

IDP Project 2016-17

Finding Fatty Alcohol derivatives

- Fatty alcohol ethoxylates (FAE)
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0) Study objective

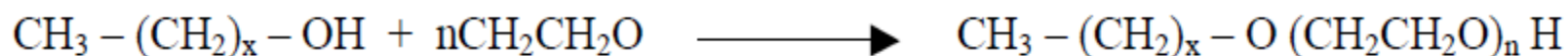
Finding of Value added alcohol derivatives and to recommend two products for implementation.

This study will help participants & provide----

- Exposure to alcohol derivatives market.
- Familiarization of fatty alcohols and oleo chemical language.
- Manufacturing processes.
- Developing business case.
- Project/ product costing.
- Toll processors information.

1) Basics of Alcohol Ethoxylates

- Ethoxylates are Non ionic surfactant (The term non-ionic surfactant will be defined in next slide)
- Alcohol Ethoxylates are produced by reaction called “Ethoxylation”.
- This is a chemical reaction in which Ethylene oxide reacts with Fatty Alcohol in presence of catalyst & heat.
- Alcohol ethoxlates are Surfactants and directly used in Detergent formulation or often converted to related species called ethoxysulfates by reacting with Sulphur trioxide.
- Chemical Reaction:



$$x = 5-17$$

1) Basics of Alcohol Ethoxylates Contd...

Surfactants ??

Classification:

(1) Anionics : In these surfactants the hydrophilic group is negatively charged. They are the most widely used type of surfactants for laundering, dishwashing liquids and shampoos. They are particularly good at keeping the dirt, once dislodged, away from fabrics.

Four anionic surfactants are used:

a) alkylbenzene sulfonates (b) alkyl sulfates (c) alkyl ether sulfates (d) soaps

(2) Cationics: With these surfactants, the hydrophilic head is positively charged.

Although they are produced in much smaller quantities than the anionics, there are several types, each used for a specific purpose.

(a) Mono alkyl quaternary systems (b) Esterquats

(3) Nonionics: These surfactants do not bear an electrical charge and are often used together with anionic surfactants. An advantage is that they do not interact with calcium and magnesium ions in hard water.

They account for nearly 50% of surfactant production (excluding soap). The major group of nonionics are the ethoxylates made by condensing long chain alcohols with ethylene oxide to form ethers.

(4) Amphoteric: Amphoteric (or zwitterionic) surfactants are so called because the head-group carries both a negative and positive charge. A range of methods is used to produce such materials, almost all of which contain a quaternary ammonium ion (a cation). The negatively charged group can be carboxylate, -CO_2^- , sulfate, -OSO_3^- or sulfonate, -SO_3^- . One such well-used class is the alkyl betaines which have a carboxyl group. A long-chain carboxylic acid reacts with a diamine to form a tertiary amine. On further reaction with sodium chloroethanoate, a quaternary salt is formed.

2) Uses of Alcohol Ethoxylates

- Ethoxylates are basically used as Non ionic surfactant
- Normal use levels: 1- 6% in most detergent formulations
- Ethoxylates are used for making Anionic surfactants like Sodium Laureth Sulphate.
- Ethoxylates are used as thickener in cosmetic surfactant preparations like shampoos, shower preparations and foam baths.
- Ethoxylates are used in various cosmetics and toiletries such as conditioners, bath oils, creams, lotions, and shaving products. Builds good viscosity, structures in surfactant solutions in combination with sodium chloride.
- They provide moderate, stable foam and high detergency for use in laundry products, consumer and hard surface cleaners.

2) Uses of Alcohol Ethoxylates Contd...

- Typical formulation where Alcohol Ethoxylates are used as Non ionic surfactant
- **Godrej Industries makes “GINONIC L242” and uses in below formulation:-**

GINONIC L 242 is nonionic surfactant prepared by ethoxylating fatty alcohol. GINONIC L 242 used as thickener in cosmetic surfactant preparations like shampoos, shower preparations and foam baths. Also used in various cosmetics and toiletries such as conditioners, bath oils, creams, lotions, and shaving products. Builds good viscosity, structures in surfactant solutions in combination with sodium chloride, similar to the fatty acid alkanolamides and nitrogen-free.

Clear Shampoo

		%
A	Sodium laureth Sulphate	35.0
A	Ammonium Lauryl Sulphate	15.0
A	Cocoamidopropyl betaine	6.0
B	Wheat protein	2.0
B	Water(Q.S.)	100
B	D-Pantheonl	0.5
B	Benzophenone-4	1.0
C	DMDM Hydantoin	0.4
C	Ginonic L242	2.0
C	Perfume	0.6

3) Market Size of Alcohol Ethoxylates

- Today, more than 6 million metric tons per year of nonionic surfactants are produced worldwide by some over 200 different ethoxylators.
- The annual growth of ethoxylates varies around the different regions in the world reaching yearly growths up to 4 to 5 %.
- Overall worldwide growth is in the region of 2 %.
- The global alcohol ethoxylate market was valued at \$5,124.8 million in 2014 and is projected to grow at a CAGR of 3.5% during the forecast period from 2014 to 2019.
- The market, by application, was led by the house hold and personal care segment in 2014, with a 49.6% share. Europe is a key market for alcohol ethoxylate.

3) Market Size of Alcohol Ethoxylates Contd...

Region wise

Table 1: Annual Capacity for Nonionic Surfactants					
yearly growth rate-%	1.7				
Region	Annual Ethoxylates	Annual Ethoxylates	Annual Ethoxylates	Annual Ethoxylates	Annual Ethoxylates
	Capacity in 1994	Capacity 2000	Capacity 2018	Capacity 2019	Capacity 2020
	(1,000 t/year)	(1,000 t/year)	(1,000 t/year)	(1,000 t/year)	(1,000 t/year)
North America	1237	1,365	1,858	1,890	1,923
South America	138	160	218	222	225
West Europe	1652	1,800	2,450	2,492	2,535
East Europe	400	430	585	595	606
Middle East & Africa	10	12	16	17	17
Asia	367	425	578	588	599
Japan	402	450	613	623	634
Total	4206	4642	6318	6428	6539

The current demand for non-ionic ethoxylates in Asia region is about **5,78,000 MT per annum.**

3) Market Size of Alcohol Ethoxylates Contd..

During the last 35 years, nonionic surfactants have increased their market share, to reach about 40 % of the total surfactant production worldwide.

Market share of different surfactants	
33 % Soaps, carboxylates, lignosulfonates:	
50 % soaps for domestic use.	
35 % other acids for industrial use.	
22 % Synthetic Detergents, mostly sulfonates or sulfates:	
50 % domestic use (powder, liquid).	
17 % petroleum industry.	
7 % concrete additives.	
4 % agro and food processing.	
3 % cosmetics and pharmaceuticals.	
40 % Nonionics (mostly ethoxylated) or ethoxysulfates:	
40 % ethoxylated alcohols.	
20 % ethoxylated alkylphénols (in fast regression)	
15 % fatty acid esters.	
10 % amine or amide derivatives.	
4 % Cationics, mostly quaternary ammoniums.	
1 % Amphoteric, mostly betaines and amino acid derivatives.	



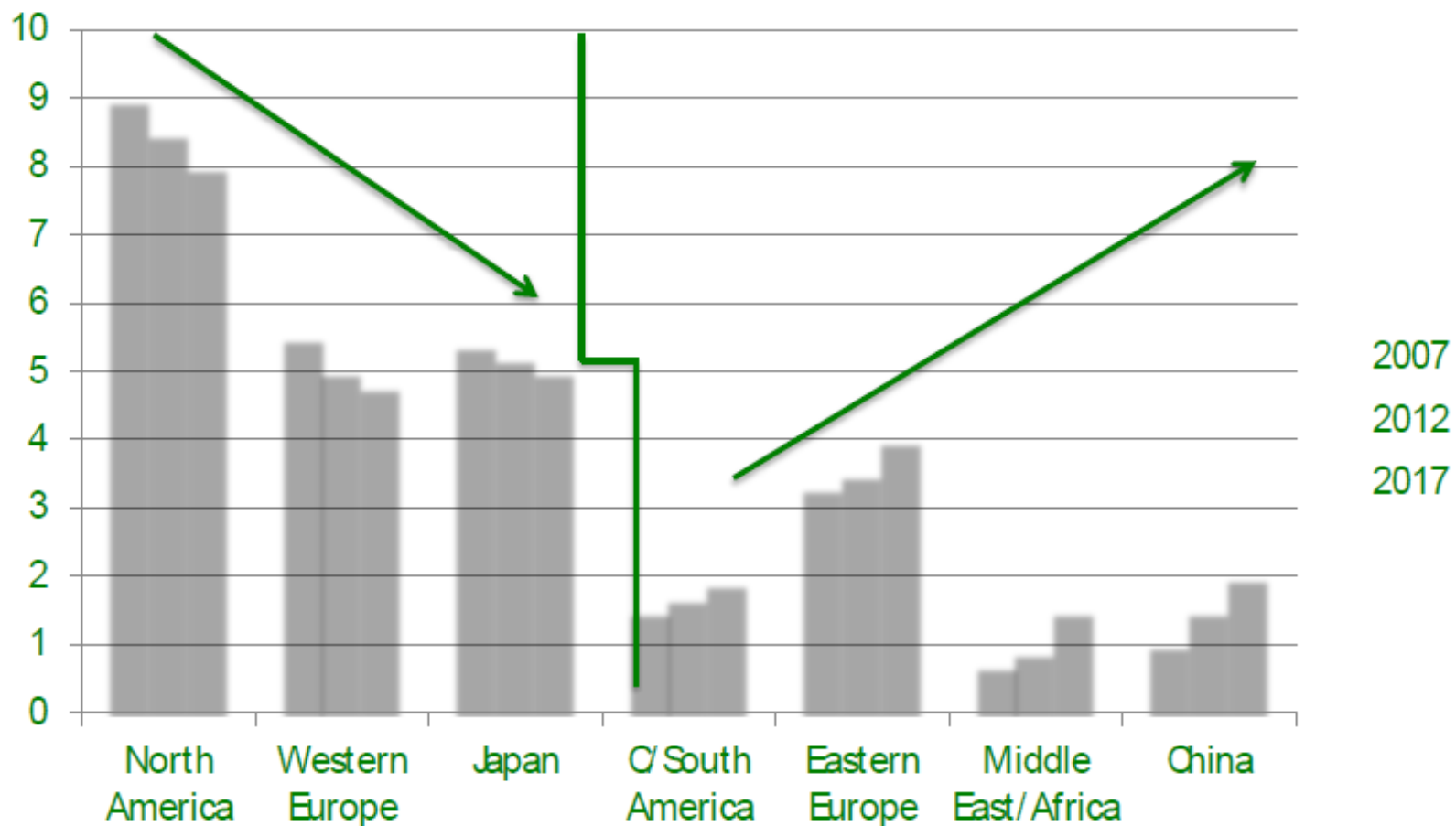
3) Market Size of Alcohol Ethoxylates Contd..

TABLE 1 GLOBAL ALCOHOL ETHOXYLATE PEER MARKET SIZE, 2014 (USD MN)

Market	Values	Growth Rate (%)
Alcohol Ethoxylate	5,124.8	3.5
Fatty Amine Ethoxylate	1,332.0	3.4
Fatty Acid Ethoxylate	1,137.1	3.3
Methyl Ester Ethoxylate	934.6	3.0
Glyceride Ethoxylate	640.7	2.4

4) Per Capita consumption

Estimated Surfactant per Capita, 2006-2016 (kg/ yr)



Source: Linden Tree Partners, ICIS Asian Surfactant Conference

5) Market Players

GLOBAL:

- 1) BASF SE (Germany),
- 2) Huntsman Corporation (U.S.)
- 3) Clariant AG (Switzerland)
- 4) Stepan Company (Illinois)
- 5) Shell Chemicals (Netherlands)
- 6) Sasol Ltd (South Africa)
- 7) Ineos Group (Switzerland)
- 8) India Glycols (India)
- 9) The Dow Chemical Company (U.S.)

INDIAN:

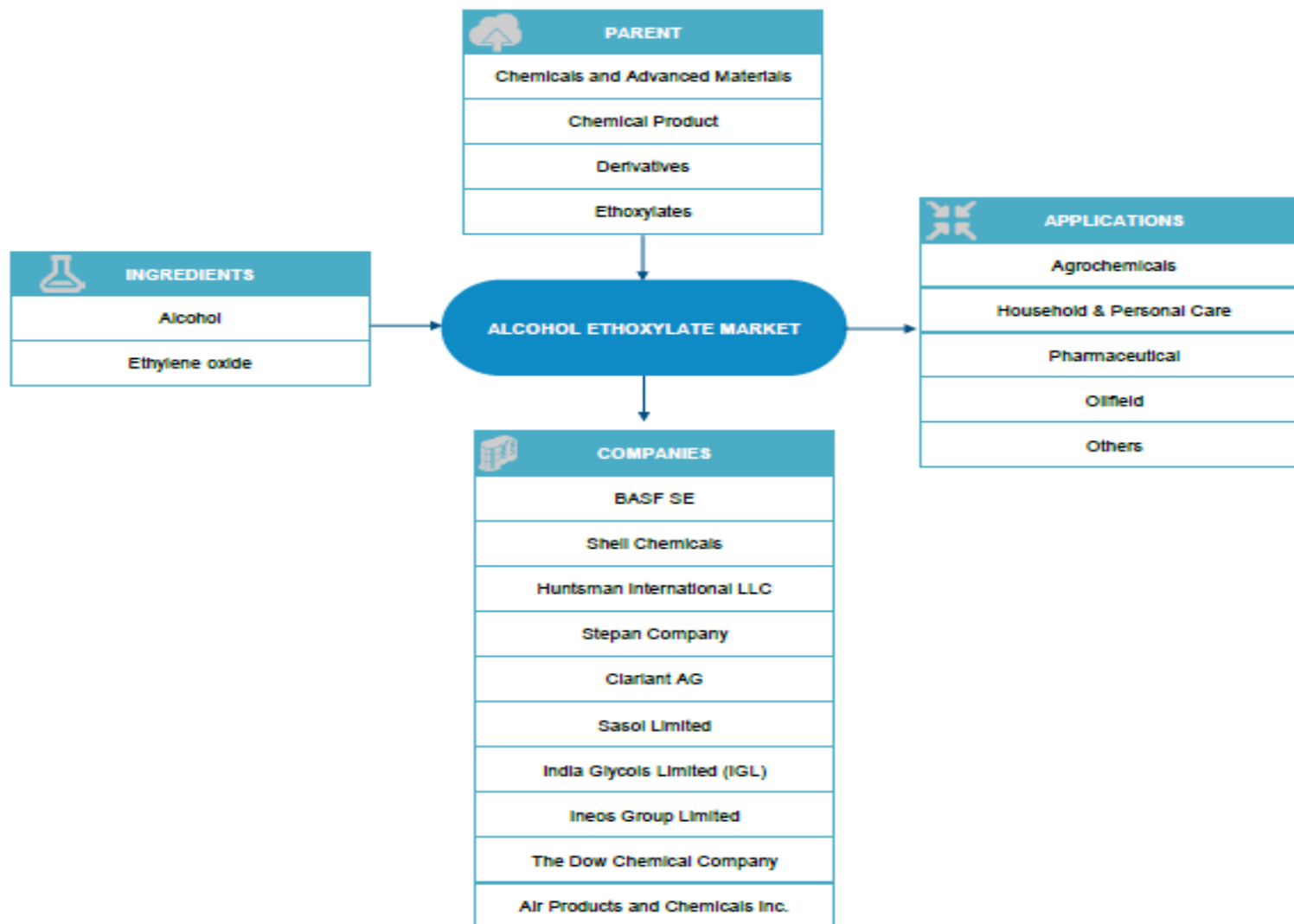
- 1) Rimpro India
- 2) VENUS Goa
- 3) Galaxy surfactants
- 4) Core chemicals
- 5) Saibaba surfactants
- 6) Aarti surfactants
- 7) Unitop chemicals

5) Market Players Contd...

Geography wise presence	Asia-Pacific	Europe	North America	Latin America	Middle East & Africa
BASF SE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Huntsman International LLC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Stepan Company	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Clariant AG	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Sasol Limited	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
India Glycols Limited (IGL)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ineos Group Limited	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The Dow Chemical Company	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<div> <input checked="" type="checkbox"/> Company has major presence in the region <input type="checkbox"/> Company does not have major presence in the region </div>					

5) Market Players Contd...

GLOBAL ALCOHOL ETHOXYLATE MARKET: INTEGRATED ECOSYSTEM



6) Recent & Planned Downstream Investment in FAEs



Company	Downstream Investment	Location	Products
Wilmar	New capacity fatty alcohol	Rotterdam, Netherlands (on Huntsman site)	Lauryl, cetyl, tearyl alcohols & 8-10 acids
Wilmar	Acquisition of Huntsman European surfactant business	Lavera & St. Mihiel, France, Castiglione, Italy	LAS, SLES, SLS & detergent ethoxylates
Wilmar	Joint venture with Elevance on metathesis plant	Surabaya, Indonesia	Renewable olefins, diacids & other intermediates
Musim Mas	New capacity for fatty alcohol	Medan, Indonesia	Lauryl, cetyl, tearyl alcohols & 8-10 acids
Musim Mas	New capacity ethoxylation	Terneuzen, Netherlands (next to Dow EO)	Detergent ethoxylates
Sinar Mas	Joint venture with CEP SA	Dumai, Sumatra Indonesia	Lauryl, cetyl, stearyl alcohols & 8-10 acids
Sinar Mas	CEPSA/Sinar Mas joint venture acquires Gemini Holding's sulfonation plant (formerly a Hansa Group asset)	Genthin, Germany	LAS, SLES & SLS
Sime Darby	Joint ownership of Emery Oleochemicals with PTT of Thailand	Cincinnati, Malaysia	Fatty acids, alcohols, MES, sulfonates & sulfates
Ecogreen	New fatty alcohol capacity and acquired sulfonation assets in France (former Witco), ethoxylation	Batam, Indonesia, Singapore, St-Pierre-lès-Elbeuf, France	Fatty alcohols, detergent alcohols, LAS, SLS & SLES
KLK	New capacity for fatty alcohol	Westport, Malaysia	Lauryl, cetyl, stearyl alcohols & 8-10 acids
KLK	Acquisition of Tensachem	Ougree Belgium	LAS, SLS, SLES
KLK	Acquisition of Kolb	Moerdijk, Netherlands & Hedingen, Switzerland	Ethoxylates

Table 1 – Recent & planned downstream investments by palm oil companies

7) Value Chain

**Feedstock
Suppliers**



Converters



**Applications
Specialists**

LAB
Alcohols
EO

Sulfonation
Ethoxylation
Quaternization

Cosmetics
Lubricants
Agriculture
Cleaning

For Example:

SASOL

STEPAN

CRODA

7.1) Fatty Alcohol Market Snapshot

<u>Region</u>	<u>Mkt</u> (KMT/yr)	<u>Ann</u> <u>Growth</u>	<u>Capacity</u> (KMT/yr)	<u>Comment</u>
North America	750	2 – 3%	630	75% is Petrochem capacity
Latin America	150	5%	100	1 plant, <u>Oxiteno</u>
Europe	570	-	700	Several Old plants
Asia	1,000	6 - 7%	1,800	Fast growing, Many new players
ROW	30	4%	70	
TOTAL	2,500	~4%	3,300	

There is excess capacity of Fatty Alcohol worldwide, this favors converting it into Fatty Alcohol Ethoxylates/end use chemicals

8) Technology

- Many plants have been designed and operated on a batch system with various stirring systems and recirculation loops since the early 1950s but the latest thinking for bulk production is probably the plants that Davy Process Technology has developed for alkoxylation. This is Buss Loop Reactor technology.
- At least 10 plants of its design have been put into beneficial operation since they were first introduced in 1990 and are based on the Buss Loop Reactor technology.

Technologies:-

1. Batch system
2. Batch/Continuous system

8) Technology Contd...

1. Batch system

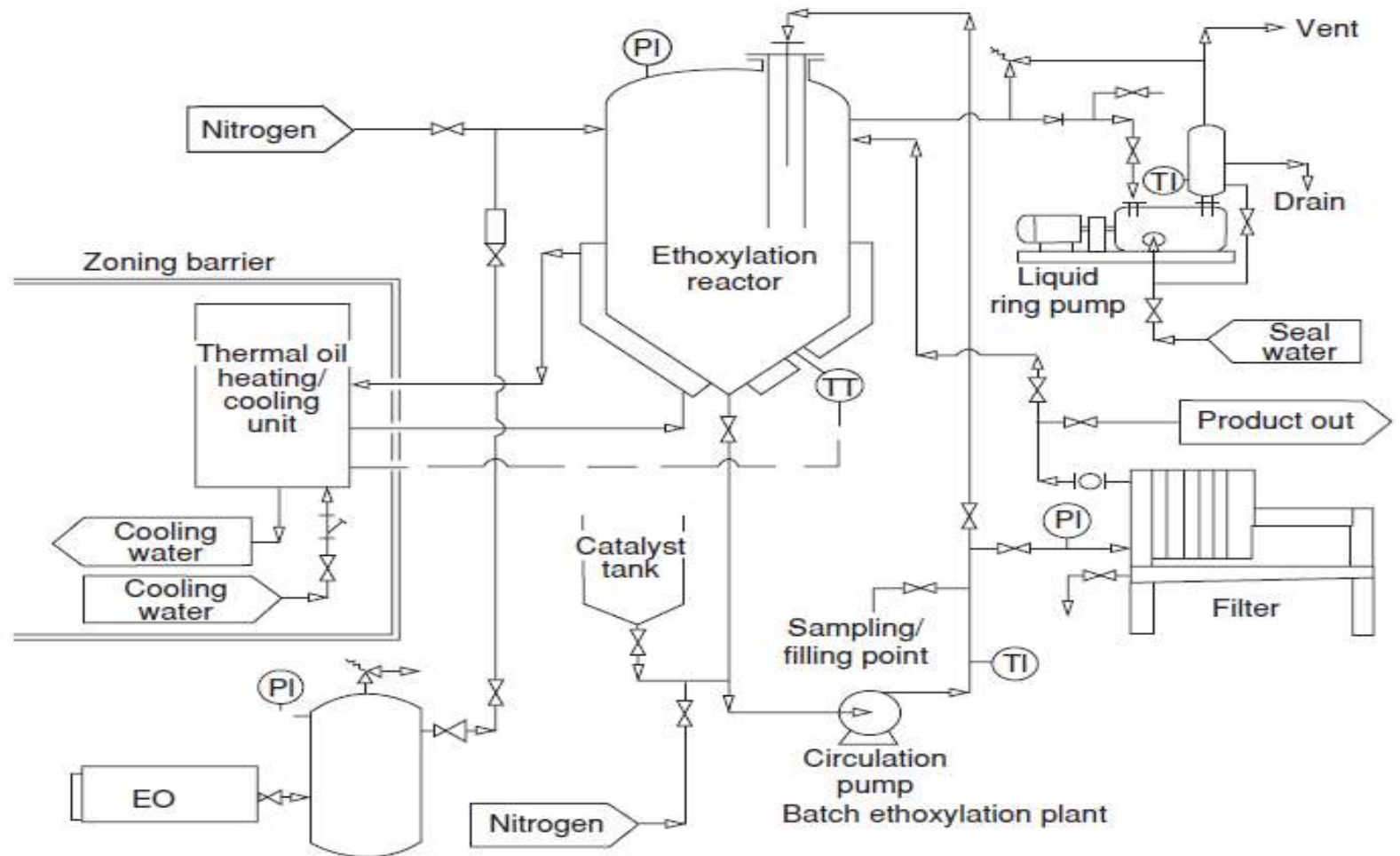


Figure 5.1 Batch ethoxylation unit.

8) Technology Contd...

2. Batch/Continuous system

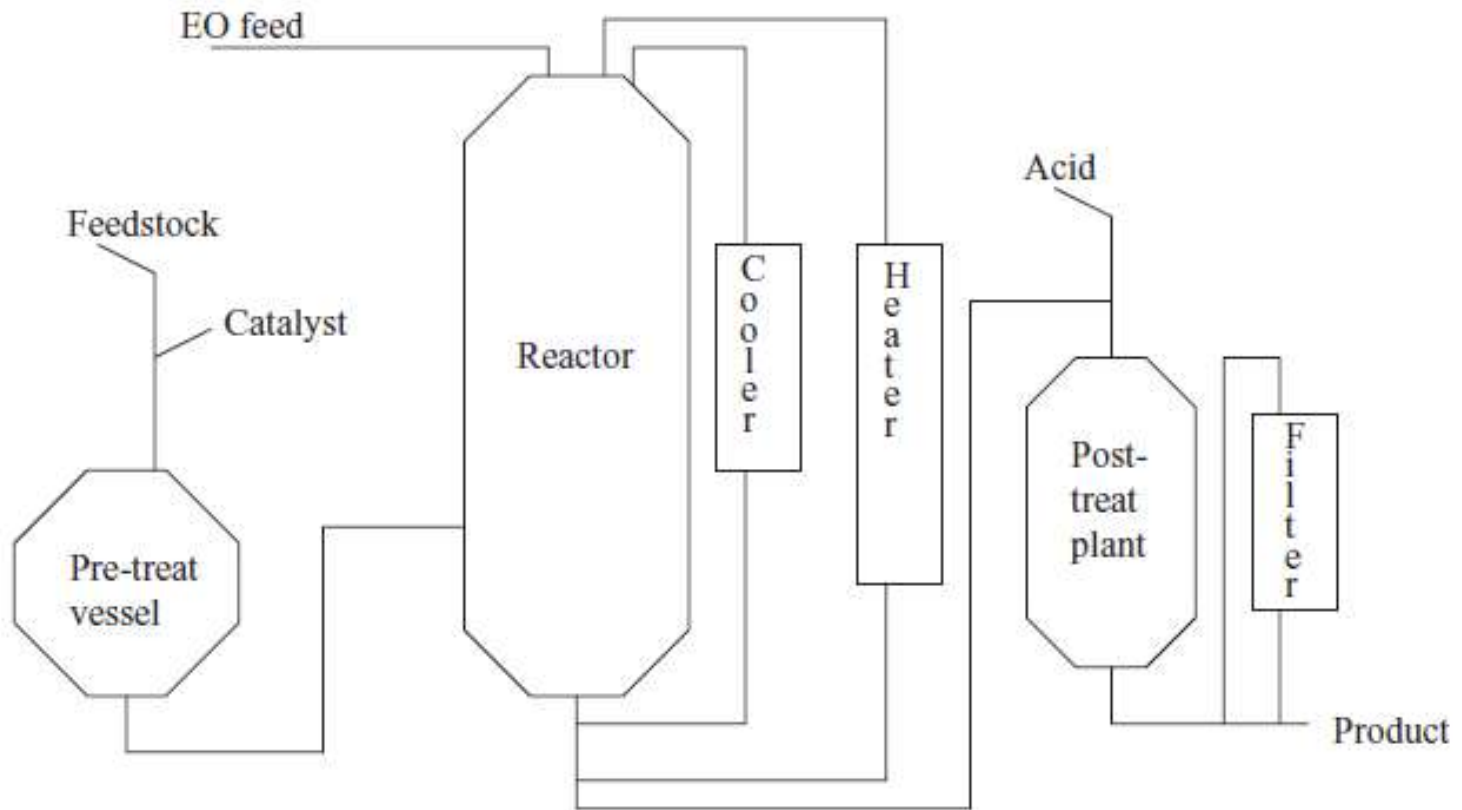
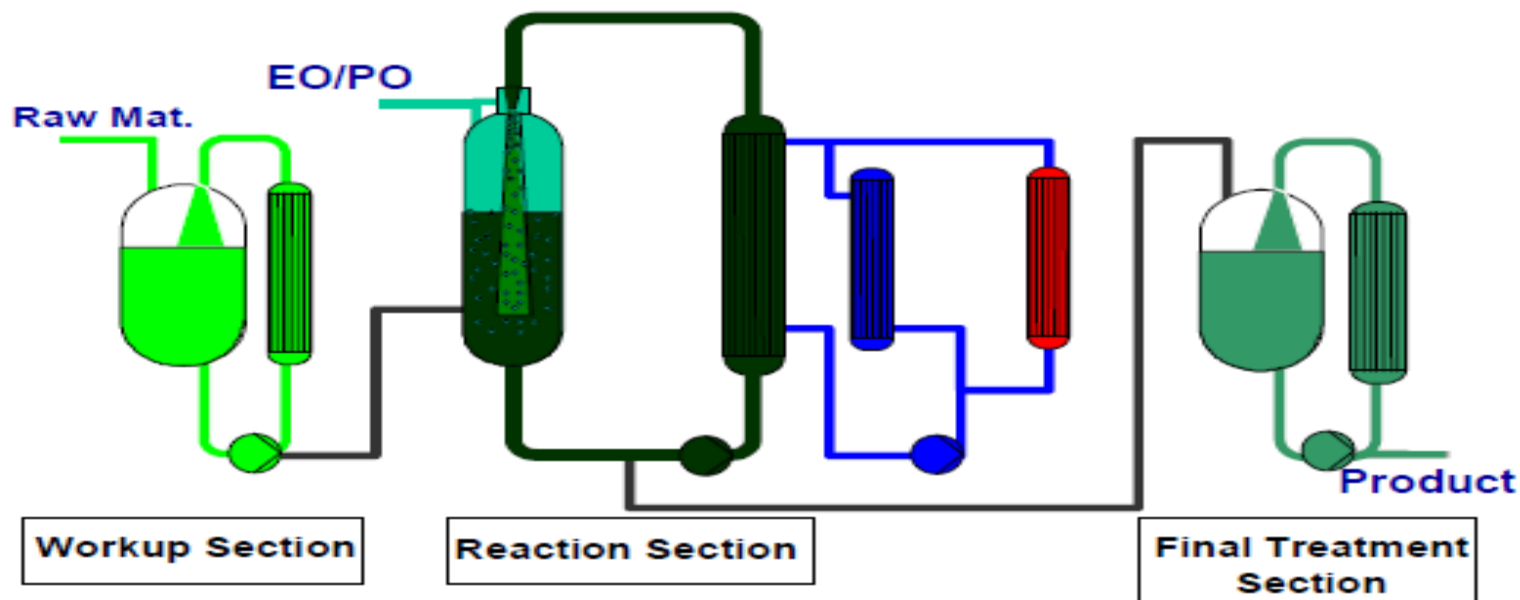


Figure 5.2 Schematic of batch/continuous process.

8) Technology Contd...

The new reactor plant concept involves a practical and rather optimal break up of the various sequences between the different treatment vessels. Thus the HH batch process is simultaneously carried out in 3 plant sections:

Workup Section	Reaction Section	Final Treatment Section
<ol style="list-style-type: none"> 1. Charge 2. Deodorize 3. Preheat 4. Add Catalyst 5. Dry under vacuum/sampling 6. Preheat to reaction temperature 7. Transfer to Reactor 	<ol style="list-style-type: none"> 1. Charge 2. Adjust reaction setpoints 3. Reaction 4. Post-reaction 5. Transfer to Final Treatment Section 	<ol style="list-style-type: none"> 1. Charge 2. Cool down 3. Add Acid 4. Sampling 5. Degassing 6. Cool down 7. Discharge to Filtration or storage



9) Opportunity for VVF

- Global demand for FAE's in 2018 would be about 6,318,000 MT/year.
- If VVF targets 0.5% market share, the opportunity would be about 31590 MT/year
- At present VVF toll manufacturers FAE's about 6000 MT/year and markets the same.
- So, 25590 MT/year FAE's potential is available.

10) Capability Gaps analysis

Capability Gaps for VVF to enter into Nonionic surfactants business				
Sr.No.	Parameter	Requirment	VVF Capabilities	Gap analysis
1	Market Demand scenerio	Present ethoxylate global market demand- 6,318,000 MT/year, To target 0.5% market share which comes to 31590 MT/year	No inhouse manufacturing facility but Toll manufacturing about 6000 MT per annum is being done	To invest in 25590 MT per annum Manufacturing Plant OR To develop equivalent capacity toll manufacturer
2	Technology of manufacture	Ethoxylation technology available generally from Licensor like Buss Chemtech, HH Technology	No available	VVF need to source the appropriate technology through licensor / equipment manufacturer and invest for infrastrucur
3	Raw material - Ethylene oxide	To ensure supply security as per desired capacity	No available	To develop long term supply security
4	Marketing Setup	Industry specilist in marketing is required in leadership roll along with supporting team	Partly avilable	Need to strenthen with application specilist and market exposure

11) Conclusions

- FAE can continue to support VVF through increased Tolling or new plant infrastructure
- On global scenerio, companies like Wilmar, KLR, Musim mas are integrating vertically and investing into downstream processing capacity .
- For fatty alcohol ethoxylation, the concern will be securing EO supply on longterm basis.

12) Learning's from Project

- Fatty alcohol ethoxylate market insight & global players
- The learning about technology
- Capability gap analysis

Thank you

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