Moles of Asp-OMe-Phe} = \text{Moles of L-Phenylalanine} = p (\text{Efficiency}) * (p) =$$

Moles of Asp-OMe-Phe

$$p = \text{moles} / 0.65$$

$$p = 11.69056 / 0.65 \text{ K mole}$$

$$p = 17.9855 \text{ K mole}$$

7) Similarly,

Moles of Methanol = Moles of Aspartic Acid = $q (80/100)*(q) = \text{Moles of OMe-Asp-OMe} = 17.9855 \text{ K mole}$

$$q = 22.4818 \text{ K mole}$$

8) Mass of Aspartic Acid = $(22.4818) * (\text{Molar Mass of Aspartic Acid})$

$$\text{Mass of Aspartic Acid} = 2992.34 \text{ Kg}$$

9) Mass of Methanol = $(22.4818) * (32) = 719.42 \text{ Kg}$

10) Mass of OMe-Asp-OMe = $(193) * (17.9855) = 3471.20 \text{ Kg}$

Similarly Calculated Mass of L-Phenylalanine & Asp-OMe-Phe

- c. List the capacity of reactors needed and evaluate the cost. Use Glass-lined carbon steel (GS-lined CS) as the construction material (MOC). Use the pressure according to reaction conditions. You will use only 70% of the total volume. If you design a 1000 L reactor, you can only fill 700 L reaction mixture.

ans:

Assuming the chemical density is 1 gm/cm^3 to 1.5 gm/cm^3 . Density of $\text{Na}_2\text{CO}_3 = 0.254 \text{ gm/ml}$. Density Aspartic acid = 1.7 g/cm^3 .

Methanol/Density = 792 kg/m^3 . 2203 kg of sulfuric acid used in reaction with density = 1830 kg/m^3 ; Density of phenylalanine: 1340 kg/m^3 (20°C); Aspartic dimethyl ester = 3276.4150ltr; OMe-asp-phe = 3245.8207 ltr; approximately 11,973.2 kg of water would be required for washing 2394.64 kg of solid crystals of Asp-OMe-Phe.HCl. So, approximately 428.84 kg of sodium carbonate is required to neutralize 1532.5 kg of pure aspartame hydrochloride crystal. density of anhydrous sodium carbonate is around 2540 kg/m^3 ; Density of pure aspartame hydrochloride crystal = 1250 kg/m^3 .

Capital cost (only for the reactor):

Equipment	Design Capacity (L)	No. of units	Cost/unit (\$ for year 2014)	Total Cost (\$ for year 2014)
Methylation Reactor	5531.07	1	57400	57400
Condenser	5493.58	1	15000	15000
crystallizer	3245.820	1	62000	62000
vacuum filter (pan, rotary)	4111.662	1	720900	720900
washer(cyclone, Ni hard lined)	20362	1	11700	11700
vacuum dryer	1915	1	180500	180500
neutralisation reactor	1992.857	1	16000	16000

References: Provide reference for a research paper or an actual patent.

1. <http://www.matche.com/equipcost/Reactor.html>
2. https://www.researchgate.net/figure/Flow-chart-for-the-production-of-aspartame_fig2_6011307
3. <https://i0.wp.com/www.compoundchem.com/wp-content/uploads/2015/04/Aspartame-Undeserved-Reputation.png?resize=700%2C990&ssl=1>

List the contributions of each author:

- Authors 1 and 2 carried out the complete block diagram equipment and how to arrange each.
- Authors 3 and 4 carried out the calculation of the process when the product rate of given to us.

Name	Roll No	Signature(By Name)
Ujjwal Bisaria	221154	Ujjwal Bisaria
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