

Company: GreenovateX

CEO: Aditya Singh

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Chemical Formula: $C_{10}H_{19}O_6PS_2$

Chemical Name: Malathion

Use case:

a. What is the use of this compound?

Malathion is an organophosphate insecticide extensively utilized for managing a wide range of pests in agriculture, public health, and household settings.

Below are its main applications:

1. Agriculture:

- Protects crops such as fruits, vegetables, nuts, and grains from pests like aphids, leafhoppers, and mites.
- Employed in pest management for commercial crops, including cotton and rice.

2. Public Health:

- Used in mosquito control initiatives to control the transmission of diseases such as malaria, dengue, and Zika virus.
- Applied in urban environments to manage flies and other insects that carry diseases.

3. Household and Garden use:

- Included in insect sprays and treatments for home gardens.
- Utilized to eradicate fleas, lice, and ticks on pets and livestock.

4. Medical use:

- Available in medicated lotions for treating head lice and scabies in humans.

b. Are there any alternatives to this compound? Name a few.

There are several alternatives to **Malathion**, depending on the intended application. Here are some alternatives:

1. **Pyrethroids**

- Examples: Permethrin, Deltamethrin, Cypermethrin

2. **Neonicotinoids**

- Examples: Imidacloprid, Thiamethoxam, Acetamiprid

3. **Carbamates**

4. **Benzyl Alcohol Lotion**
5. **Carbaryl (Sevin)**

c. Why this compound is superior to its alternatives?

Malathion is often preferred over other insecticides due to its **broad-spectrum efficacy, cost-effectiveness, low mammalian toxicity, and rapid environmental degradation**. It is widely used in agriculture, public health, and household pest control because of its versatility and ability to target a wide range of pests, including mosquitoes, flies, and agricultural insects. Compared to alternatives like pyrethroids or neonicotinoids, malathion is more affordable and breaks down quickly in the environment.

d. Is this compound imported in India? What is the magnitude of imports?

Yes, **malathion** is imported into India, as it is widely used in agriculture, public health, and household pest control. While India does produce some malathion domestically, the demand often exceeds local production, necessitating imports.

China was the largest exporter of malathion accounting for **93.43%** of the total imports of malathion.

- Most frequently used malathion HS Code is 29309099
- Malathion worth \$329,729 have been imported.
- Average import price for malathion was \$4.83.

Import record showing that **1 unit of malathion (analytical standard, 10 mg)** was imported into India from the **United States** on **November 12, 2016**, via Ahmedabad, with a total value of **29 USD** and a price per unit of **28.74 USD**.

Date	HS Code	Description	Origin Country	Port of Discharge	Unit	Quantity	Total Value (USD)	Price Per Unit (USD)
Nov 12 2016	38220090	MALATHION (ANALYTICAL STANDARDS) (LABORATORY CHEMICALS) - FORR & D PURPOSE (1 PAC =10 MG)	United States	Ahmedabad	PCS	1	29	28.74

Economic feasibility:

- a. What input raw materials are needed for its synthesis (same as reported in the Patent application)?

There are two methods in Malathion Synthesis mentioned, the input raw materials for each of which are:

1. Direct Esterification

1. O,O-Dimethyl Phosphorodithioic Acid (DMPA) – $(\text{CH}_3\text{O})_2\text{PS}_2\text{H}$

- **Role:** Phosphorodithioate source, reacts with DEM to form Malathion.
- **Reaction:** The mixture of DMPA along with DEM reacts in Reactor 1, where it is heated to 80-100°C for 2-4 hours for the esterification to occur

2. Diethyl Maleate (DEM) – $\text{C}_2\text{H}_5\text{O}_2\text{CCH}=\text{CHCO}_2\text{C}_2\text{H}_5$

- **Role:** Ester reactant, undergoes esterification with DMPA.
- **Reaction:** Same as above. The mixture of DMPA along with DEM reacts in Reactor 1, where it is heated to 80-100°C for 2-4 hours for the esterification to occur

3. Sulphuric Acid (H_2SO_4) or p-Toluenesulfonic Acid (p-TSA)

- **Role:** Acid catalyst to drive esterification.
- **Reaction:** Protonates carbonyl oxygen to activate ester formation.
- **Source :** Low cost, locally available

4. Sodium Hydroxide (NaOH) or Sodium Carbonate (Na_2CO_3)

- **Role:** Neutralizes residual acid after reaction.
- **Source:** Widely available locally, minimal cost impact

2. Thiophosphorylation

1. Phosphorus Pentasulphide (P_2S_5)

- **Role:** Source of phosphorus and sulphur for O,O-Dimethyl Dithiophosphoric Acid.

- **Reaction:** Reacts with Methanol in Reactor 1 to form O,O-Dimethyl Dithiophosphoric Acid:

2. Methanol (CH_3OH)

- **Role:** Reacts with P_2S_5 to form O,O-dimethyl dithiophosphoric acid.
- **Reaction:** Same as above.
- **Source:** Low-cost; domestic sourcing possible.

3. Diethyl Maleate (DEM) or Diethyl Fumarate (DEF)

- **Role:** Reacts with O,O-Dimethyl Dithiophosphoric Acid to form Malathion.
- **Reaction:** O,O-Dimethyl Dithiophosphoric Acid and DEM/DEF react in Reactor 2 to form Malathion,

4. Sulfuric Acid (H_2SO_4) or Sodium Hydroxide (NaOH)

- **Role:** Catalyst (acidic or basic) for thiophosphorylation.

b) Provide preliminary economic feasibility based on cost of raw materials, solvents and product selling price.

i) Preliminary Economic Feasibility Analysis of Diethyl Maleate (DEM)

Most frequently used diethyl maleate HS Code is 29171990

- Total Value of Imports in India: \$18,426
- Average Price per Unit: \$38.82
- Top Supplier: United States (50.17%)
- Top Port of Discharge: Bangalore Air Cargo

Economic Feasibility Considerations

1. Raw Material Costs:

- The unit price of **Diethyl Maleate (DEM)** is **\$38.82**
- Its price still suggests that it could be a significant part of the overall production cost in the manufacturing process of Malathion.

2. Supply Chain & Logistics:

- **Major Suppliers: United States (50.17%) and Germany (26.11%)** are the main suppliers, suggesting a diversified source for imports. However, dependency on just two countries may pose risks in case of geopolitical or supply disruptions.
- **Port of Discharge:** Shipments primarily arrive at **Bangalore, Hyderabad, and Bombay** air cargo, which are among India's major import hubs, ensuring timely logistics and transportation.

3. Product Pricing & Market Viability:

- **Final Product Pricing:** For **Malathion production** using **DEM** as a raw material, the final product price must be set sufficiently above the raw material cost to ensure profit.
- **Market Demand: Diethyl Maleate** is used in specialized industries such as agricultural chemicals and pharmaceuticals. The varied uses of Malathion indicate that the market is likely capable of supporting premium pricing, especially given the high-quality standards required in the final product (Malathion).

Preliminary Economic Feasibility Analysis of O,O-Dimethyl Phosphorodithioic Acid (DMPA) – (CH₃O)₂PS₂H or O,O- Dimethyl dithiophosphate

Most frequently used HS Code is 29309099

- Total Value of Imports in India: \$ 103,839
- Average Price per Unit: \$2.31
- Average value per shipment : \$51,919
- Top Supplier: China
- Top Port of Discharge: Chennai Sea

Economic Feasibility Considerations

1. Raw Material Costs:

- The unit price of the chemical under HS Code **29309099** is **\$2.31** per unit.
- This cost impacts its use in various industrial applications, depending on its specific chemical properties and demand.

2. Market Analysis Report

Supply Chain & Logistics:

- **Major Supplier:** China is the top supplier for this chemical, indicating a reliance on imports from Chinese manufacturers.

- **Port of Discharge:** The primary port handling this import is **Chennai Sea**, a key entry point for specialty chemicals into India.

Product Pricing & Market Viability:

- **Total Import Value:** India's total imports for this chemical stand at **\$103,839**, reflecting its market presence.
- **Average Shipment Value:** Each shipment has an average value of **\$51,919**, suggesting bulk trading patterns.
- **Market Demand:** The relatively high average price per unit and dependency on a single primary supplier indicate that price fluctuations or trade regulations could impact market stability.

Preliminary Economic Feasibility Analysis of Phosphorus Pentasulfide (P₂S₅)

Most frequently used diethyl maleate HS Code is 28139090

- Total Value of Imports in India: \$ 3,129,283
- Average Price per Unit: \$1.59
- Average value per shipment : \$39,611
- Top Supplier: China (\$3,124,184), Germany(\$5033)
- Top Port of Discharge: Nhava Sheva Sea(\$3,124,184), Bangalore Air Cargo(\$4,713)

Economic Feasibility Considerations

1. Raw Material Costs:

- The unit price of **Phosphorus Pentasulfide (P₂S₅)** is \$1.59
- This cost reflects its use in specialized reactions such as thiophosphorylation (in Malathion production) and other chemical syntheses.

2. Supply Chain & Logistics:

- **Major Supplier:** **China** and **Germany** are the primary suppliers of **Phosphorus Pentasulfide (P₂S₅)**, which means there may be reliance on these countries for import.
- **Port of Discharge:** Major ports in India such as **Nhava Sheva**, **Chennai**, and **Mumbai** handle the import of specialty chemicals like **P₂S₅**.

3. Product Pricing & Market Viability:

- **Final Product Pricing:** Given that **P₂S₅** is a critical raw material in processes like **Malathion** production, its price will directly affect the overall cost of the final product.
 - **Market Demand:** The demand for **P₂S₅** is relatively **niche** and tied to specific applications (such as pesticide manufacturing). As a result, while its cost is high, its specialized nature allows it to remain valuable in the market.
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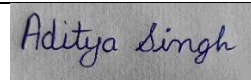
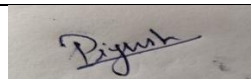
List the contributions of each author: Piyush Shah

- Designed and implemented the use case analysis of Malathion, detailing its applications in agriculture, public health, household settings, and medical uses.
- Conducted a comparative analysis of Malathion with alternative insecticides, highlighting its superior qualities such as broad-spectrum efficacy, cost-effectiveness, low mammalian toxicity, and rapid environmental degradation.
- Provided insights into market trends, including import data and the compound's demand in India, aligning findings with industry standards.

List the contributions of each author: Shubhi Verma

- Designed and implemented the economic feasibility analysis of Malathion, including raw material cost analysis (e.g., Diethyl Maleate, Phosphorus Pentasulfide), supply chain logistics, and market viability assessment.
- Researched and analysed import data for key raw materials, evaluating their cost, availability, and sourcing from countries like the United States, China, and Germany.
- Provided a preliminary economic feasibility assessment based on raw material costs, solvents, and the potential selling price of Malathion, ensuring alignment with company goals and market demand.

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