

Nature of Invention: Process design

Applicant: Catalysta Industries Pvt. Ltd.

Inventors:

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- Kavita
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- Tushar Verma

Chemical Formula: C₁₄H₁₈N₂O₅

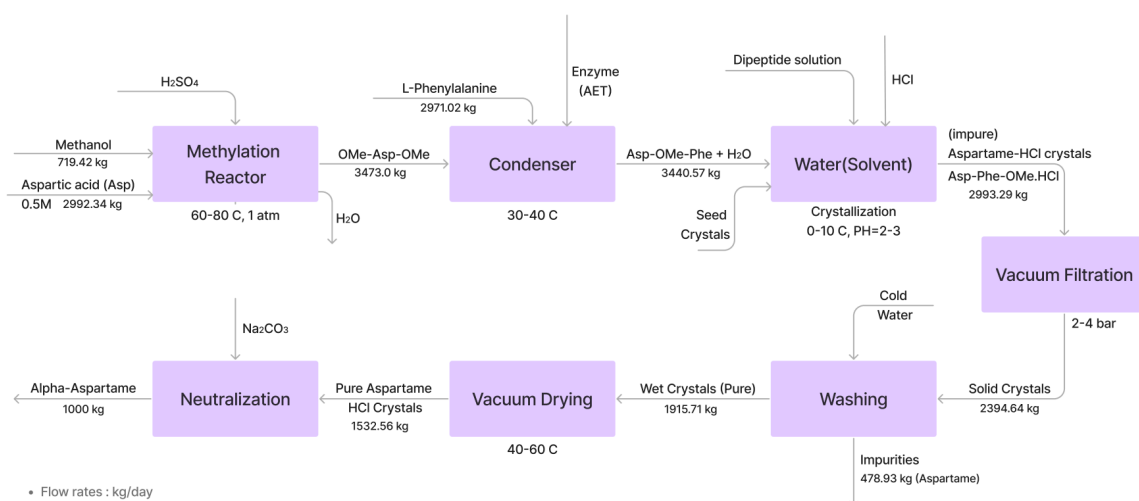
Chemical Name: Aspartame

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 capacity of 1000 kg/day. (If needed, simplify the calculations by stating assumptions)

ans:

- 1) Balance for Neutralization efficiency = 65%
- $$(65/100) * (\text{input}) = 1000 \text{ Kg}$$
- $$\text{input} = 1532.56 \text{ Kg}$$

- 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,
 Moles of Asp-OMe-Phe = 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 = $q (80/100)*(q) =$ Moles of
 OMe-Asp-OMe = 17.9855 K mole
 $q = 22.4818 \text{ K mole}$
- 8) Mass of Aspartic Acid = $(22.4818)*(Molar \text{ Mass of Aspartic Acid})$
 Mass of Aspartic Acid = 2992.34 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 material of construction (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 neutralise 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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