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Chemical Formula: $R-O-(CH_2CH_2O)_nH$

Chemical Name: Fatty Alcohol Ethoxylates (FAE)

Use case:

a. What are the uses of this compound?

Fatty Alcohol Ethoxylates (FAEs) are versatile non-ionic surfactants widely used across various industries due to their excellent emulsification, detergency, and wetting properties. Their primary applications include:

- **Household and Industrial Cleaning:** FAEs are used in detergents, dishwashing liquids, and surface cleaners for their effective cleaning and emulsifying properties.
- **Personal Care Products:** Found in shampoos, conditioners, body washes, and lotions due to their mildness and ability to produce stable foam.
- **Textile Industry:** Used as wetting agents and emulsifiers in textile processing to improve dye penetration and fabric treatment.
- **Agriculture:** Incorporated into pesticide formulations to enhance spreading, wetting, and adhesion on plant surfaces.
- **Oilfield Chemicals:** Utilized in enhanced oil recovery processes for emulsification and reducing interfacial tension between oil and water.
- **Paints and Coatings:** Act as dispersing agents for pigments in paints and coatings.

b. Are there any alternatives to its? Name a few.

Few alternatives are listed below:

- 1) **Linear Alkyl Benzene Sulfonate (LABS):** An anionic surfactant widely used in detergents for its cost-effectiveness and high cleaning performance.

- 2) **Alpha-Olefin Sulfonates (AOS):** Known for good biodegradability and mildness; commonly used in personal care formulations.
- 3) **Methyl Ester Sulfonates (MES):** Derived from renewable sources like palm or coconut oil; offers good detergency but has formulation challenges.
- 4) **Sodium Lauryl Sulfate (SLS) & Sodium Laureth Sulfate (SLES):** High foaming agents used in personal care products but can cause skin irritation.
- 5) **Bio-based Surfactants:** Emerging alternatives such as rhamnolipids and sophorolipids, which are more environmentally friendly but expensive.

c. Why is LABS superior to its alternatives?

Properties	FAE	Alternatives
Foaming Properties	Moderate foaming; suitable for controlled applications	LABS offers high foaming but may not suit all formulations
Mildness	Non-irritating to skin; ideal for personal care products	SLS/SLES can cause skin irritation
Biodegradability	Generally biodegradable	LABS degrades slower than FAEs
Versatility	Effective across a wide range of industries	LABS is versatile but limited by high pH stability requirements
Environmental Impact	Lower compared to synthetic surfactants	Bio-based surfactants are eco-friendly but costly

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

Yes, It is imported in India below is detailed analysis:

- Total Quantity: 602,262 KGS
- Total Price: 1,033,941.11 USD
- Average Import Price: \$1.5 - 2.5 per kg
- Major Exporting Countries:
 - Ukraine (1180 Shipment)
 - Vietnam
 - Russia

Monthly Import Trends (Latest)

Date	Quantity	Price (USD)
26 May 2023	190 KGS'	1771.6
30 May 2023	41 MTS	70467.5
31 May 2023	10,050 KGS	7525.43
20 June 2023	61 MTS	103689.02
21 June 2023	1 KGS	61.34
21 June 2023	26,000 KGS	12974
1 July 2023	110 KGS	1293.21
21 July 2023	500 KGS	1481.97
22 Aug 2023	20,070 KGS	42663.6
6 Oct 2023	1 KGS	127.02
21 Oct 2023	20,020 KGS	41558.32
21 Oct 2023	20,070 KGS	41662.11
21 Oct 2023	20,020 KGS	41558.32
27 Oct 2023	60,140 KGS	104254.67
6 Nov 2023	40,050 KGS	61742.31
9 Nov 2023	40,070 KGS	61773.14
13 Nov 2023	1 KGS	63.73
24 Nov 2023	900 KGS	4008.6
1 Dec 2023	80,130 KGS	123753.65
15 Dec 2023	5,000 KGS	42259.56
19 Dec 2023	20,050 KGS	40820.2
19 Dec 2023	20,070 KGS	40860.71
23 Dec 2023	900 KGS	4048.34
1 Jan 2024	20,030 KGS	38950.38
22 Jan 2024	20,050 KGS	39619.6
21 Feb 2024	20,050 KGS	39619.6
23 Feb 2024	1900 KGS'	70733.82
29 Feb 2024	20,040 KGS	39599.84
1 April 2024	5,000 KGS	42165.5
11 April 2024	550 KGS	4907.17
25 April 2024	40,130 KGS	54467.65

EXPORTS:

— Top Exporters of Fatty Alcohol Ethoxylates from India ;

- a) VVF India Limited
- b) Godrej Industries Limited
- c) Esteem Industries
- d) Stepan India Private Limited
- e) Galaxy Surfactants Limited

— India exported 91 shipments of Fatty Alcohol Ethoxylates between February 2023 and January 2024, reflecting an 82% growth compared to the previous year

— Globally, India leads in exports with 1,326 shipments during this period, surpassing the European Union (1,054 shipments) and Germany (932 shipments)

— Exports of fatty alcohol ethoxylates have shown consistent growth due to increasing global demand for eco-friendly surfactants.

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Economic feasibility:

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

RAW MATERIALS REQUIRED:

1.Fatty Alcohols

- Fatty alcohols can be produced through the hydrogenation of fatty acids or fatty acid esters, the Oxo process (hydroformylation followed by hydrogenation), and the Ziegler process (ethylene chain growth).
- For cost-effectiveness in bulk industrial production, the Hydrogenation of Fatty Acids/Esters is the cheapest and most widely used method, especially when natural feedstocks (palm oil, tallow, coconut oil) are available.

Fatty Acids and Fatty Acid Esters:

- India has a robust oleochemical industry, with numerous manufacturers and suppliers offering a variety of fatty acids and their esters. Platforms like

TradelIndia list multiple suppliers, including Godrej Industries Limited and KRISH IMPEX, providing these raw materials.

- Prices for fatty acids can vary based on purity, chain length, and market conditions. Approximate prices:
 - Godrej Industries Limited: ₹120 per kilogram.
 - KRISH IMPEX: ₹190 per kilogram for 99% pure fatty acid.
 - SHIV SHAKTI INDIA: ₹135 per kilogram for 99% pure fatty acid.

Catalyst's: Nickel (Ni), Copper-Chromium (Cu/Cr), and Copper-Zinc (Cu/Zn):

- Nickel (Ni) catalyst is widely used for fatty acid hydrogenation due to its cost-effectiveness, high activity, and industrial availability.
- Several Indian companies specialize in the production and supply of nickel catalysts GM Catalysts, Gorwara Chemical Industries, Nutech Air Project, Vineeth Chemicals, Indian Platinum Pvt. Ltd.
- Some suppliers offer nickel catalysts at approximately ₹1,050 per kilogram.

2.Ethylene Oxide (EO)

- India's key ethylene oxide (EO) producers include Reliance Industries Limited (RIL), the largest supplier, along with Indian Oil Corporation (IOCL), India Glycols Limited, HPCL-Mittal Energy Limited (HMEL), and Bharat Petroleum Corporation Ltd. (BPCL). These companies cater to various industries, ensuring domestic EO supply for applications like petrochemicals, detergents, and surfactants.
- The catalytic oxidation of ethylene is the most efficient, scalable, and environmentally feasible method for EO production in India.
- Price range for EO is 63.5 INR per kilogram.

3.Catalyst

- Potassium Hydroxide (KOH) and Sodium Hydroxide (NaOH) are widely used catalysts in the production of fatty alcohol ethoxylates

Sodium Hydroxide (NaOH):

- Major suppliers for NaOH include Harshita International Exports in Visakhapatnam, Andhra Pradesh and Brane Enterprise in Ankleshwar, Gujarat.
- Industrial-grade caustic soda flakes are priced between **₹40 to ₹50** per kilogram.

Potassium Hydroxide (KOH):

- KOH is supplied by various manufacturers in India, such as Paramount Chemical & Acid Corporation in Mumbai, Maharashtra and Jigs Chemical Limited in Ahmedabad, Gujarat.
- Industrial-grade potassium hydroxide prices vary based on purity and form. For instance: Paramount Chemical & Acid Corporation offers KOH at approximately **₹130 per kilogram** and Jigs Chemical Limited lists KOH at ₹122 per kilogram.

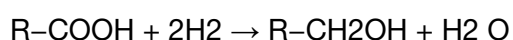
4. Stabilizers/Inhibitors

5. Neutralizing Agents

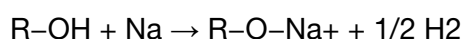
- Common agents like phosphoric acid or acetic acid are used to neutralize residual catalysts.
- Industrial-grade acetic acid prices fluctuate based on factors such as purity, supplier, and market conditions. Recent listings indicate prices around ₹80 per liter.
- The cost of phosphoric acid varies based on purity and supplier. As of recent data, prices range from approximately **₹85 to ₹120 per kilogram**. For example, Harshita International Exports offers industrial-grade phosphoric acid at ₹85 per liter.

REACTIONS:

Step 1: Hydrogenation of Fatty acids or Fatty acid esters

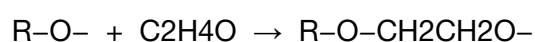


Step 2: Catalyst Activation and Alkoxide Formation

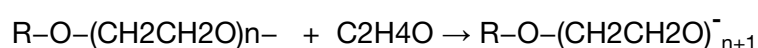


Step 3: Ethoxylation Reactions

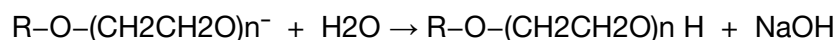
- Nucleophilic Attack on Ethylene Oxide (EO):



- Chain Propagation (Ethoxylate Chain Growth):



- Termination (Protonation):



1. Raw Material Requirements per 1 kg of Fatty Alcohol Ethoxylates:

- Fatty Acid: 0.52kg
- Ethylene Oxide (EO): 0.49 kg
- Catalyst (KOH/NaOH): 1.03kg

2. Raw Material Costs (per kg):

- Fatty acid : 135/Kg
- EO : 63.5/Kg
- NaOH : 45/Kg

3. Total Raw Material Cost per 1 kg of FAE

- Fatty acid : 0.52kg \times ₹135/kg = ₹70.2
- EO : 0.49g \times ₹63.5/kg = ₹31.115
- NaOH : 1.03kg \times ₹45/kg = ₹46.35

Total Raw Material Cost: ₹147.665 per kg of Fatty Alcohol Ethoxylates

4. Profit Calculation:

- Selling price : ₹250 per kg of FAE
- Raw Material Cost: ₹147.665
- Gross Profit per kg: ₹250 - ₹147.665 = ₹102.4
- Gross Profit Margin: $(\text{₹}102.4/\text{₹}250) \times 100 = 40.9\%$

5. Daily and Annual Production:

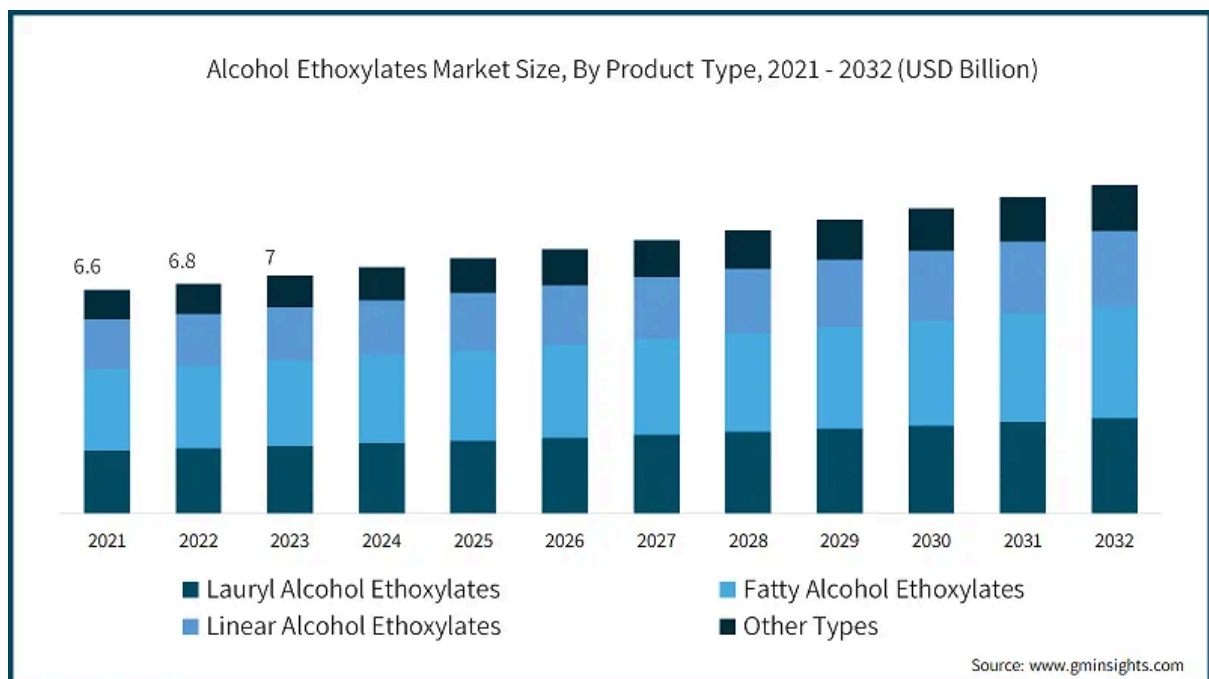
- Daily production : 1 tonne (1,000 kg)
 - Daily gross profit: ₹102.4/kg \times 1000 kg = ₹1,02,400
 - Annual gross profit: ₹1,02,400 \times 365 days = ₹ 3,73,76,000/yr (**3.7 cr/yr**)
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Detailed Analysis

1) Introduction

Fatty alcohol ethoxylates belong to alcohol ethoxylates derivatives and their market can be broadly categorised into three segments depending on the uses and carbon no.

1. *Linear Alcohol Ethoxylates (C10-C18)*: Highly biodegradable, widely used in detergents and industrial cleaners.
2. *Lauryl Alcohol Ethoxylates (C12-C14)*: Key ingredient in personal care products due to excellent foaming and emulsifying properties.
3. *Fatty Alcohol Ethoxylates (C10-C18)*: Versatile surfactants used in agrochemicals, textiles, and industrial applications.

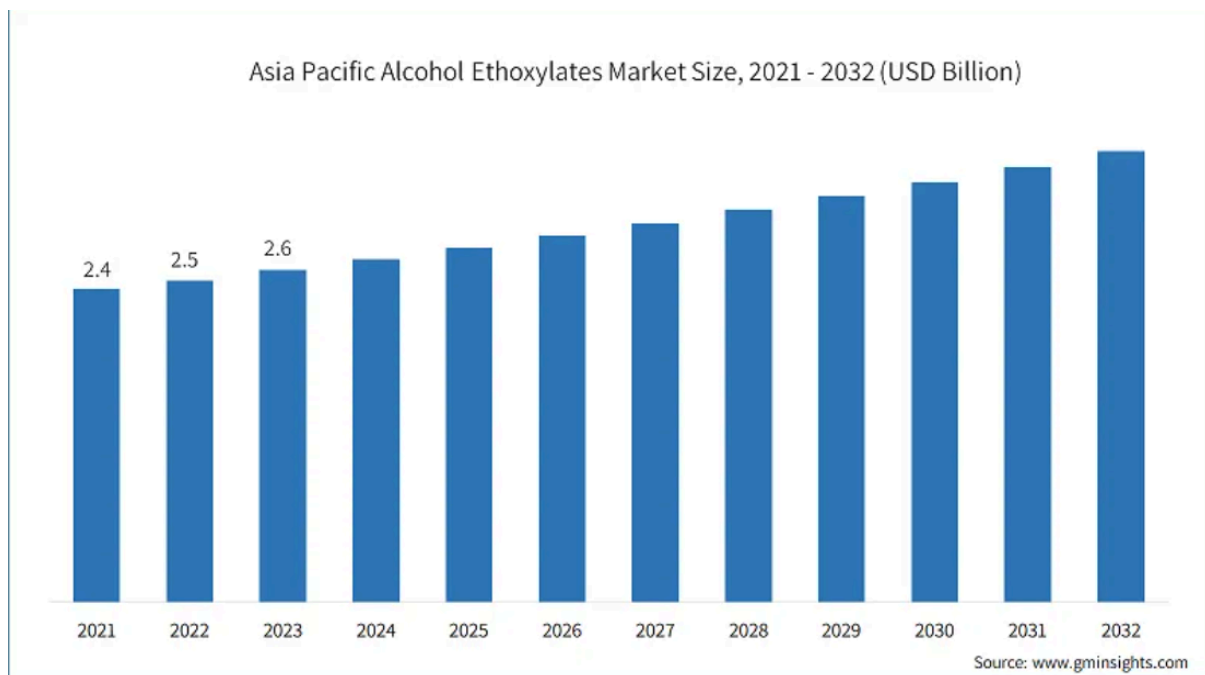


2) Market Size and Growth rate

- The *global* fatty alcohol ethoxylates market has demonstrated steady growth over recent years. In 2021, the market was valued at approximately USD 3.2 billion and is projected to reach around USD 4.4 billion by 2030, growing at a compound annual growth rate (CAGR) of **4.2% from 2022 to 2030**. Major regions contributing to this

growth are

- Asia- Pacific region
 - Europe
- The *Indian* ethoxylates market, encompassing FAEs, was valued at approximately USD 612.4 million in 2022 and is projected to reach USD 884.7 million by 2030, reflecting a compound annual growth rate (CAGR) of **4.7% from 2023 to 2030**.



3) Key Drivers

- *Personal Care and Cosmetics*: The burgeoning personal care industry, including skincare, haircare, and cosmetics, is driving demand for FAEs due to their emulsifying and foaming properties.
- *Pharmaceuticals*: The growing pharmaceutical sector in India utilizes FAEs in various formulations, contributing to market expansion.
- *Eco-Friendly Surfactants*: There is a growing preference for biodegradable and environmentally friendly surfactants, positioning FAEs as a favorable choice in various applications.
- *Agricultural Sector Growth*: Enhanced use of FAEs as emulsifiers and dispersants in agrochemical formulations.

- *Advancements in R&D:* Continuous research leading to innovative applications and improved product formulations.

4) **SWOT Analysis -(NOT LIMITED)**

Strengths:

- FAEs exhibit excellent emulsifying and foaming properties, making them suitable for a wide range of applications.
- With a significant share in industries like personal care and homecare, FAEs have a robust market foundation.

Weaknesses:

- Despite being more eco-friendly than some alternatives, the production and disposal of FAEs can still pose environmental challenges.
- Fluctuations in the prices of raw materials, such as fatty alcohols, can impact production costs.

Opportunities:

- Rapid industrialization and urbanization in regions like Asia-Pacific present significant growth opportunities.
- Developing FAEs with enhanced properties can open new application avenues and increase market share.

Threats:

- Stringent environmental regulations may impact production processes and increase compliance costs.
- The emergence of new surfactants could potentially erode the market share of FAEs.

5) **End-Use Industries**

- *Personal Care & Cosmetics:* Shampoo, conditioners, body lotion, skin cream, hair dyes and styling products
- *Household & Industrial Cleaning:* Liquid detergents, surface cleaners, fabric softeners, dishwashing liquids and Industrial degreasers
- *Agrochemical:* Emulsifiers in pesticides, herbicides, and fungicides

- *Textiles & Leather Processing:* Wetting and scouring agents, dye dispersants, Leather softeners and tanning auxiliaries
 - *Paints, Coatings & Inks:* Wetting agents in printing inks, emulsifiers for water-based paints, dispersants for pigment stabilization
 - *Oil and Gas Industry:* Demulsifier for crude oil separation, surfactants in enhanced oil recovery
 - *Paper & Pulp Processing:* De-inking agents in paper recycling, Foaming control in pulp washing
 - *Pharmaceuticals:* Drug solubilizers in formulations, Surfactants in topical creams and ointments
 - *Metalworking & Lubricants:* Cutting fluids and metal cleaning agents, corrosion inhibitors and emulsifiers
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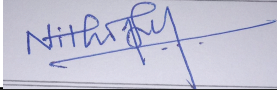
List the contributions of each author:

- Venugopal looked at use cases.
- Sajag carried out detailed analysis.

Market Analysis Report

- Shivam Dongare carried out import and export data.
- Priyanka looked at economic feasibility

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