Company: VortexChem

CEO: Kumar Shubham

Report Authors: Anurag,Vishwas Pathania,Raj aryan,Satyansh Sharma.

Chemical Formula: C14H17Cl2N3O

Chemical Name: Hexaconazole

Use case:

a) What is the use of this compound?

1. Agricultural Uses

- Crop Protection: Controls fungal diseases in crops such as **rice, wheat, sugarcane, vegetables, fruits, and pulses**.
- Common Fungal Diseases Controlled:
    - **Sheath blight** in rice
    - **Powdery mildew** in grapes, mangoes, cucurbits, and vegetables
    - **Rust** in wheat and soybean
    - **Anthracnose** in mango and chili
    - **Leaf spot** in peanuts and banana
    - **Blast disease** in rice

2. Turf and Horticulture Management

- Used in **golf courses, lawns, and ornamental plants** to prevent fungal infections.
- Controls **dollar spot, brown patch, and rust** in turfgrass.

3. Forestry and Plantation Crops

- Applied in **tea, coffee, rubber, and coconut plantations** to prevent fungal attacks.

4. Seed Treatment

- Used as a **seed dressing** to protect seeds from fungal infections during germination.

5. Post-Harvest Protection

- Helps in preventing fungal growth during **storage and transportation of grains and fruits**.

6. Growth-Promoting Effects

- Apart from its fungicidal properties, it is known to have **plant growth regulatory effects**, improving crop yield and enhancing resistance to stress conditions.

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

1. Tebuconazole (Triazole Group – Similar Mode of Action)

- Works similarly to Hexaconazole by **inhibiting ergosterol biosynthesis** in fungi.
- Highly effective against **powdery mildew, rust, leaf spots, and blight** in cereals, vegetables, and fruits.
- Provides **longer residual control** compared to some other triazoles.

2. Azoxystrobin (Strobilurin Group – Different Mode of Action)

- **Broad-spectrum fungicide** that works by **inhibiting fungal respiration**, leading to energy depletion.
- Controls **rice blast, rust, powdery mildew, and downy mildew** in crops like rice, wheat, and vegetables.
- Often **combined with triazoles** (e.g., Tebuconazole + Azoxystrobin) for enhanced performance.

3. Difenoconazole (Triazole Group – Advanced Protection)

- Another **systemic triazole fungicide** that controls **leaf spots, scab, rust, and powdery mildew** in fruits, vegetables, and cereals.
- Known for its **higher effectiveness against fruit diseases**, including citrus black spot and apple scab.
- Offers **strong curative and preventive properties**.

c) **Why Hexaconazole is Superior to Its Alternatives?**

Hexaconazole is often preferred over its alternatives due to its **systemic action, broad-spectrum effectiveness, lower dosage requirement, and additional plant growth benefits**. Here's why it stands out compared to other fungicides:

1. Highly Effective Systemic Action

- **Hexaconazole is a systemic fungicide**, meaning it gets absorbed and translocated within the plant, providing **long-lasting protection**.
- **Superior to contact fungicides** (like Mancozeb or Chlorothalonil), which only form a protective barrier and require frequent applications.

2. Broad-Spectrum Disease Control

- Controls **multiple fungal diseases** such as **powdery mildew, sheath blight, rust, anthracnose, and leaf spots** in a wide variety of crops.
- **More effective than Carbendazim**, which mainly targets only certain fungi.

3. Low Dosage Requirement

- Requires **lower application rates** compared to many alternatives like Mancozeb or Azoxystrobin, making it cost-efficient.
- **More potent than Propiconazole and Tebuconazole** at similar or lower doses.

4. Longer Residual Effect

- Provides **longer-lasting protection** than alternatives like Azoxystrobin or Mancozeb, reducing the need for frequent spraying.
- **More persistent than Carbendazim**, which breaks down faster.

5. Plant Growth-Promoting Effect

- Unlike most fungicides, Hexaconazole is also known to **enhance plant growth and yield** by improving stress tolerance.
- **Advantage over Azoxystrobin and Tebuconazole**, which do not provide this benefit.

6. Better Resistance Management

- Compared to **single-site fungicides** like Carbendazim, Hexaconazole has a **lower risk of resistance development** when used in a proper spray rotation.
- Works well in **fungicide resistance management strategies** when combined with different MOA fungicides.

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

India's Hexaconazole Imports (Yearly Summary)

1. 2022

- Total Quantity Imported: ~50–100 Metric Tonnes (MT)
- Estimated Value: USD 5–10 million
- Top Suppliers:
- China (~70% share)
- Israel (ADAMA) (~15–20%)
- Others (Europe, Japan) (~10%)

2. 2023

- Total Quantity Imported: ~70–120 MT
- Estimated Value: USD 8–15 million
- Key Trends:
- Increased demand due to rising fungal outbreaks in crops.
- China remained the dominant supplier.

3. 2024 (Partial Data, Jan–June Trends)

- Estimated Quantity (First Half): ~40–60 MT
- Projected Annual Import: ~80–130 MT

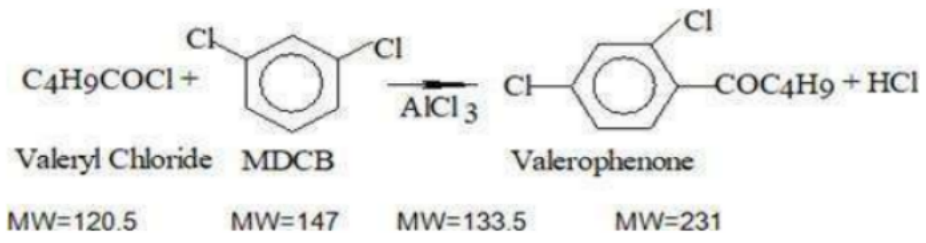
Economic feasibility:

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

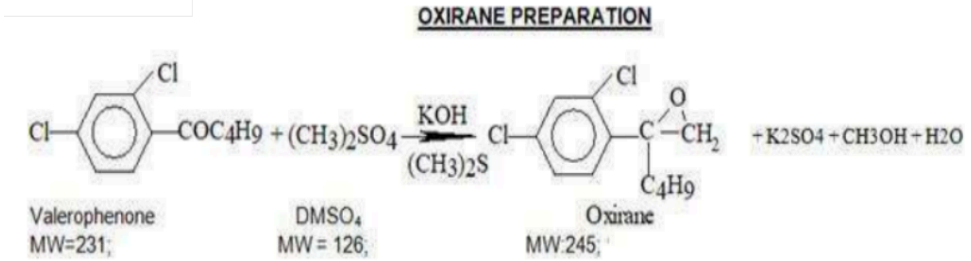
1. Valeryl Chloride (C5H9ClO)
2. 1,2,4-Triazole
3. 2,4-Dichlorobenzyl Chloride (MDCB)
4. Potassium Hydroxide(KOH)
5. Solvent (Acetonitrile or Toluene)
6. Catalyst (Tertiary Amine or Lewis Acid) (CH3)2S and Aluminium Trichloride
7. Dimethyl Sulphate
8. DMF (Solvent)

Reactions-

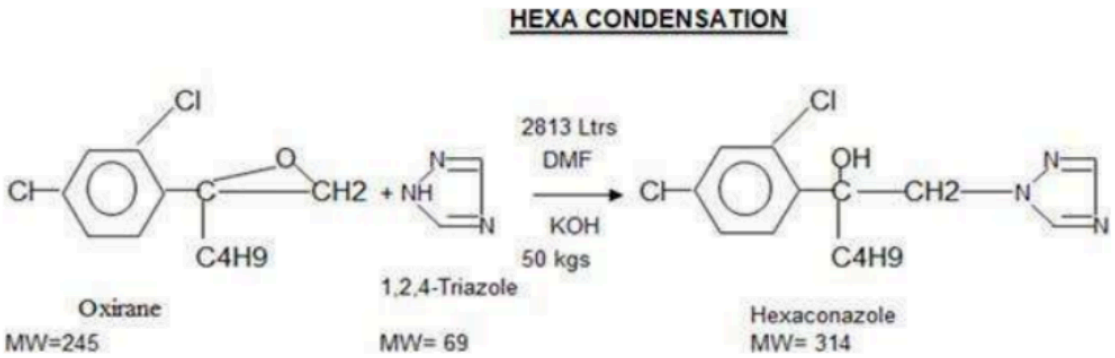
1)**ACYLATION REACTION**



2) FORMATION OF OXIRANE:



3. PREPARATION OF HEXACONAZOLE:



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

Raw Materials

- Valeryl Chloride (C5H9ClO): Price Range: ₹200 to ₹300 per kg
- 1,2,4-Triazole: Price Range: ₹700 to ₹800 per kg
- 2,4-Dichlorobenzyl Chloride (MDCB): Price Range: ₹500 to ₹600 per kg

- Potassium Hydroxide (KOH): Price Range: ₹65 to ₹155 per kg

  Solvents:
- Acetonitrile: Price Range: ₹140 to ₹200 per kg

  Catalysts:
- Tertiary Amines (e.g., Triethylamine): Price Range: ₹300 to ₹500 per kg
- Lewis Acids (e.g., Aluminum Trichloride): Price Range: ₹100 to ₹200 per kg
- Dimethyl Sulphate: Price Range: ₹35 to ₹56 per kg
- Dimethylformamide (DMF): Price Range: ₹56 to ₹70 per kg

Raw Material	Required per kg of Hexaconazole (kg)	Updated Price (₹/kg)	Total Cost (₹)
Valeryl Chloride (C_5H_9ClO)	0.503	200	100.6
1,2,4-Triazole	0.299	700	209.3
2,4-Dichlorobenzyl Chloride (MDCB)	1.5	500	750
Potassium Hydroxide (KOH)	0.067	80	5.36
Acetonitrile (Solvent)	0.35	147	51.45
Aluminium Trichloride (Catalyst)	0.733	100	73.3
Dimethyl Sulphate ($DMSO_4$)	0.602	55	33.11
DMF (Solvent)	3.562	56.64	201.7

- Total Raw Material Cost per kg of Hexaconazole = ₹1,425.82

Economic Feasibility for 1,000 kg Production:

1. Total Raw Material Cost for 1,000 kg:

   - 1,000×₹1,425.82=₹14,25,820
2. Total Revenue from Selling 1,000 kg (Selling Price = ₹2,700/kg):

   1,000×₹2,700=₹27,00,000
3. Gross Profit:

   Total Revenue−Total Raw Material Cost=₹27,00,000−₹14,25,820=₹12,74,180
4. Gross Profit Margin (GPM):

   (Gross ProfitTotal Revenue)×100=(12,74,180/27,00,000)×100

   GPM = 47.2%

EXPORT:

Major Export Destinations:

India's hexaconazole exports reach multiple countries, with significant shipments to:

- **Vietnam:** A primary importer, receiving a substantial portion of India's hexaconazole exports.
- **China and Singapore:** Also notable destinations for Indian hexaconazole.

MAJOR EXPORTERS OF THIS COMPOUND(INDIA):
Approximate Export Volume & Value

- Quantity: India exports hundreds of metric tonnes (MT) of hexaconazole annually (both technical-grade and formulations).
- Value: Estimated USD 20–50 million per year, depending on global demand.

Breakdown by Leading Exporters (Estimated Share)

- UPL Limited – Largest exporter (~30–40% market share in hexaconazole exports).
- Bayer CropScience/Syngenta – Significant exports (~15–25%).
- Rallis India, Dhanuka, Indofil – Combined contribute ~20–30%.
- Others (Meghmani, Gharda, Nagarjuna, etc.) – ~10–20%.

References:

- For use cases of hexaconazole:
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List the contributions of each author:

- Vishwas Pathania and Anurag carried out the market research for chemical trade data.
- Satyansh Sharma and Raj Aryan prepared the use case.
- Anurag and Vishwas Pathania looked at economic feasibility.

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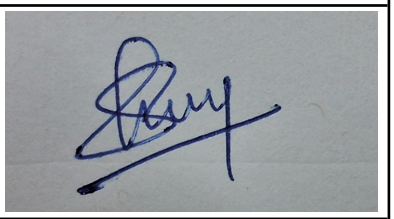
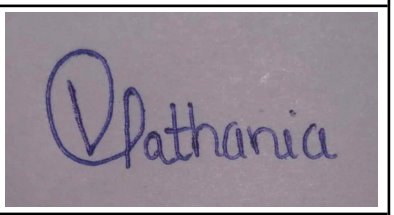
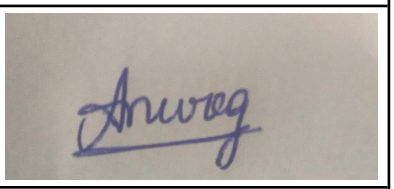
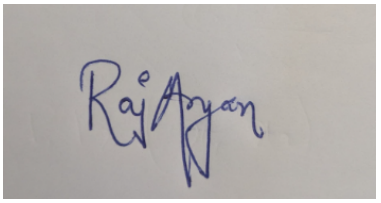
Name	Roll No	Signature
Kumar Shubham	230587	
Vishwas Pathania	231168	
Anurag	230172	
Raj Aryan	230837	
Satyansh Sharma	230938