



GLOBAL VINYL ESTER RESIN MARKET FORECAST & OPPORTUNITIES, 2030

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MARKET INTELLIGENCE. CONSULTING

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from NOW to NEXT

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Executive Summary

Brief insight about the company and project:



Established - 1973

Turnover (Consolidated) - INR 5,39,238 Crore (FY Year 2020-21)

1.1. Overview of the Company:

- India based Reliance Industries Limited, one of the well-known MNCs which manufacture and sale diverse range of products including polymers, aromatics, elastomers etc. globally.
- The company caters customers and various industries viz., healthcare, automotive, packaging etc across over 70 countries worldwide.
- The company's total production capacity of PE, PP and PVC is 2.3, 2.9 and 0.7 million MT per annum, respectively as of 2019.
- The company exported 1.1 million MT of polymers globally in 2019.
- The company has 6 state-of-the-art manufacturing facilities to produce polymers.

1.2 Brief Profile of Board of Directors:

Mukesh Ambani: Mr. Mukesh D. Ambani (DIN 00001695) is a Chemical Engineer from the Institute of Chemical Technology, Mumbai (erstwhile the University Department of Chemical Technology, University of Mumbai). He pursued an MBA from Stanford University in the US. He has been on the Board of Reliance since 1977.

Nita M. Ambani: Mrs. Nita M. Ambani (DIN 03115198) is a Commerce Graduate from Mumbai University and a diploma holder in Early Childhood Education.

Hital R. Mezwani: Mr. Hital R. Mezwani (DIN 00001623) is a Management & Technology graduate from the University of Pennsylvania (UPenn) in the USA.

Nikhil R. Mezwani: Nikhil Mezwani is an Executive

Director on the Board of Reliance. A chemical engineer from the University Institute of Chemical Technology (UICCT) Mumbai, he joined Reliance in 1986.

P.M.S. Prasad: PMS Prasad is an Executive Director at Reliance and one of the longest serving members on the Board and the company.

P.K. Kapil: PK Kapil is an Executive Director on the

Board of Reliance. With experience spanning four decades, he is a driving force in the HSE, Technology, Reliability and Operations of all manufacturing sites.

R.A. Mashelkar: R.A. Mashelkar is an independent Director on the Board of Reliance. An eminent scientist and champion of the Innovation Movement in India, he is the Chairman of Reliance Innovation Council.

Adil Zainulbhai: Adil Zainulbhai is an independent Director on the Board of Reliance. One of the world's foremost consultants, he is a mechanical engineering graduate from IIT and holds an MBA from Harvard.

Mansingh L. Bhakta: Mansingh Bhakta is an

independent Director on the Board of Reliance. An advocate par excellence, he has almost six decades of experience.

Dipak C. Jain: Dipak Jain is an independent Director on the Board of Reliance. One of the world's top educationalists, he is a former Dean of Kellogg School of Management and INSEAD.

Dharam Vir Kapur: Dharam Vir Kapur is an independent Director on the Board of Reliance. A technology, industrial development, and project implementation expert, he has a long and illustrious career in the Indian government.

Mahesh P. Modi: Mahesh Modi is an independent

Director on the Board of Reliance. He has in-depth management experience in the petrochemical, telecommunications, energy, and insurance industries.

Yogendra P. Trivedi: Yogendra Trivedi is an independent Director on the Board of Reliance. He is an expert in the fields of economics, politics, education, sports, and social and professional services.

Ashok Misra: Ashok Misra is an independent Director on the Board of Reliance. An IIT Director from 2000-2008, Misra was the driving force behind its transformation into a leading research and development institute.

1.3 Brief Project Summary:

Vinyl ester resins (VERs) are high-performance unsaturated resins derived by the addition reaction of various epoxide resins with unsaturated carboxylic acids. These resins have been classified under unsaturated polyester resins & comes with different grades such as Bisphenol-A Epoxy Resin, Low styrene Monomer Bisphenol-A Resin, Novolac Based Epoxy Resin, Brominated Epoxy Resin, and multifunctional epoxy resins.

Vinyl ester resin are easy to manufacture as process is simple and all raw materials are available. Backward integration into raw materials such as Epoxy Resin, Styrene and Methacrylic Acid will allow consistent supply and competitive pricing of vinyl ester resin.

1.4 Key Highlights of the projects

Reliance Industries Limited (RIL) proposes to enter Vinyl Ester Resin business. With the increasing demand within India and across the globe, there is a great opportunity to enter in this manufacturing business. The company's total production capacity of PE, PP and PVC is 2.3, 2.9 and 0.7 million MT per annum, respectively as of 2019. Success for the greenfield project is mainly due to:

- Cost Competitiveness against all major companies operating in the market
- Early Adaptation of 5G Technology by telecom sector
- India being the Top 10 preference for FDI Inflows in the country.
- India being the 4th largest producer of Chemicals in Asia Pacific region.
- “AatmaNirbhar Bharat” and “Make in India” policies are further incentivizing domestic manufacturer to come up with green field capacity.

Demand for vinyl ester resin has been proposed to have double digit growth in India due to the robust growth in end user industries. India's Fiberglass Reinforced Plastics (FRP) coating and lining Industry has been witnessing high growth numbers due to increasing inclination towards corrosion resistant products and other technological advancements. Vinyl ester resin is also finding its wide applications majorly in materials for pipe linings, steel and concrete linings, secondary containment, and to fabricate FRP (Fiberglass Reinforced Plastics) storage tanks. Vinyl ester resin prevents the hydrolysis induced osmotic blistering by the formation of skin

between the gel coat and the glass/polyester laminate or over the gel coat. It can be used for the entire lamination of boats which provides greater flexibility and toughness than polyester.

Growth Drivers for India Vinyl Ester Market

Name of the Product	Domestic Demand Market	Export Potential	Import Substitution
FRP (Pipes and Tanks)	✓	✓	
Electronics and Telecommunication	✓	✓	✓
Marine Components	✓		
Renewable Energy (Wind)	✓	✓	
Aerospace and Defense	✓		✓
Chemicals	✓		✓

Product Profile

2.1. Product Overview (Introduction and Characteristics):

Vinyl Ester Resins are intermediate between polyester and epoxy resin specifically designed for greater resistance to vibrational loads. They are thermosetting group of resins derived from the reaction of epoxy resin and unsaturated carboxylic acid group such as methacrylic or acrylic acid.

Vinyl Ester Resin forms cross linking between epoxy backbone and functional side groups leaving fewer area to attach water molecule which means these resins are very resistant to water and other chemicals. As they are less susceptible to damage by hydrolysis, therefore find applications in pipes and chemical storage tanks, marine, recreation industries etc. This type of side group cross linking also provides vinyl ester resin with excellent thermal stability and are frequently found in applications such as semiconductor encapsulation, electronics, and communication, construction, and automobile industries.

Few globally used grades of vinyl ester resin are described below

S. No	Grade	Application
1	Bisphenol-A Epoxy Based Vinyl Ester Resin	Provide Resistance to acid, alkalis, solvents, excellent toughness, and fatigue resistance
2	Low styrene Monomer Bisphenol-A Vinyl Ester Resin	Chemical reaction vessels
3	Novolac Based Epoxy Vinyl Ester Resin	Excellent, thermal, and chemical resistance, resistance to solvents, acids
4	Brominated Epoxy Based Vinyl Ester Resin	High degree of fire retardance, resistance to chemical, tougher and fatigue resistant
5	Brominated Novolac Epoxy Based Vinyl Ester Resin	Moderate degree of retardance, application in hot, wet flue gas environment
6	Elastomer-modified Bisphenol-A Epoxy Based Vinyl Ester Resin	High impact and fatigue resistance, chemically resistant FRP linings
7	Urethane Modified Vinyl Ester Resin	Heat, Corrosion and Chemical resistant, application in marine, pultrusion, carbon fibre

With the growing fibre reinforced composites market in the Asia Pacific, the demand is high for predictable and cohesive vinyl ester resin and polyester resin systems. The experience of composites in quality infrastructure over the last 30 years has provided the boulders for new corrosion infrastructure applications that shall apply to Asian as well as global markets.

The usage of fiberglass reinforced underground gasoline storage tanks has been successful in the last quarter century. Power station pipes, some as large as 4.9 meters in diameter, have been performing well without any problem. The recently developed composite products include sewer liners, short span bridges for handling pedestrian bridges, regular road traffic, water covers for water treatment plants.

Vinyl ester resin composites have achieved a remarkable degree of commercial acceptance in a variety of applications like infrastructure, chemical and marine industry.

Polyester and Vinyl Ester Resins are among the most used matrix resins to create polymer composites. The formulations of Vinyl ester have been providing increased corrosion resistance and have a broad range of heat distortion, available strength, and shrinkage characteristics. The automotive and transportation industry is expected to drive the demand for composite materials. As the strength-to-weight ratio of most composites is higher than that of steel and aluminium. Vinyl ester resin stands serve as the intermediate chemical of epoxy and polyester in terms of mechanical properties and price.

2.2 Production routes & related details

Vinyl ester resin Technology is typically developed in-house with the critical equipment being outsourced. It requires in-house independent R & D, equipped with latest state of art technologies and facilities. Vinyl Ester Resin is mainly of three types, namely Bisphenol A, F, S Vinyl Ester Resin, Novolac Vinyl Ester Resin, and Brominated Vinyl Ester Resin.

Some applications of Novolac vinyl ester resin includes heat shields, resistance coatings, parts for flue gas desulfurization, chimney liners, and other structural composite components where high heat resistance is required. The Brominated vinyl ester resins are flame retardant and provide corrosion resistance from a wide variety of acidic and alkaline environments.

Novolac based vinyl ester resin, despite possessing better properties than Bisphenol A vinyl ester resin, holds less share than Bisphenol A as the technology to manufacture is quite complex, expensive, requires infrastructure, raw materials, & above all expertise. Others include urethane and elastomer modified vinyl ester resins which are modified with many unique features, providing exceptional characteristics. The elastomer modified may also be used as a primer on carbon steel, high density PVC foam and other dissimilar substrates.

Production Route for producing Bisphenol A Based Vinyl Ester Resin:

Firstly, Epoxy resin and Bisphenol A are added to the reactor and heated to the temperature of 170°C and that temperature should be maintained for a period of 2-4 hours. Secondly, Epoxy equivalent weight is measured and after an optimum value has been achieved then it is allowed to cool down to 100°C and then finally to 80°C. Solid resins from the reactor is then discharged into blender containing blender and the temperature of the discharge resin should not rise above 70°C. To limit the temperature to the required limit water needs to be circulated around the blender. Finally, viscosity, gel time etc testing are to be done and should be adjusted accordingly.

Mass Balance:

INPUT	'QUANTITY (MT/MT)	OUTPUT	QUANTITY (MT/MT)
Epoxy Resin	0.30	Vinyl Ester Resin	1.0
Bisphenol-A	0.14	By Product	Nil
Methacrylic Acid	0.11	Yield Loss	0.00
Styrene Monomer	0.44	Gaseous	-
Total	1.00	Total	1.00

Production Route for Novolac Based Vinyl Ester Resin: Initially, reactor should be charged with required quantity of solid Novolac epoxy resin and should be heated to 100°C. After that, Methacrylic Acid and Maleic Anhydride are added to the reactor, while adding, temperature of the reactor should be maintained between 90°C to 100°C. Finally, Solid Novolac resin from the reactor needs to be discharged into a styrene monomer containing blender.

Mass Balance:

INPUT	QUANTITY (MT/MT)	OUTPUT	QUANTITY (MT/MT)
Epoxy Resin	0.40	Vinyl Ester Resin	1.0
Methacrylic Acid	0.12	By Product	Nil
Tri Ethyl amine	0.01	Yield Loss	-
Maleic Anhydride	0.03	Gaseous	-
Styrene Monomer	0.44	Solid waste	-
Total	1.00	Total	1.00

2.3 Properties and Applications

Property	Bisphenol-A*	Bisphenol-A*	Novolac
Viscosity, cP, 25°C	200~700	2000~3000	300~500
Specific Gravity, 25°C	1.04~1.06	1.06~1.08	1.07~1.09
Gel Time *a, minutes, 25°C	20~30	20~30	15~25
	Co(6%)=0.4%	Co(6%)=0.4%	Co(6%)=0.4%
	MEKPO=1.6%	MEKPO=1.6%	MEKPO=1.2%
Styrene Content, %	43~47	33~37	31~35
Stability, Dark at 25°C(month)	6	6	3

*The difference lies in the chemical properties of the two products like viscosity, specific gravity, styrene content etc.

Product Name	Features	Applications
Bisphenol-A*	■ Low viscosity.	■ Raw material tanks, pipe and process equipment.
	■ Excellent mechanical properties and easy processing.	■ Most commercial FRP fabrication processes.
	■ Excellent corrosion resistance to a wide range of acids, alkalis and salt solutions.	■ Anti-corrosion tank linings and coatings.
	■ Comply with FDA regulation 21 CFR 177.2420 when treated well.	■ Yacht, Wind turbine blade.
	■ Obtained the DNV Type Approval Certificate.	
Bisphenol-A*	■ High viscosity (SM=35%).	■ Fabricating tanks, pipe and process equipment.
	■ Excellent mechanical properties and corrosion resistance.	
Novolac	■ Excellent mechanical properties, good retention of strength and toughness at high temperatures.	■ High temperature chlorination or caustic scrubbing tower and storage tank.
	■ High resistance to solvents and chemicals.	■ Industrial waste treatment facilities.
	■ Excellent resistance to acidic oxidizing environments.	■ Flue gas desulfurization (FGD) system.
		■ Hydrochloric acid tank truck, organic solvent storage tank and most commercial FRP fabrication processes.

*The difference lies in the chemical properties of the two products like viscosity, specific gravity, styrene content etc.

2.4 End of Life and Sustainability

Health, Safety & Environment (HSE) :

Vinyl Ester Resin grades are classified under category 3 of flammable liquids, further these Resins are classified under health hazards in different categories mention below.

Health Hazards	Category
Acute toxicity (inhalation: vapour)	Category 4
Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 2
Germ cell mutagenicity	Category 2
Specific target organ toxicity — single exposure (central nervous system)	Category 1
Specific target organ toxicity — Single exposure	Category 3, (Respiratory tract irritation)
Specific target organ toxicity — Repeated exposure	Category 1 (respiratory system, liver, nervous system, blood)

Source: - SHOWA DENKO K.K

Under Environmental hazards, Vinyl ester resins are classified under category 2 for aquatic environment.

End of the life

Vinyl Ester Resin have maximum shelf life of around 18 months when stored in a controlled environment as per guidelines issued by manufacturer. The Shelf life of the product depends on grade and company to company. For Instance, Derakane™ Signia™ produce by IENOS claim to have a shelf life of 18 months.

Environment Pollution Index (EPI) Baseline

Emission Sources	Baseline Emissions (lb/yr)
Resin Finishing	30
Steam jet Exhausts	200
Vapor containment from synthesis	1300
Storage tanks	1800
Wastewater	17000
Equipment Leaks	N/A

The baseline emission varies depending on the capacity of the manufacturing plant, reactants and the product manufactured.

3. Market Outlook and Relevance of the Project

3.1. Demand Supply Outlook – Global Vinyl Ester Resin Market

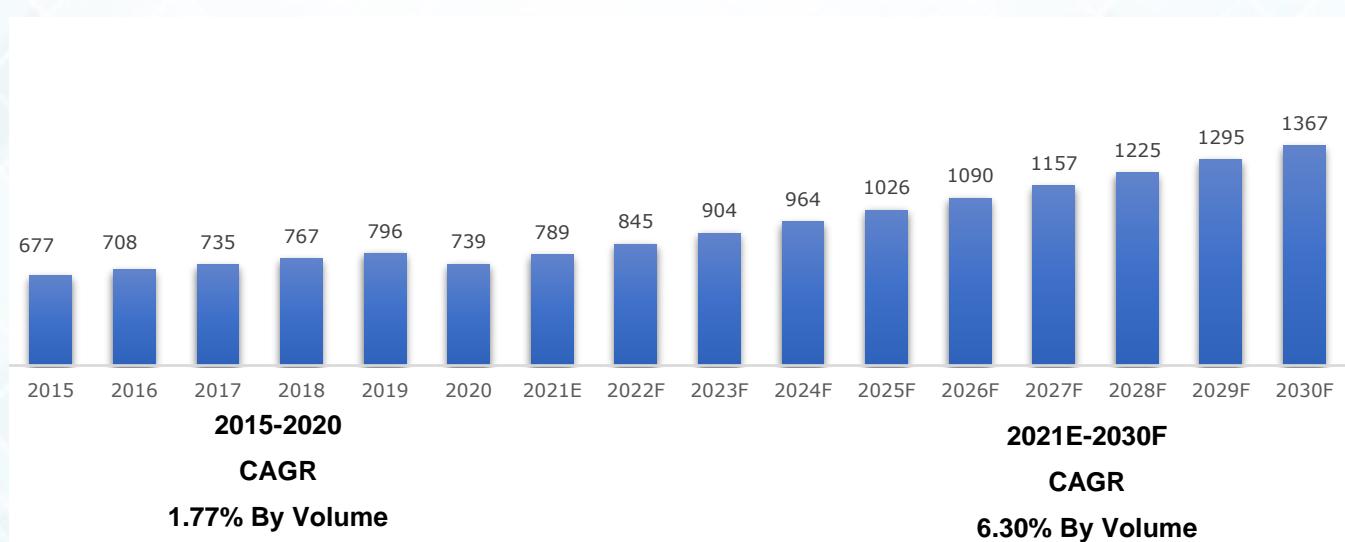
Global Vinyl Ester Resin Demand-Supply Scenario, 2015-2030F (Thousand Tonnes)

Parameters	2015	2020	2021E	2025F	2030F
Global Vinyl Ester Resin Capacity	938	985	1020	1025	1030
Global Vinyl Ester Resin Production	733	759	808	866	929
Global Vinyl Ester Resin Demand	677	739	789	1026	1367
Global Vinyl Ester Resin Demand (Y-O-Y Growth Rate, %)	3.87%	-7.14%	6.71%	6.42%	5.58%

Source: TechSci Research

- Demand has increased after the slump of 2020, where downstream sectors have increased consumption in the wake of economic recovery. A trend has been witnessed where the companies having captive market have gained improved margins while others have witnessed a cutback in margins due to uneven price assessments of raw materials. Demand from the marine and renewables sector has shown an upward trend contributing to the increase in demand in 2021.
- APAC and North America region accounted for the largest share in the global vinyl ester resin based FRP composites market in 2020 and 1st half of 2021 and trend is expected to remain same during forecast period as well. The aerospace industries in the USA and Mobile Manufacturing units in North-East Asia are the largest consumers in the world and is emanating high demand for composites for manufacturing fighter aircraft, airplanes, LCD panels and their components.

Global Vinyl Ester Resin Demand, By Volume (Thousand Tonnes), 2015–2030F



- The betterment of supply chain management and rising demand from various end user industries contributed to the increasing market for vinyl ester resin.
- Companies have been noticing the rise in their revenue quarterly, especially through vinyl ester resin. INEOS Group and Hexion Inc. both witnessed the increase in revenues by 26% and 13%, respectively from Q1 2021 to Q2 2021.
- The Increase in demand is led by strong demand for excellent chemical and thermal resistant material in downstream applications such as semiconductor encapsulation, electronics and communication, construction, and automobile industries.

3.1.1. Capacity By Company

Global Vinyl Ester Resin Capacity, By Company (Thousand Tonnes), 2015-2030F

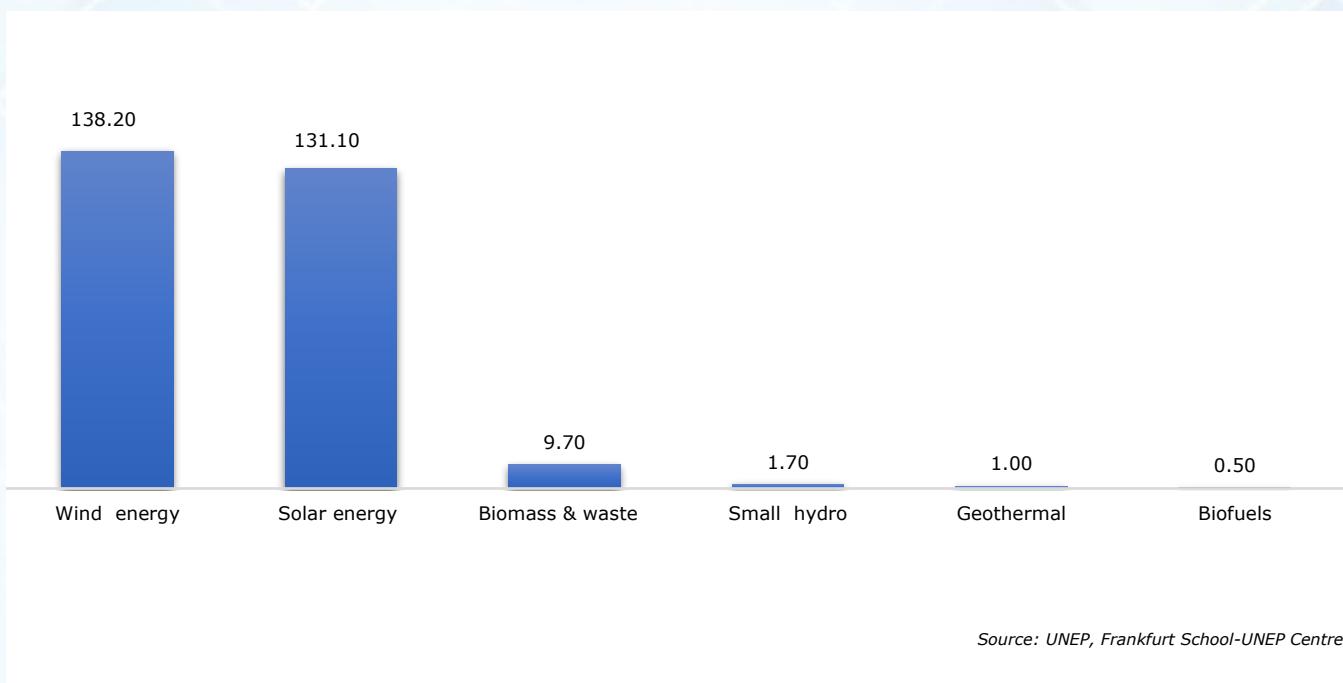
Company	Capacity					
	Location	2015	2020	2021E	2025F	2030F
AOC Resins	China	70.0	70.0	70.0	70.0	70.0
	Switzerland	5.0	5.0	5.0	5.0	5.0
	USA	60.0	70.0	70.0	70.0	70.0
INEOS Composites	China	50.0	50.0	50.0	50.0	50.0
	Germany	0.0	30.0	30.0	30.0	30.0
	USA	50.0	85.0	85.0	85.0	85.0
Swancor Holding Co., LTD.	Taiwan	60.0	70.0	70.0	70.0	70.0
Showa Denko K.K.	China	20.0	20.0	50.0	50.0	50.0
	Japan	20.0	20.0	20.0	20.0	20.0
	Singapore	15.0	15.0	15.0	15.0	15.0
Scott Bader Company Ltd.	France	15.0	15.0	15.0	15.0	15.0
	United Kingdom	20.0	20.0	20.0	20.0	20.0
	United Arab Emirates	20.0	20.0	20.0	20.0	20.0
Polynt-Reichhold	India	0.4	0.4	0.4	0.4	0.4
	Italy	5.0	5.0	5.0	5.0	5.0
	USA	35.0	35.0	35.0	35.0	35.0
Eternal Materials Co.,Ltd.	China	10.0	10.0	10.0	10.0	10.0
	Taiwan	20.0	20.0	20.0	20.0	20.0
	Malaysia	10.0	15.0	15.0	15.0	15.0
Sino Polymer	China	20.0	20.0	20.0	20.0	20.0
	Italy	18.0	18.0	18.0	18.0	18.0
Hexion Inc.	Netherlands	30.0	30.0	30.0	30.0	30.0
DIC Corporation	Japan	30.0	30.0	30.0	30.0	30.0
Poliya	Russia	15.0	15.0	15.0	15.0	15.0
	Turkey	15.0	15.0	15.0	15.0	15.0
Saudi Arabia Industrial Resins Ltd.	Saudi Arabia	20.0	20.0	20.0	20.0	20.0
Reinhold GmbH	Germany	20.0	20.0	20.0	20.0	20.0
Interplastic Corporation	USA	20.0	20.0	20.0	20.0	20.0
Allnex group	Germany	20.0	20.0	20.0	20.0	20.0
En Chuan Chemical Industries Co., Ltd.	Taiwan	10.0	10.0	10.0	10.0	10.0
	South Korea	3.0	3.0	3.0	3.0	3.0
Innovative Resins Pvt. Ltd.	India	1.8	1.8	1.8	1.8	1.8
Orson Chemicals	India	0.7	0.7	0.7	0.7	0.7
Satyen Polymers Pvt. Ltd.	India	0.6	0.6	0.6	0.6	0.6
Crystic Resins India Private Limited	India	0.6	0.6	0.6	0.6	0.6
Mechemco resins pvt ltd	India	0.4	0.4	0.4	0.4	0.4
Moras Chemicals India Pvt. Ltd.	India	0.4	0.4	0.4	0.4	0.4

Ashland Global Holdings Inc.	Germany	25.0	0.0	0.0	0.0	0.0
	USA	30.0	0.0	0.0	0.0	0.0
Others		172.3	184.3	189.3	194.3	199.3
Total		938.1	985.1	1020.1	1025.1	1030.1

Source: TechSci Research

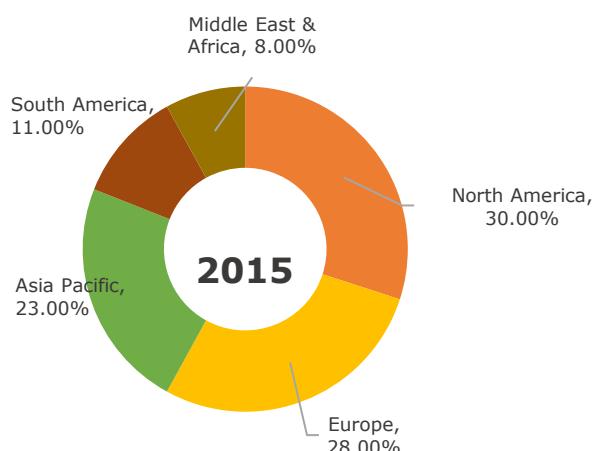
- Major manufacturing company, INEOS Composites acquired the Ashland's composite business in 2019.
- In 2020, Showa Denko K.K, a Japanese Vinyl Ester Resin producer expanded its VER production line to almost double of its existing capacity through its Chinese subsidiary Shanghai Showa Highpolymer Co., Ltd. (SSH).
- Also, in 2014 Chinese Vinyl Ester resin market leader Sino Polymer Co. Ltd announced strategic cooperation with Europe's Nord Composites under which Nord Composites would produce Sino Polymer's MFE brand of VER in its plant located in Italy.

Global Investment in Renewable Energy Capacity by Sector in 2019 (USD Billion)

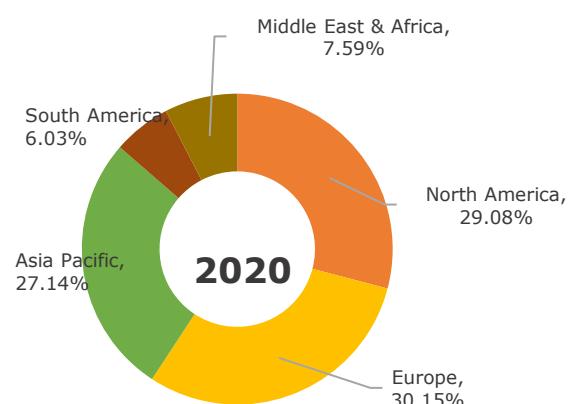


- The increase in production is mainly led by high demand for vinyl ester resin in downstream fiber reinforced plastic (FRP) applications.
- Asia Pacific region holds approximately 44% of the total production capacity, which can be attributed to the presence of major players like Jinling AOC Resins Co., Ltd., Showa Denko K.K., Sino Polymer, INEOS Composites, among others.
- The total production value in 2020 saw a decline of approximately 8% as compared to the 2019 production level. However, approximately 7% growth in production is expected in 2021 due to increasing demand of vinyl ester resin globally.

Global Advanced Composites* Market Share, By Region, By Value, 2015 & 2020



Source: TechSci Research



Source: TechSci Research

*Advanced Composites are lightweight and strong engineered materials consisting of high-performance reinforcing fibers embedded in a toughened polymeric matrix that exhibit high stiffness, or modulus of elasticity characteristics, compared to other materials

3.1. 4. Operating Efficiency By Company

Global Vinyl Ester Resin Operating Efficiency, By Company, 2015-2030F

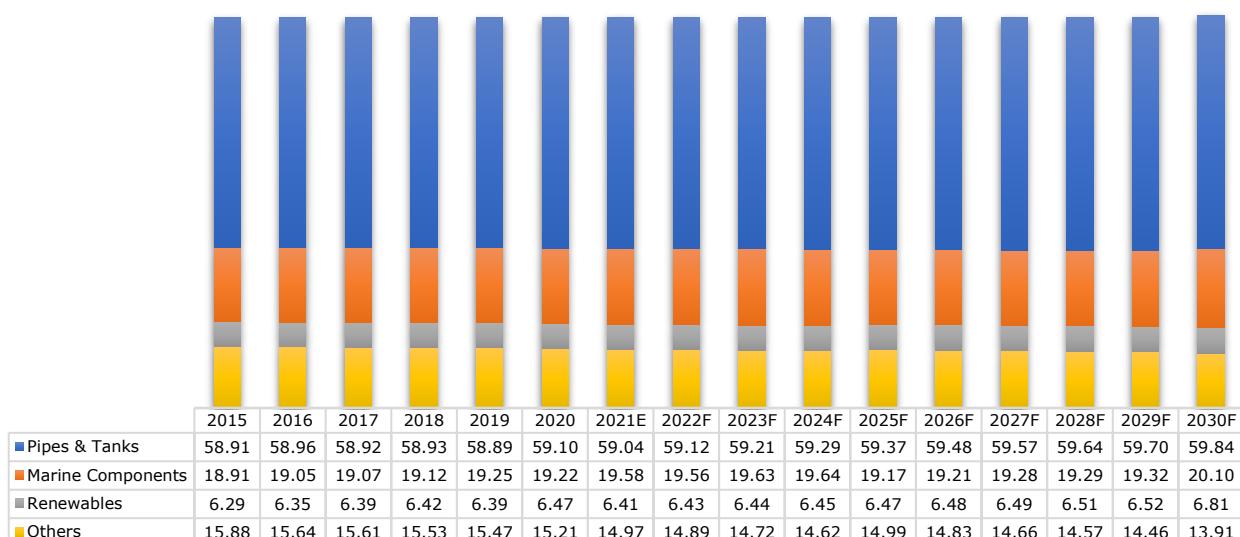
Company	Operating Efficiency (%)				
	2015	2020	2021E	2025F	2030F
AOC Resins	87	81	80	91	96
INEOS Composites	29	49	49	54	59
Swancor Holding Co., LTD.	73	80	84	90	96
Showa Denko K.K.	79	82	84	88	95
Scott Bader Company Ltd.	82	82	84	86	91
Polynt-Reichhold	81	80	80	85	86
Eternal Materials Co.,Ltd.	77	76	79	86	93
Sino Polymer	80	77	81	84	88
Poliya	85	85	86	89	93
Hexion Inc.	79	80	83	84	85
DIC Corporation	75	79	82	86	91
Saudi Arabia Industrial Resins Ltd.	76	78	86	89	97
Reinhold GmbH	77	74	78	82	90
Interplastic Corporation	75	72	71	77	78
Allnex group	75	72	73	80	90
En Chuan Chemical Industries Co., Ltd.	72	73	77	87	93
SEWON CHEMICAL	81	84	87	92	96
Innovative Resins Pvt. Ltd.	76	80	74	84	91
Orson Chemicals	78	82	76	86	93
Satyen Polymers Pvt. Ltd.	77	81	71	79	92
Crystic Resins India Private Limited	74	79	68	77	90
Mechemco resins pvt ltd	73	76	80	90	95
Moras Chemicals India Pvt. Ltd.	88	79	83	86	93
Ashland Global Holdings Inc.	81	0	0	0	0

Source: TechSci Research

- Globally, companies are producing at high operating rates in 2021 than last year due to increasing demand of FRP coating and lining from the pipes & tanks industry, construction sector and marine industry.
- Moreover, rising investment in the defense sector by major economies drove the companies to operate at higher efficiency.
- Other factors supporting operating rates are increasing investment in renewable energy sources like wind and solar energy in emerging economies in the Asia Pacific.

3.1.5. Demand By Application

Global Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



Source: TechSci Research

Demand by Application	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	399	417	433	452	469	437	466	609	818
Marine Components	128	135	140	147	153	142	155	197	270
Renewables	43	45	47	49	51	48	51	66	89
Others	108	111	115	119	123	112	118	154	190
Total	677	708	735	767	796	739	789	1026	1367

Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

3.1.6. Demand By Type

Global Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

Regional Segmentation of Bisphenol A, F & S Consumption for Vinyl Ester Resin

Production

Region/ Country	Bisphenol A	Bisphenol F	Bisphenol S
India	92%	5%	3%
APAC	88%	9%	4%
Europe	81%	15%	4%
North America	83%	12%	5%
South America	94%	4%	2%
Middle East and Africa	86%	10%	4%

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A, F,S vinyl ester resin	351	365	379	398	412	383	409	534	715
Novolac vinyl ester resin	184	193	201	210	218	203	215	283	380
Brominated vinyl ester resin	60	62	63	65	67	64	67	87	114
Other	83	87	91	94	99	89	97	123	159
Total	677	708	735	767	796	739	789	1026	1367

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

- The Bisphenol- A type vinyl ester resin contributes to around 50% of the global vinyl ester resin types due to its excellent properties of corrosion resistance to a variety of alkalis, organic and inorganic salts, salt solutions and oxidizing chemicals, etc
- As Bisphenol A has been banned in Europe, the demand for Bisphenol A Vinyl Ester Resin is expected to gradually decrease as Bisphenol A will be replaced by Bisphenol F and S.
- Novolac vinyl ester resin contributes to around 27% which has been specially modified for improved fabrication properties. It provides improved product quality and fabrication efficiency to end users, which offers extended shelf life and adds improved flexibility to fabricators.

Global Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousands Tonnes)

	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Capacity	938	938	953	965	980	985	1020	1025	1030
Production	733	750	775	790	812	759	808	866	929
Import	125.99	122.12	117.69	114.67	121.38	105.97			
Export	125.99	122.12	117.69	114.67	121.38	105.97			
Total Demand	677.49	707.79	734.69	767.44	796.32	739.49	789.09	1026.25	1367.33
Y-O-Y Growth (%)	-	4.47%	3.80%	4.46%	3.76%	-7.14%	6.71%	6.42%	5.58%
Demand Supply Gap							19.23	-159.81	-438.76

Source: TechSci Research

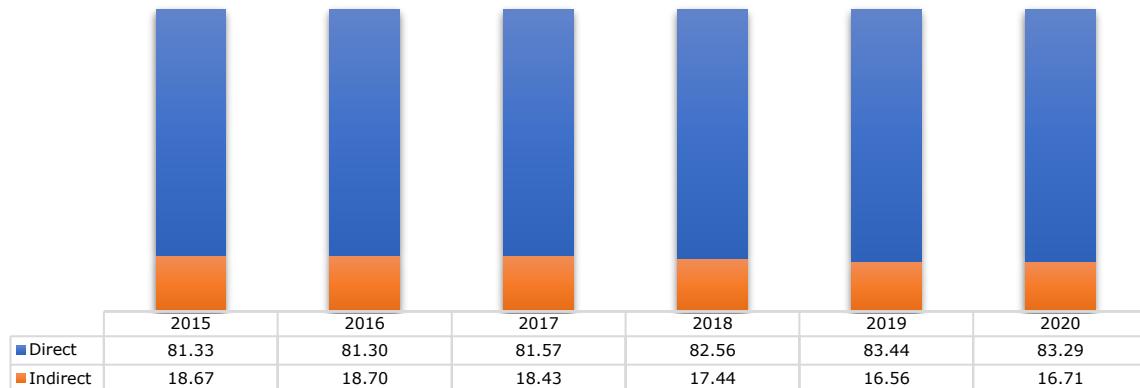
Global Vinyl Ester Resin Demand, By Volume, 2020-2030F (000' Tonnes)

Demand Scenario	2020	2021E	2022F	2023F	2024F	2025F	2026F	2027F	2028F	2029F	2030F
Optimistic	739.49	807.80	885.74	969.34	1058.92	1153.73	1254.68	1362.92	1477.58	1600.04	1729.79
Realistic	739.49	789.09	845.26	903.66	964.31	1026.25	1090.08	1156.54	1224.57	1295.08	1367.33
Pessimistic	739.49	766.69	798.03	828.98	859.50	888.67	917.01	945.14	972.10	998.62	1024.07

Source: TechSci Research

3.1.7. Demand By Sales Channel

Global Vinyl Ester Resin Demand, By Sales Channel, By Volume (000' Tonnes) (%), 2015–2030F



Source: TechSci Research

Demand by Sales Channel (000' Tonnes)	2015	2016	2017	2018	2019	2020
Direct	551	575	599	634	664	616
Indirect	126	132	135	134	132	124
Total	677	708	735	767	796	739

Source: TechSci Research

3.1.8. Demand By Region

Global Vinyl Ester Resin Demand, By Region, By Volume (000' Tonnes), 2021E & 2030F

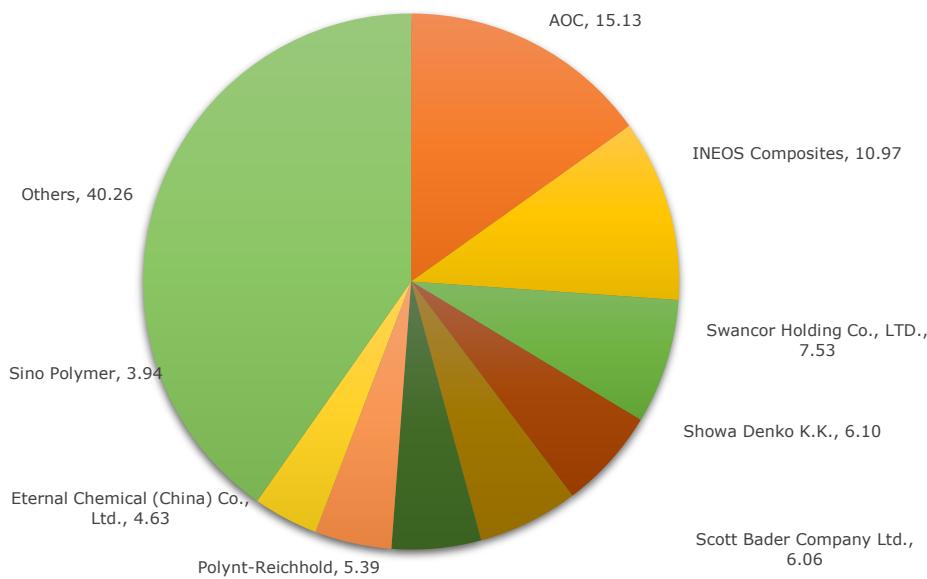
Region/Country	2015	2020	2021E	2025F	2030F	CAGR (2015–2020)	CAGR (2021E–2030F)
Asia Pacific	283	322	349	485	688	2.61%	14.51%
India	9	10	11	17	30	3.10%	11.70%
China	131	145	158	224	331	2.04%	8.55%
Japan	46	47	55	79	123	0.60%	9.48%
South Korea	35	41	46	67	98	2.96%	8.85%
Others	63	79	80	98	106	4.85%	3.19%
Global APAC (Percentage Share)	41.82%	43.58%	44.29%	47.24%	50.33%		
Europe	171	178	187	229	282	0.75%	8.55%

Germany	33	35	37	46	58	1.04%	5.21%
France	16	16	16	18	23	0.44%	4.84%
United Kingdom	18	17	18	20	25	-0.89%	3.76%
Others	104	110	116	144	175	2.17%	5.02%
Global Europe (Percentage Share)	25.25%	24.02%	23.71%	22.27%	20.62%		
North America	153	164	173	215	275	1.40%	9.74%
USA	140	148	157	198	257	1.22%	5.58%
Canada	6	7	7	9	12	1.55%	6.48%
Mexico	7	9	8	7	6	4.59%	-3.70%
Global North America (Percentage Share)	22.52%	22.11%	21.89%	20.93%	20.10%		
South America	20	20	21	25	31	0.67%	7.90%
Brazil	12	12	13	16	20	0.84%	4.72%
Argentina	1	1	1	1	1	5.21%	2.65%
Others	7	7	7	8	10	-0.22%	3.75%
Global South America (Percentage Share)	2.90%	2.74%	2.65%	2.43%	2.24%		
Middle East and Africa	51	56	59	73	92	1.86%	9.28%
Saudi Arabia	17	20	21	23	29	2.55%	3.60%
Others	34	36	38	50	63	1.49%	5.80%
Global MEA (Percentage Share)	7.51%	7.54%	7.46%	7.13%	6.71%		

- With the countries moving towards more and more sustainable energy solutions, the demand for wind energy is expected to grow exponentially in the Asia Pacific during the forecast period, hence the region will keep the dominating share in the global market.

3.1.9. Sales By Company

Global Vinyl Ester Resin Sales, By Company, By Volume (000' Tonnes) (%), 2020



Others include Poliya, Hexion Inc., DIC Corporation, Saudi Arabia Industrial Resins Ltd., Reinhold GmbH, Interplastic Corporatio, Allnex Group, Sewon Chemical, Innovative Resins Pvt. Ltd., Orson Chemicals etc.

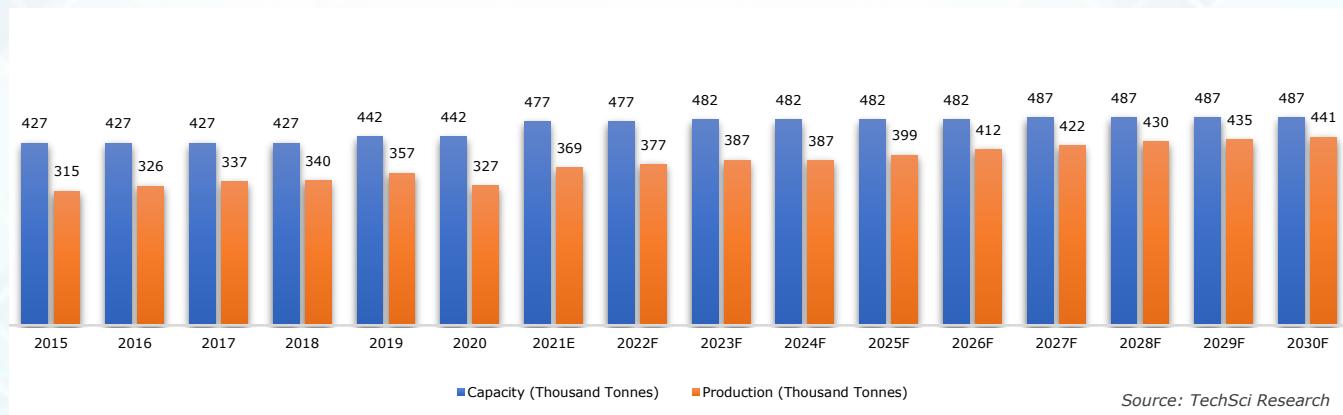
Source: TechSci Research

- AOC is leading the market, followed by INEOS Composites and Swancor Holding Co., Ltd.
- AOC, the leader in composites market, has been able to bring novel styrene free resins to commercial sales in the last twenty years and has also partnered with various companies to develop out of the box solutions which may bring both sustainability and performance.
- INEOS Composites provides high quality vinyl ester products such as AME™, Arotran™, Derakane™, Derakane™ Signia™, Hetron™.
- Most of the Indian companies such as Mechemco resins Pvt Ltd., Innovative Resins Pvt. Ltd. etc. manufacture vinyl ester of INEOS's vinyl ester quality. The major drivers identified for their growth are robust supply chain management clubbed with proposed expansion plans for upcoming Vinyl Ester Resin manufacturing facilities.

ASIA PACIFIC VINYL ESTER RESIN DEMAND SUPPLY OUTLOOK



Asia Pacific Vinyl Ester Resin Capacity & Production (000' Tonnes), 2015-2030F

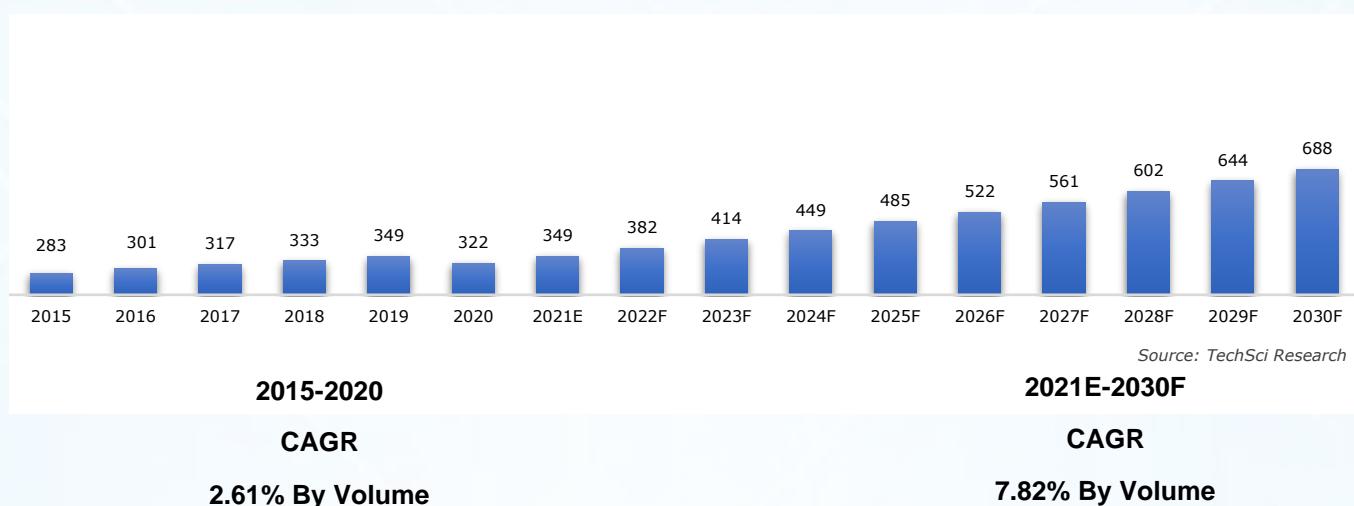


Company	Location	2015	2020	2030F
Jinling AOC Resins Co., Ltd.	China	70	70	70
Swancor Holding Co., LTD.	Taiwan	60	70	70
INEOS Composites	China	40	40	40
DIC Corporation	Japan	30	30	30
Sino Polymer	China	20	20	20
Others	Rest of APAC	207	212	257
Total		427	442	487

Source: TechSci Research

3.2.1. Asia Pacific Demand Supply Outlook

Asia Pacific Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015–2030F

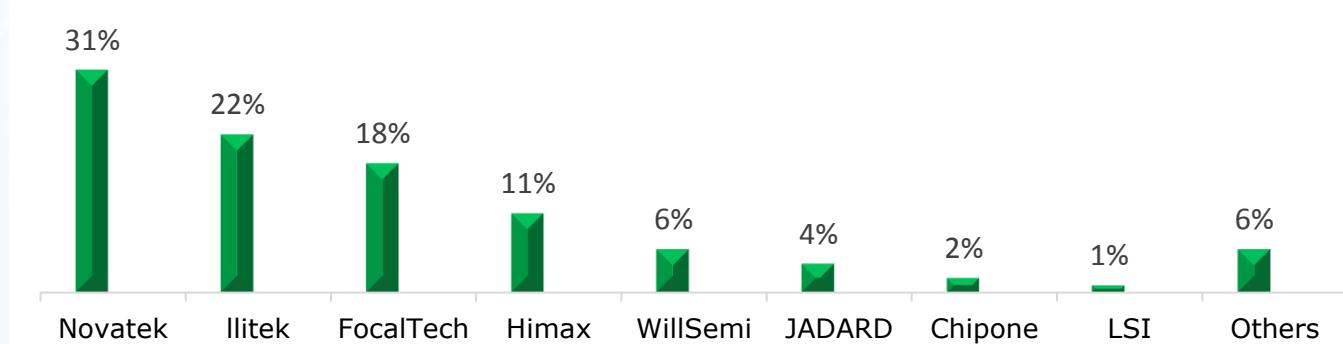


- Exports are higher than imports due to the presence of major vinyl ester resin producers in the region.
- Total export in 2020 stood at around 23 thousand tonnes while imports stood at around 24 thousand tonnes. Increasing export is attributed to the increasing demand for vinyl ester resin from fiber reinforced plastic (FRP) application in the pipe and tank industry.
- Several manufacturers are investing heavily in capacity expansion to meet the growing demand for vinyl ester resin in the region.

Electronic, Telecommunication and Renewables sector have high latent demand in APAC region:

- Increasing market of electronic parts due to development in telecommunication technologies as well as 5G revolution in mobile application has led to increase in consumption of LCD and touch panels leading to increasing demand of Vinyl ester resin.
- Vinyl ester resin is used as inner lining material in electronic items due to its excellent corrosion and chemical resistance properties.
- Vinyl ester resin has also application in semiconductor and chip encapsulation due to its heat resistance properties. Growth of display panel market has augmented the demand of display driver chips.
- As per CINNO survey, APAC demand of display driver chips in 2020 is valued around 6 billion which is 8.7% rise from 2019 value. Moreover, demand for smartphone driver chips valued around 1.2 billion in 2020.

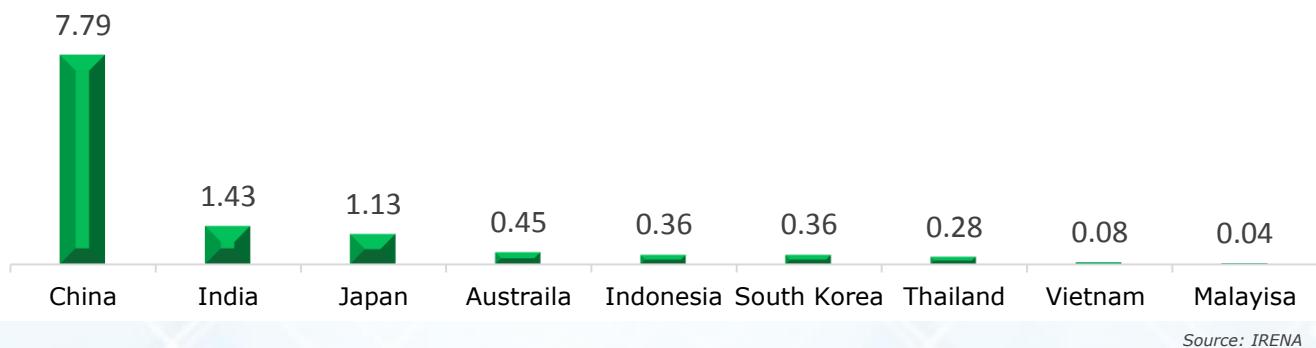
LCD Smartphone display driver chips vendor shipment share, 2020



Source: CINNO

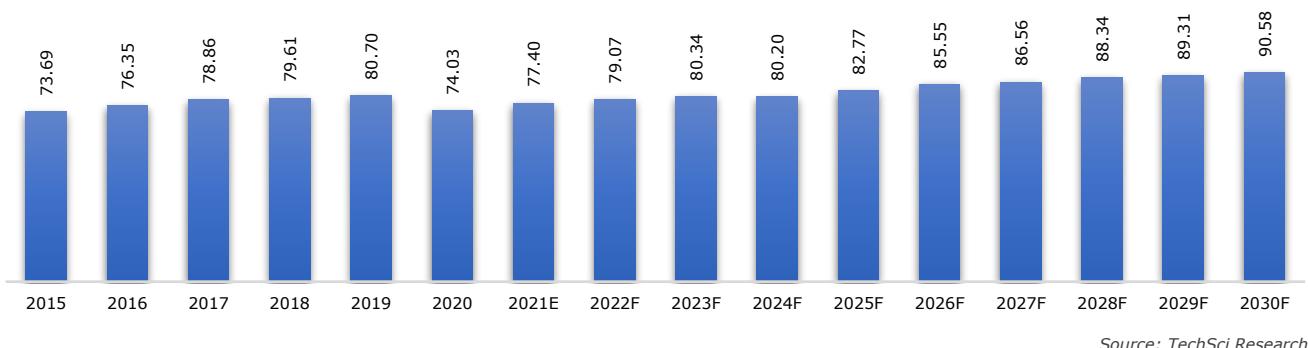
Renewable energy Consumption in Asia-Pacific region in 2020, By Country (In exajoules)

China holds largest share of renewable energy consumption in Asia Pacific region led by increasing investments into development of renewable energy. China's consumption of renewable energy is approximately 8 exajoules in 2020. India and Japan are also significantly increasing investments into building energy infrastructure such as solar energy and wind energy.



3.2.1.2. Operating Efficiency

Asia Pacific Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F



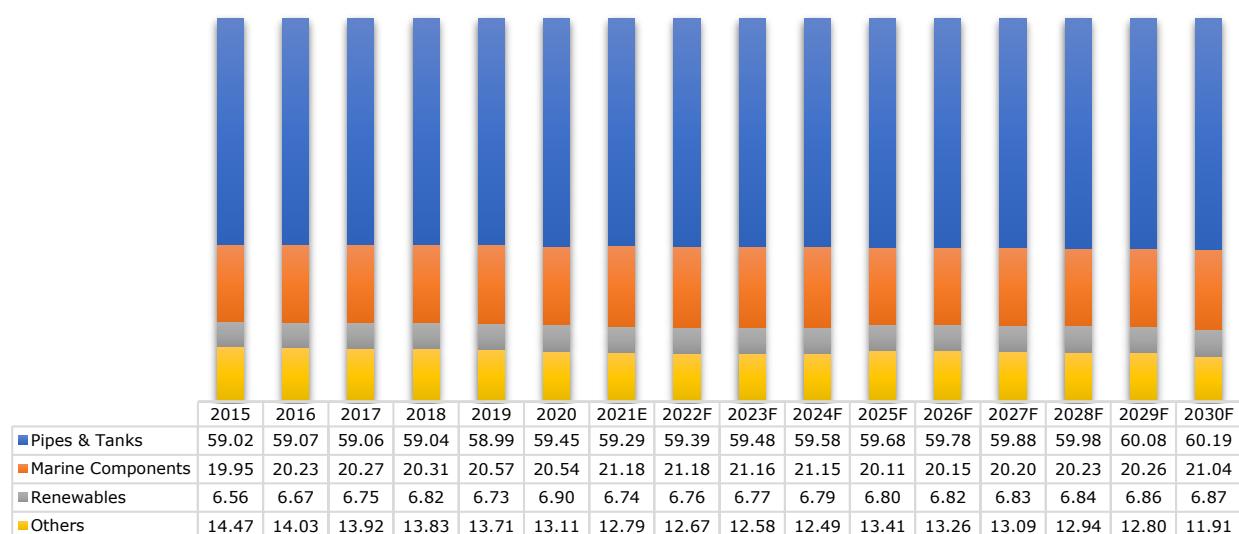
Real GDP Growth Forecast for Major Economies in APAC Region

Country	2023	2025
India	7.67%	7.42%
China	5.75%	5.60%
Japan	1.26%	0.72%
South Korea	2.45%	3.44%
World	3.84%	3.56%

Source: IMF, World Bank

3.2.1.3. Demand By Application

Asia Pacific Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



Others include Defense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Demand by Application	2015	2016	2017	2018	2019	2020	2021 E	2025 F	2030 F
Pipes & Tanks	167	178	187	196	206	192	207	289	414
Marine Components	57	61	64	68	72	66	74	97	145
Renewables	19	20	21	23	23	22	24	33	47
Others	40	42	45	46	48	42	44	66	82
Total	283	301	317	333	349	322	349	485	688

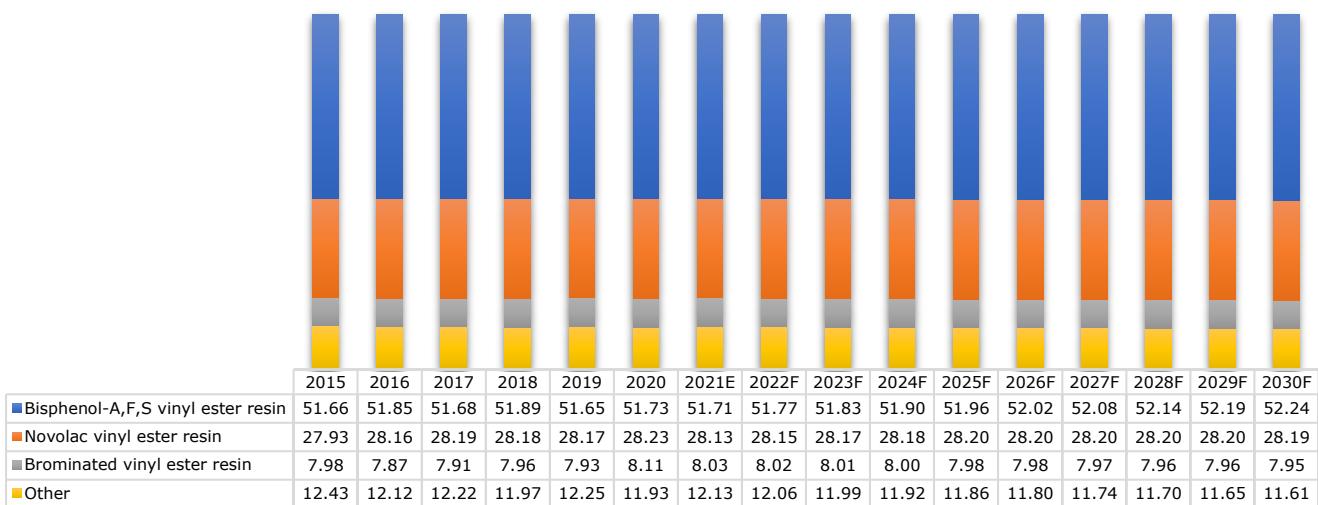
Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

- Vinyl Ester Resin market in the APAC region has been dominated by construction sector as demand for pipes and tanks remained robust in the region catering to increase in consumption from infrastructure development and residential buildings. This trend is likely to be continued during the forecasted period as construction sector is expected to lead the demand growth.
- In the APAC region, rising demand for portable water and expansion of piped water will continue to pressure demand for pipes and tanks, however degrading water quality and arrival of water treatment plants have mandated the use of vinyl ester resins in pipes and tanks manufacturing because of its good corrosion resistant and abrasion resistant qualities.
- Furthermore, Indian government's flagship program "Har Nal se Jal" under which government has envisioned to provide drinking water connections to every rural household by 2024 will augment for demand prospects in the region.
- APAC region is in line with its renewable energy targets as per Paris Agreement and is likely to build upon the available renewables, however uncertainties regarding current circumstances have forced countries to take more calculative and realistic approach which may impact the market prospects of renewables.

3.2.1.4. Demand By Type

Asia Pacific Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin, etc.

Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A,F,S vinyl ester resin*	146	156	164	173	180	167	181	252	360
Novolac vinyl ester resin	79	85	89	94	98	91	98	137	194
Brominated vinyl ester resin	23	24	25	26	28	26	28	39	55
Other chemistry	35	36	39	40	43	38	42	57	79
Total	283	301	317	333	349	322	349	485	688

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin, etc.

Source: TechSci Research

*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in Asia Pacific was 88%, 9% and 4%, respectively.

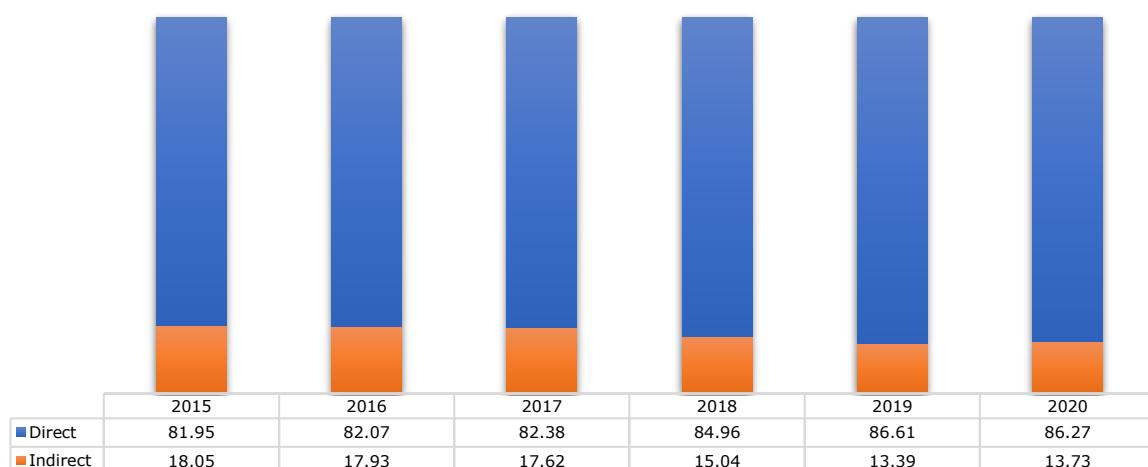
Asia Pacific Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousand Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Asia Pacific	Capacity	427	427	427	427	442	442	477	482	487
	Production	315	326	337	340	357	327	369	399	441
	Total Demand	283.31	301.03	317.07	332.53	348.58	322.29	349.49	484.81	688.20
	Y-O-Y Growth (%)	-	6.26%	5.33%	4.88%	4.83%	-7.54%	8.44%	8.06%	6.84%
	Demand Supply Gap	0.00	0.00	0.00	0.00	0.00	0.00	27.90	-32.22	-102.63

Source: TechSci Research

3.2.1.5. Demand By Sales Channel

Asia Pacific Vinyl Ester Resin Demand, By Sales Channel, By Volume (000' Tonnes) (%), 2015–2020



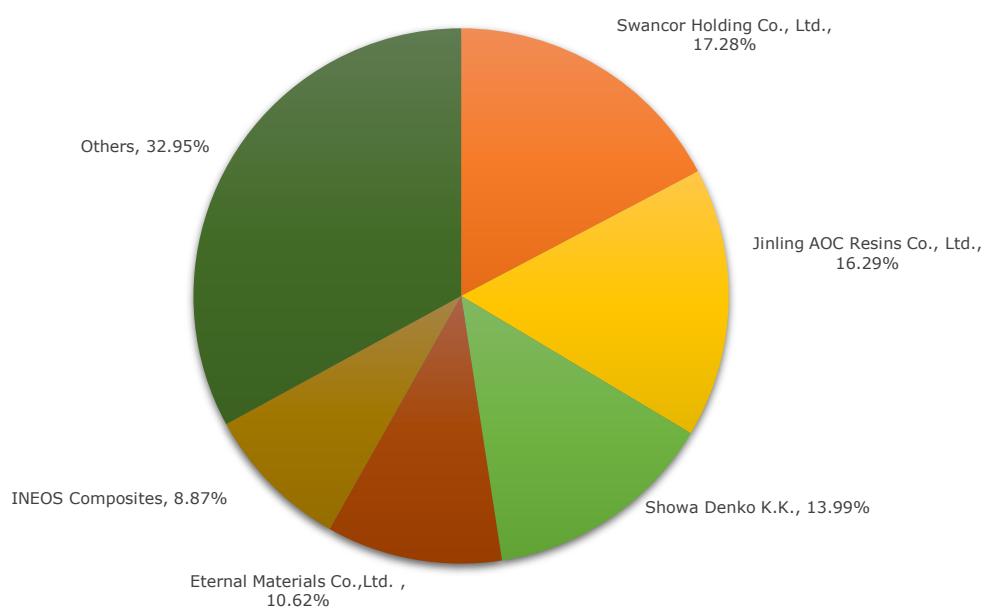
Source: TechSci Research

Demand by Sales Channel	2015	2016	2017	2018	2019	2020	2021E
Direct	232	247	261	283	302	278	232
Indirect	51	54	56	50	47	44	51
Total	283	301	317	333	349	322	283

Source: TechSci Research

3.2.1.6. Sales By Company

Asia Pacific Vinyl Ester Resin Sales, By Company, By Volume (000' Tonnes), 2020



Others include DIC Corporation, Sino Polymer, Innovative Resins Pvt. Ltd., Orson Chemicals, Reichhold India Pvt. Ltd. etc.

Source: TechSci Research

- Swancor Holding and Jinling AOC are the major manufacturers in the APAC region with the combined market share of close to one-third in terms of sales.
- AOC, globally, has been a key producer of specialty resins and collaboration with China based Jinling has enhanced the VER market prospects in the region.
- With construction sector and electrical & electronics sector are likely to lead demand growth in the region, market participants are expected to consolidate on the market prospects.
- Taiwan headquartered Swancor Holding has observed improved performance in the last two quarters after a lackluster 2020.
- INEOS Composites, a US based company, also cater to the market demand in Asia Pacific countries with several manufacturing units in China.

Asia Pacific Market Insights

VER is classified as highly versatile resin, and its market is growing tremendously due to healthy demand growth across several downstream sectors. The demand for VER grew at a CAGR of 2.61% between 2015-2020 and is expected to register a CAGR of 7.82% by volume between 2021-2030. As per our estimates, VER industry operating rate in Asia stands around 77.21% in the current year. Strong projections of GDP growth in several Asian countries will propel the market growth in the coming years, with India leading among several Asian countries.

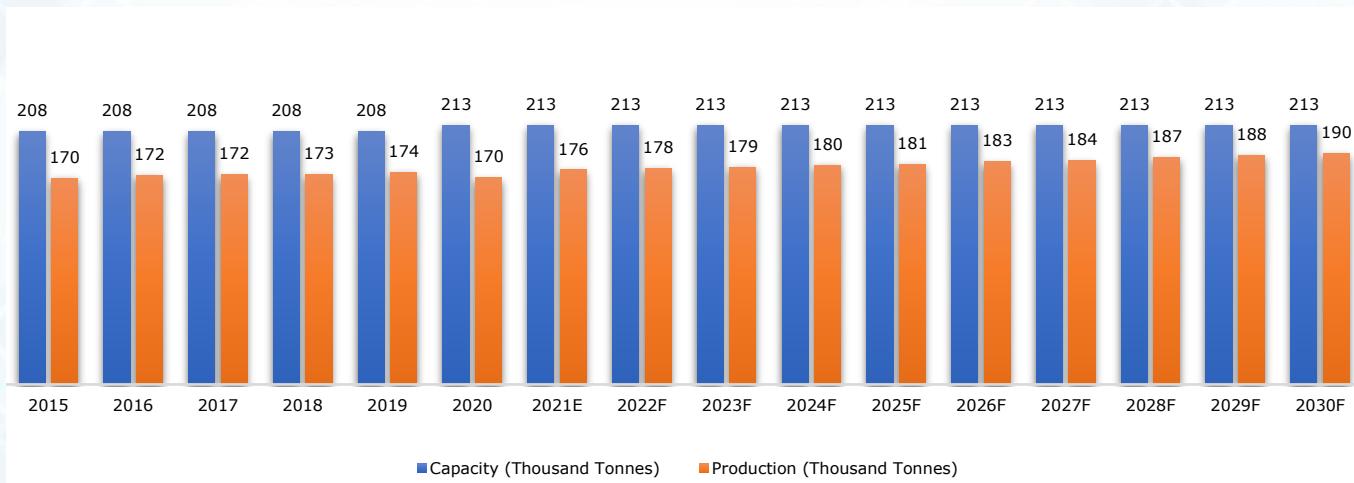
Based on application, the APAC VER market has been segmented into pipes and tanks, marine composites, renewables and others, with pipes & tanks holding more than 59% share in the overall demand, followed by marine composites. This is largely attributed to rising demand for portable water and expansion of piped water from the agricultural sector.

Based on Type, Bisphenol A, F, S based VER dominates the Asian market, holding more than 50% share followed by Novolac VER. Strong demand share of BPA-based VER is attributed to their versatile chemical applications and their high corrosion resistance.

EUROPE VINYL ESTER RESIN DEMAND SUPPLY OUTLOOK



Europe Vinyl Ester Resin Capacity & Production, By Volume, 2015 - 2030F (000' Tonnes)



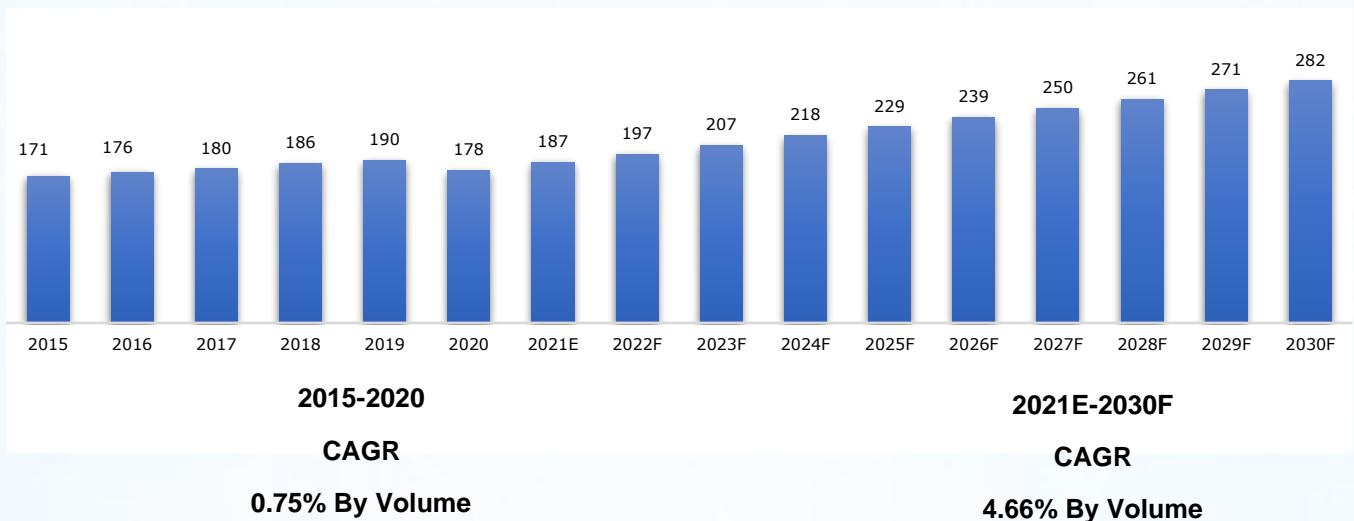
Source: TechSci Research

Company	2015	2020	2030F
INEOS Composites	0	30	30
Hexion Inc.	30	30	30
Allnex group	20	20	20
Reinhold GmbH	20	20	20
Scott Bader Company Ltd.	20	20	20
Others	118	93	93
Total	208	213	213

Source: TechSci Research

3.2.3. Europe Vinyl Ester Resin Demand Supply Outlook

Europe Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015–2030F

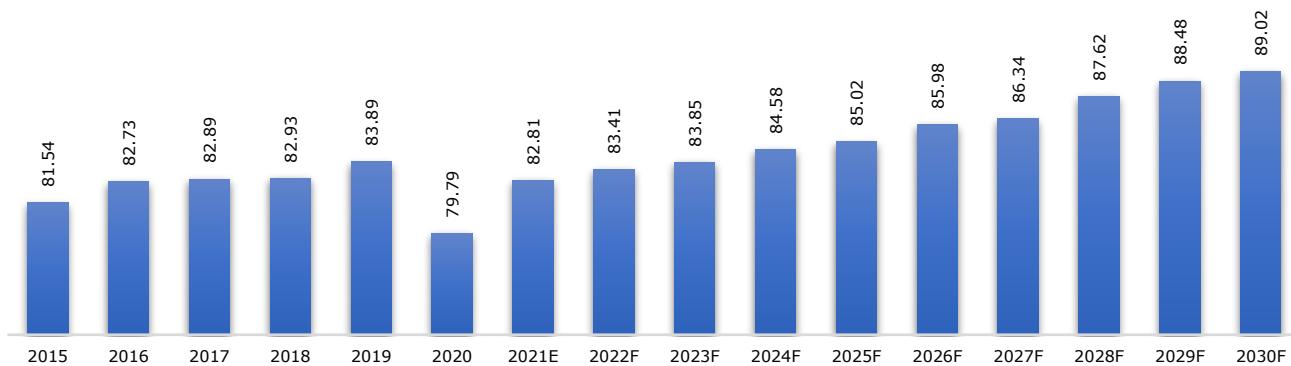


Source: TechSci Research

- Substantial increase in wind energy installation, marine components production and defense project allocation coupled with stable lending rate is contributing to the rapid growth in the sales of vinyl ester resin in Europe.
- Product availability, flexibility and convenience are the major factors propelling the demand. Furthermore, with technological advancements, and product innovations is also continuously increasing. Moreover, manufacturers are rapidly innovating their products with an aim of providing multi-functional features.
- Merger & acquisition activities are becoming prevalent in the market in Europe. For Instance, in 2019, INEOS Composite completed the acquisition of the Ashland Composites polymer business. The company sells the product under the brand name of Derakane, Hetron, Arotran and Signia.

3.2.3.2. Operating Efficiency

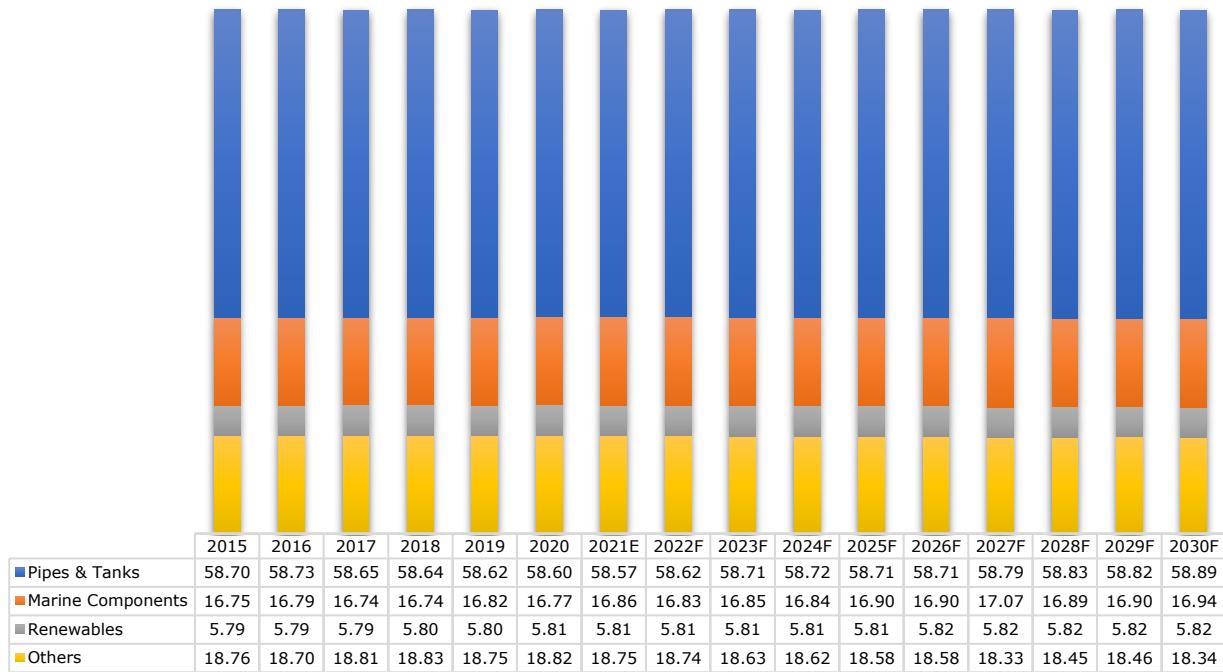
Europe Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F



Source: TechSci Research

3.2.3.3. Demand By Application

Europe Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



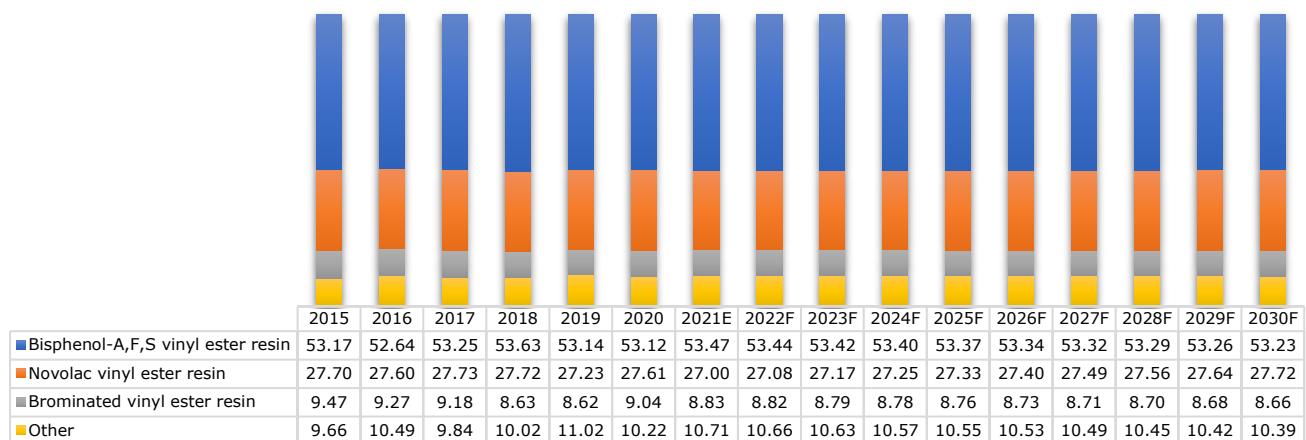
Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Demand by Application	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	100	103	105	109	111	104	110	134	166
Marine Components	29	30	30	31	32	30	32	39	48
Renewables	10	10	10	11	11	10	11	13	16
Others	32	33	35	35	36	34	34	43	52
Total	171	176	180	186	190	178	187	229	282

3.2.3.4. Demand By Type

Europe Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A,F,S vinyl ester resin	91	93	96	100	101	94	100	122	150
Novolac vinyl ester resin	47	49	50	51	52	49	51	62	78
Brominated vinyl ester resin	16	16	16	16	16	16	17	20	24
Other chemistry	17	18	18	19	21	18	20	24	29
Total	171	176	180	186	190	178	187	229	282

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in Europe was 81%, 15% and 4%, respectively.

Europe Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousands Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Europe	Capacity	208	208	208	208	208	213	213	213	213
	Production	169.60	172.07	172.40	172.50	174.49	169.95	176.39	181.09	189.61
	Total Demand	171.09	175.88	179.66	185.58	189.85	177.60	187.10	228.54	281.95
	Y-O-Y Growth (%)	-	2.80%	2.15%	3.30%	2.30%	-6.45%	5.35%	4.72%	3.86%
	Demand Supply Gap	0.00	0.00	0.00	0.00	0.00	0.00	-10.70	-47.45	-92.34

Source: TechSci Research

3.2.3.5. Demand By Sales Channel

Europe Vinyl Ester Resin Demand, By Sales Channel, By Volume (000' Tonnes), 2015–2020



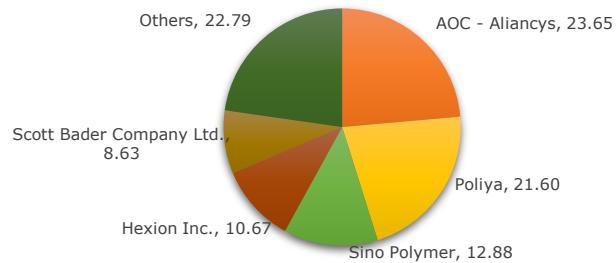
Source: TechSci Research

Demand by Sales Channel (000' Tonnes)	2015	2016	2017	2018	2019	2020	2021E
Direct	140	144	148	152	156	146	140
Indirect	31	32	32	34	34	32	31
Total	171	176	180	186	190	178	171

Source: TechSci Research

3.2.3.6. Sales By Company

Europe Vinyl Ester Resin Sales, By Company, By Volume (000' Tonnes) (%), 2020



Others include Polynt S.p.A., Reinhold GmbH, Ashland Global Holdings Inc., Allnex group, etc.

Source: TechSci Research

Europe Market Insights

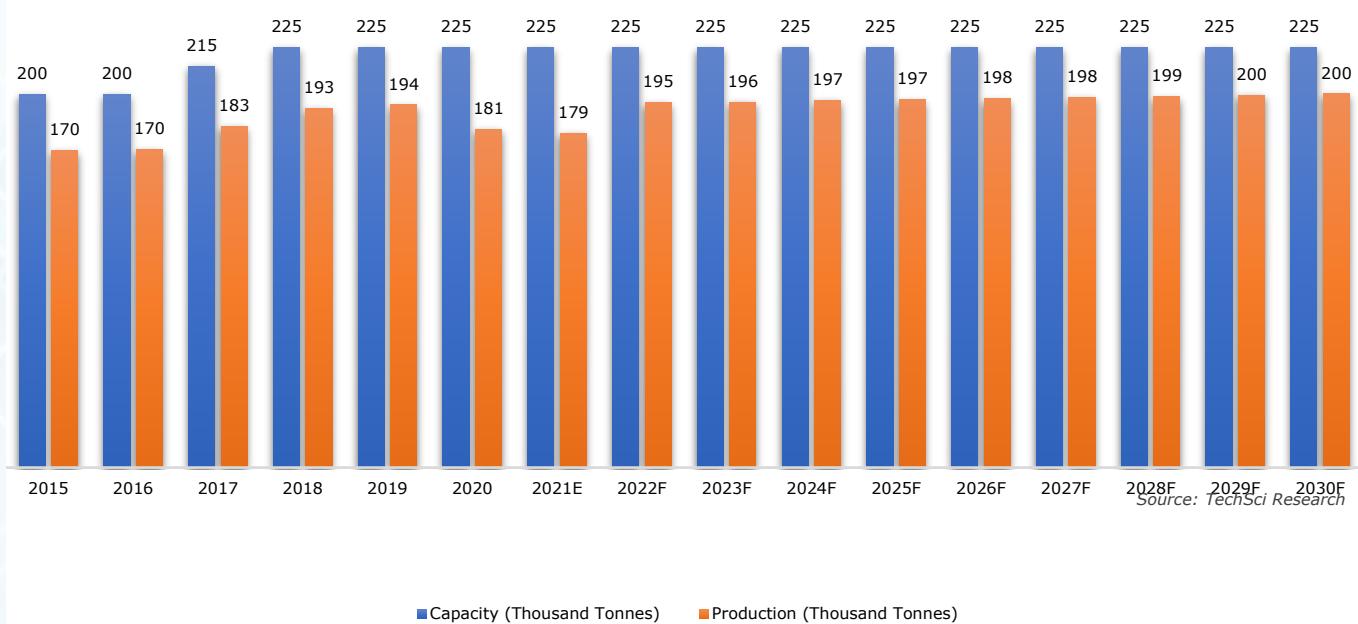
VER demand in Europe has registered a CAGR of around 0.75% from 2015-2020. It is expected to grow at a substantial pace with a CAGR of 4.66% from 2021-2030 driven by its increasing preference in pipes and marine components owing to the effective chemical and corrosion resistance offered.

European VER market is being controlled by INEOS Composites and Hexion Inc. each having 30KTPA capacity.

NORTH AMERICA VINYL ESTER RESIN DEMAND SUPPLY OUTLOOK



North America Vinyl Ester Resin Capacity & Production, By Volume (000' Tonnes), 2015 - 2030F (Thousand Tonnes)



Company	Location	2015	2020	2030F
AOC - Aliancys	USA	60	70	70
Polynt-Reichhold	USA	35	45	45
INEOS Composites	USA	0	35	35
Interplastic Corporation	USA	20	20	20
Ashland Global Holdings Inc.	USA	30	0	0
Others	Rest of North America	55	55	55
Total		200	225	225

Source: TechSci Research

Capacity and Production by Company

The total installed capacity in North America region stood at 225 thousand tonnes in 2020. The key market players in the region are AOC – Aliancys, Polynt-Reichhold, INEOS composites, and Interplastics Corporation. AOC – Aliancys and Polynt-Reichhold together contribute to 51% of the total installed capacities.

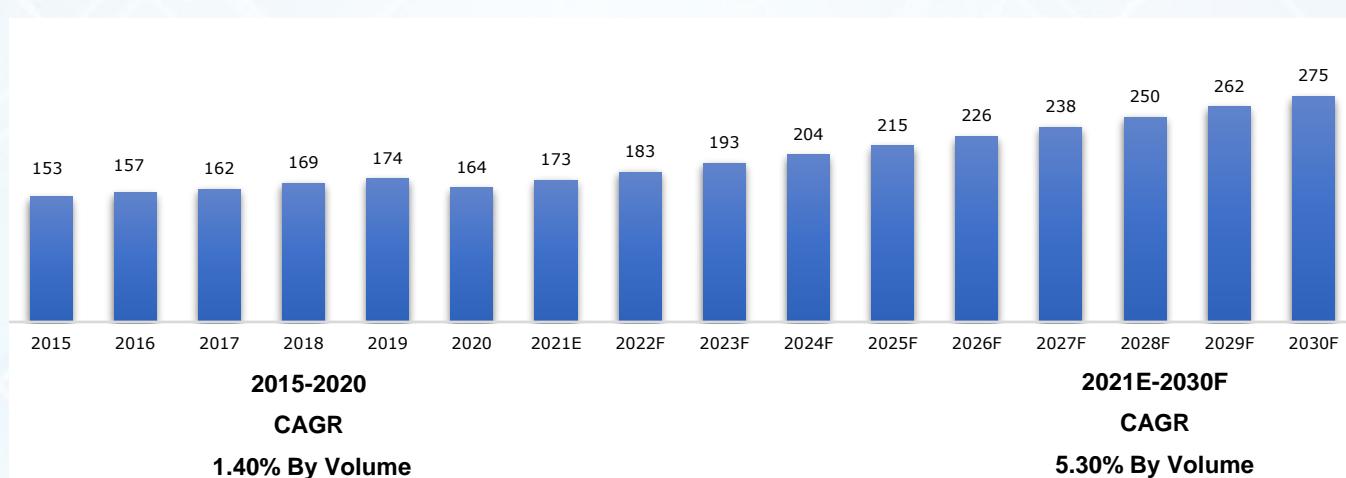
In 2019, INEOS composites took complete acquisition of Ashland Global Holdings taking over its 30 thousand tonnes per annum of vinyl ester resin capacity.

The production of vinyl ester resin in 2020 volumed to 181 thousand tonnes, which was lower than its production of 194 thousand tonnes in 2019 due to the subdued operations in the pandemic period.

The increasing demand in the end-user industries is going to propel the companies to produce higher volumes of vinyl ester resin which is expected to rise to 200 thousand tonnes by 2030.

3.2.4. North America Vinyl Ester Resin Demand Supply Outlook

North America Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015–2030F



Source: TechSci Research

The vinyl ester resin market in North America has grown at a steady pace in the historical years. However, limitations in the downstream sectors owing to operation halts and lockdown constraints restricted the market growth in 2020 which stood at 164 thousand tonnes.

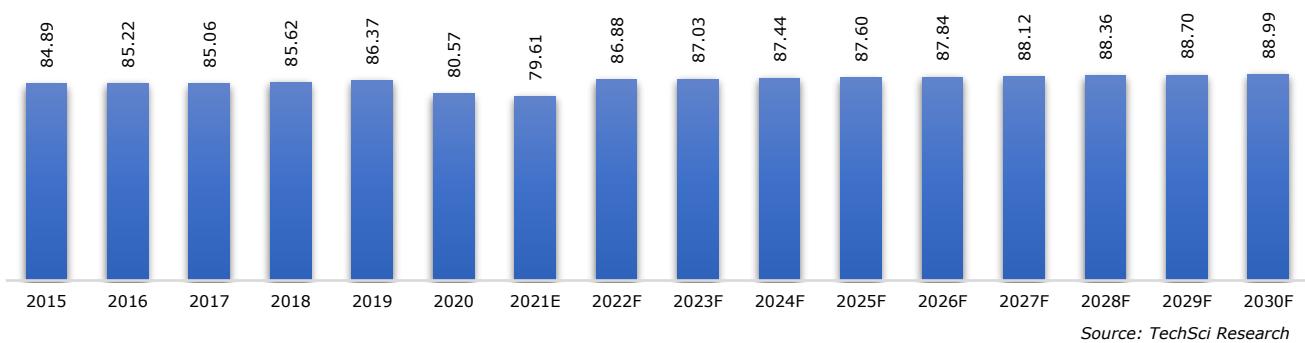
With revival of infrastructural projects post-COVID19 period and increasing investment in renewables are expected to drive the vinyl ester resin market growth at a quite healthy CAGR of 5.3% by 2030.

Several manufacturers are investing heavily in capacity expansion and new technology development to meet the growing demand for vinyl ester resin in the region.

- This increase in demand is attributed to growing infrastructure projects and increasing investment in renewable energy sector.
- Several manufacturers are investing heavily in capacity expansion and new technology development to meet the growing demand for vinyl ester resin in the region.

3.2.4.2. Operating Efficiency

North America Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F

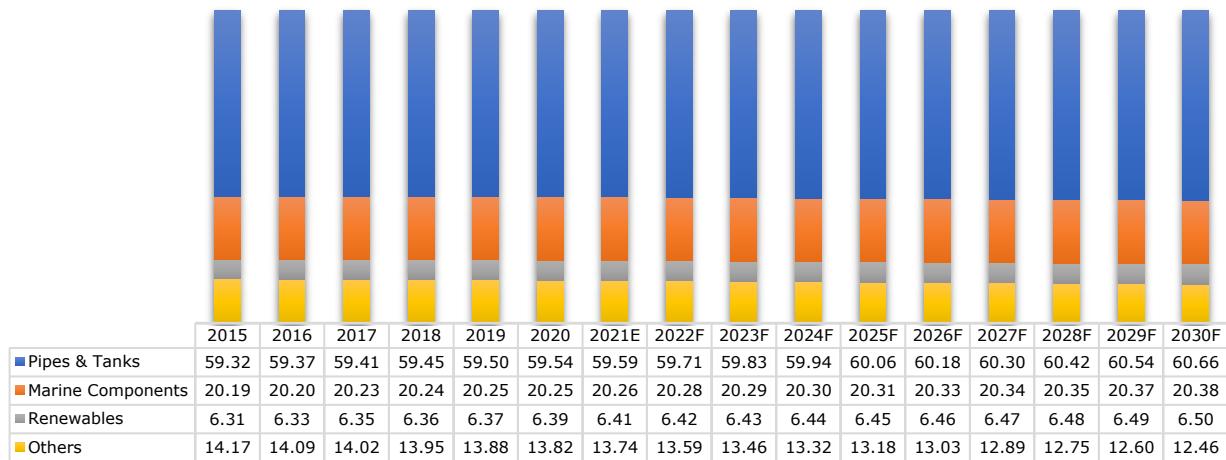


Majority of the vinyl ester resin producers operate at 84-86% utilization rate. The operating rates declined to 80% in 2020 owing to limited demand and operational constraints due the outbreak of COVID19 pandemic.

With recovering operational activities in 2021 in North America, the companies have regained pace of operating at 86% rate which is expected to further rise to almost 89% in 2030 with rise in epoxy resin demand in the end-user industries.

3.2.4.3. Demand By Application

**North America Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%),
2015–2030F**



Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Demand by Application	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	91	93	96	101	104	97	103	129	167
Marine Components	31	32	33	34	35	33	35	44	56
Renewables	10	10	10	11	11	10	11	14	18
Others	21	22	23	23	24	24	24	28	34
Total	153	157	162	169	174	164	173	215	275

Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

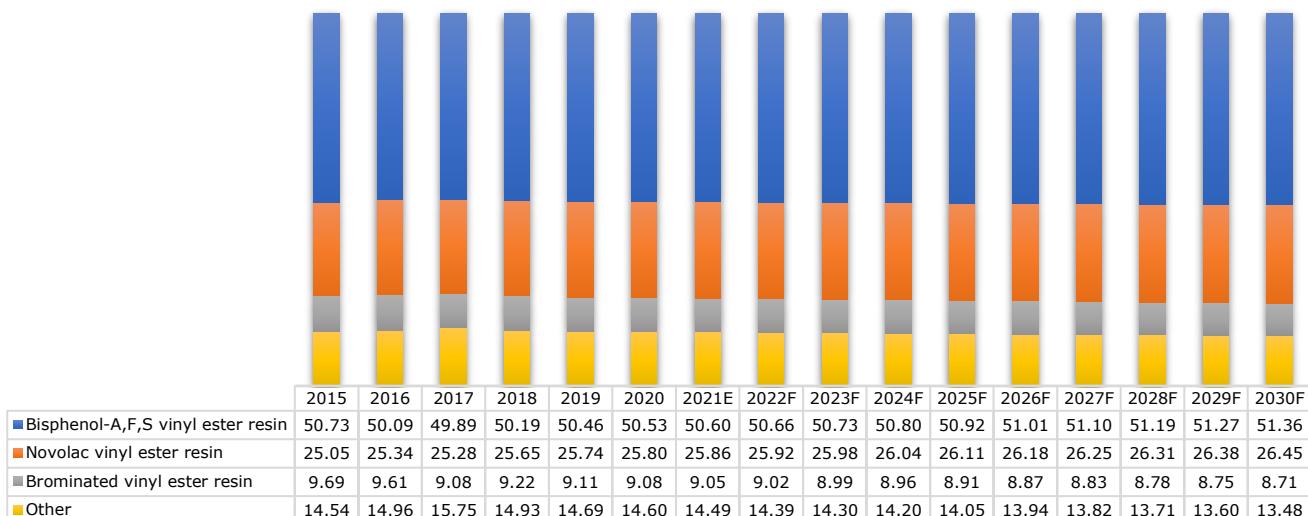
The application of vinyl ester resins in tanks and pipes for corrosion resistance materials and coatings holds the highest demand share rounding to 59.5%. It is widely used to manufacture tanks and vessels in Fiberglass Reinforced Plastics (FRP) coating and lining Industry.

The corrosion resistance ability attracts its application in marine industry that accounts for 20% of the total demand share. Application in Renewables hold 6% market share.

The increasing industrialization will drive the use of vinyl ester resins in tanks and pipes manufacturing which will dominate the vinyl ester resins market by taking an volume share of 167 thousand tonnes in 2030 rising from 97 thousand tonnes in 2020.

3.2.4.4. Demand By Type

North America Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A,F,S vinyl ester resin	77	79	81	85	88	83	87	109	141
Novolac vinyl ester resin	38	40	41	43	45	42	45	56	73
Brominated vinyl ester resin	15	15	15	16	16	15	16	19	24
Other	23	23	25	25	25	24	25	31	37
Total	153	157	162	169	174	164	173	215	275

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

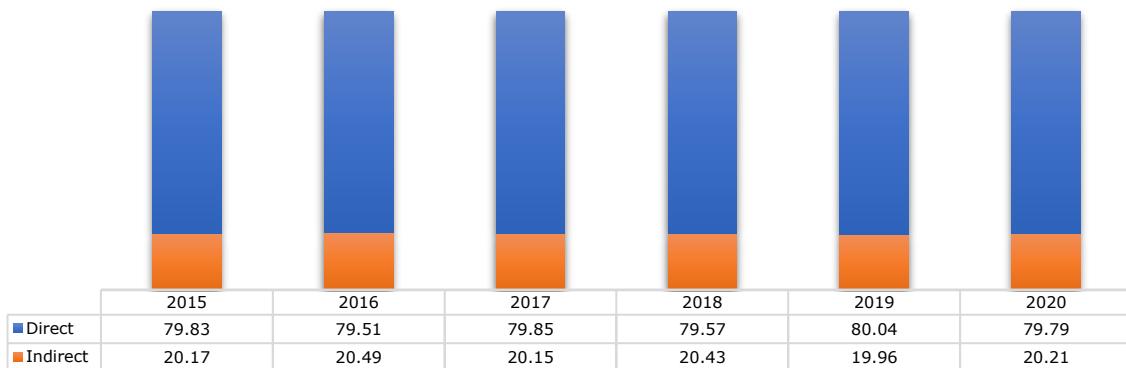
*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in North America was 83%, 12% and 5%, respectively.

Bisphenol-A,F,S vinyl ester enjoys the highest demand of 50.5% amounting to 83 thousand tonnes in 2020 owing to its corrosion and chemical resistance properties.

Novolac vinyl ester contributes to 25.8% of the total demand in North America due to its excellent bonding and adhesion properties. They are specifically applied in harsh environments due to their high mechanical and thermal stability.

3.2.4.5. Demand By Sales Channel

North America Vinyl Ester Resin Demand, By Sales Channel, By Volume (000' Tonnes) (%), 2015–2020



Source: TechSci Research

Demand by Sales Channel	2015	2016	2017	2018	2019	2020	2021E
Direct	122	125	129	135	140	130	122
Indirect	31	32	33	34	34	34	31
Total	153	157	162	169	174	164	153

Source: TechSci Research

Vinyl ester resins manufacturers sell their product in bulk quantities directly to their customers in bulk quantities. Hence direct sales channels contribute to 79.8% of the total sales in this region.

Indirect sales channel of vinyl ester resins come into play in cases where bulk volume is not required and demand for the same is addressed by distributors and agents.

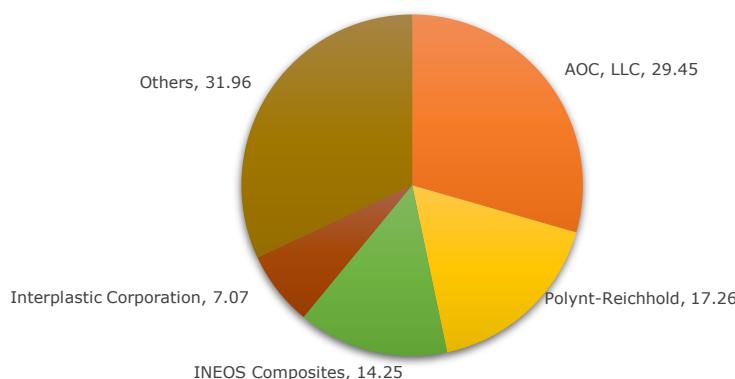
North America Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousand Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
North America	Capacity	200.00	200.00	215.00	225.00	225.00	225.00	225.00	225.00	225.00
	Production	169.77	170.43	182.88	192.65	194.34	181.28	179.12	197.09	200.24
	Total Demand	152.59	157.31	162.11	169.14	174.44	163.53	172.74	214.79	274.88
	Y-O-Y Growth (%)	-	3.10%	3.05%	4.34%	3.14%	-6.25%	5.63%	5.36%	4.82%
	Demand Supply Gap	0.00	0.00	0.00	0.00	0.00	0.00	6.38	-17.69	-74.65

Source: TechSci Research

3.2.4.6. Sales By Company

North America Vinyl Ester Resin Sales, By Company, By Volume (000' Tonnes) (%), 2020



Source: TechSci Research

AOC – Aliancys has emerged as the largest player holding a market share of more than 29%.

Polynt-Reichhold, INEOS composites and Interplastics Corporation account for 17%, 14% and 7% market share respectively. Strong sales network is the key reason behind the leading market position of the mentioned players.

SOUTH AMERICA VINYL ESTER RESIN MARKET OUTLOOK



South America Vinyl Ester Resin Capacity & Production, By Volume (000' Tonnes), 2015 - 2030F

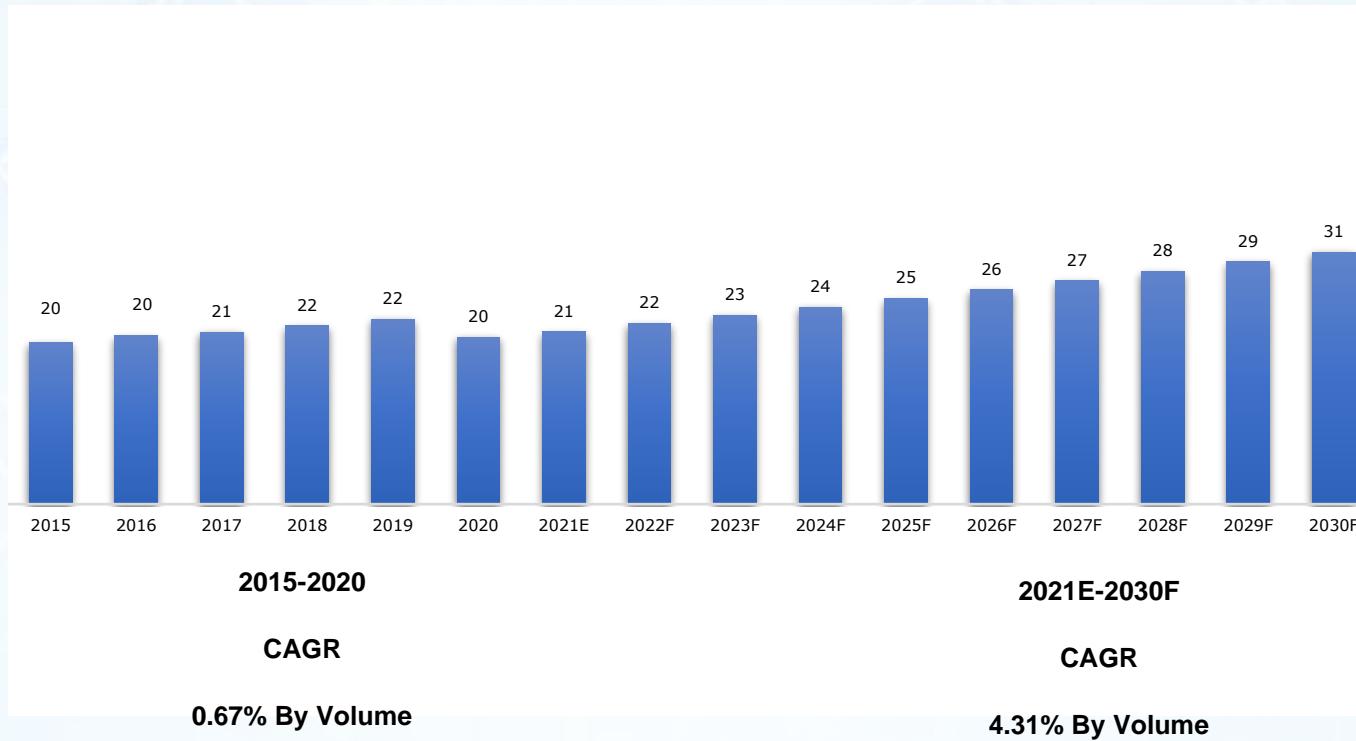


Source: TechSci Research

In South America, as of 2020 the total capacity of vinyl ester stood at about 22 thousand tonnes with production of about 16 thousand tonnes. An increase in production of vinyl ester is estimated in forecasted years as the South American market recovers to its pre pandemic levels of economic activity.

3.2.5. South America Vinyl Ester Resin Demand Supply Outlook

South America Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015–2030F

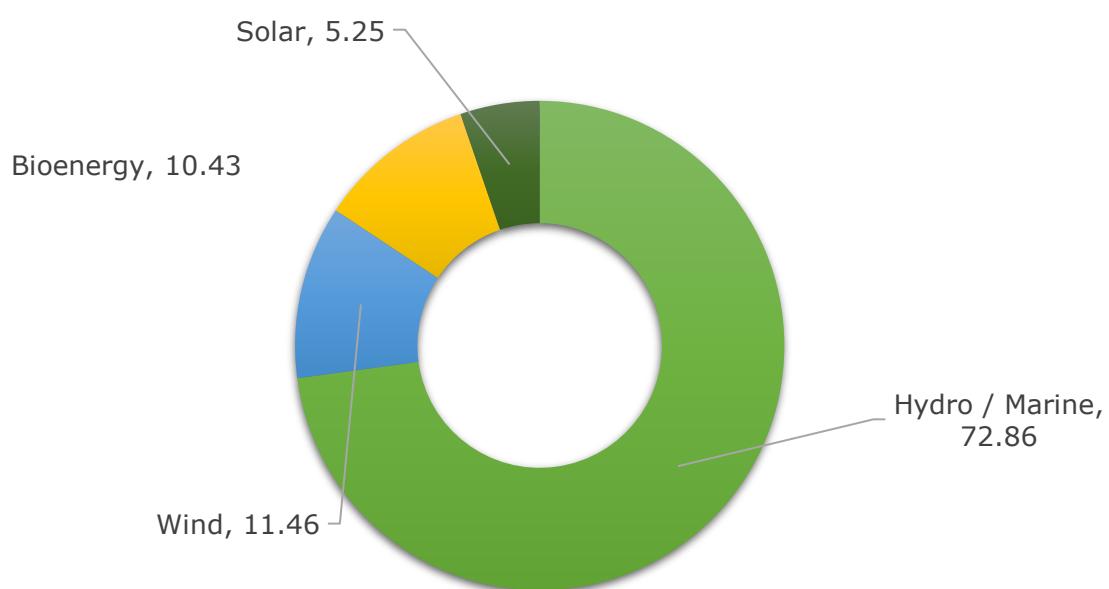


Source: TechSci Research

The South American vinyl ester market grew at an average CAGR of 0.67% in terms of volume during the period 2015-2020 and is forecasted to grow at CAGR of 4.31% by 2030 owing to the increasing infrastructural development, increasing demand of manufacturing corrosion-resistant materials and growing demand of using fibre reinforced plastics for tanks and vessels.

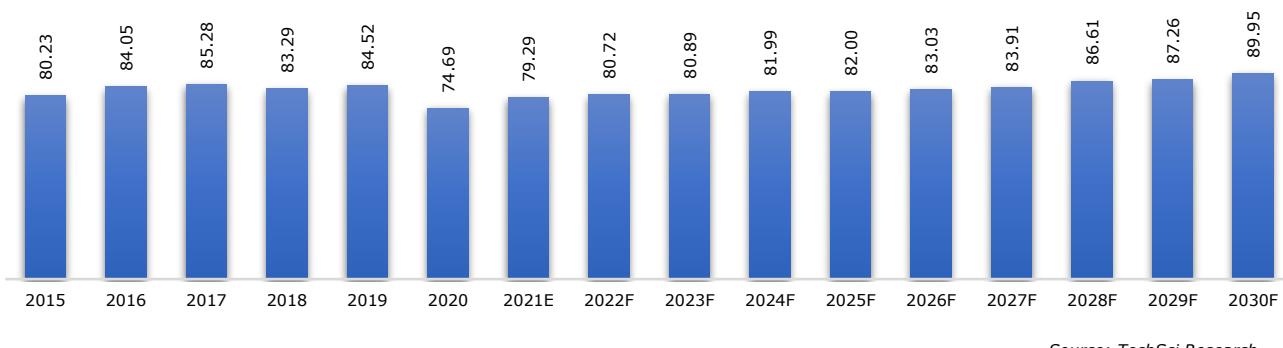
- This increase in demand is led by strong demand growth in fiber reinforced plastics (FRP), marine components and wind energy sector.
- Rising industrialization and urbanization have also contributed to the rising demand of the product in the region.
- The increase in demand in industrial applications where it is used as a lining system for water treatment, air pollution, chemical processing and mineral processing providing resistance from corrosion stimulated the market of vinyl ester resin in the region.

Brazil Renewable Energy Production Percentage Share, By types of Sources in 2020.



3.2.5.2. Operating Efficiency

South America Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F

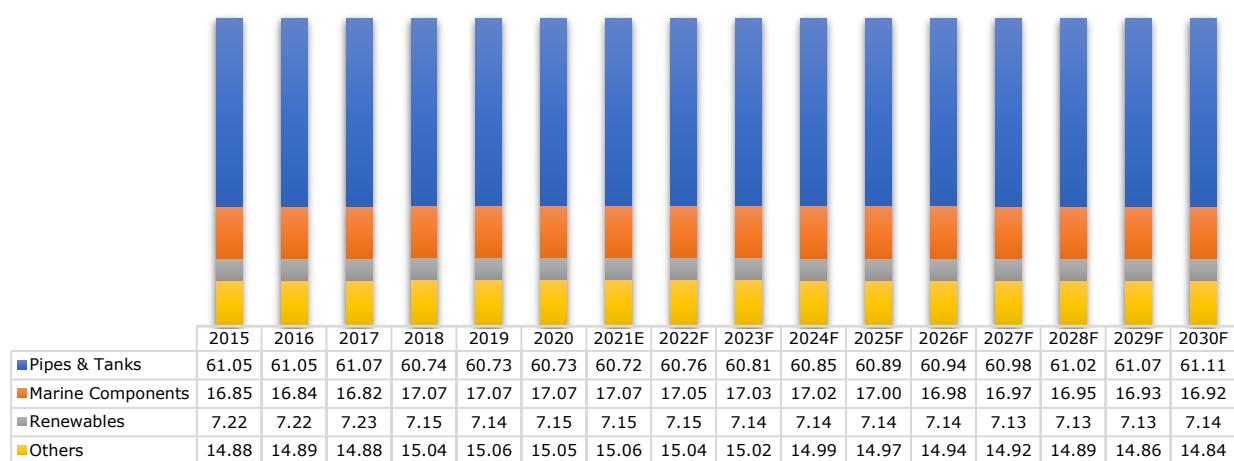


Source: TechSci Research

There is a gradual increase in operating efficiency of all key manufacturers till 2019. The companies suffered a backlog in production efficiency rates in the year 2020 owing to the pandemic. However, as the South American market recovers to its pre pandemic levels of economic activity, the demand for vinyl ester in general is going to increase significantly showing operating efficiency of more than 70 %

3.2.5.3. Demand By Application

South America Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



Others include Défense, Aerospace, Electrical and electronics etc.

Demand by Application	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	12	12	13	13	14	12	13	15	19
Marine Components	3	3	4	4	4	3	4	4	5
Renewables	1	1	2	2	2	1	1	2	2
Others	4	4	2	3	2	4	3	4	5
Total	20	20	21	22	22	20	21	25	31

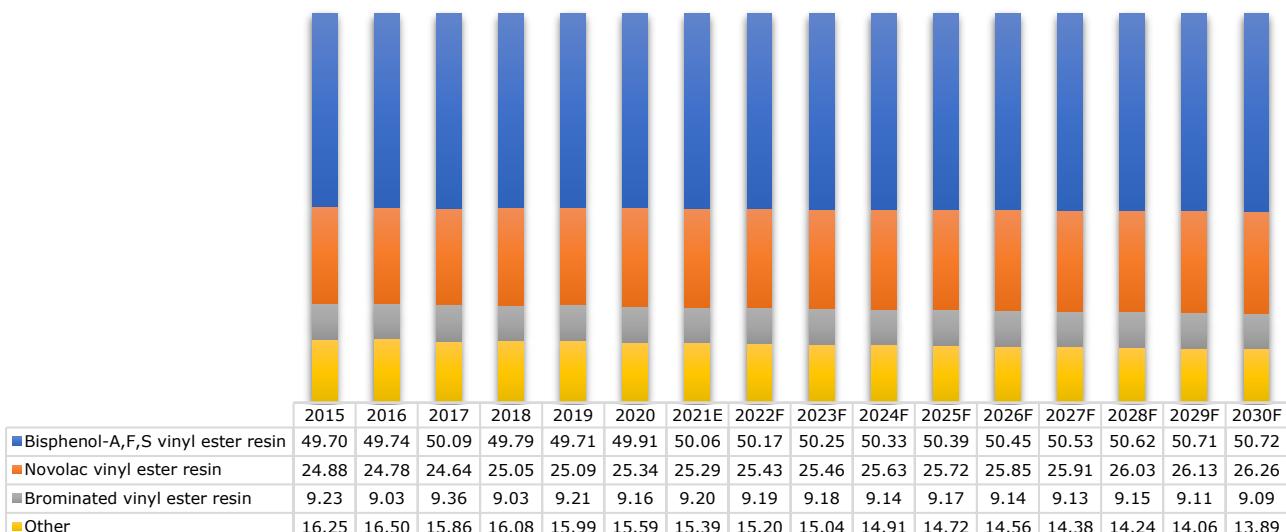
Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Vinyl Ester offers wide range of applications including pipes and tanks, marine components, renewables etc. Over the past several years, pipes and tanks segment holds largest market share in the vinyl ester market at about 60% as of 2020 and is forecasted to hold more than 60% market share by 2030 owing to increasing demand in Chlor-alkali and chemical industry, power generation industry, mining and metal industry, industrial water and wastewater industry, food processing industry, and pulp and paper industry.

3.2.5.4. Demand By Type

South America Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin, etc.

Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A,F,S vinyl ester resin	10	10	10	11	11	10	10	13	16
Novolac vinyl ester resin	5	5	5	5	6	5	5	6	8
Brominated vinyl ester resin	2	2	2	2	2	2	2	2	3
Other	3	3	4	4	3	3	4	4	4
Total	20	20	21	22	22	20	21	25	31

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin, etc.

Source: TechSci Research

*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in South America was 94%, 4% and 2%, respectively.

Depending on the type, Bisphenol-A,F,S vinyl ester resin holds the largest demand share of about 49% as of 2020. It continues to dominate the market among other categories comprising of Novolac vinyl ester resin, Brominated vinyl ester resin and others which include Urethane Modified vinyl ester resin and Elastomer Modified vinyl ester resin.

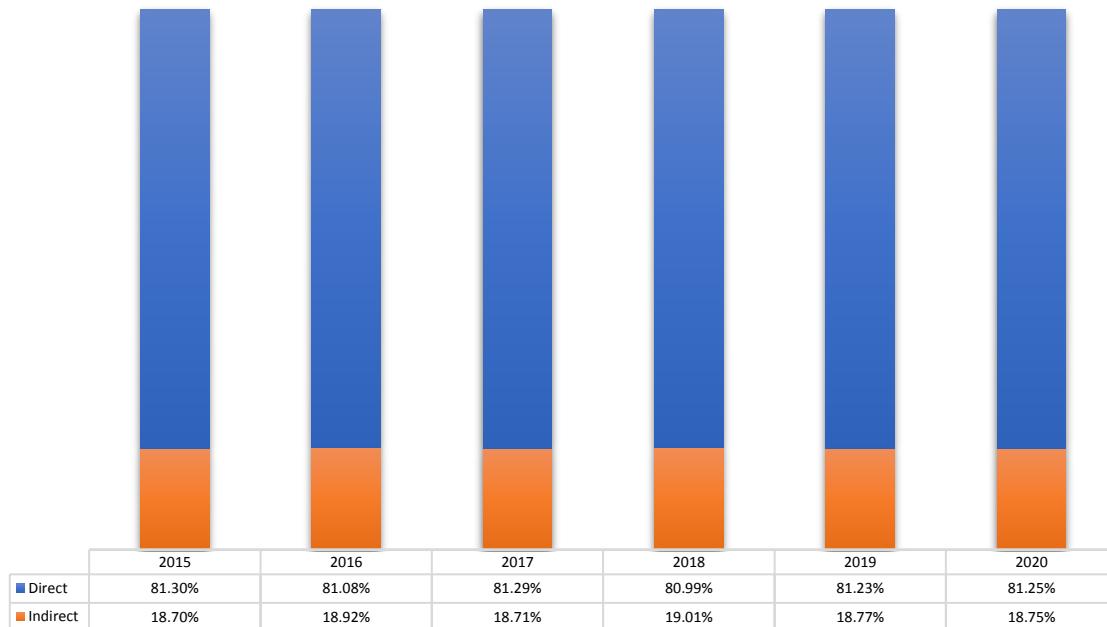
South America Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousand Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
South America	Capacity	20	20	20	22	22	22	22	22	22
	Production	16	17	17	18	19	16	17	18	20
	Total Demand	20	20	21	22	22	20	21	25	31
	Y-O-Y Growth (%)	-	4.33%	2.15%	3.64%	3.68%	-9.71%	3.23%	4.32%	4.05%
	Demand Supply Gap	0.00	0.00	0.00	0.00	0.00	0.00	-3.49	-6.93	-10.83

Source: TechSci Research

3.2.5.5. Demand By Sales Channel

South America Vinyl Ester Resin Market Share, By Sales Channel, By Volume (000' Tonnes) (%), 2015–2020



Source: TechSci Research

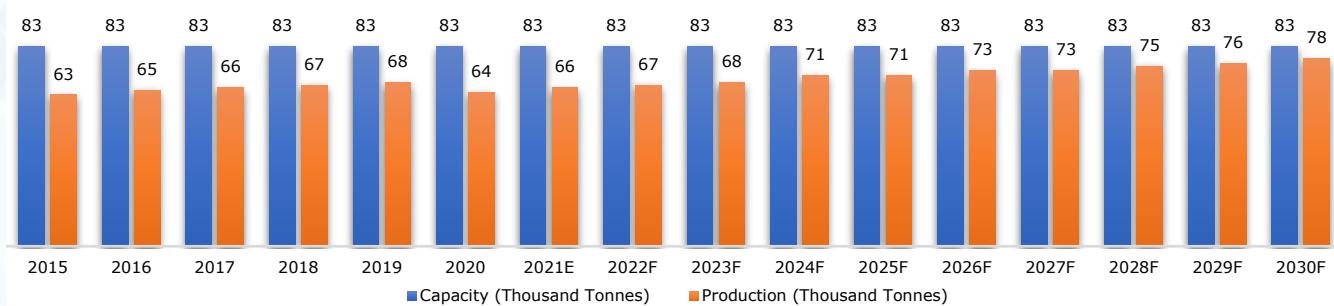
Demand by Sales Channel (000' Tonnes)	2015	2016	2017	2018	2019	2020	2021E
Direct	16	17	17	18	18	16	16
Indirect	4	3	4	4	4	4	4
Total	20	20	21	22	22	20	20

Source: TechSci Research

MIDDLE EAST & AFRICA VINYL ESTER RESIN MARKET OUTLOOK



Middle East & Africa Vinyl Ester Resin Capacity & Production, By Volume (000' Tonnes), 2015 - 2030F



Source: TechSci Research

In Middle East, as of 2020 the total capacity of vinyl ester stood at about 83 thousand tonnes with production of about 64 thousand tonnes. An increase in production of vinyl ester is estimated in forecasted years as the market recovers to its pre pandemic levels of economic activity.

Major Demand Drivers of Vinyl Ester Resin During Forecast Period

➤ Increasing Desalination Construction Projects

GCC nations have limited water resources due to which these countries rely heavily on desalination plants. Due to growing population, GCC nation plans to construct more desalination projects such as Shuaibah IWPP, Ras Abu Fontas A3 project, etc. Countries such as Saudi Arabia plan to invest USD24.30 billion in desalination projects by 2026. These desalination plants are projected to drive need for FRP pipes and tanks.

➤ Smart Cities Development

A smart city adopts high-end technological infrastructure incorporating comprehensive IT infrastructure, a network of sensors, cameras, wireless devices, and data centers for the effective delivery of essential services such as electricity, water supply, sanitation, etc. The vinyl ester resin manufacturers will benefit from smart city projects. In April 2017, Saudi Arabia announced an investment of USD70 billion for the development of four new “Economic Cities” on the concept of smart cities by 2030, with an aim to diversify its economy from hydrocarbon sector to other commercial sectors.

➤ Growth in Infrastructure Projects

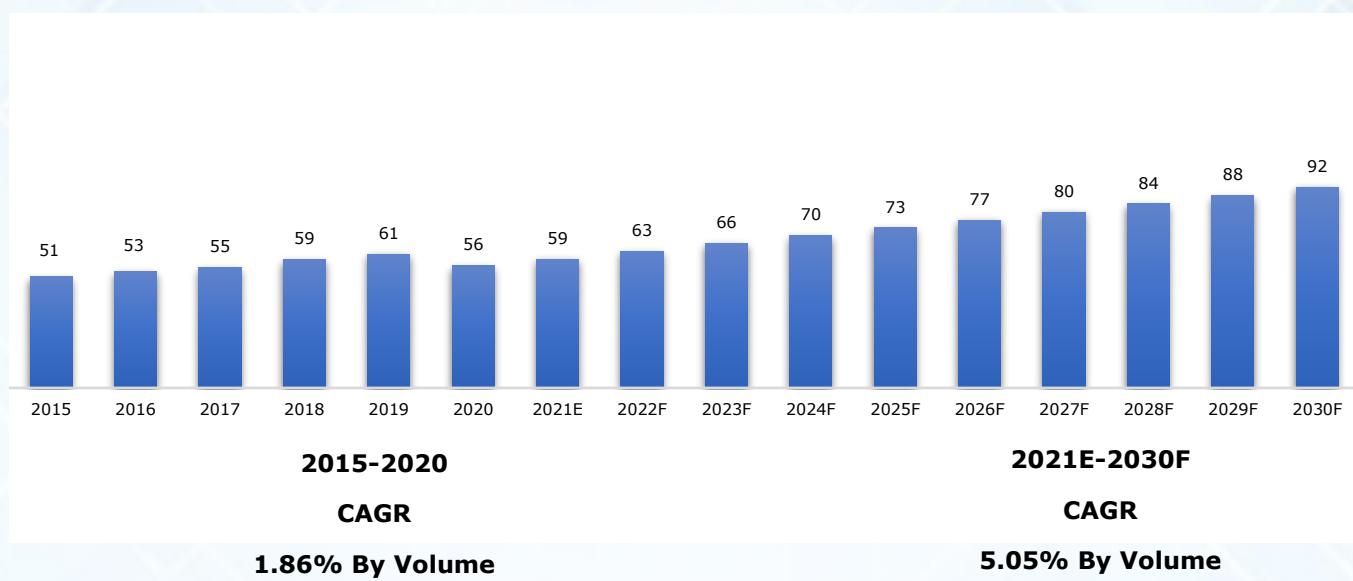
GCC nations are boosting their infrastructure by investing heavily on development of railway, roadways, and seaports. Various metro projects have been initiated across different cities in GCC countries such as Jeddah Metro, Kuwait Metro, Doha Metro, Dubai Metro, etc. Development of railway network is projected to lead to the deployment of overhead railway lines and thus drive demand for unsaturated polyester resin including vinyl ester resin in the GCC region.

Major Infrastructure and Industrial Projects in GCC Region under Planning or Execution, By Value, By 2020 (USD Million)

Activity	Saudi Arabia	UAE	Kuwait	Qatar	Oman	Bahrain
Chemical	64,916	24,809	565	1,484	15,450	5,000
Construction	475,218	539,793	80,080	139,843	43,160	30,967
Gas	25,402	21,083	11,848	12,889	25,712	1,258
Industrial	28,717	8,996	250	970	12,179	4,656
Oil	23,409	50,899	55,188	16,559	14,659	5,025
Power	332,305	35,055	29,019	8,785	9,039	6,148
Transport	217,569	99,226	46,876	103,083	36,506	11,050
Water	36,035	6,253	8,732	16,098	6,860	1,778

3.2.6. Middle East & Africa Vinyl Ester Resin Demand Supply Outlook

Middle East & Africa Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015–2030F

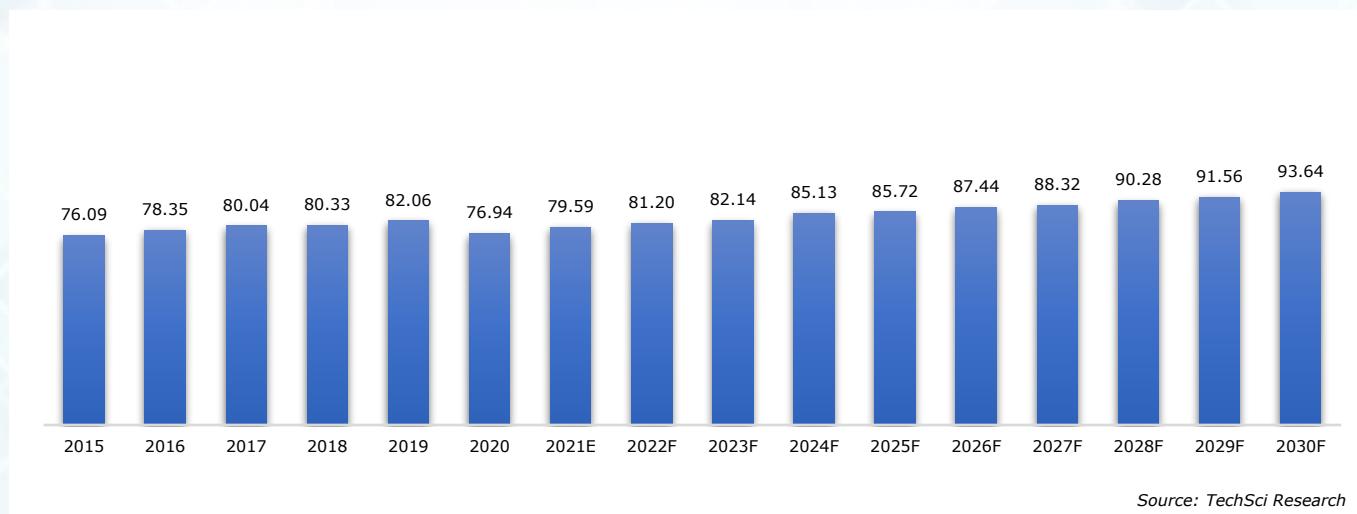


Source: TechSci Research

The Middle East vinyl ester market grew at an average CAGR of 1.86% in terms of volume during the period 2015-2020 and is forecasted to grow at CAGR of 5.05% by 2030 owing to rising demand from end user industries.

3.2.6.2. Operating Efficiency

Middle East & Africa Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F

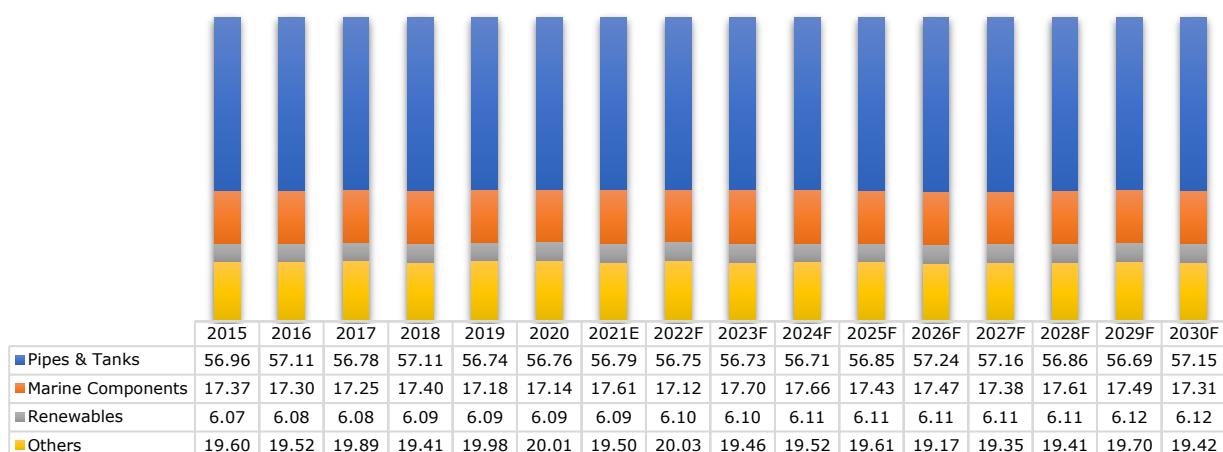


Source: TechSci Research

There is a gradual increase in operating efficiency of all key manufacturers till 2019. The companies suffered a backlog in production efficiency rates in the year 2020 owing to the pandemic. However, post pandemic as the middle east market recovers, the demand for vinyl ester in general is going to increase significantly showing operating efficiency of more than 70 % and forecasted to reach about 90% by 2030.

3.2.6.3. Demand By Application

Figure 45: Middle East & Africa Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



Others include Defense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Demand by Application (000' Tonnes)	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	29	30	31	33	35	32	33	42	52
Marine Components	9	9	9	10	10	10	10	13	16
Renewables	3	3	3	4	4	3	4	4	6
Others	10	11	12	12	12	11	12	14	18
Total	51	53	55	59	61	56	59	73	92

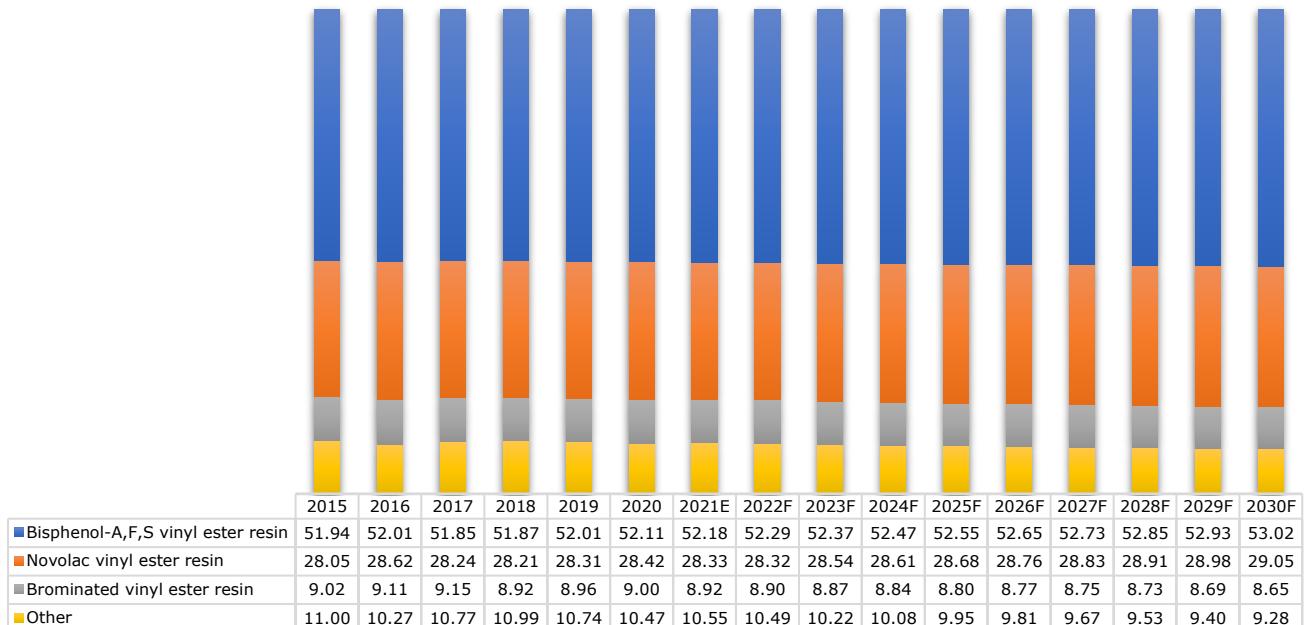
Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

In Middle East region, vinyl ester finds their major application in pipes and tanks followed by marine components, renewables etc. Pipes and tanks segment holds largest market share in the vinyl ester market at about 56% as of 2020.

3.2.6.4. Demand By Type

Figure 46: Middle East & Africa Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A,F,S vinyl ester resin	26	28	28	30	32	29	31	38	49
Novolac vinyl ester resin	14	15	16	17	17	16	17	21	27
Brominated vinyl ester resin	5	5	5	5	5	5	5	6	8
Other chemistry	6	5	6	7	7	6	6	8	8
Total	51	53	55	59	61	56	59	73	92

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin, etc.

Source: TechSci Research

*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in Middle East & Africa was 86%, 10% and 4%, respectively.

Depending on the type, Bisphenol-A,F,S vinyl ester resin holds the largest demand share of about 52% as of 2020. It continues to dominate the market among other categories comprising of Novolac vinyl ester resin, Brominated vinyl ester resin and others which include Urethane Modified vinyl ester resin and Elastomer Modified vinyl ester resin.

Middle East & Africa Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousand Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Middle East & Africa	Capacity	83	83	83	83	83	83	83	83	83
	Production	63	65	66	67	68	64	66	71	78
	Total Demand	50.89	53.10	54.95	58.53	60.98	55.79	58.83	73.14	91.68
	Y-O-Y Growth (%)	-	4.33%	3.49%	6.51%	4.20%	-8.51%	5.45%	5.05%	4.42%
	Demand Supply Gap*							7.23	-1.99	-13.96

Source: TechSci Research

* Demand-Supply Gap is considered for forecast period only.

3.2.6.5. Demand By Sales Channel

Figure 47: Middle East & Africa Vinyl Ester Resin Demand, By Sales Channel, By Volume (000' Tonnes) (%), 2015–2020



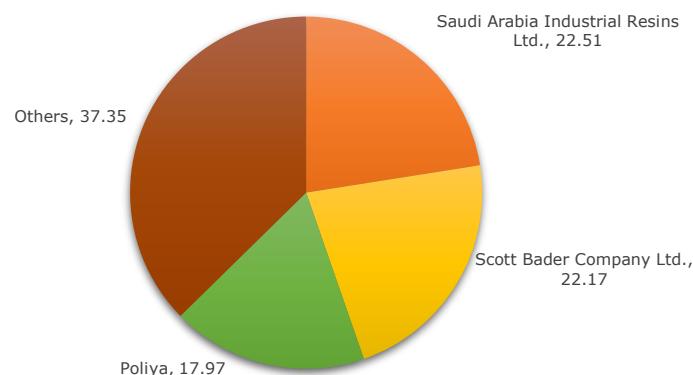
Source: TechSci Research

Demand by Sales Channel	2015	2016	2017	2018	2019	2020	2021E
Direct	41	43	44	47	49	45	41
Indirect	10	10	11	12	12	11	10
Total	51	53	55	59	61	56	51

Source: TechSci Research

3.2.6.6. Sales By Company

Figure 48: Middle East & Africa Vinyl Ester Resin Sales, By Company, By Volume (000' Tonnes), 2020

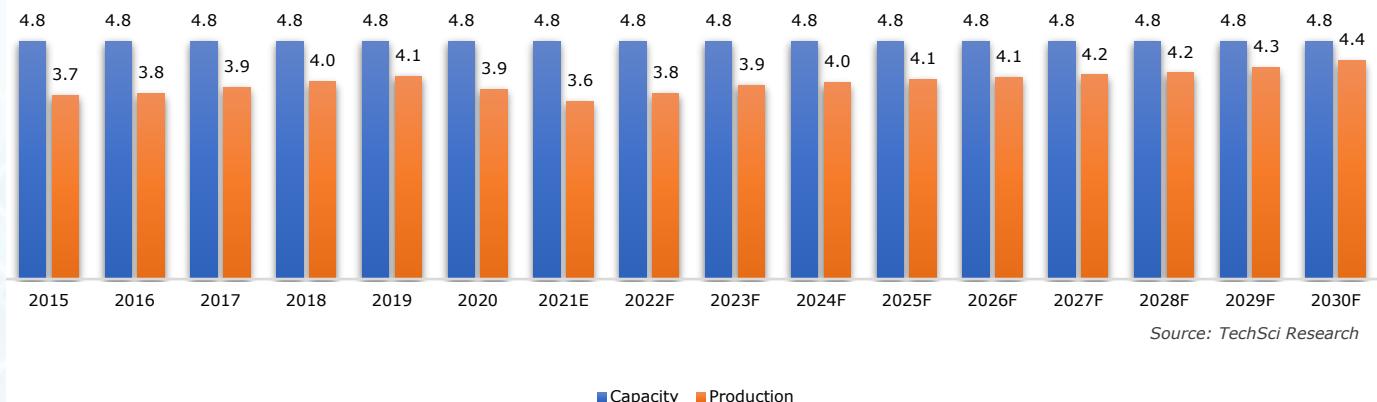


Others include Imports

Source: TechSci Research

India Demand Supply Scenario

India Vinyl Ester Resin Capacity, Production and Demand, By Volume (000' Tonnes), 2015 - 2030F



Company (000' Tonnes)	Location	2015	2020	2030F
Orson Chemicals	Silvassa	0.72	0.72	0.72
Reichhold India Pvt. Ltd.	Maharashtra	0.36	0.36	0.36
Moras Chemicals India Pvt. Ltd.	Gujarat	0.36	0.36	0.36
Innovative Resins Pvt. Ltd.	Rajasthan	1.8	1.8	1.8
Mechemco resins Pvt Ltd	Maharashtra	0.4	0.4	0.4
Satyen Polymers Pvt. Ltd.	Maharashtra	0.6	0.6	0.6
Crystic Resins India Private Limited	Haryana	0.6	0.6	0.6
Total		4.84	4.84	4.84

- The Indian market for Epoxy Resins is quite fragmented and none of the manufacturers have capacity more than 100 tonnes per month.
- The Indian total capacity stands at 4.84 thousand Tonnes. Most of the manufacturing plants are in Western and Northern region of India like Maharashtra, Gujarat, Haryana and Rajasthan.
- The market share of Innovative Resins Pvt Ltd. is approximately 35% in the domestic market followed by Orson Chemicals, Satyen Polymers Pvt Ltd, ad Crystic Resins India Private Limited with market share of approximately 14%, 12% and 11%.

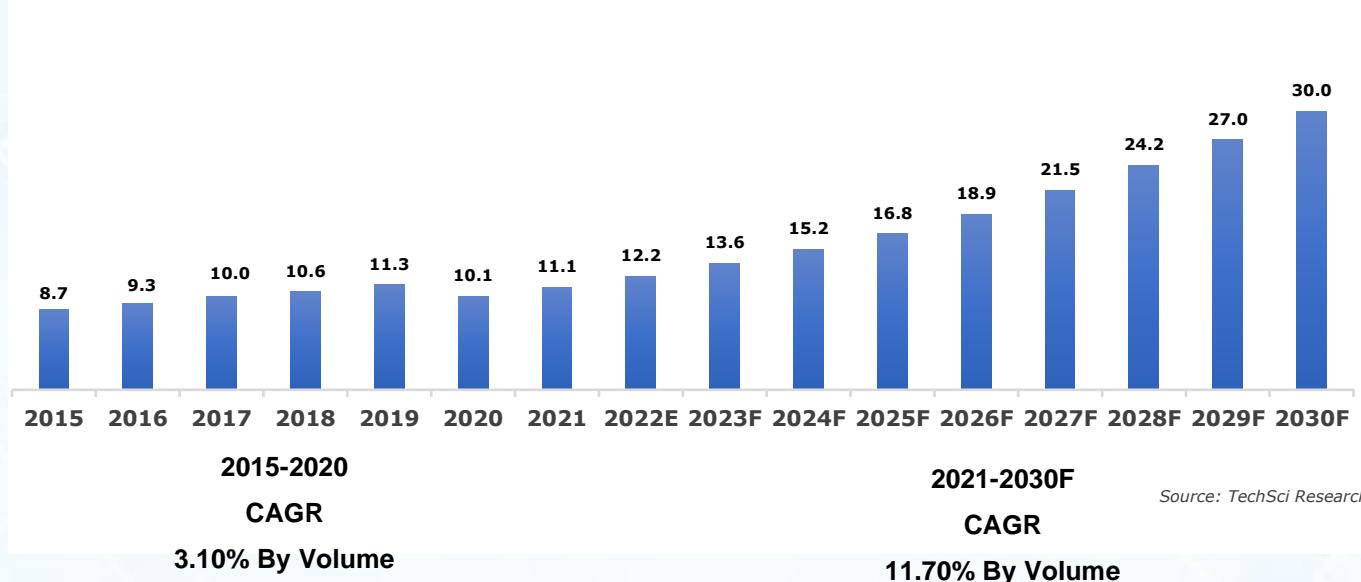
Operating Efficiency

India Vinyl Ester Resin Operating Efficiency (Percentage), 2015-2030F



Source: TechSci Research

India Vinyl Ester Resin Demand, By Volume (000' Tonnes), 2015-2030F



Development of 5G technology in India will increase the demand of VER

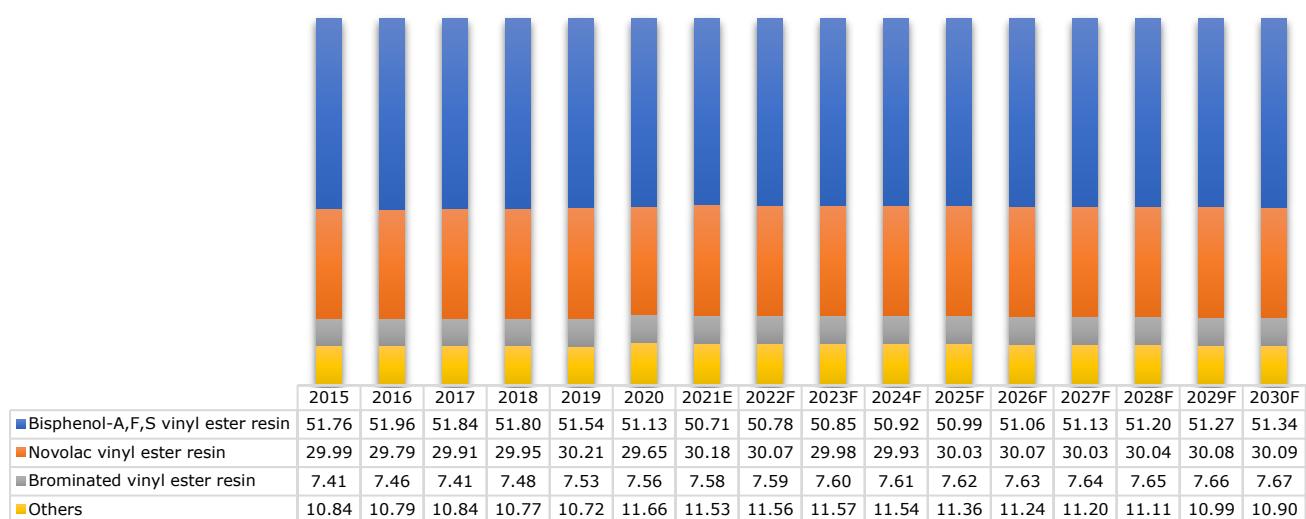
- 5G is a fifth-generation cellular network technology which tends to increase the internet speed up to 100 gigabits per second and is expected to be 100 times faster than fourth generation technology (4G) and provides lower latency.
- 5G will be able to support huge number of connected devices without lags and can provide longer battery life which is expected to propel the market of IoT across various manufacturing units. 5G is the foundation for realizing the full potential of IoT.
- For instance, in 2020, Bharti Airtel Ltd launched its internet of things (IoT) platform for enterprises to connect and manage billions of devices and applications. Largest Telecom Player in terms of market share, Reliance Jio announced launch of Jio Phone Next with collaboration of Google.
- VER has application in semiconductor encapsulation that is used manufacturing of smartphones screens. With the rising awareness about the 5G Technology, the demand of smartphone is anticipated to increase the demand of VER Resins.
- VER has application in semiconductor encapsulation that is used manufacturing of smartphones screens. With the rising awareness about the 5G Technology, the demand of smartphone is anticipated to increase the demand of VER Resins.

India Vinyl Ester Resin Trade Dynamics, By Value (USD million) By Volume- (000' tonnes)

Imported Country	2019		2020		2021	
	Value	Volume	Value	Volume	Value	Volume
Spain	6.36	2.44	5.34	2.09	3.57	1.27
United Kingdom	0.80	0.02	1.74	0.59	0.13	0.05
China	0.94	0.27	1.70	0.53	0.86	0.28
Taiwan	1.42	0.63	0.99	0.49	0.21	0.08
Japan	0.00	0.00	0.76	0.29	0.37	0.14
Others	3.93	4.54	2.60	2.71	7.59	5.48
Total	13.45	7.9	13.12	6.7	12.74	7.3
Exported Country	2019		2020		2021	
	Value	Volume	Value	Volume	Value	Volume
Saudi Arabia	0	0.02	0	0.01	0.02	0.15
Qatar	0.06	0.16	0.03	0.08	0.02	0.06
Bangladesh	0	0.32	0	0	0	0.01
United Arab Emirates	0	0.01	0.01	0.03	0	0
Bahrain	0	0	0	0	0	0.01
Others	0.04	0.09	0.03	0.28	0.01	0.03
Total	0.1	0.6	0.07	0.4	0.05	0.26

Demand By Type

India Vinyl Ester Resin Demand, By Type, By Volume (000' Tonnes) (%), 2015–2030F



Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

Demand by Type	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Bisphenol-A, F,S vinyl ester resin*	4.5	4.8	5.2	5.5	5.8	5.2	5.6	8.6	15.4
Novolac vinyl ester resin	2.6	2.8	3	3.2	3.4	3	3.3	5.1	9
Brominated vinyl ester resin	0.6	0.7	0.7	0.8	0.9	0.8	0.8	1.3	2.3
Other chemistry	1	1	1.1	1.1	1.2	1.1	1.4	1.8	3.3
Total	8.7	9.3	10	10.6	11.3	10.1	11.1	16.8	30

Others include Urethane Modified vinyl ester resin, Elastomer Modified vinyl ester resin etc.

Source: TechSci Research

*Note: In 2020, the percentage distribution of Bisphenol- A, F and S in India was 92%, 5% and 3%, respectively.

India Vinyl Ester Resin Demand Supply Analysis, By Volume, 2015-2030F (Thousands Tonnes)

		2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
India	Capacity	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
	Production	3.7	3.8	3.9	4.0	4.1	3.9	3.6	4.1	4.4
	Import	5.4	6.1	6.7	7.3	7.9	6.7	0.00	0.00	0.00
	Export	0.4	0.5	0.6	0.6	0.6	0.4	0.00	0.00	0.00
	Total Demand	8.7	9.3	10.0	10.6	11.3	10.1	11.1	16.8	30.0
	Y-O-Y Growth (%)	-	6.90%	7.53%	6.0%	6.60%	-10.62%	9.90%	10.86%	11.21%
	Demand Supply Gap							-7.46	-12.76	-25.55

Source: TechSci Research

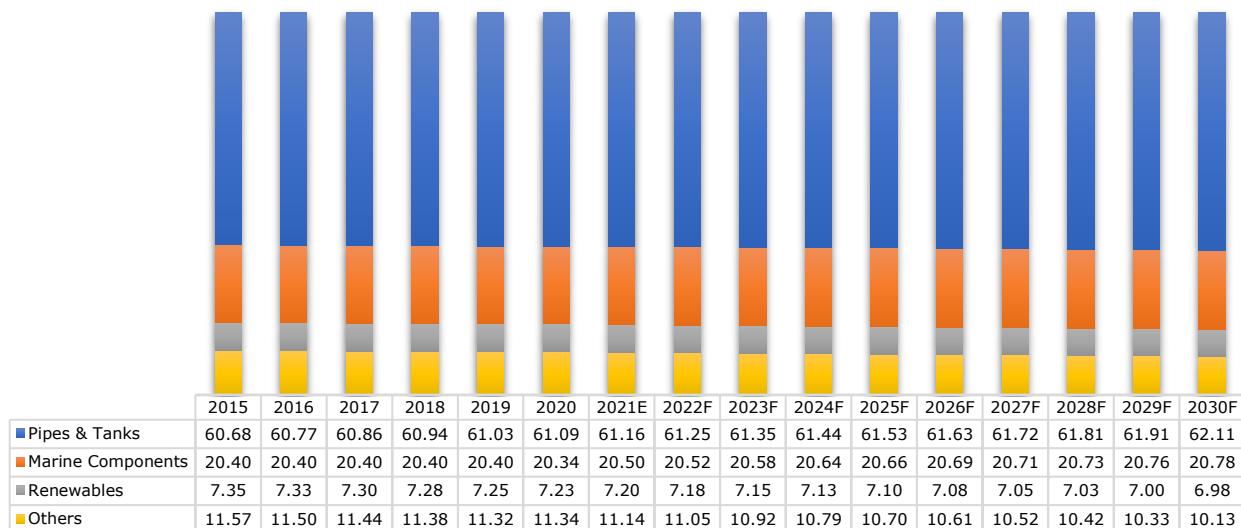
India Vinyl Ester Resin Demand, By Volume, 2020-2030F (000' Tonnes)

Demand Scenario	2020	2021E	2022F	2023F	2024F	2025F	2026F	2027F	2028F	2029F	2030F
Optimistic	10.11	11.33	12.8	14.59	16.59	18.81	21.64	25.16	28.93	32.96	37.48
Realistic	10.11	11.08	12.24	13.64	15.17	16.81	18.92	21.52	24.21	26.97	30
Pessimistic	10.11	10.77	11.58	12.55	13.58	14.65	16.05	17.77	19.45	21.08	22.81

Source: TechSci Research

Demand By Application

India Vinyl Ester Resin Demand, By Application, By Volume (000' Tonnes) (%), 2015–2030F



Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

Demand by Application (000' Tonnes)	2015	2016	2017	2018	2019	2020	2021E	2025F	2030F
Pipes & Tanks	5.3	5.6	6.1	6.4	6.9	6.2	6.8	10.3	18.6
Marine Components	1.8	1.9	2	2.2	2.3	2.1	2.3	3.5	6.2
Renewables	0.6	0.7	0.7	0.8	0.8	0.7	0.8	1.2	2.1
Others	1	1.1	1.2	1.2	1.3	1.1	1.2	1.8	3.1
Total	8.7	9.3	10	10.6	11.3	10.1	11.1	16.8	30.0

Others include Défense, Aerospace, Electrical and electronics etc.

Source: TechSci Research

India Market Insights

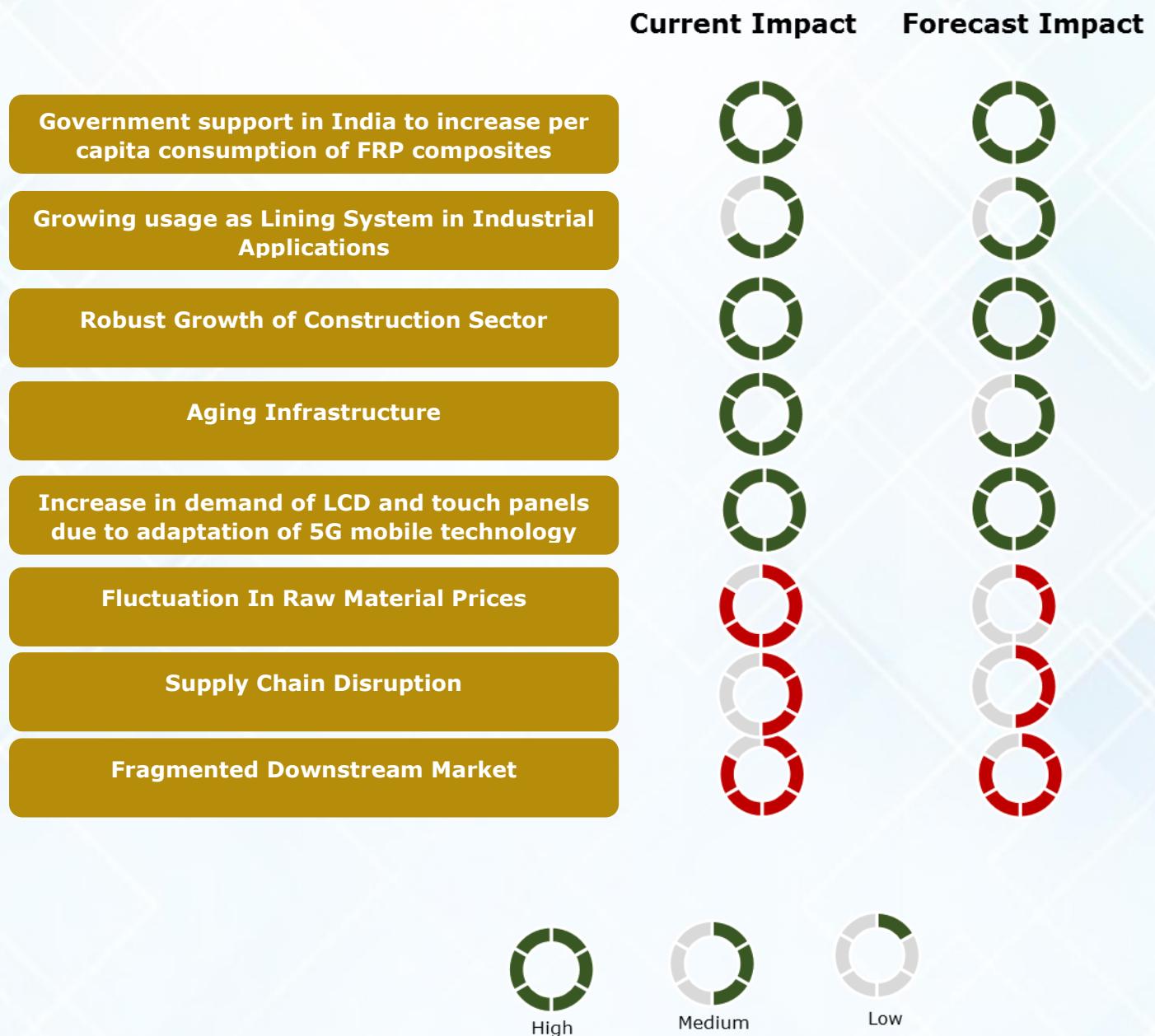
India's VER capacity stood around 4.8 KT in 2020 and the resin demand is anticipated to grow at a CAGR of 11.70% (by volume) between 2021-2030. Vinyl ester resins finds varied applications due to their high chemical and electrical resistivity that serve several critical industries. Because of their varied applications, Epoxy resins find high utility in end user products which relates the demand growth of Epoxy Resins to India's overall GDP.

Trade dynamics of the country show that Saudi Arabia, Qatar and Bangladesh are the key importers of Indian VER while Spain, United Kingdom and China are the top three exporters of VER to India.

By type, Bisphenol A, F and S-based vinyl ester resin dominate the Indian VER industry with around 50.71% demand share as of 2020. Due to their desirable characteristics, BPA-based VERs have portrayed strong growth projections in the forecast years as well. Novolac VER resin holds nearly 30% demand share in the Indian VER market

Based on application, Pipes and Tanks dominate the Indian VER demand, holding more than 60% share of the country's total demand. Demand for Marine components is around 20% of the total while others hold more than 10% share of the resin demand.

3.8. MARKET DYNAMICS



*Green color denotes market drivers

*Red color denotes market challenges

Market Drivers

Government support in India to increase per capita consumption of FRP composites

Driven by strong demand from various end use industries such as wind energy, transportation, electrical and electronics, defence, aerospace, pipes and tanks, construction and marine, the composite industry, also known as fibre-reinforced plastics (FRP) industry, will also be supporting government's 'Make in India' initiative giving a big push to future market of vinyl ester resin. The per capita consumption of composites in China and the United States has been 2.8 kg and 11.4 kg, respectively in 2021. The per capita consumption in India stood at 0.36 kg in 2021, which is the lowest.

Growing usage as Lining System in Industrial Applications

Vinyl ester resin lining systems are used in several industrial applications like water treatment, chemical processing, and air pollution control and mineral processing as they provide unparalleled corrosion resistance to fiberglass reinforced plastic tanks, ducting, stacks & chimneys, scrubbers, pipes and other components. Therefore, vinyl ester resin liners fit best for the most challenging industrial environments due to their properties like high heat resistance, exceptional durability, and minimal maintenance requirements.

Robust Growth of Construction Sector

With rising urban population and public and private sector investments in construction projects, the overall construction market is witnessing rapid growth. The demand for vinyl ester resins in building & construction industry has been rising over the last few years owing to their varied Types including Bisphenol, Novolac and Brominated. Robust growth in construction sector in Japan coupled with the implementation of favourable government policies to support infrastructure development are the primary factors expected to influence the demand.

Aging Infrastructure

The aging infrastructure is driving opportunities for building materials including VER based FRP tanks. Most of the infrastructure such as roads, water supply and sewerage systems constructed in developed nations are 30-40 years old. The government and local civic bodies incur huge maintenance cost hence there is an urgent need for repair of these systems.

Europe Percentage of Infrastructure that is minimum 50 years old, 2018, 2023 & 2033

	2018	2023	2033
Highway Bridges	Approx. 25%	Approx. 39%	Approx. 63%
Tunnels	Approx. 20%	Approx. 27%	Approx. 42%
River Management Facilities	Approx. 32%	Approx. 42%	Approx. 62%
Sewage Pipes	Approx. 4%	Approx. 8%	Approx. 21%

Source: Eurostat

Market Challenges

Fragmented market of composites industry in China and India

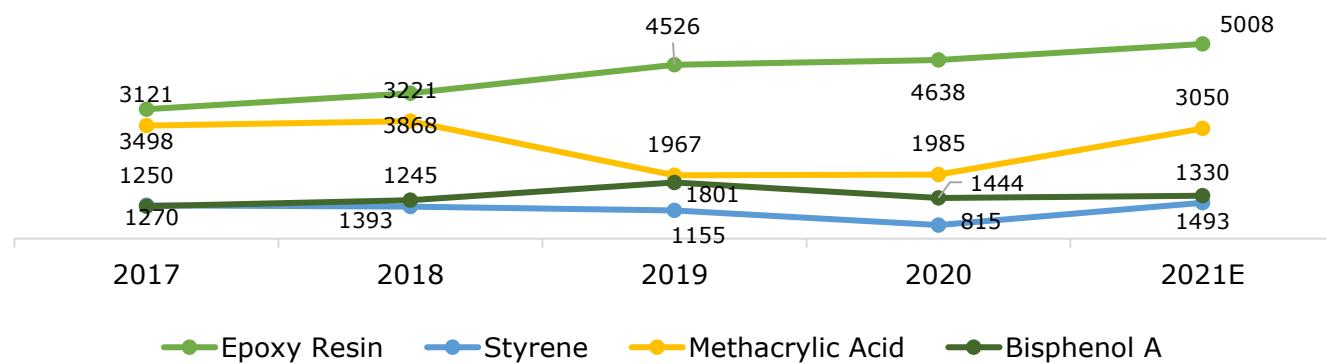
The fragmented composite industry in India and China consists of around 15000 stakeholders in the value chain including small, mid-sized and large players. Also, the lack of awareness among end-user industries is the major challenge for the growth of vinyl ester which also impacts the margin of the industry. Lack of regulatory framework, absence of a recycling policy and standardization of end-use products are some of the major challenges for the composites industry. Global composites market is highly fragmented with more than 1000 mid and small regional players operating in the market.

High Volatility in Raw Material Prices

Styrene, epoxy resin, methacrylic acid, etc., are few of the raw materials majorly used in the production of construction sealants and bonding such as butyl rubber, acrylic urethane, silicone rubber sealant, etc. Over the years, raw materials used in sealants industry have observed price

fluctuations globally. Diligently working on product selling prices to react to changes in raw material cost and simultaneously maintaining market share is a key challenge for construction sealants producers

India Styrene Monomer, Methacrylic Acid and Epoxy Resin Prices, 2017-2021E (USD per Ton)



Source: TechSci Research

3.9. MARKET TRENDS & DEVELOPMENTS

Capacity Expansion by Existing Players in APAC Region

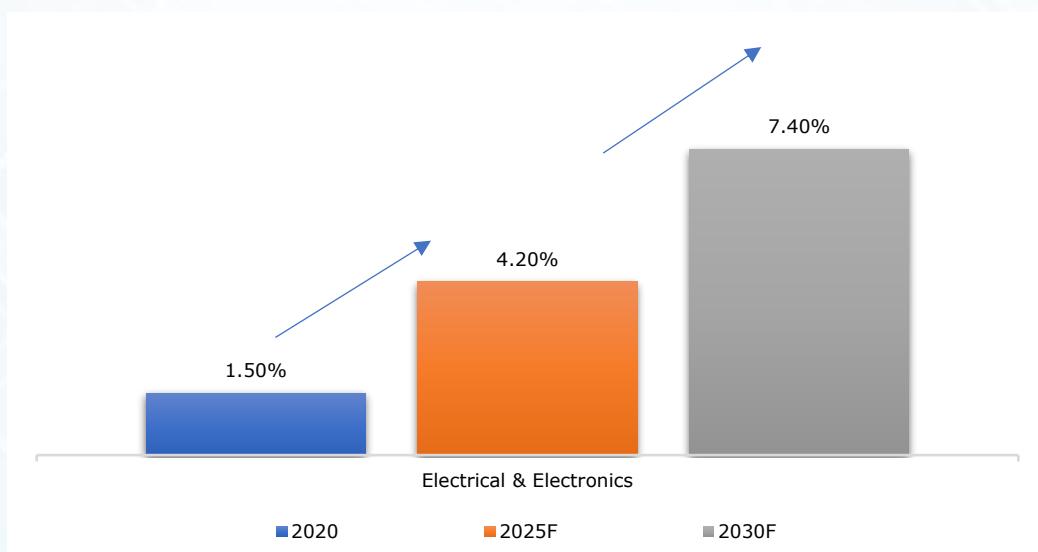
With growing demand for Vinyl Ester Resin in various sector such as wind energy, transportation, electrical and electronics, defence, aerospace, pipes and tanks, construction and marine, companies have started investing in expanding manufacturing facilities. Moreover, companies are increasingly focusing on developing nations like China and India, due to availability of cheap labour in these countries. For instance, Showa Denko Group completes expansion of lines to produce vinyl ester in Shanghai due to increasing demand of the product in electronic parts such as Liquid Crystal Displays (LCDs) and touch panels on account of the progress in telecommunication technologies.

Emerging applications

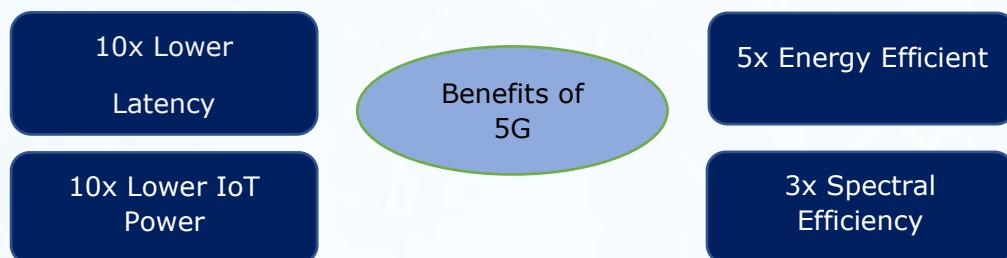
The emerging application of vinyl ester resin is in electronics and telecommunication due to its use in the process to produce electronic parts including LCDs and touch panels, which has been rapidly increasing in APAC region mainly in China. Moreover, its application in pipes and tanks, marine industry, defence, transportation, etc. has been rapidly increasing due to its excellent corrosion resistance and chemical resistance properties. Vinyl Ester resins' usage in the making

of pipes and tanks also adds to their increasing demand. Growing utilization of Vinyl Ester Resins in electronics and telecommunications is likely to increase its foothold in the market over coming years.

Electrical & Electronics Industry Market Share in Vinyl Ester Resin Applications, 2020, 2025F and 2030F



The future wave in the telecom industry is the 5G network, which covers less distance than the existing 4G network. In India, the Ministry of Telecommunications and The Telecom Regulatory Authority of India (TRAI) plans to implement 5G in the coming years. With this implementation, usage of VER for the telecom industry is expected to register strong growth in the coming years.





Mergers and Acquisitions

Merger & acquisition activities are becoming prevalent in the vinyl ester resin market globally. In 2019, INEOS Composites acquired Ashland Composites. Additionally, Polynt and Reichhold also had a merger in the same year to expand and increase their market share. Showa Denko, a prominent player in the vinyl ester resin market, is continuously expanding its capacity to cater to the increasing demand in China.

Mergers & Acquisitions in Vinyl Ester Resin Industry			
S.No.	Target Company	Acquirer / Merged Entity	Year
1	Mar-Bal Inc	Chagrin Falls, Ohio	2020
2	Ashland Global Holdings Inc.	INEOS Enterprise	2019
3	Aliancys & AOC Resin	CVC Capital Partners	2018
4	Polynt	Reichhold Group	2017
5	Kemrock Industries Ltd	Reliance Industries Ltd	2018

Source: TechSci Research

3.10. Technology Evaluation:

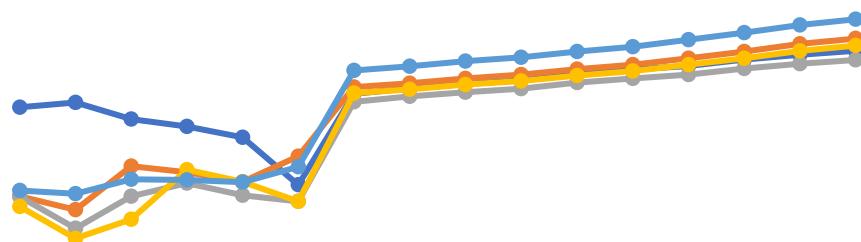
Vinyl Ester Resins are downstream products of Epoxy Resin. Most manufacturing companies have their in-house technologies and R&D facilities to make formulations. Key reactions are carried out with the help of a batch reactor and blender which can be outsourced. Conventionally, manufacturing process involves charging batch reactor with a feedstock and then blending it with an organic solvent such as styrene monomer. There is no technology licensor for the product.

Indian manufacturing companies such as Innovative Resins, Satyen Polymers, Mechemco Resins among others have In-house batch reactor set up. However, they depend on domestic or international market for feedstocks Epoxy resin, Bisphenol-A, and other additives.

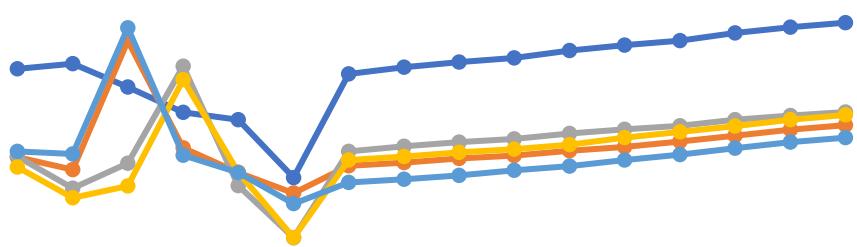
3.11. Pricing Analysis

Discussions on Vinyl Ester Resin remained firm since the beginning of 2021 following the pickup in the market activities as the economy significantly rebounded from COVID-19 repercussions. However, the increment has been marginal yet consistent due to constraint fluctuations in base Novolac costs. There has been little to no adverse impact of the second wave of Covid in India, as demand for the material remained consistent from packaging sector amidst favourable consumer sentiments. Thus, after showcasing a marginal dullness in May 2021, prices again revived in June 2021, following the resumption in market activities across the nation. Besides, soaring freight cost along several trade routes since the beginning of 2021 has also contributed to raise in values at times of prevalent demand pattern.

Global Vinyl Ester Resin Yearly Prices, 2015-2030 (USD/Tonne)



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Vinyl Ester Resin-Novalac Based Ex Mumbai	3802	3869	3633	3531	3375	2705	3990	4070	4131	4181	4269	4333	4385	4477	4544	4599
Vinyl Ester Resin-Novalac Based FOB Texas	2543	2354	2970	2883	2746	3110	4085	4142	4208	4261	4338	4403	4495	4590	4695	4771
Vinyl Ester Resin-Novalac Based FOB Seoul	2540	2091	2546	2730	2559	2473	3877	3955	4014	4062	4148	4210	4261	4350	4416	4469
Vinyl Ester Resin-Novalac Based FOB Qingdao	2400	1950	2220	2921	2749	2474	4000	4056	4121	4172	4248	4311	4402	4494	4598	4672
Vinyl Ester Resin-Novalac Based FOB Hamburg	2625	2580	2783	2774	2745	2959	4319	4379	4450	4505	4586	4655	4753	4853	4964	5044



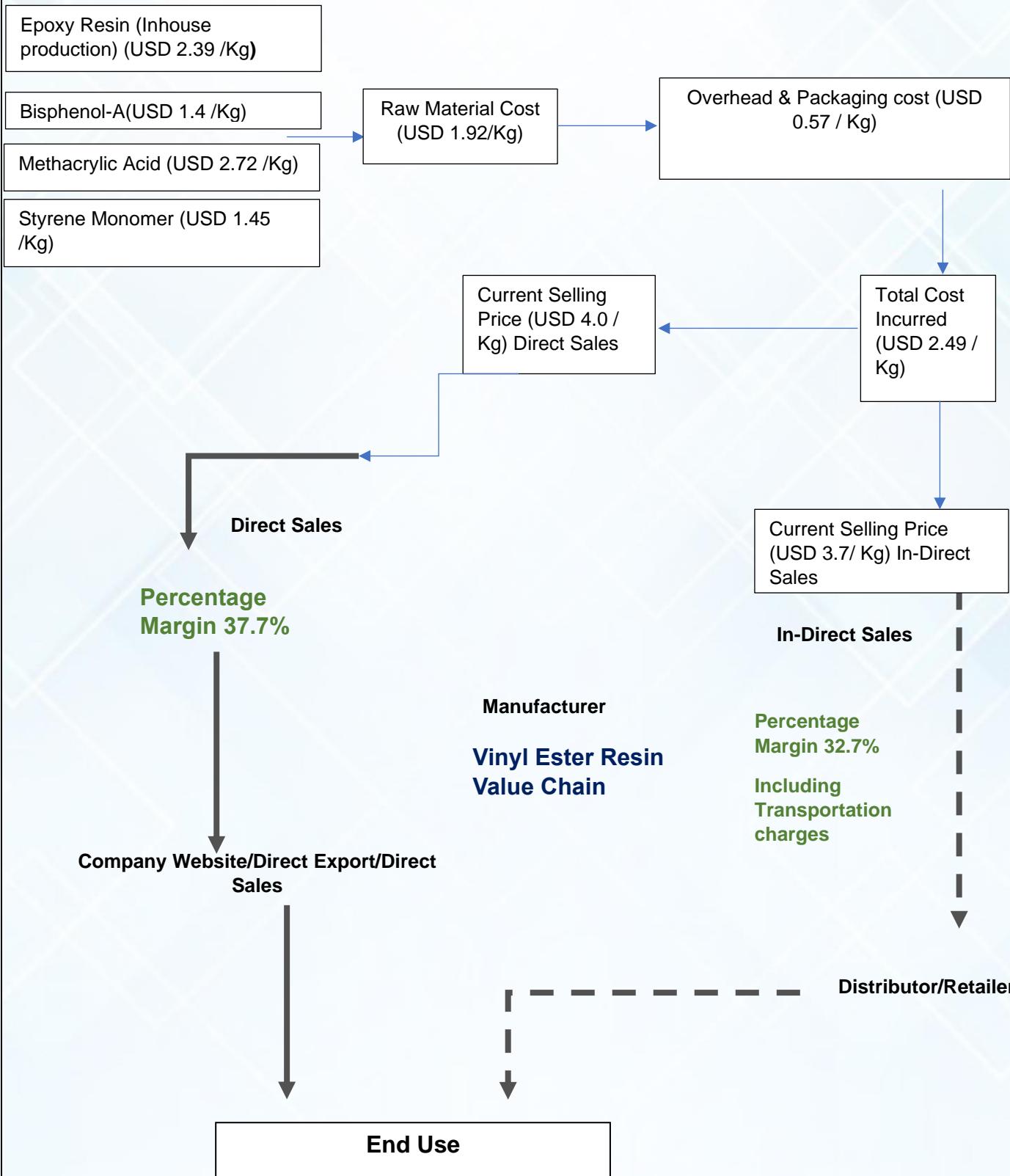
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Vinyl Ester Resin-Epoxy Based Ex Mumbai	4863	4938	4602	4243	4139	3311	4792	4888	4961	5021	5127	5204	5266	5377	5458	5524
Vinyl Ester Resin-Epoxy Based FOB Texas	3604	3423	5265	3737	3384	3088	3477	3526	3582	3627	3692	3748	3826	3907	3996	4061
Vinyl Ester Resin-Epoxy Based FOB Seoul	3613	3160	3515	4902	3197	2451	3685	3759	3815	3861	3942	4001	4050	4135	4197	4248
Vinyl Ester Resin-Epoxy Based FOB Qingdao	3461	3019	3189	4711	3387	2452	3562	3612	3670	3716	3782	3881	3962	4045	4138	4205
Vinyl Ester Resin-Epoxy Based FOB Hamburg	3686	3649	5452	3628	3383	2937	3243	3288	3341	3415	3476	3563	3638	3732	3818	3880

Vinyl Ester Resin market which faced dullness earlier under COVID-19 repercussion has witnessed a significant rebound across the global market since January 2021. Global freight cost hike has also impacted the overall market fundamentals for VER across international market. Some major players like AOC frequently revised their offers for Epoxy based VER to tackle rising freight charges, and feedstock cost since January. Meanwhile, countries like UK were heard struggling to procure enough raw materials to satisfy the domestic consumption, which impacted the price trend across Europe. However, during May-July 2021, while India was battling with second wave of pandemic, other countries witnessed mixed sentiments that varied with rate of economic recovery and ongoing pandemic related restrictions. Some factors like freight cost and raw material scarcity remained common behind any significant increase in prices of VER across the globe.

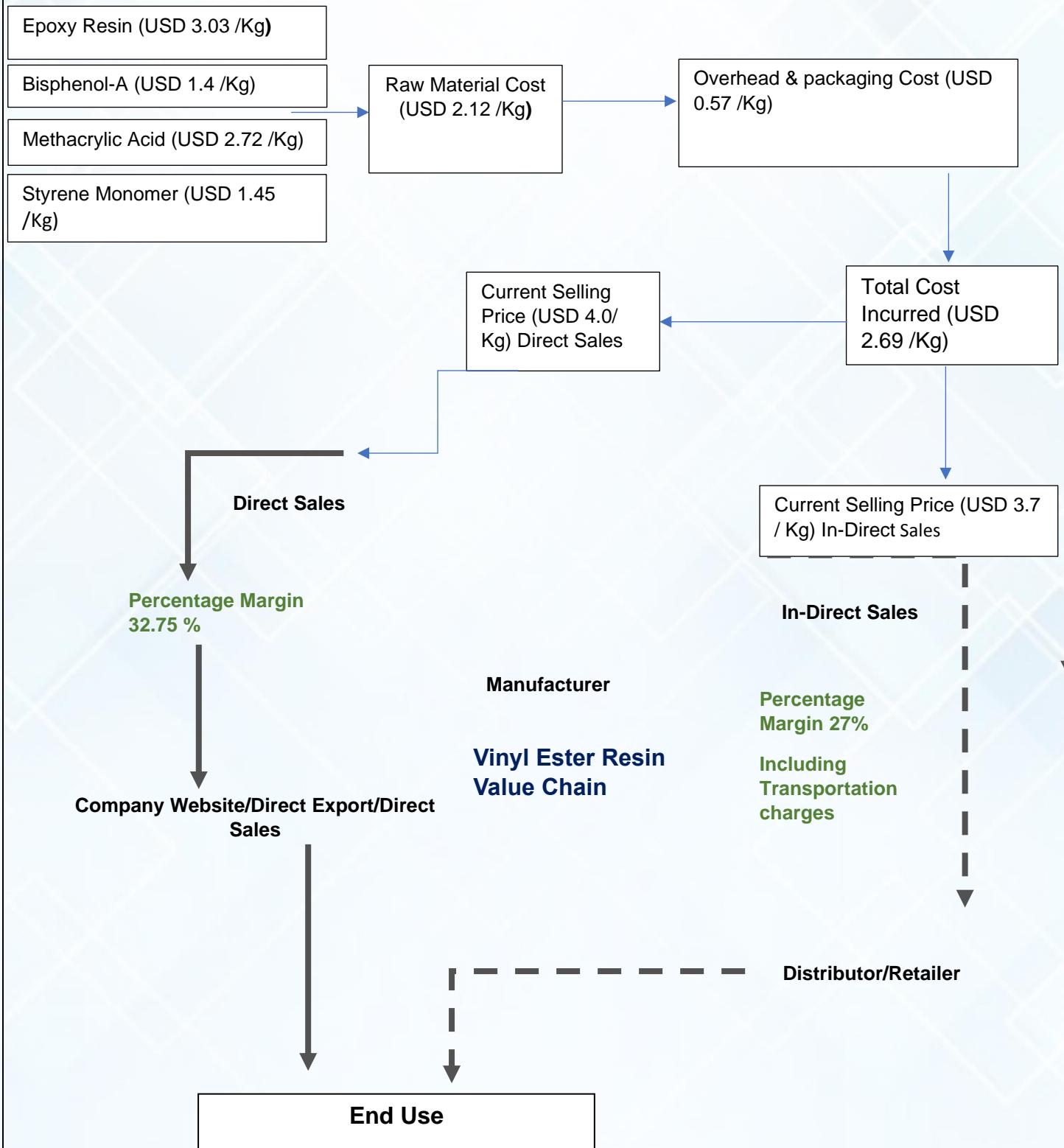
As per the analysis, it was observed that demand for both Epoxy and Novolac based VER runs parallelly across the global market. However, fluctuations in prices of VER primarily emerge after considerable revisions in prices of raw materials. Therefore, due to differences in raw materials, hike in prices may differ, but both Novolac and Epoxy based VER shares the similar market dynamics. Epoxy based VER usually varies with Bisphenol A (BPA) and Epichlorohydrin (ECH) price trend, while Novolac based Epoxy fluctuates with phenol and formaldehyde price dynamics.

3.12. Value Chain Analysis for Captive Vinyl Ester Resin Manufacturer

Value Flow Analysis for Captive Vinyl Ester Resin Manufacturer



Value Flow Analysis for Non-Captive Vinyl Ester Resin Manufacturer



3.13. Cost of Production

COST OF PRODUCTION				
	VARIABLE COST	Norm of Consumption (Tonne)	Unit Rate	Amount
			USD / Tonne	USD
A	VARIABLE COST			
1	RAW MATERIALS			
I	Epoxy Resin	0.3	3030	909
II	BPA	0.14	1400	196
III	Methacrylic Acid	0.11	2720	299
IV	Styrene Monomer	0.45	1450	653
	Sub-Total (1)		8600	2057
2	Packing Materials			147
3	Catalyst & Chemicals			65
4	Utilities			55
	TOTAL VARIABLE COST		2324	
B	FIXED COST			
1	Repair & Maintenance			250
2	Salaries & Wages			
3	Research & Development			
4	Transportation & Clearance			
5	Corporate Overheads			
	TOTAL FIXED COST			250
C	VARIABLE + FIXED COST			2574
D	INTEREST ON WORKING CAPITAL			20
E	CASH MANUFACTURING COST			2594
F	DEPRECIATION			1.9
G	PRODUCTION COST	2596		

3.14. Customer Analysis

Destination Country	Product Description	Customer / Distributor Name	Supplier Name	Annual Off-take Quantity (Tonnes)	Price Range (USD/kg)
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Reichhold India Private Limited	Reichhold Polymers Tianjin, China	2600	3.4-4.23
Saudi Arabia	Bisphenol-a Type Epoxy Vinyl Ester Resin	Saudi Arabian AMIANTIT Company	Sino Polymer, China	1440	5.25-6.53
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Orson Chemicals	Swancor Ind M Sdn Bhd, Malaysia/Taiwan	1050	2.3-2.87
Egypt	Bisphenol-a Type Epoxy Vinyl Ester Resin	Future Pipe Industries	Eternal Materials Co Ltd, Taiwan	600	2.46-3.06
India	Novolac Vinyl Ester Resin	Chemical Process Equipments Pvt Ltd	Ineos Composites, Spain	470	5.17-6.43
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Sunrise Industries India Ltd	Jinling AOC Resins Co Ltd, China/Thailand	370	3.17-3.94
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Carborundum Universal Limited	Swancor Ind M Sdn Bhd, Malaysia/Taiwan/China	290	2.01-2.5
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Nagase India Private Limited	Showa Highpolymer Singapore Pte Ltd, Japan	240	2.71-3.37
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Epp Composites Pvt Ltd	Eternal Materials Co Ltd, Taiwan	48	2.86-3.56
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Vibrant Specialties	Synthomer Trading Limited, France	40	1.99-2.48
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Rex Resins	Eternal Materials Co Ltd, Taiwan	35	1.89-2.35
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Dakle Industrial Plastics	M S Swancor Highpolymer Co Ltd, Taiwan	32	2.08-2.59
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Apex Printing Sleeves India Private Limited	M S AOC LLC, United States of America, Poland	30	6.38-7.94

India	Bisphenol-a Type Epoxy Vinyl Ester Resin	BASF India Limited	BASF Construction Chemicals UAE LLC, United Arab Emirates	25	10.13-12.61
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	JRD Polymer Pvt Ltd	Aliancys Ag, France	16	3.48-4.33
Pakistan	Bisphenol-a Type Epoxy Vinyl Ester Resin	Bin Tariq (Pvt) Limited	Changzhou Pro-tech Trade Co.,Ltd., China	14	2.13-2.65
Pakistan	Bisphenol-a Type Epoxy Vinyl Ester Resin	Fiber Craft Inds.	Saudi Industrial Resins Limited, Saudi Arabia	12	2.88-3.58
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Devi Polymers Private Ltd	Eternal Materials Co Ltd, Taiwan	10	2.1-2.61
Sri Lanka	Bisphenol-a Type Epoxy Vinyl Ester Resin	B A F F Polymech Pvt Ltd	Scott Bader Middle East Ltd, United Arab Emirates	8	4.05-5.04
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Hindustan Zinc Limited	China Nonferrous Metal Industrys Foreign Engineeri, China	5	6.4-7.96
India	Novolac Vinyl Ester Resin	Mahindra Cie Automotive Limited	M S Swancor Highpolymer Co Ltd, Taiwan	3	2.5-3.11
India	Novolac Vinyl Ester Resin	Mahindra Cie Automotive Limited	M S Swancor Highpolymer Co Ltd, Taiwan	3	2.5-3.11
Sri Lanka	Bisphenol-a Type Epoxy Vinyl Ester Resin	Edgeng Pvt Ltd	Wee Tee Tong Chemicals Pte Ltd, Singapore	3	2.32-2.89
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Emerald Performance Chemical Private Limited	Eternal Materials Co Ltd, Taiwan	2	1.84-2.28
India	Bisphenol-a Type Epoxy Vinyl Ester Resin	Kalinga Inceptum Private Limited	Eternal Materials Co Ltd, Taiwan	2	2.65-3.29

Source: TechSci Research

3.15. Global Foreign Trade Analysis

Global Vinyl Ester Resin Trade Dynamics – Import (000' Tonnes), 2015-2020

Country	2015		2016		2017		2018		2019		2020	
Import	Value	Volume										
United States	25.63	12.83	32.61	15.03	30.15	15.03	42.94	17.95	28.04	14.81	26.91	16.82
China	5.12	2.73	35.81	17.05	50.05	24.06	38.05	19.92	35.91	19.92	20.05	11.71
Brazil	6.42	3.15	13.55	6.1	12.88	6.7	15.03	7.25	14.91	7.30	12.91	6.95
India	5.16	2.44	8.12	4.05	11.21	5.91	6.22	3.05	8.94	4.15	9.15	6.70
Mexico	3.05	1.52	6.42	3.21	8.25	4.20	6.21	3.05	7.25	3.77	9.21	5.62
Turkey	2.15	1.05	4.15	2.82	6.43	3.25	5.62	2.85	6.21	3.05	5.10	3.92
South Africa	5.12	2.50	5.12	2.73	4.21	2.12	5.21	2.62	5.53	2.91	4.73	2.84
Russia	2.44	1.73	4.41	2.73	3.21	1.56	4.15	1.82	5.25	2.81	5.12	2.82
Indonesia	5.81	3.05	3.12	1.55	3.04	1.22	2.63	1.73	5.05	2.54	3.57	2.05
Vietnam	10.25	5.4	2.84	1.50	1.26	0.63	3.05	1.44	1.83	1.00	2.44	1.44
Others	109.66	89.57	109.68	65.33	70.75	52.99	91.44	52.99	125.89	59.12	151.36	45.10
Total	180.91	125.99	225.83	122.12	201.44	117.69	220.55	114.67	244.81	121.38	250.55	105.97

Others Argentina, Iran, Qatar etc.

Source: TechSci Research

Global Vinyl Ester Resin Trade Dynamics – Export (000' Tonnes), 2015-2020

Country Export	2015		2016		2017		2018		2019		2020	
	Value	Volume										
South Korea	22.73	11.04	15.09	8.41	15.38	9.18	15.59	9.20	11.04	6.33	11.82	6.53
Germany	26.13	12.02	28.10	12.16	23.63	15.66	35.37	13.65	41.97	16.11	37.58	15.48
Spain	19.32	9.20	16.55	9.30	19.75	12.88	24.57	10.53	25.69	14.45	25.65	14.70
China	17.74	7.68	22.24	7.77	23.84	10.54	21.06	7.61	28.95	12.27	25.91	10.14
Japan	13.54	6.39	12.12	6.46	11.94	8.25	13.61	6.35	13.68	7.95	13.19	7.12
Netherlands	6.12	2.36	5.16	2.39	5.68	3.28	6.70	2.73	6.85	3.50	6.58	3.64
USA	4.42	2.16	3.52	2.18	4.14	2.84	5.84	2.62	5.61	3.37	5.00	3.25
Poland	6.73	3.00	5.20	3.03	5.92	4.06	6.57	2.77	5.43	2.87	4.92	2.71
Saudi Arabia	5.39	2.37	6.56	2.40	9.23	3.30	8.54	3.03	9.63	3.34	6.36	2.53
Taiwan	3.87	1.95	4.72	1.97	5.59	2.65	6.15	2.37	6.74	2.65	6.70	2.38
Others	117.15	67.82	121.74	66.06	111.80	45.05	90.85	53.81	71.07	48.54	69.80	37.49
Total	243.15	125.99	241.01	122.12	236.89	117.69	234.86	114.67	226.64	121.38	213.51	105.97

Others Finland, Turkey, Russia etc

Source: TechSci Research

3.16. Suggested Capacities

Global Scenario: The current global capacity of Vinyl Ester Resin is 985 thousand tonnes. Top five producers account for 54 percent of the total capacity. Regional analysis indicates surplus in Northeast Asia, and deficit in Indian Sub-continent, Europe, South America, Middle East, and South America, resulting in heavy trade within the region as well as international trade. Overall Europe, Middle East & Africa and South America will remain a deficit area throughout the study period.

Indian Scenario: Present capacity in the country is 4.84 thousand tonnes and production are totally project based. These companies produce all the major grades conforming with global standards. It is expected that, based on individual end-use sector growth, consumption of vinyl ester resin will register an overall growth of about 11.70 percent per annum average growth over the next ten years' period.

India is expected to remain a deficit area and likely to increase from present level of 7.16 thousand tonnes per annum to 24.74 thousand tonnes per annum by 2030.

Considering demand – supply situation and export market, enough scope exists in the country for a 30 thousand tonnes per annum vinyl ester resin unit by 2023. Moreover, there is latent demand of the product due to anticipated growth in telecom, chemicals & petrochemicals, and renewable sector.

Recommendations

- RIL may consider setting-up a 30 thousand tonnes vinyl ester resin unit as enough scope exists from demand – supply point of view. However, before taking up this decision, should also consider the project from economic viability point of view.

- Considering capacity utilization of 60 percent in first year and 90 percent in second year onwards, entire quantity is likely to be absorbed within the country itself by 2030.
- Although as per demand – supply position, substantial gap in international markets is expected, exploring export is also advisable from realization angle.
- Reliance Industries Ltd should also have 100 percent captive epoxy resin unit for better margin and assured supply of critical raw materials.

Name of the Product (KTPA)	2023	2027	Total
Unsaturated Polyester Resin	25	25	50
Vinyl Ester Resin	15	15	30

4.1. Setup Related Details

4.1.1. Target End-Use Applications

S. No	Grade	Target Applications	Specifications		
			Viscosity 25° C (cps)	Gel Time (min)	Monomer Content (%)
1	Bisphenol-A Epoxy Resin	Provide Resistance to acid, alkalis, solvents, excellent toughness, and fatigue resistance	180-800	20-32	33-45
2	Low styrene Monomer Bisphenol-A Resin	Chemical reaction vessels	NA	NA	NA
3	Novolac Based Epoxy Resin	Excellent thermal, and chemical resistance, resistance to solvents, acids	300-400	20-25	36-40
4	Brominated Epoxy Resin	High degree of fire retardance, resistance to chemical, tougher and fatigue resistant	200-500	20-35	34-39
5	Brominated Novolac Epoxy Vinyl Resin	Moderate degree of retardance, application in hot, wet flue gas environment	300-450	20-35	36-40
6	Elastomer-modified Bisphenol-A Epoxy Vinyl Resin	High impact and fatigue resistance, chemically resistant FRP linings, composites, adhesives, electrical castings, electrical laminates, and fibres	40-8000	NA	NA
7	Urethane Modified Vinyl Ester Resin	Heat, Corrosion and Chemical resistant, application in marine, pultrusion, carbon fibre	NA	NA	NA
8	Amine Accelerated Vinyl Ester Resins	Composites	300-500	10-15	34-41
9	Bisphenol A Vinyl ester/ DCPD blend	Hydrolysis resistance, Marine	NA	27-33	60-64

* Gel Time refers to the time taken by the resin (VER) to transform from liquid to highly viscous gel state in which the resin is no longer workable.

Source: TechSci Research

4.1.2. Plant Process Description

Manufacturing Process

Vinyl Ester Resin (VER) has been manufactured in a batch reactor, traditionally. Initially, the reactor needs to be charged with a mixture of Epoxy resin, Bisphenol-A and should be heated for 4-5 hours at temperature of 160-170°C. Then, decrease the reactor temperature to 100-120°C and add Methacrylic acid to advance the esterification process. Esterification takes place along the epoxy chain between carboxyl and epoxy group and likewise between carboxyl and hydroxyl

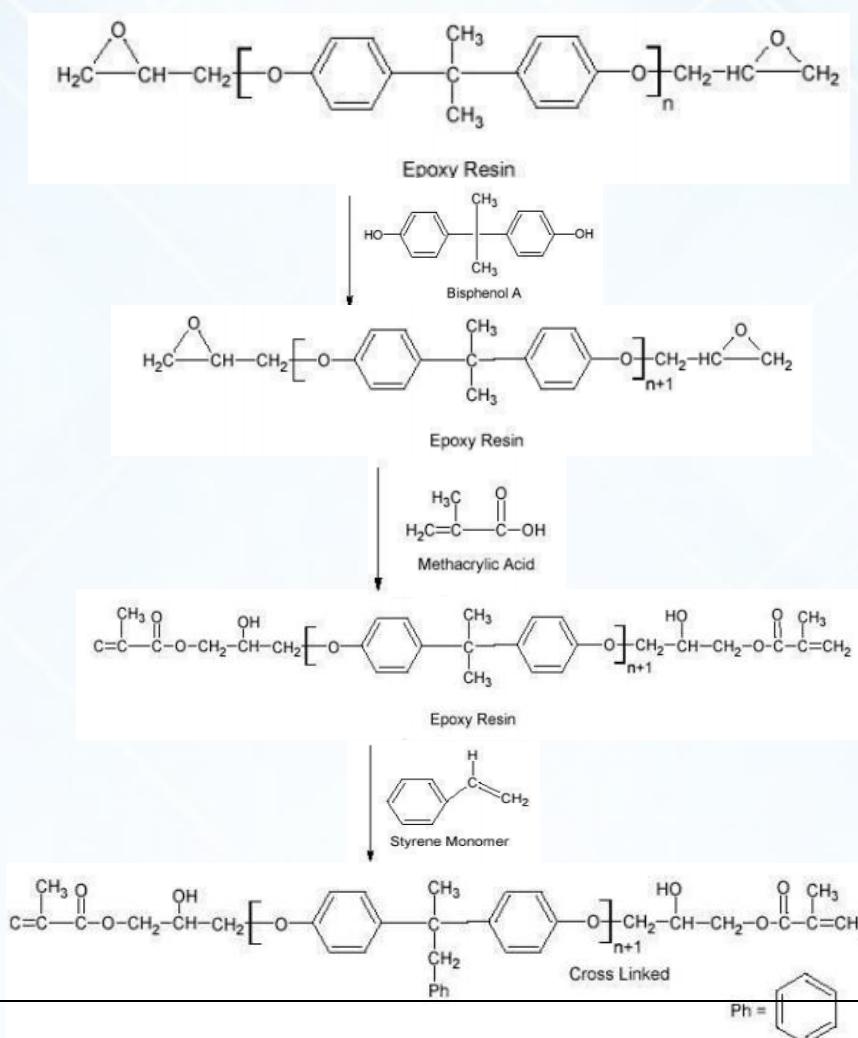
group. As the temperature declines to 100° C, additives like Maleic Anhydride and Tri-Ethyl Amine needs to be added as a base catalyst and the mixture is heated for another 4-6 hours.

After that, Epoxy Resin needs to be withdrawn from the batch reactor and fed to the blender containing Styrene Monomer which is a volatile organic solvent. During polymerization, styrene reacts with vinyl esters to form cross linking at unsaturation points. This cross linking make the resin polymerizable and improves resin processability. In addition to this, Styrene Monomer also acts as a diluent to reduce viscosity and improve curing degree leading to excellent mechanical and thermal properties of composite epoxy solution. Further, Blender temperature should be maintained around 70° C. Finally, Water is circulated around blender jacket to gradually cool and reduce the heat to room temperature. Generally, it takes 12-14 hours to process Vinyl Ester Resin. It's a very critical and temperature sensitive reaction and should be undertaken with utmost caution as a small error can gel the batch immediately.

As all the raw materials used will be consumed in the process itself, hence there will not be any generation of by-product, Effluent, Gaseous waste, solid waste.

Finally, the finished product is withdrawn from blender and packed in drums.

Reaction Involved

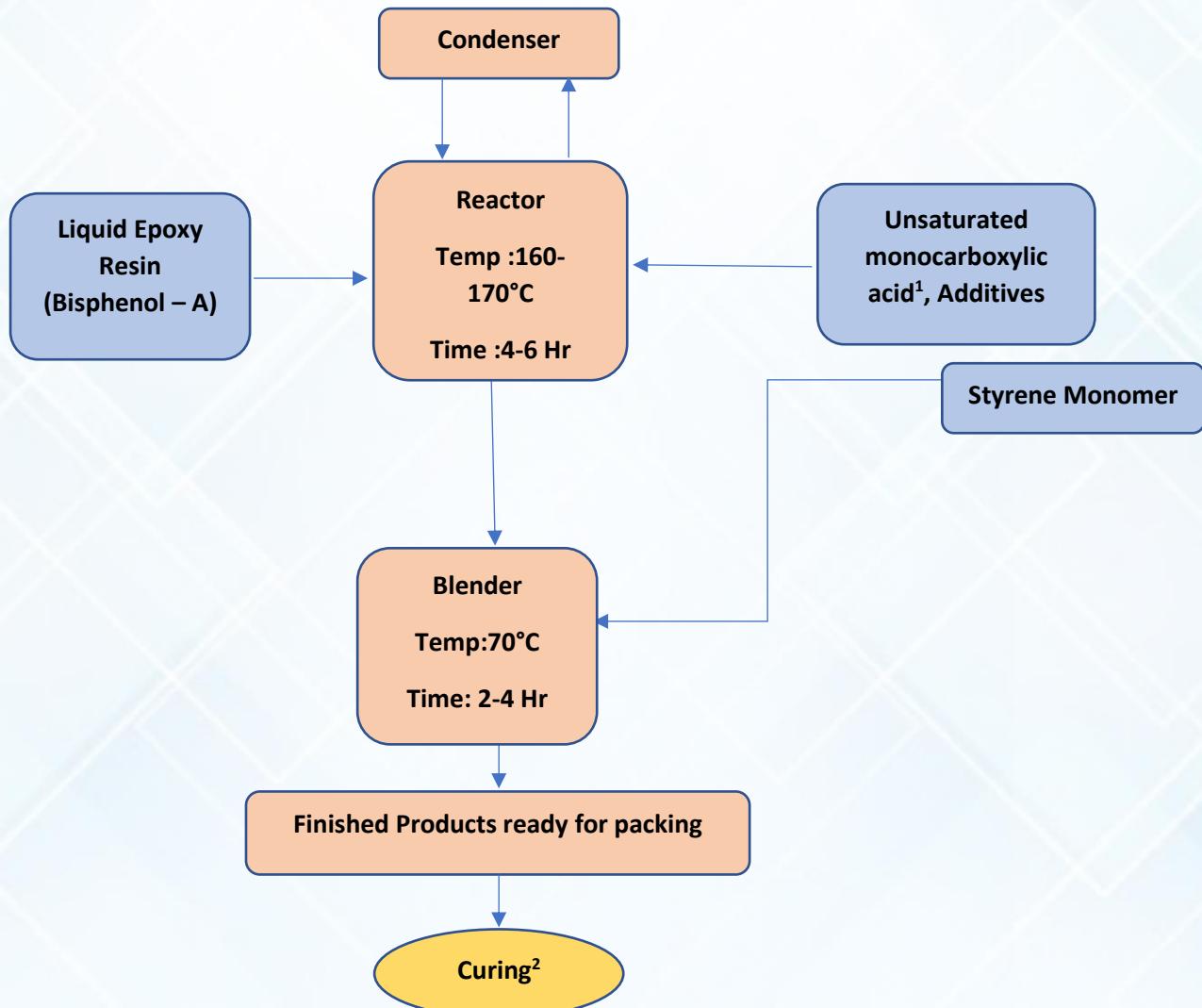


Key Challenges

One of disadvantages of vinyl ester resin manufacturing process is use of styrene, which is a toxic volatile organic compound. A special care is taken while using styrene monomer during the vinyl ester resin manufacturing process so that it is not exposed to outside environment. Exposure to styrene can cause skin irritation, rash, dryness. It can also irritate eye, nose, and throat. Additionally, prolong exposure can hamper concentration, memory and may affect brain and liver functions. According to Environmental protection Agency (EPA), It is listed under hazardous air pollutant and may be a potential carcinogenic substance as it has been found to cause lung cancer in animals. Studies have been conducted to find substitute of styrene such as vinyl derivatives of benzene and methyl acrylates. Further, efforts have been made to find novel monomers by using renewable feedstocks such as lignin, fatty acids, and carbohydrates.

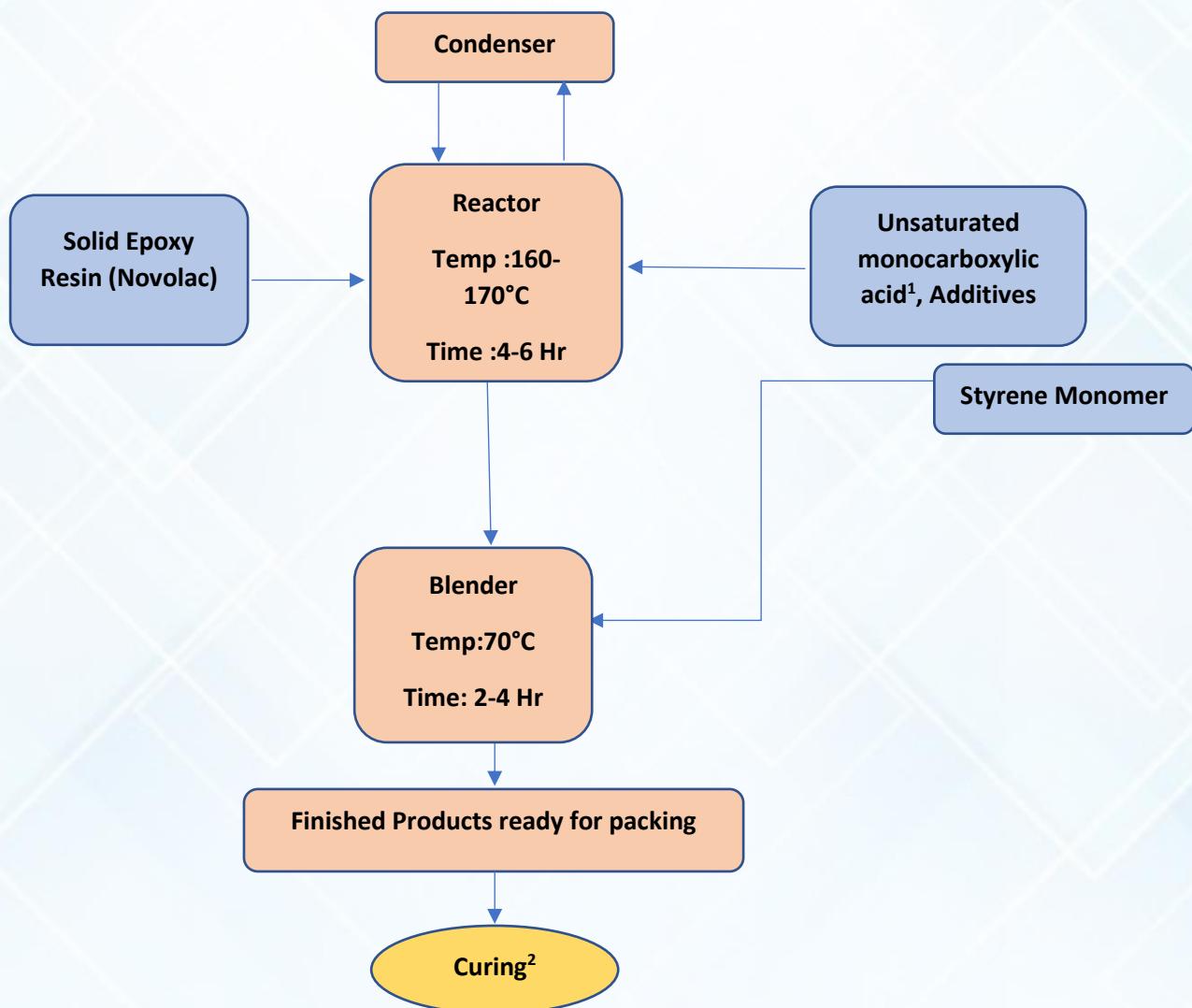
4.1.3. Process Flow Diagram

Vinyl Ester Resin Manufacturing Process Based on Liquid Epoxy Resin (Bisphenol – A)



Source: TechSci Research

Vinyl Ester Resin Manufacturing Process Based on Solid Epoxy Resin (Novolac)

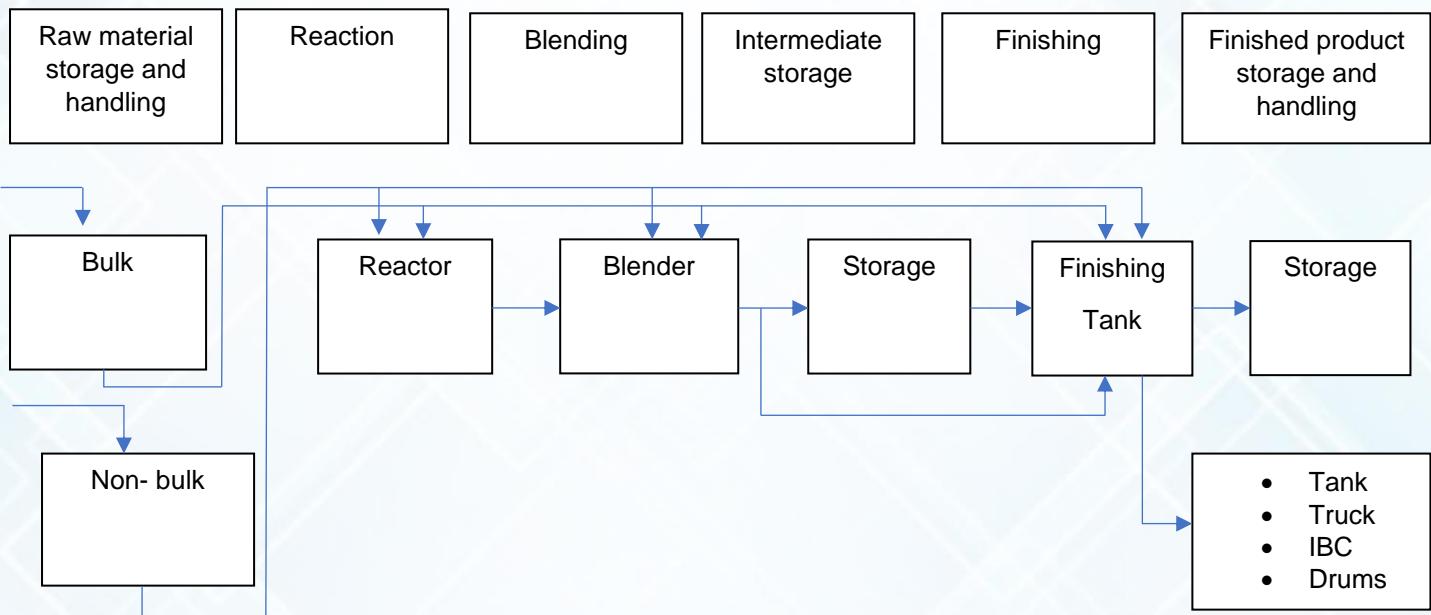


Source: TechSci Research

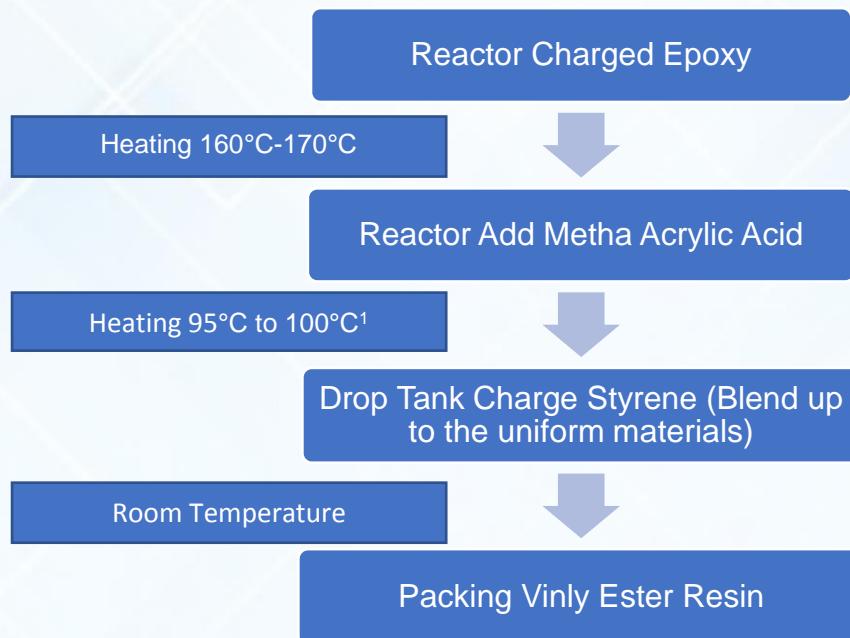
¹ Unsaturated monocarboxylic acid include acrylic acid, methacrylic acid, crotonic acid, monoesters of unsaturated polycarboxylic acids, and monoesters of maleic acid. The unsaturated acids and monoesters may be used singly or as a mixture of two or more of them. The unsaturated monocarboxylic acids can be derived from renewable sources like lignin or soyabean oil therefore, the name bio-based vinyl ester resin is used.

² Curing of vinyl ester resin is done by the end user industries according to the application in which it is used. Curing defines the gelation time of vinyl ester resin. Curing is a process that is employed to change the viscosities of the epoxy resin according to the customer's requirement. This process is completely optional and varies from manufacturer to manufacturer depending on the grade of VER to be manufactured.

Process Flow Diagram



Source: TechSci Research



Source: TechSci Research

1. The temperature is gradually decreased from a range of 160°C-170°C to 95°C-100°C.

Standard Process

One mole of bisphenol A was catalytically reacted with two moles of diglycidylether of bisphenol A at 150° C for two hours under atmospheric conditions. This yielded a polyepoxide resin having an epoxide equivalent weight of 500 (g/eq) which was subsequently cooled to 130° C. Next, two moles of methacrylic acid and 180 ppm of hydroquinone (based on finished product) were added under an air sparge and esterified at 120° C until an acid value less than 10 units was recorded. The vinyl ester resin was then cooled to 110° C and 0.05 moles of maleic anhydride were added. The vinyl ester resin was allowed to continue esterifying for 15 minutes at these conditions before thinning with styrene monomer to 65% non-volatiles and cooling to room temperature. This product is the control.

Specialised Process (Low Epoxy Value)

This vinyl ester resin was prepared the same way as standard process, except that 2.26 moles of methacrylic acid were used and the vinyl ester resin was esterified to an epoxy value (epoxy value EW is the reciprocal of the epoxy number and thus describes the number of epoxy groups that are contained in 100 g of resin) less than two units before cooling to 110° C and adding maleic anhydride. This product was thinned in styrene monomer to 65% non-volatiles and cooled to room temperature.

Low Styrene Emission Vinyl Ester Resin

The production of low styrene emission vinyl ester resin includes paraffin as a styrene emission inhibitor and a drying oil as an adhesion promoter for fibre-reinforced applications. It has been found that due to paraffin wax additives there is a substantial loss in the adhesive properties of the vinyl ester resin therefore adhesion promoter in the form of a drying oil is added.

India Scenario of Vinyl Ester Process

The standard process is majorly used in the country as the demand of the product is project based in which only blending is done in the reactor which involves no technology licensor. Indian Companies manufactures vinyl ester of INEOS's quality like Derakane™. The specialized process is mainly used by western companies as they produce low epoxy and styrene free vinyl ester resin.

4.1.4. Major Equipment List (List of major equipment in terms of value & importance)

S No	Equipment	Tag No
1	Hopper	H-101 &102
2	Crusher	T-101
3	Condenser	S-101
4	Vacuum Pump	VP-101
5	Batch Reactor	R-101
6	Epoxy Storage Tank	V-101
7	Epoxy Transfer Pump	P-101
8	Styrene Storage Tank	V-102
9	Styrene Transfer pump	P-102
10	Methyl Methacrylic storage tank	V-103
11	Methyl Methacrylic Transfer Pump	P-103
12	Jacketed Blender	B-101
13	Packaging Equipment	PA-101

4.1.5. Technology Licenser

- Vinyl ester resins are downstream product of Epoxy Resin. Mostly manufacturing companies have their in-house technology and R&D facilities to make formulations.
- Major reactions are carried out with the help of batch reactor and blender which can be outsourced. For 30KTPA, 15 different size reactors of 1 to 20 tons to produce 45 tons per batch.
- Generally, manufacturing process involves mixing of feedstock material in batch reactor and blending with organic solvent such as styrene monomer.
- There is no technology licenser for the product. Indian manufacturing company Atul limited has vertically integrated Epoxy resin capacity and downstream integrated Vinyl Ester Resin capacity while other Indian players such as Innovative Resins, Satyen Polymers, Mechenco Resins among others have in-house batch reactor set up. However, they import feedstocks Epoxy resin, Bisphenol-A, and other additives from the domestic or international market.

4.1.6. Utilities Overview (For a 30 KTPA plant)

Energy/power Requirements

- Total connected load is 1000 KW which is sufficient to carry out proposed vinyl ester resin manufacturing activity.

Fuel

- LDO will be used as fuel in Thermic Oil Heater with quantity 352 Lit./Hr. Electricity will be used in reactors.
- Diesel will be used to run the D.G. set, if needed.

Water Requirement

- Total water requirement will be 5 KL/day for the vinyl ester resin plant which will be used in cooling. There is no use of any water in vinyl ester resin manufacturing process.

Sr. No.	Usage	Water consumption (KL/Day)	Wastewater generation (KL/day)
1.	Processing	0	30
2.	Cooling	5	0
	Total	5	30

Source: TechSci Research and EC Report of Innovative Resins Pvt. Ltd.

4.1.7. Waste Generation, Management, and Disposal

Hazardous Waste Management

The proposed plant will generate the following hazardous wastes

Sr. No.	Name of the Waste	Source	Mode of Disposal
1	ETP Sludge/Evaporation Residue	ETP/ Evaporator	TSDF Site
2	Used Oil	Lubrication/ D.G.set	Reuse as Lubricant within premises.
3	Discarded drums/bags	Stores	Sold To Recycler

Source: TechSci Research

ETP (Effluent Treatment Plant) sludge serves as the main source of hazardous waste generation from proposed activity. The other sources of hazardous waste generation from proposed activity includes spent or used oil generation from plant machinery and discarded barrel or containers from handling and storage of raw materials.

A dedicated storage area will be provided in the unit for the hazardous storage within premises having waterproof floor and roof cover.

4.1.8 Raw Material Required and Key Suppliers in India Market

S. No	Raw Material	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5
1.	Epoxy Resin	Grasim Industries Ltd	Atul Ltd.	Covestro AG	Huntsman Corporation	Hexion Inc.
2.	Bisphenol-A	Atul Ltd.	Dow Chemical	LG Chem	Mitsubishi Chemical	Mitsui Chemicals
3.	Methacrylic Acid	Evonik Industries	Dow Chemicals	Formosa Plastics	Kusumoto Chemicals Ltd	Celanese
4.	Styrene Monomer	SABIC	INEOS Group Ltd	Hanwha Group	Royal Dutch Shell plc	Chevron Phillips Chemical
5.	Tri-Ethyl Amine	Balaji Amines Ltd	Alkyl Amine Ltd	BASF SE	Eastman Corporation	Dow Chemicals

5. Economic Evaluation

5.1 Estimated Investment: For the suggested capacity of 30 KTPA, overall investment is USD 10.8 million. The exchange rate is considered USD 1 = INR 73.30. Considering current volatility in commodity cycles and exchange rate, capital expenditure for the project may increase by 10-12 percent if project is implemented by near future.

5.2 Fixed Cost & Variable Cost Analysis:

In particular, the total capital investment was based on the percentage of the delivered equipment cost method for a processing plant.

	ITEM	[USD Million]
A	TOTAL FIXED-CAPITAL INVESTMENT	10.56
	TOTAL DIRECT PLANT COST	7.69
	TOTAL INDIRECT PLANT COST	2.86
B	WORKING CAPITAL	0.22
	TOTAL CAPITAL INVESTMENT	10.78

5.3. Machinery & Equipment Cost Analysis:

The total cost of the equipment is approximately USD 2.73 Million including the auxiliary equipment. Being exothermic reaction process, product is process parameter sensitive (consistency need to be maintained), hence considering the reactor and Blender as a complex part of the Production, therefore are considered as auxiliary equipment. construction material is SS 304. The client is preferred to consider whole plant both manually & automated. The equipment cost might vary for different manufacturers depending on the complexity and the material of construction. Construction and Installation of large size equipment (volume more than 100 m³) like LER Storage Tanks, Styrene is done on-site as the transportation of such equipment is not feasible.

	MAIN PROCESS EQUIPMENTS	CAPACITY	UNITS	Unit Rate [USD million]	Category
1	Hopper	m^3	2	0.027	Indigenous
2	Crusher	kg/hr	4	0.355	Indigenous
3	Condenser	m^2	1	0.044	Indigenous
4	Vacuum Pump	m^3/h	2	0.082	Indigenous
5	Batch Reactor	m^3	2	0.266	Auxiliary
6	Epoxy Storage Tank	m^3	2	0.195	Indigenous
7	Epoxy Transfer Pump	m^3/h	4	0.041	Indigenous
8	Styrene Storage Tank	m^3	2	0.222	Indigenous
9	Styrene Transfer pump	m^3/h	4	0.053	Indigenous
10	Methyl Methacrylic storage tank	m^3	2	0.177	Indigenous
12	Methyl Methacrylic Transfer Pump	m^3/h	4	0.044	Indigenous
13	Jacketed Blender	m^2	2	0.355	Auxiliary
14	Feed Pump	m^3/h	6	0.115	Indigenous
15	Dust Collector	m^3/h	3	0.071	Indigenous
16	Product Tank	m^3	3	0.532	Indigenous
17	Packaging Equipment	KG/bag	3	0.150	Indigenous
TOTAL MAIN EQUIPMENT COST				2.73	

5.4. Annual Cost of Production

Raw Material Cost is considered as the base case, the annual cost of raw materials reached a value of USD 61.7 Million per year for 30 thousand tonnes per annum plant capacity. Major raw materials considered are Epoxy Resin, Bisphenol A, Styrene, Methacrylic Acid with stoichiometry ratio of 0.3, 0.14, 0.45 & 0.11 respectively.

	ITEM	[USD Million]	
C	Manufacturing Cost	63.33	
C1	Raw materials	61.71	
C2	Labour	0.57	
C3	Variable Overheads including Utilities	1.05	
D	Fixed Overheads	1.45	
D1	Maintenance and repairs	0.53	Fixed
D2	Operating supplies	0.08	Fixed
D3	Laboratory charge	0.07	Fixed
D4	Plant Overhead Cost	0.66	Fixed
D5	Administrative Cost	0.11	Fixed
E	Selling Overheads	8.42	
	Total Production Cost (C+D+E)	73.20	

* The Overall Cost accuracy is ± 25-30%.

5.5. Payback Period:

PROFITABILITY PARAMETER	
	Value (USD Million)
NPV @ 10%	31.40
Internal Rate Of Return (%) On Total Capital - Before Taxes	50.02%
Payback Period, Years	2.36
Simple	2.51%
Discounted @ 12%	3.46%

5.6. Project Sensitivity Analysis:

NPV in USD Million					
	BASE CASE	90.00%	95.00%	105.00%	110.00%
CAPITAL COST					
IRR%	50.02%	54.25%	52.04%	48.16%	46.44%
NPV	31.4	32.02	31.7	31.1	30.79
REVENUE					
IRR%	50.02%	27.48%	39.23%	60.22%	70.04%
NPV	31.4	10.6	21	41.8	52.2
RAW MATERIALS COST					
IRR%	50.02%	63.99%	57.09%	42.71%	35.09%
NPV	31.4	45.8	38.6	24.2	17.1

- 1 IRR is highly attractive
- 2 Project is moderately sensitive to variations in Investment and highly sensitive to Selling Price as also the Feedstock prices. Relative sensitivity, in decreasing order is:
 - a. Selling Price (i.e., Revenue)
 - b. Feedstock Prices (i.e., Raw Material Costs)
 - c. Investment (i.e., Capital Cost)

5.7 Project Schedule

	Phase 1				Phase 2					
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Operating Rate	30%	40%	45%	50%	55%	60%	65%	70%	70%	70%
Operating Revenue (USD Million)	26	35	40	45	51	56	62	68	69	70
Quantity Produced (Thousand Tonnes)	9	12	14	15	17	18	20	21	21	21

The demand of vinyl ester resin is totally project based therefore the operating rate has been taken as per industrial norms. Due to its diverse application in specialised products, the demand is anticipated to further increase therefore, the plant can operate at a maximum of 70%. As per the Industry practice, in the same reactor other UPR can also be produced, therefore it cannot operate at an optimum capacity i.e., between 85% to 95%. The same applies for Reliance Industries Ltd.