STUDY OF ACRYLIC ACID AND ACRYLATES – INDIAN SCENARIO YEAR-2022

Asst. Prof. Padma Patil/ Mr. Shivaji Patil

Assistant Professor /B. Tech. in Chemical Engineering MBA International Business Management

Dnyan Ganga Education Trust's Degree College of Arts, Commerce & Science /Atlas Chem AG - Business Manager -India

Abstract

ACRYLIC ACID AND ACRYLATES INDIAN SCENARIO

Acrylic acid is an important organic synthesis raw material and synthetic resin monomer, and it is a vinyl monomer with a very fast polymerization rate. Acrylic acid is also known as: acrylic (ester) copolymer, acrylic acid CAS No.: 25035-69-2.

Acrylic acid is the simplest unsaturated carboxylic acid, consisting of a vinyl group and a carboxyl group. Pure acrylic acid is a colorless, clear liquid with a characteristic pungent odor. It is miscible with water, alcohol, ether and chloroform, and is prepared from propylene obtained from an oil refinery. Most of them are used to make acrylates such as methyl acrylate, ethyl acrylate, butyl acrylate and hydroxyethyl acrylate.

Waterborne acrylic anti-corrosion coatings are usually used in medium and light anti-corrosion fields, usually consisting of a combination of three coats of primer, middle coat and top coat to form a coating system and play a role. Primer is the basis of the entire coating to prevent the penetration of water, ions and oxygen. It has good adhesion and corrosion resistance. It can be used with water-based epoxy and acrylic primers, and it can also be used with solvent-based coatings to form a composite system.

Acrylic intermediate coating is mainly used to improve the adhesion to the topcoat and primer, to make the bonding between the two coating films closer, increase the thickness of the coating, and improve the shielding ability of the entire coating system; the topcoat has beautiful decoration and anti-permeation effect, usually a pigment-free varnish to improve the weather resistance of the entire coating.

Acrylates are a group of chemicals that are derived from acrylic acid and used in various industries, including adhesives, coatings, textiles, and plastics. In the Indian scenario, acrylates have gained significant importance and are widely used in several sectors. Here are some key points about the acrylates industry in India:

1. Market Growth: The acrylates market in India has experienced substantial growth in recent years. The demand for acrylates is driven by the expanding manufacturing sector, increasing population, and rising disposable income, which has led to higher consumption of consumer goods and industrial products.
2. Applications: Acrylates find applications in diverse industries. They are extensively used in the production of paints and coatings, adhesives and sealants, textiles, plastics, and construction materials. Acrylic-based products have gained popularity due to their durability, versatility, and aesthetic appeal.
3. Paints and Coatings: Acrylates are widely used in the paints and coatings industry in India. Acrylic emulsions, which are water-based coatings, are preferred for their excellent adhesion, weather resistance, and low VOC (volatile organic compound) content. Acrylic-based paints are commonly used for both interior and exterior applications.

4. Adhesives and Sealants: The adhesives and sealants industry in India extensively utilizes acrylates. Acrylic adhesives offer fast bonding, high strength, and good resistance to heat and chemicals. They find applications in industries such as automotive, construction, packaging, and woodworking.
5. Textiles: Acrylic fibers are commonly used in the textile industry for manufacturing fabrics, garments, upholstery, and carpets. Acrylic fibers are lightweight, soft, and possess excellent drape and color retention properties. They are often used as a substitute for wool due to their cost-effectiveness.
6. Plastics: Acrylates are used in the production of various plastic materials. Acrylic plastics, such as polymethyl methacrylate (PMMA), are widely used in signage, displays, automotive parts, lighting fixtures, and household products. Acrylic sheets are also extensively used in architectural applications.
7. Production and Key Players: Acrylates are manufactured in India by both domestic and multinational companies. Some of the major producers include Asian Paints, BASF India, Clariant Chemicals, Arkema, and LG Chem. These companies have manufacturing facilities and distribution networks to cater to the growing demand in the Indian market.
8. Environmental Concerns: While acrylates offer several benefits, it is important to address environmental concerns associated with their production and usage. Efforts are being made to develop more sustainable alternatives and promote responsible manufacturing practices to reduce the impact on the environment.

Overall, the acrylates industry in India is witnessing steady growth due to the increasing demand from various sectors. The versatility and wide range of applications of acrylates make them an important component in several industries, contributing to the country's economic development.

In the Indian scenario, acrylates play a significant role in various industries such as adhesives, coatings, textiles, and construction. Acrylates are a group of chemicals derived from acrylic acid, and they are known for their excellent adhesive and bonding properties.

One of the major applications of acrylates in India is in the adhesives industry. Acrylic-based adhesives are widely used in sectors like automotive, packaging, and textiles. They offer strong bonding capabilities and are resistant to heat, chemicals, and UV radiation. Acrylic-based adhesives are used for bonding metal, glass, plastic, and other materials in manufacturing processes.

In the coatings industry, acrylates find applications in the production of water-based paints, varnishes, and lacquers. Water-based acrylic coatings have gained popularity due to their low volatile organic compound (VOC) content, environmental friendliness, and ease of application. These coatings are used in residential and commercial buildings, automotive refinishing, and industrial equipment.

Acrylates are also utilized in the textile industry for manufacturing synthetic fibers and non-woven fabrics. Acrylic fibers are known for their softness, warmth, and durability. They are used in the production of clothing, upholstery, carpets, and blankets.

In the construction sector, acrylates are used for producing sealants and caulks. Acrylic sealants are commonly used for filling gaps, cracks, and joints in buildings. They provide excellent adhesion to a variety of surfaces and offer resistance to weathering and aging.

The demand for acrylates in India has been growing steadily due to the rapid expansion of industries, urbanization, and infrastructure development. The country's strong manufacturing base, coupled with increasing consumer demand, has created a favourable market for Acrylates-based products.

However, it's important to note that the production and use of acrylates also come with environmental and health concerns. Proper handling, storage, and disposal practices are crucial to minimize any potential negative impacts. Regulatory bodies in India, such as the Central Pollution Control Board (CPCB) and the Ministry of Environment, Forest and Climate Change (MoEFCC), have implemented guidelines and regulations to ensure the safe use of acrylates and other chemicals.

Overall, acrylates play a vital role in several industries in India, contributing to economic growth and providing innovative solutions in areas such as adhesives, coatings, textiles, and construction.

Acrylates are a group of chemicals that are derived from acrylic acid or methacrylic acid. They are widely used in various industries, including paints and coatings, adhesives, textiles, and plastics. In the Indian scenario, the acrylates industry has experienced significant growth in recent years, driven by the country's expanding economy and increasing industrial activities.

One of the major applications of acrylates in India is in the paint and coatings industry. With the booming construction sector and rising demand for decorative and industrial paints, the consumption of acrylates in this sector has been growing steadily. Acrylates are used as binders, thickeners, and film-forming agents in paint formulations, providing improved durability, adhesion, and weather resistance.

The adhesives industry is another significant consumer of acrylates in India. Acrylic-based adhesives offer excellent bonding properties and are widely used in sectors such as packaging, automotive, construction, and textiles. The growing manufacturing sector and increasing demand for packaging materials have propelled the demand for acrylates-based adhesives in the country.

Textiles is another important sector where acrylates find applications in India. Acrylic fibers, which are made

INTRODUCTION

Acrylic acid is a versatile organic compound that is widely used in various industries for its unique properties. It is a clear, colorless liquid with a strong, pungent odor. The chemical formula for acrylic acid is CH2=CHCOOH, and its IUPAC name is prop-2-enoic acid.

Acrylic acid is primarily produced through the catalytic oxidation of propylene, a petroleum-derived hydrocarbon. The process involves the reaction of propylene and air in the presence of a catalyst, typically a metal oxide such as molybdenum or cobalt. This oxidation reaction results in the formation of acrylic acid.

One of the significant characteristics of acrylic acid is its ability to undergo polymerization, forming polyacrylic acid or its salts, known as acrylic polymers or acrylic resins. These polymers exhibit a wide range of properties depending on their molecular weight and composition. They can be water-soluble or water-insoluble, and they have applications in various industries such as adhesives, coatings, textiles, and superabsorbent materials.

The most common application of acrylic acid is in the production of superabsorbent polymers (SAPs), which are widely used in the manufacturing of diapers, adult incontinence products, and feminine hygiene products. SAPs can absorb and retain large amounts of liquid, making them ideal for these applications.

Acrylic acid is also used in the production of coatings and adhesives. Acrylic-based coatings offer excellent weather resistance, durability, and adhesion properties, making them suitable for a wide range of applications, including automotive coatings, architectural coatings, and industrial coatings.

In addition to its use in polymers, acrylic acid can also be esterified to produce acrylic esters such as methyl acrylate, ethyl acrylate, and butyl acrylate. These esters are used as monomers in the production of various polymers, including acrylic paints, textiles, and plastics.

However, it is worth noting that acrylic acid and its vapors can be hazardous and irritating to the skin, eyes, and respiratory system. Proper safety measures and personal protective equipment should be used when handling acrylic acid to minimize the risk of exposure.

Overall, acrylic acid plays a crucial role in many industries due to its ability to form polymers with unique properties. Its versatility and wide range of applications make it an essential compound in the manufacturing of various consumer and industrial products.

Physical properties of Acrylic Acid

Acrylic acid is a clear, colorless liquid with a pungent odor. Here are some key physical properties of acrylic acid:

1. Molecular Formula: CH2=CHCOOH
2. Molecular Weight: 72.06 g/mol
3. Density: The density of acrylic acid is around 1.051 g/cm³ at 20°C.
4. Melting Point: Acrylic acid has a relatively low melting point of around -13.2°C.
5. Boiling Point: The boiling point of acrylic acid is approximately 141°C.
6. Solubility: Acrylic acid is highly soluble in water, with a solubility of around 100 g/100 mL at 20°C. It is also miscible with many organic solvents such as ethanol and acetone.
7. Vapor Pressure: The vapor pressure of acrylic acid is relatively high. At 20°C, it has a vapor pressure of about 12 mmHg.
8. Viscosity: Acrylic acid has a relatively low viscosity, which increases with decreasing temperature. The viscosity at 20°C is approximately 1.9 CP (centipoise).
9. Odor: Acrylic acid has a strong, pungent odor that is often described as sharp or acrid.

It's important to note that acrylic acid can be a corrosive substance and should be handled with care. Proper safety precautions, such as using protective equipment and working in well-ventilated areas, should be followed when dealing with acrylic acid to avoid skin, eye, or respiratory irritation.

Chemical Properties of Acrylic Acid

Acrylic acid exhibits various chemical properties that contribute to its reactivity and usefulness in different applications. Here are some key chemical properties of acrylic acid:

1. Polymerization: Acrylic acid readily undergoes polymerization reactions, forming polyacrylic acid or its salts (acrylic polymers). The polymerization can be initiated through various methods, such as heat, light, or chemical initiators. This property allows acrylic acid to be used in the production of a wide range of acrylic-based polymers and resins with different properties.
2. Acidic Nature: Acrylic acid is a carboxylic acid, containing a carboxyl group (-COOH). It exhibits typical acidic behavior, meaning it can donate a proton (H+) in aqueous solutions, resulting in the formation of acrylic acid ions (acrylate ions).
3. Reactivity with Bases: Acrylic acid reacts with bases, such as alkalis and metal hydroxides, to form acrylic acid salts or acrylates. For example, reacting acrylic acid with sodium hydroxide (NaOH) produces sodium acrylate.
4. Esterification: Acrylic acid can undergo esterification reactions with alcohols, resulting in the formation of acrylic esters. This reaction is often carried out in the presence of an acid catalyst. Acrylic esters, such as methyl acrylate, ethyl acrylate, and butyl acrylate, have their own unique properties and are widely used in the production of various polymers, coatings, and adhesives.
5. Addition Reactions: Acrylic acid can undergo addition reactions, particularly with compounds containing double bonds or other reactive functional groups. These reactions can lead to the formation of new chemical bonds and the modification of acrylic acid's structure and properties.
6. Oxidation: Acrylic acid is susceptible to oxidation reactions, which can occur under certain conditions, such as exposure to air or oxidizing agents. These reactions can result in the formation of by products or degradation of acrylic acid if not controlled or prevented.
7. Polymer Crosslinking: Acrylic acid-containing polymers can undergo crosslinking reactions, either through chemical or physical means. Crosslinking enhances the mechanical strength, stability, and durability of acrylic-based materials.

It's important to note that the reactivity and behaviour of acrylic acid can vary depending on the specific reaction conditions, including temperature, pressure, presence of catalysts, and other reactants. Safety precautions should be followed when handling acrylic acid due to its corrosive and potentially hazardous nature.

End Applications of Acrylic Acid

Acrylic acid (C3H4O2) is a versatile compound that finds numerous applications in various industries. Here are some of the end applications of acrylic acid:

1. Production of Acrylic Polymers: Acrylic acid is primarily used in the production of acrylic polymers, such as polyacrylic acid (PAA) and its copolymers. These polymers have a wide range of applications in industries such as textiles, adhesives, coatings, superabsorbent polymers (SAPs), and personal care products.
2. Adhesives and Sealants: Acrylic acid and its derivatives are key components in the formulation of adhesives and sealants. Acrylic-based adhesives offer excellent bonding strength and adhesion to a variety of substrates, including metals, plastics, and composites. They find applications in industries such as construction, automotive, and packaging.
3. Coatings and Paints: Acrylic acid is used in the production of acrylic-based coatings and paints. These coatings offer good weather resistance, durability, and color retention. They are widely used in architectural coatings, automotive coatings, industrial coatings, and marine coatings.
4. Textiles and Fibers: Acrylic acid-based polymers are used in the production of synthetic fibers and textiles. Acrylic fibers are lightweight, soft, and possess excellent thermal properties. They are used in applications such as clothing, upholstery, carpets, and outdoor fabrics.
5. Superabsorbent Polymers (SAPs): Acrylic acid is a key component in the production of superabsorbent polymers. SAPs have the ability to absorb and retain large amounts of liquid relative to their own weight. They are used in applications such as diapers, adult incontinence products, feminine hygiene products, and agricultural products.
6. Water Treatment: Acrylic acid-based polymers, such as polyacrylic acid (PAA), are used in water treatment processes. They act as dispersants, scale inhibitors, and flocculants, helping to control water quality, reduce scaling and fouling, and improve the efficiency of water treatment systems.
7. Personal Care Products: Acrylic acid derivatives, such as acrylates and acrylate copolymers, are used in personal care products. They are used as thickening agents, stabilizers, and film-forming agents in products such as creams, lotions, gels, hair care products, and cosmetics.
8. Ion-exchange Resins: Acrylic acid-based polymers are used in the production of ion-exchange resins. These resins are employed in various industries for water purification, separation processes, and chromatography.
9. Plastic Additives: Acrylic acid and its derivatives are used as additives in plastics to enhance their properties. They can improve impact resistance, adhesion, and UV stability of plastic materials.

These are some of the significant end applications of acrylic acid, highlighting its versatility and importance in various industries.

Acrylates (**prop-2-enoates**) are the salts, esters, and conjugate bases of acrylic acid. The **acrylate ion** is the anion CH_2=CHCO−2. Often, acrylate refers to esters of acrylic acid, the most common member being methyl acrylate. These acrylates contain vinyl groups. These compounds are of interest because they are bifunctional: the vinyl group is susceptible to polymerization and the carboxylate group carries myriad functionalities.

Introduction on Acrylates

Acrylates are a class of chemical compounds that are derived from acrylic acid or its esters. They are widely used in various industries due to their versatile properties and applications. Acrylates exhibit a range of characteristics, including high reactivity, good adhesion, flexibility, and resistance to weathering. They are commonly used in the production of polymers, coatings, adhesives, and other materials.

Acrylates are primarily derived from acrylic acid through esterification reactions with different alcohols. The resulting compounds are known as acrylic esters or acrylates. Some common examples of acrylates include methyl acrylate, ethyl acrylate, butyl acrylate, and 2-ethylhexyl acrylate. Each acrylate has its own unique properties and applications.

One significant application of acrylates is in the production of acrylic polymers or acrylic resins. By polymerizing acrylates, such as methyl acrylate or butyl acrylate, it is possible to create polymers with varying molecular weights and properties. These acrylic polymers find wide use in industries such as adhesives, coatings, textiles, and construction materials. They offer benefits such as good adhesion, flexibility, weather resistance, and chemical stability.

Acrylates are also commonly used as monomers in the synthesis of various polymers. For instance, they are utilized in the production of acrylic-based paints, which are known for their excellent color retention, durability, and weather resistance. Additionally, acrylates are employed in the manufacturing of pressure-sensitive adhesives, which are widely used in tapes, labels, and sticky notes.

Another notable application of acrylates is in the formulation of superabsorbent polymers (SAPs). SAPs are extensively used in products such as diapers, adult incontinence products, and feminine hygiene products. These polymers have the ability to absorb and retain large amounts of liquid, making them suitable for absorbing bodily fluids.

Furthermore, acrylates find applications in the textile industry for fabric coatings, in the construction industry for sealants and caulks, and in the medical field for dental materials and medical adhesives.

It is important to handle acrylates with caution, as they can be flammable and may cause skin, eye, or respiratory irritation. Proper safety measures and personal protective equipment should be used when working with acrylates to ensure safe handling and minimize the risk of exposure.

In summary, acrylates are a versatile class of compounds derived from acrylic acid or its esters. Their reactivity and unique properties make them valuable in a wide range of industries, including adhesives, coatings, textiles, and construction.

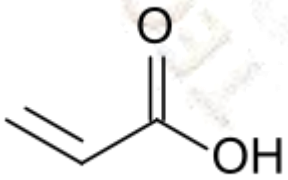
Monomers

Acrylates are defined by the formula $CH_2=CHCO_2R$, where R are can be many groups:

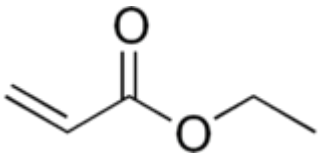
- Acrylic acid
- Methyl acrylate
- Ethyl acrylate
- 2-Ethylhexyl acrylate
- Butyl acrylate

The versatility of the resulting polymers is owed to the range of R groups.

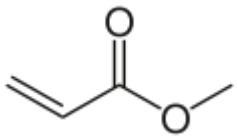
- Structures of some acrylates



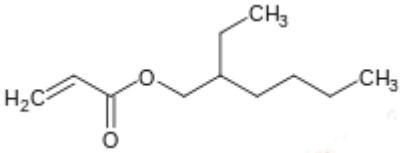
Acrylic Acid



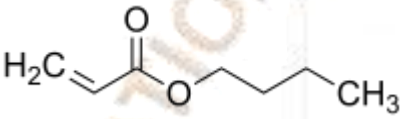
Ethyl Acrylate ester



Methyl acrylate, an acrylic ester



2-Ethyl Hexyl Acrylate

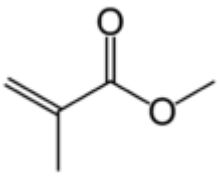


Butyl Acrylate

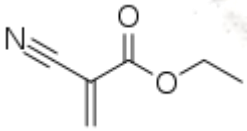
Acrylate derivatives

Methacrylate's ($CH_2=C(CH_3)CO_2R$) and cyanoacrylates($CH_2=C(CN)CO_2R$,) are closely related to acrylates. The feature a methyl and a nitrile in place of the H alpha to the carboxy functional group. They share several properties, being polymerized by radicals and being colourless.

Structures of some important modified acrylates



Methyl methacrylate, precursor to "Perspex" (plexiglass)



Ethyl cyanoacrylate, precursor to "super glue"

Physical properties of Methyl Acrylate

Methyl acrylate, also known as propenoic acid methyl ester, is an organic compound with the chemical formula C4H6O2. It is a clear, colorless liquid with a characteristic sweet odor. Here are some of the physical properties of methyl acrylate:

1. Molecular weight: The molecular weight of methyl acrylate is approximately 86.09 grams per mole.
2. Density: The density of methyl acrylate is about 0.963 grams per cubic centimeter at 25 degrees Celsius.
3. Melting point: Methyl acrylate has a melting point of -75 degrees Celsius (-103 degrees Fahrenheit).
4. Boiling point: The boiling point of methyl acrylate is around 80 degrees Celsius (176 degrees Fahrenheit).
5. Solubility: Methyl acrylate is soluble in many organic solvents, such as ethanol, acetone, and ether. It is slightly soluble in water, with a solubility of about 5.3 grams per 100 milliliters of water at 20 degrees Celsius.
6. Vapor pressure: The vapor pressure of methyl acrylate is relatively low. At 20 degrees Celsius, the vapor pressure is about 55 millimeters of mercury (mmHg).
7. Refractive index: The refractive index of methyl acrylate is approximately 1.409 at 20 degrees Celsius.
8. Flash point: Methyl acrylate has a flash point of around -4 degrees Celsius (25 degrees Fahrenheit), indicating its flammable nature.
9. Viscosity: The viscosity of methyl acrylate is relatively low, with a value of about 0.81 centipoise at 20 degrees Celsius.

It is important to note that these physical properties may vary slightly depending on the purity and specific conditions of the sample.

Chemical Properties of Methyl Acrylate

Methyl acrylate (C4H6O2) is an ester compound with several notable chemical properties. Here are some key chemical properties of methyl acrylate:

1. Polymerization: Methyl acrylate readily undergoes polymerization reactions, either through free-radical polymerization or via anionic polymerization. This property makes it a valuable monomer in the production of polymers and copolymers, such as poly(methyl acrylate) and its derivatives.
2. Reactivity: Methyl acrylate is highly reactive due to the presence of the acrylate functional group (-COOCH3). It can undergo various chemical reactions, including addition reactions, esterification, transesterification, and hydrolysis.
3. Ester Hydrolysis: Methyl acrylate is susceptible to hydrolysis, particularly under acidic or alkaline conditions. In the presence of water and a catalyst, such as acid or base, the ester bond can be cleaved, yielding methacrylic acid (CH2=C(CH3)COOH) and methanol (CH3OH).
4. Acidity: Methyl acrylate is a weak acid, and its acidity arises from the presence of the carboxylic acid moiety (-COOH) in the hydrolyzed form (methacrylic acid). It can donate a proton to a base, resulting in the formation of the corresponding carboxylate ion.
5. Nucleophilic Addition: Methyl acrylate is susceptible to nucleophilic addition reactions. The electron-deficient carbon-carbon double bond (C=C) can react with nucleophiles, such as amines or thiols, leading to the formation of addition products.
6. Esterification: Methyl acrylate can undergo esterification reactions with alcohols in the presence of an acid catalyst. This reaction results in the formation of various esters, including methyl methacrylate (CH2=C(CH3) COOCH3), which is a widely used monomer in the production of polymethyl methacrylate (PMMA) and other acrylic polymers.
7. Oxidation: Methyl acrylate is susceptible to oxidation reactions, particularly under the influence of oxidizing agents. Oxidation can lead to the formation of various oxidation products, such as carboxylic acids or peroxides.
8. Combustibility: Methyl acrylate is flammable and has a low flash point. It can undergo combustion reactions in the presence of a sufficient amount of oxygen, producing carbon dioxide, water vapor, and other combustion by-products.

These are some of the notable chemical properties of methyl acrylate, highlighting its reactivity and its role as a precursor in the synthesis of polymers and other chemical compounds.

End Application of Methyl Acrylate

Methyl acrylate finds various applications across different industries due to its reactivity and ability to polymerize. Here are some end applications of methyl acrylate:

1. Polymers and Coatings: Methyl acrylate is a key monomer in the production of polymers and copolymers. It is commonly used in the synthesis of poly(methyl acrylate), which is a flexible, transparent, and durable polymer with applications in coatings, adhesives, and sealants. Methyl acrylate is also used in the production of acrylic and methacrylic resins, which find use in paints, varnishes, and protective coatings.
2. Textiles and Fibers: Methyl acrylate can be copolymerized with other monomers to produce acrylic fibers. These fibers have properties such as high strength, excellent moisture management, and resistance to sunlight and chemicals. Acrylic fibers find application in the textile industry for the production of clothing, upholstery, carpets, and outdoor fabrics.
3. Adhesives and Sealants: Methyl acrylate is utilized in the formulation of adhesives and sealants due to its ability to form strong bonds with various substrates. It provides good adhesion to metals, plastics, and other materials, making it suitable for applications such as construction adhesives, automotive adhesives, and sealants.
4. Emulsion Polymers: Methyl acrylate is employed in the production of emulsion polymers, which are water-based dispersions of polymer particles. These emulsion polymers find applications in various industries, including paints, coatings, textiles, paper coatings, and adhesives. They offer advantages such as ease of use, improved environmental performance, and excellent film-forming properties.
5. Specialty Chemicals: Methyl acrylate is a precursor in the production of various specialty chemicals. For example, it is used in the synthesis of methyl methacrylate (MMA), a monomer used extensively in the production of polymethyl methacrylate (PMMA) plastics, commonly known as acrylic or plexiglass. PMMA is used in applications such as optical lenses, signage, automotive parts, and medical devices.
6. Crosslinking Agents: Methyl acrylate can be utilized as a crosslinking agent in the production of crosslinked polymers. These polymers have enhanced properties such as improved heat resistance, chemical resistance, and mechanical strength. Crosslinked polymers find applications in the production of wire and cable insulation, automotive components, coatings, and molded products.

It is important to note that proper handling and safety precautions should be followed when working with methyl acrylate due to its flammability and reactivity.

Physical Properties of Ethyl Acrylate

Ethyl acrylate (C5H8O2) is an organic compound and ester that is commonly used in various industries. Here are some of the physical properties of ethyl acrylate:

1. Molecular weight: The molecular weight of ethyl acrylate is approximately 100.12 grams per mole.
2. Appearance: Ethyl acrylate is a colorless liquid with a characteristic fruity odor.
3. Density: The density of ethyl acrylate is around 0.923 grams per cubic centimeter at 25 degrees Celsius.
4. Melting point: Ethyl acrylate has a melting point of -71 degrees Celsius (-96 degrees Fahrenheit).
5. Boiling point: The boiling point of ethyl acrylate is approximately 99 degrees Celsius (210 degrees Fahrenheit).
6. Solubility: Ethyl acrylate is slightly soluble in water, with a solubility of about 1.1 grams per 100 milliliters of water at 20 degrees Celsius. However, it is highly soluble in many organic solvents, such as ethanol, acetone, and ether.
7. Vapor pressure: The vapor pressure of ethyl acrylate is relatively low. At 20 degrees Celsius, the vapor pressure is approximately 22 millimeters of mercury (mmHg).
8. Refractive index: The refractive index of ethyl acrylate is around 1.414 at 20 degrees Celsius.
9. Flash point: Ethyl acrylate is flammable and has a relatively low flash point of around 9 degrees Celsius (48 degrees Fahrenheit).
10. Viscosity: Ethyl acrylate has a viscosity of about 0.87 centipoise at 20 degrees Celsius.

These physical properties may slightly vary depending on the purity and specific conditions of the sample.

Chemical Properties of Ethyl Acrylate

Ethyl acrylate (C5H8O2) is an ester compound with several notable chemical properties. Here are some key chemical properties of ethyl acrylate:

1. Polymerization: Ethyl acrylate readily undergoes polymerization reactions, either through free-radical polymerization or via anionic polymerization. It is often copolymerized with other monomers, such as methyl acrylate or acrylic acid, to produce polymers with tailored properties. The resulting polymers find applications in coatings, adhesives, textiles, and other industries.
2. Reactivity: Ethyl acrylate is highly reactive due to the presence of the acrylate functional group (-COOCH2CH3). It can undergo various chemical reactions, including addition reactions, esterification, transesterification, and hydrolysis.
3. Ester Hydrolysis: Ethyl acrylate is susceptible to hydrolysis, particularly under acidic or alkaline conditions. In the presence of water and a catalyst, such as acid or base, the ester bond can be cleaved, yielding acrylic acid (CH2=CHCOOH) and ethanol (CH3CH2OH).
4. Acidity: Ethyl acrylate is a weak acid, and its acidity arises from the presence of the carboxylic acid moiety (-COOH) in the hydrolyzed form (acrylic acid). It can donate a proton to a base, resulting in the formation of the corresponding carboxylate ion.
5. Nucleophilic Addition: Ethyl acrylate is susceptible to nucleophilic addition reactions. The electron-deficient carbon-carbon double bond (C=C) can react with nucleophiles, such as amines or thiols, leading to the formation of addition products.
6. Esterification: Ethyl acrylate can undergo esterification reactions with alcohols in the presence of an acid catalyst. This reaction results in the formation of various esters, which can have applications in fragrances, flavors, and other industries.
7. Crosslinking: Ethyl acrylate can be used as a crosslinking agent in the production of crosslinked polymers. By copolymerizing ethyl acrylate with other monomers, such as a multifunctional acrylate, crosslinked materials with improved mechanical properties and chemical resistance can be obtained.
8. Combustibility: Ethyl acrylate is flammable and has a low flash point. It can undergo combustion reactions in the presence of a sufficient amount of oxygen, producing carbon dioxide, water vapor, and other combustion by-products.

These are some of the notable chemical properties of ethyl acrylate, highlighting its reactivity and its role as a precursor in the synthesis of polymers and other chemical compounds.

End Applications of Ethyl Acrylate

Ethyl acrylate (C5H8O2) finds various applications across different industries due to its reactivity and ability to polymerize. Here are some of the end applications of ethyl acrylate:

1. Coatings and Paints: Ethyl acrylate is commonly used as a monomer in the production of acrylic polymers used in coatings and paints. The resulting polymers provide properties such as adhesion, durability, and weather resistance, making them suitable for architectural coatings, automotive paints, and industrial coatings.
2. Adhesives and Sealants: Ethyl acrylate is employed in the formulation of adhesives and sealants due to its ability to form strong bonds with various substrates. It provides good adhesion to metals, plastics, and other materials, making it suitable for applications such as construction adhesives, packaging adhesives, and sealants.
3. Textiles and Fibers: Ethyl acrylate is used in the production of acrylic fibers, which have properties such as softness, warmth, and moisture-wicking ability. These fibers find application in textiles for the manufacturing of clothing, upholstery, carpets, and outdoor fabrics.
4. Emulsion Polymers: Ethyl acrylate is employed in the production of emulsion polymers, which are water-based dispersions of polymer particles. Emulsion polymers based on ethyl acrylate are used in various applications such as paper coatings, textile coatings, adhesives, and paints. They offer advantages such as ease of use, improved environmental performance, and excellent film-forming properties.

5. Construction Materials: Ethyl acrylate-based polymers are used in the construction industry for applications such as concrete additives, mortar modifiers, and waterproofing coatings. These polymers enhance the strength, durability, and flexibility of construction materials.
6. Specialty Chemicals: Ethyl acrylate serves as a precursor in the production of various specialty chemicals. For example, it is used in the synthesis of ethyl methacrylate (EMA), which is a key monomer in the production of polymethyl methacrylate (PMMA) plastics. PMMA is used in applications such as optical lenses, signage, medical devices, and automotive parts.
7. Packaging Materials: Ethyl acrylate-based polymers are used in packaging materials, such as films and coatings, due to their good barrier properties against moisture and gases. These materials help to extend the shelf life of packaged goods and maintain their quality.

It is important to note that proper handling and safety precautions should be followed when working with ethyl acrylate due to its flammability and reactivity.

Physical Properties of 2-Ethyl Hexyl Acrylate

2-Ethylhexyl acrylate, also known as 2-EHA, is an organic compound with the chemical formula C11H20O2. It is an ester that is commonly used in various industries. Here are some of the physical properties of 2-ethylhexyl acrylate:

1. Molecular weight: The molecular weight of 2-ethylhexyl acrylate is approximately 184.28 grams per mole.
2. Appearance: 2-Ethylhexyl acrylate is a clear, colorless liquid.
3. Density: The density of 2-ethylhexyl acrylate is around 0.87 grams per cubic centimeter at 20 degrees Celsius.
4. Melting point: 2-Ethylhexyl acrylate has a melting point of approximately -76 degrees Celsius (-105 degrees Fahrenheit).
5. Boiling point: The boiling point of 2-ethylhexyl acrylate is around 250 degrees Celsius (482 degrees Fahrenheit).
6. Solubility: 2-Ethylhexyl acrylate is not soluble in water but is miscible with most organic solvents such as alcohols, ethers, and hydrocarbons.
7. Vapor pressure: The vapor pressure of 2-ethylhexyl acrylate is relatively low. At 20 degrees Celsius, the vapor pressure is approximately 0.6 millimeters of mercury (mmHg).
8. Refractive index: The refractive index of 2-ethylhexyl acrylate is approximately 1.44 at 20 degrees Celsius.
9. Flash point: 2-Ethylhexyl acrylate is flammable and has a flash point of around 81 degrees Celsius (178 degrees Fahrenheit).
10. Viscosity: 2-Ethylhexyl acrylate has a viscosity of about 6.5 centipoise at 25 degrees Celsius.

These physical properties may slightly vary depending on the purity and specific conditions of the sample.

Chemical Properties of 2-Ethyl Hexyl Acrylate

2-Ethylhexyl acrylate (C11H20O2) is an ester compound with several notable chemical properties. Here are some key chemical properties of 2-ethylhexyl acrylate:

1. Polymerization: 2-Ethylhexyl acrylate readily undergoes polymerization reactions, particularly through free-radical polymerization. It is commonly used as a monomer in the production of acrylic polymers and copolymers. These polymers find applications in coatings, adhesives, sealants, and various other industries.
2. Reactivity: 2-Ethylhexyl acrylate is highly reactive due to the presence of the acrylate functional group (-COOCH2CH(C2H5)(CH2)3CH3). It can undergo various chemical reactions, including addition reactions, esterification, transesterification, and hydrolysis.
3. Ester Hydrolysis: 2-Ethylhexyl acrylate is susceptible to hydrolysis, particularly under acidic or alkaline conditions. In the presence of water and a catalyst, such as acid or base, the ester bond can be cleaved, yielding acrylic acid (CH2=CHCOOH) and 2-ethylhexanol (CH3(CH2)3CH(C2H5)CH2OH).

4. Acidity: 2-Ethylhexyl acrylate is a weak acid in its hydrolyzed form (acrylic acid). It can donate a proton to a base, resulting in the formation of the corresponding carboxylate ion.
5. Nucleophilic Addition: 2-Ethylhexyl acrylate is susceptible to nucleophilic addition reactions. The electron-deficient carbon-carbon double bond (C=C) can react with nucleophiles, such as amines or thiols, leading to the formation of addition products.
6. Esterification: 2-Ethylhexyl acrylate can undergo esterification reactions with alcohols in the presence of an acid catalyst. This reaction results in the formation of various esters, which can have applications in fragrances, flavors, and other industries.
7. Combustibility: 2-Ethylhexyl acrylate is flammable and has a relatively low flash point. It can undergo combustion reactions in the presence of a sufficient amount of oxygen, producing carbon dioxide, water vapor, and other combustion by-products.
8. Crosslinking: 2-Ethylhexyl acrylate can be used as a crosslinking agent in the production of crosslinked polymers. By copolymerizing 2-ethylhexyl acrylate with other monomers, crosslinked materials with improved mechanical properties and chemical resistance can be obtained.

These are some of the notable chemical properties of 2-ethylhexyl acrylate, highlighting its reactivity and its role as a precursor in the synthesis of polymers and other chemical compounds.

End Application of 2-Ethyl Hexyl Acylate

2-Ethylhexyl acrylate (2-EHA) finds various applications across different industries due to its reactivity and ability to polymerize. Here are some of the end applications of 2-ethylhexyl acrylate:

1. Coatings and Paints: 2-Ethylhexyl acrylate is commonly used as a monomer in the production of acrylic polymers used in coatings and paints. The resulting polymers provide properties such as adhesion, flexibility, and weather resistance, making them suitable for architectural coatings, automotive paints, industrial coatings, and wood coatings.
2. Adhesives and Sealants: 2-Ethylhexyl acrylate is utilized in the formulation of adhesives and sealants due to its ability to form strong bonds with various substrates. It provides good adhesion to different materials, including plastics, metals, and wood. It is used in applications such as construction adhesives, pressure-sensitive adhesives, and sealants.
3. Textiles and Fibers: 2-Ethylhexyl acrylate is used in the production of acrylic fibers and textiles. Acrylic fibers made from 2-EHA possess properties such as softness, warmth, and excellent color fastness. These fibers find application in clothing, upholstery, carpets, outdoor fabrics, and industrial textiles.
4. Emulsion Polymers: 2-Ethylhexyl acrylate is employed in the production of emulsion polymers, which are water-based dispersions of polymer particles. Emulsion polymers based on 2-EHA are used in various applications such as paper coatings, textile coatings, adhesives, and paints. They provide benefits such as ease of use, improved environmental performance, and excellent film-forming properties.
5. Construction Materials: 2-Ethylhexyl acrylate-based polymers are used in the construction industry for applications such as concrete additives, mortar modifiers, and waterproofing coatings. These polymers enhance the strength, durability, and flexibility of construction materials, providing benefits such as improved adhesion and resistance to weathering.
6. Personal Care Products: 2-Ethylhexyl acrylate is used in the formulation of personal care products, such as hair styling gels, nail polishes, and adhesives for false eyelashes. It imparts film-forming properties and adhesion in these products.

It is important to note that proper handling and safety precautions should be followed when working with 2-ethylhexyl acrylate due to its flammability and reactivity.

Physical Properties of Butyl Acrylate

Butyl acrylate (C7H12O2) is an organic compound and ester that is commonly used in various industries. Here are some of the physical properties of butyl acrylate:

1. Molecular weight: The molecular weight of butyl acrylate is approximately 128.17 grams per mole.
2. Appearance: Butyl acrylate is a clear, colorless liquid with a characteristic fruity odor.
3. Density: The density of butyl acrylate is around 0.897 grams per cubic centimeter at 20 degrees Celsius.
4. Melting point: Butyl acrylate has a melting point of approximately -68 degrees Celsius (-90 degrees Fahrenheit).
5. Boiling point: The boiling point of butyl acrylate is around 145 degrees Celsius (293 degrees Fahrenheit).
6. Solubility: Butyl acrylate is slightly soluble in water, with a solubility of about 0.5 grams per 100 milliliters of water at 25 degrees Celsius. However, it is highly soluble in organic solvents such as alcohols, ethers, and hydrocarbons.
7. Vapor pressure: The vapor pressure of butyl acrylate is relatively low. At 20 degrees Celsius, the vapor pressure is approximately 5.1 millimeters of mercury (mmHg).
8. Refractive index: The refractive index of butyl acrylate is around 1.416 at 20 degrees Celsius.
9. Flash point: Butyl acrylate is flammable and has a flash point of around 19 degrees Celsius (66 degrees Fahrenheit).
10. Viscosity: Butyl acrylate has a viscosity of about 2.2 centipoise at 20 degrees Celsius.

These physical properties may slightly vary depending on the purity and specific conditions of the sample.

Chemical Properties of Butyl Acrylate

Butyl acrylate (C7H12O2) is an ester compound with several notable chemical properties. Here are some key chemical properties of butyl acrylate:

1. Polymerization: Butyl acrylate readily undergoes polymerization reactions, particularly through free-radical polymerization. It is commonly used as a monomer in the production of acrylic polymers and copolymers. These polymers find applications in coatings, adhesives, sealants, and various other industries.
2. Reactivity: Butyl acrylate is highly reactive due to the presence of the acrylate functional group (-COOCH2CH2CH2CH3). It can undergo various chemical reactions, including addition reactions, esterification, transesterification, and hydrolysis.
3. Ester Hydrolysis: Butyl acrylate is susceptible to hydrolysis, particularly under acidic or alkaline conditions. In the presence of water and a catalyst, such as acid or base, the ester bond can be cleaved, yielding acrylic acid (CH2=CHCOOH) and butanol (CH3CH2CH2CH2OH).
4. Acidity: Butyl acrylate is a weak acid in its hydrolyzed form (acrylic acid). It can donate a proton to a base, resulting in the formation of the corresponding carboxylate ion.
5. Nucleophilic Addition: Butyl acrylate is susceptible to nucleophilic addition reactions. The electron-deficient carbon-carbon double bond (C=C) can react with nucleophiles, such as amines or thiols, leading to the formation of addition products.
6. Esterification: Butyl acrylate can undergo esterification reactions with alcohols in the presence of an acid catalyst. This reaction results in the formation of various esters, which can have applications in fragrances, flavors, and other industries.
7. Combustibility: Butyl acrylate is flammable and has a relatively low flash point. It can undergo combustion reactions in the presence of a sufficient amount of oxygen, producing carbon dioxide, water vapor, and other combustion by-products.
8. Crosslinking: Butyl acrylate can be used as a crosslinking agent in the production of crosslinked polymers. By copolymerizing butyl acrylate with other monomers, crosslinked materials with improved mechanical properties and chemical resistance can be obtained.

These are some of the notable chemical properties of butyl acrylate, highlighting its reactivity and its role as a precursor in the synthesis of polymers and other chemical compounds.

End Applications of Butyl Acrylate

Butyl acrylate (C7H12O2) is widely used in various industries due to its versatility and reactivity. Here are some of the end applications of butyl acrylate:

1. Coatings and Paints: Butyl acrylate is commonly used as a monomer in the production of acrylic polymers for coatings and paints. These polymers provide excellent adhesion, flexibility, and weather resistance. Butyl acrylate-based coatings and paints are used in architectural coatings, automotive paints, industrial coatings, and wood coatings.
2. Adhesives and Sealants: Butyl acrylate is employed in the formulation of adhesives and sealants due to its ability to form strong bonds with various substrates. It provides good adhesion to different materials, including plastics, metals, and wood. Butyl acrylate-based adhesives and sealants are used in construction adhesives, pressure-sensitive adhesives, and sealants.
3. Textiles and Fibers: Butyl acrylate is used in the production of acrylic fibers and textiles. Acrylic fibers made from butyl acrylate possess properties such as softness, warmth, and excellent color fastness. These fibers find application in clothing, upholstery, carpets, and industrial textiles.
4. Emulsion Polymers: Butyl acrylate is employed in the production of emulsion polymers, which are water-based dispersions of polymer particles. Emulsion polymers based on butyl acrylate are used in various applications such as paper coatings, textile coatings, adhesives, and paints. They provide benefits such as ease of use, improved environmental performance, and excellent film-forming properties.
5. Construction Materials: Butyl acrylate-based polymers are used in the construction industry for applications such as concrete additives, mortar modifiers, and waterproofing coatings. These polymers enhance the strength, durability, and flexibility of construction materials, providing benefits such as improved adhesion and resistance to weathering.
6. Personal Care Products: Butyl acrylate is used in the formulation of personal care products such as hair styling gels, nail polishes, and adhesives for false eyelashes. It imparts film-forming properties, adhesion, and flexibility in these products.
7. Specialty Chemicals: Butyl acrylate serves as a precursor in the production of various specialty chemicals. It is used in the synthesis of other acrylate monomers and polymers, which find applications in areas such as adhesives, coatings, textiles, and plastics.

It is important to note that proper handling and safety precautions should be followed when working with butyl acrylate due to its flammability and reactivity.

Physical Properties of Methyl Methacrylate

Methyl methacrylate (C5H8O2) is an organic compound and ester that exhibits the following physical properties:

1. Molecular weight: The molecular weight of methyl methacrylate is approximately 100.12 grams per mole.
2. Appearance: Methyl methacrylate is a clear, colorless liquid with a characteristic fruity odor.
3. Density: The density of methyl methacrylate is around 0.94 grams per cubic centimeter at 20 degrees Celsius.
4. Melting point: Methyl methacrylate has a melting point of approximately -48 degrees Celsius (-54 degrees Fahrenheit).
5. Boiling point: The boiling point of methyl methacrylate is around 100 degrees Celsius (212 degrees Fahrenheit).
6. Solubility: Methyl methacrylate is slightly soluble in water, with a solubility of about 0.6 grams per 100 milliliters of water at 25 degrees Celsius. However, it is highly soluble in organic solvents such as alcohols, ethers, and hydrocarbons.
7. Vapor pressure: The vapor pressure of methyl methacrylate is relatively low. At 20 degrees Celsius, the vapor pressure is approximately 59 millimeters of mercury (mmHg).
8. Refractive index: The refractive index of methyl methacrylate is around 1.41 at 20 degrees Celsius.

9. Flash point: Methyl methacrylate is flammable and has a flash point of around 12 degrees Celsius (54 degrees Fahrenheit).
10. Viscosity: Methyl methacrylate has a viscosity of about 0.4 centipoise at 20 degrees Celsius.

These physical properties may slightly vary depending on the purity and specific conditions of the sample.

Chemical Properties of Methyl Methacrylate

Methyl methacrylate (C5H8O2) is an ester compound with several notable chemical properties. Here are some key chemical properties of methyl methacrylate:

1. Polymerization: Methyl methacrylate readily undergoes polymerization reactions, particularly through free-radical polymerization. It is the primary monomer used in the production of polymethyl methacrylate (PMMA), commonly known as acrylic glass or Plexiglas. PMMA is a transparent and rigid material used in various applications such as optical lenses, automotive parts, signage, and lighting fixtures.
2. Reactivity: Methyl methacrylate is highly reactive due to the presence of the methacrylate functional group (-COOCH3). It can undergo various chemical reactions, including addition reactions, esterification, transesterification, and hydrolysis.
3. Ester Hydrolysis: Methyl methacrylate is susceptible to hydrolysis, particularly under acidic or alkaline conditions. In the presence of water and a catalyst, such as acid or base, the ester bond can be cleaved, yielding methacrylic acid (CH2=C(CH3) COOH) and methanol (CH3OH).
4. Acidity: Methacrylic acid, the hydrolyzed form of methyl methacrylate, is a weak acid. It can donate a proton to a base, resulting in the formation of the corresponding carboxylate ion.
5. Nucleophilic Addition: Methyl methacrylate is susceptible to nucleophilic addition reactions. The electron-deficient carbon-carbon double bond (C=C) can react with nucleophiles, such as amines or thiols, leading to the formation of addition products.
6. Esterification: Methyl methacrylate can undergo esterification reactions with alcohols in the presence of an acid catalyst. This reaction results in the formation of various esters, which can have applications in fragrances, flavors, and other industries.
7. Combustibility: Methyl methacrylate is flammable and has a relatively low flash point. It can undergo combustion reactions in the presence of a sufficient amount of oxygen, producing carbon dioxide, water vapor, and other combustion by-products.
8. Crosslinking: Methyl methacrylate can be used as a crosslinking agent in the production of crosslinked polymers. By copolymerizing methyl methacrylate with other monomers, crosslinked materials with improved mechanical properties and chemical resistance can be obtained.

These are some of the notable chemical properties of methyl methacrylate, highlighting its reactivity and its role as a precursor in the synthesis of polymers and other chemical compounds.

End Applications of Methyl Methacrylate

Methyl methacrylate (MMA) is a versatile compound that finds numerous applications in various industries. Here are some of the end applications of methyl methacrylate:

1. Polymethyl Methacrylate (PMMA) Sheets and Shapes: Methyl methacrylate is primarily used in the production of polymethyl methacrylate (PMMA), commonly known as acrylic glass or Plexiglas. PMMA is a transparent and durable material that is used in a wide range of applications, including optical lenses, safety shields, skylights, displays, signage, and automotive components.
2. Coatings and Paints: Methyl methacrylate is utilized as a monomer in the production of acrylic polymers for coatings and paints. Acrylic coatings provide excellent adhesion, weather resistance, and durability. They are used in architectural coatings, automotive coatings, industrial coatings, and marine coatings.

3. Adhesives and Sealants: Methyl methacrylate-based adhesives and sealants offer high strength and excellent adhesion to various substrates, including metals, plastics, and composites. They are used in applications where strong and durable bonds are required, such as construction, automotive, and aerospace industries.
4. Dental Materials: Methyl methacrylate is used in the production of dental materials, such as denture bases and temporary crowns. PMMA-based dental materials offer good aesthetics, durability, and biocompatibility.
5. Impact Modifiers: Methyl methacrylate is used as a co-monomer in the production of impact modifiers for plastics. These modifiers enhance the toughness and impact resistance of polymers, making them suitable for applications such as automotive parts, electrical enclosures, and consumer goods.
6. Optical Materials: Methyl methacrylate is used in the production of optical fibers, light guides, and light diffusers. PMMA's optical clarity, low absorption of light, and ease of processing make it suitable for these applications.
7. Medical Devices: Methyl methacrylate is used in the production of various medical devices, including intraocular lenses, catheters, and orthopedic implants. PMMA's biocompatibility, durability, and ease of sterilization make it suitable for medical applications.
8. Decorative and Architectural Applications: Methyl methacrylate-based products, such as decorative panels, light fixtures, and architectural elements, are used in interior design, construction, and signage industries.
9. Resins and Composites: Methyl methacrylate is used as a building block in the production of specialty resins and composites. These materials find applications in marine structures, wind turbine blades, aerospace components, and sporting goods.

These are some of the significant end applications of methyl methacrylate, demonstrating its versatility and utility in various industries.

Physical Properties of Ethyl Cyanoacrylate

Ethyl cyanoacrylate (C6H7NO2) is a type of cyanoacrylate adhesive that exhibits the following physical properties:

1. Molecular weight: The molecular weight of ethyl cyanoacrylate is approximately 125.13 grams per mole.
2. Appearance: Ethyl cyanoacrylate is a clear, colorless liquid with a low viscosity.
3. Odor: It has a characteristic sharp, pungent odor.
4. Density: The density of ethyl cyanoacrylate is around 1.06 grams per cubic centimeter at 20 degrees Celsius.
5. Melting point: Ethyl cyanoacrylate does not have a distinct melting point, as it undergoes rapid polymerization upon heating.
6. Boiling point: The boiling point of ethyl cyanoacrylate is approximately 150 degrees Celsius (302 degrees Fahrenheit).
7. Solubility: Ethyl cyanoacrylate is not soluble in water but is soluble in organic solvents such as acetone, ethyl acetate, and methanol.
8. Vapor pressure: The vapor pressure of ethyl cyanoacrylate is relatively low. At room temperature, it is typically below 1 mmHg.
9. Viscosity: Ethyl cyanoacrylate has a low viscosity, which allows it to flow easily into small gaps and bond quickly.
10. Polymerization: Ethyl cyanoacrylate rapidly polymerizes in the presence of moisture. This property is essential for its adhesive properties but requires proper handling and storage to prevent premature curing.
11. Flammability: Ethyl cyanoacrylate is highly flammable and can ignite easily. It should be kept away from heat, sparks, and open flames.
12. Adhesive properties: Ethyl cyanoacrylate is known for its fast-setting and strong bonding capabilities. It forms strong bonds with a wide range of substrates, including plastics, metals, rubber, ceramics, and glass.

It is important to note that the physical properties of ethyl cyanoacrylate can vary slightly depending on the specific formulation and purity of the adhesive.

Chemical Properties of Ethyl Cyanoacrylate

Ethyl cyanoacrylate (C6H7NO2) is a type of cyanoacrylate adhesive known for its rapid polymerization and strong bonding properties. Here are some of the chemical properties of ethyl cyanoacrylate:

1. Polymerization: Ethyl cyanoacrylate readily undergoes anionic polymerization in the presence of moisture. The moisture initiates the polymerization reaction, leading to the formation of a strong and durable polymeric network. This rapid polymerization process enables quick-setting adhesion.
2. Cyanoacrylate Group: Ethyl cyanoacrylate contains a cyanoacrylate functional group (-C≡C-C(=O)-O-C2H5). This group is highly reactive and allows the adhesive to form strong bonds with various surfaces.
3. Moisture Sensitivity: Ethyl cyanoacrylate is highly sensitive to moisture. The presence of even trace amounts of moisture triggers the polymerization reaction. It is important to ensure that the surfaces to be bonded are clean and dry to prevent premature curing.
4. pH Sensitivity: The polymerization of ethyl cyanoacrylate is influenced by pH levels. Alkaline conditions can accelerate the curing process, while acidic conditions can inhibit or slow down the polymerization.
5. Thermal Stability: Ethyl cyanoacrylate exhibits good thermal stability. It can withstand moderate temperatures without significant degradation or loss of adhesive properties.
6. Chemical Resistance: Ethyl cyanoacrylate has limited resistance to chemicals, particularly strong acids and bases. It may degrade or lose its adhesive properties when exposed to certain chemical environments.
7. Reactivity: Ethyl cyanoacrylate can undergo various chemical reactions, such as ester hydrolysis. Hydrolysis of the ester bond in ethyl cyanoacrylate leads to the formation of cyanoacetate and ethanol.
8. Flammability: Ethyl cyanoacrylate is highly flammable and can ignite easily. It releases heat during the polymerization process, which can pose a fire hazard. Proper safety precautions should be taken when handling and storing ethyl cyanoacrylate.
9. Biocompatibility: Ethyl cyanoacrylate is generally not considered biocompatible and is not suitable for use in medical applications that require long-term implantation or direct contact with living tissue.

These are some of the key chemical properties of ethyl cyanoacrylate that contribute to its adhesive characteristics and handling requirements. Understanding these properties is essential for safe and effective use of this adhesive.

End Applications of Ethyl Cyanoacrylate

Ethyl cyanoacrylate, with its fast-setting and strong adhesive properties, finds numerous applications across various industries. Here are some of the end applications of ethyl cyanoacrylate:

1. General Purpose Adhesive: Ethyl cyanoacrylate is widely used as a general-purpose adhesive for bonding a wide range of materials, including plastics, metals, rubber, ceramics, glass, and wood. It provides quick and strong bonds, making it suitable for various household, industrial, and commercial applications.
2. Electronics and Electrical Industry: Ethyl cyanoacrylate is commonly used in the electronics and electrical industry for bonding components, wires, and connectors. Its fast-setting nature and ability to bond different materials make it ideal for assembly and repair tasks.
3. Automotive and Aerospace Industries: Ethyl cyanoacrylate is utilized in the automotive and aerospace sectors for bonding parts, such as interior trims, knobs, panels, and gaskets. It offers excellent adhesion to various substrates and withstands vibrations, making it suitable for demanding applications.
4. Medical and Veterinary Applications: Ethyl cyanoacrylate is used in certain medical and veterinary applications, such as wound closure and sutureless skin bonding. It provides a fast and effective method for closing minor cuts and incisions.
5. Dental Applications: Ethyl cyanoacrylate finds application in dental procedures for temporary repairs, such as attaching temporary crowns or bridges. It can also be used in orthodontics for bonding brackets and attaching prosthetic appliances.
6. Craft and Hobby Projects: Ethyl cyanoacrylate is popular among hobbyists and craft enthusiasts for various projects, including model building, jewellery making, and DIY repairs. Its quick-bonding properties and versatility make it a convenient adhesive for intricate work.

7. Medical Device Assembly: Ethyl cyanoacrylate is used in the assembly of medical devices, such as syringes, catheters, and blood filters. It provides secure and reliable bonding in medical equipment manufacturing processes.
8. Optical and Eyewear Industry: Ethyl cyanoacrylate is utilized in the assembly of optical lenses, eyeglass frames, and other eyewear components. Its transparent nature and strong bond strength make it suitable for precision optical applications.
9. Industrial and Manufacturing Applications: Ethyl cyanoacrylate is employed in various industrial and manufacturing applications, such as bonding rubber gaskets, O-rings, and seals. It is also used for assembling components in electrical appliances, machinery, and equipment.

These are some of the significant end applications of ethyl cyanoacrylate, highlighting its versatility, fast-setting properties, and strong adhesive capabilities.

PRODUCT PORTFOLIO

Atlas Chem portfolio has a variety of products. We have long term contracts with reputable petrochemical manufacturers all over the world.

A.) Acrylates& Monomers

- 2 Ethyl Hexyl Acrylate
- Acrylic Acid
- Butyl Acrylate
- Ethyl Acrylate
- Methyl Acrylate
- Methyl Methacrylate
- Styrene Monomer
- Vinyl Acetate Monomer

B.) Alcohols & Oxo Alcohols

- 2-Ethylhexanol
- Bio Ethanol
- Isobutanol
- Isopropyl Alcohol
- Normal Butyl Alcohol
- Methanol
- Synthetic Ethanol

C.) Acetates & Solvents

- Acetone
- Butyl Acetate
- Ethyl Acetate
- Methyl Acetate
- Methylene Chloride
- Phenol

D.) Glycols & Plasticizers

- Dioctyl Phthalate (DOP)
- Dioctyl Terephthalate (DOTP)
- Dioctyl Phthalate (DINP)
- Di Ethylene Glycol
- Mono Ethylene Glycol
- Mono Propylene Glycol

E.) Others

- Acetone Cyanohydrin
- Acetonitrile
- Acrylonitrile
- Alpha Methyl Styrene
- Maleic Anhydride
- Methyl Tert-Butyl Ether (MTBE)
- Phthalic Anhydride
- Sulphur
- Urea

PARTNERS

Atlas Chem is experienced and reliable supplier. Our main target to add value to our business partners

- Ineos Styrolution
- Synthopol
- BASF
- GNFC
- HPL Additives
- Deepak Novochem
- Oriental Aromatics Ltd
- Jesons Industries Ltd

& Many more

1.2 GENERAL INFORMATION ON ACRYLIC ACID AND ACRYLATES:

Acrylic acid (CAS 79-10-7) is an organic molecule and the simplest of the unsaturated acids. At room temperature, acrylic acid is a liquid and has a characteristic acid and tart aroma. It is corrosive in liquid and vapor forms. Acrylic acid is used mainly in the formation of polymers. Its uses include plastics, coatings, adhesives, elastomers, paints, and polishes. Additionally, acrylic acid is used in the production of hygienic medical products, detergents, and wastewater treatment chemicals. The low toxicity of acrylic acid is due to its corrosive nature. Studies have suggested that acrylic acid poses some reproductive hazards; however, conflicting data exist regarding the genotoxicity of acrylic acid.

Acrylates are a group of chemicals that are derived from acrylic acid or methacrylic acid. They are characterized by a vinyl group (-CH=CH2) attached to the carboxylic acid group (-COOH) of the acid. Acrylates are highly versatile and find applications in a wide range of industries, including paints and coatings, adhesives, textiles, plastics, and personal care products.

The most common acrylates include methyl acrylate, ethyl acrylate, butyl acrylate, and 2-ethylhexyl acrylate, among others. These acrylates differ in their molecular structure and properties, which makes them suitable for specific applications.

Acrylates are known for their excellent adhesion properties, chemical resistance, and durability. They can be easily polymerized to form polymers and copolymers, which are used as binders, thickeners, and film-forming agents in various products. Acrylic polymers derived from acrylates offer a balance of hardness, flexibility, and weather resistance, making them ideal for coatings, adhesives, and sealants.

In the paints and coatings industry, acrylates are used as binders to provide adhesion, toughness, and resistance to environmental factors. They contribute to the overall performance and durability of the paint or coating, ensuring long-lasting protection for surfaces.

Acrylates also play a crucial role in the adhesives industry, where they provide strong bonding properties. Acrylic-based adhesives are widely used in various applications, including packaging, automotive, construction, and textiles. They offer excellent adhesion to different substrates, good chemical resistance, and high strength.

In the textile industry, acrylates are used to produce acrylic fibers, which are known for their softness, warmth, and resistance to wrinkles and sunlight. Acrylic fibers are used in the production of clothing, upholstery, carpets, and other textile products.

Additionally, acrylates are used in the production of plastics, resins, and elastomers. They enhance the properties of these materials, such as impact resistance, weatherability, and thermal stability.

It's worth noting that while acrylates offer numerous benefits, they should be handled and used with proper safety precautions. Some acrylates may be toxic, irritants, or sensitizers, and exposure to high concentrations or improper handling can pose health risks. Safety guidelines and regulations should be followed when working with acrylates to ensure the well-being of workers and the environment.

1.3 TYPES OF ACRYLATES:

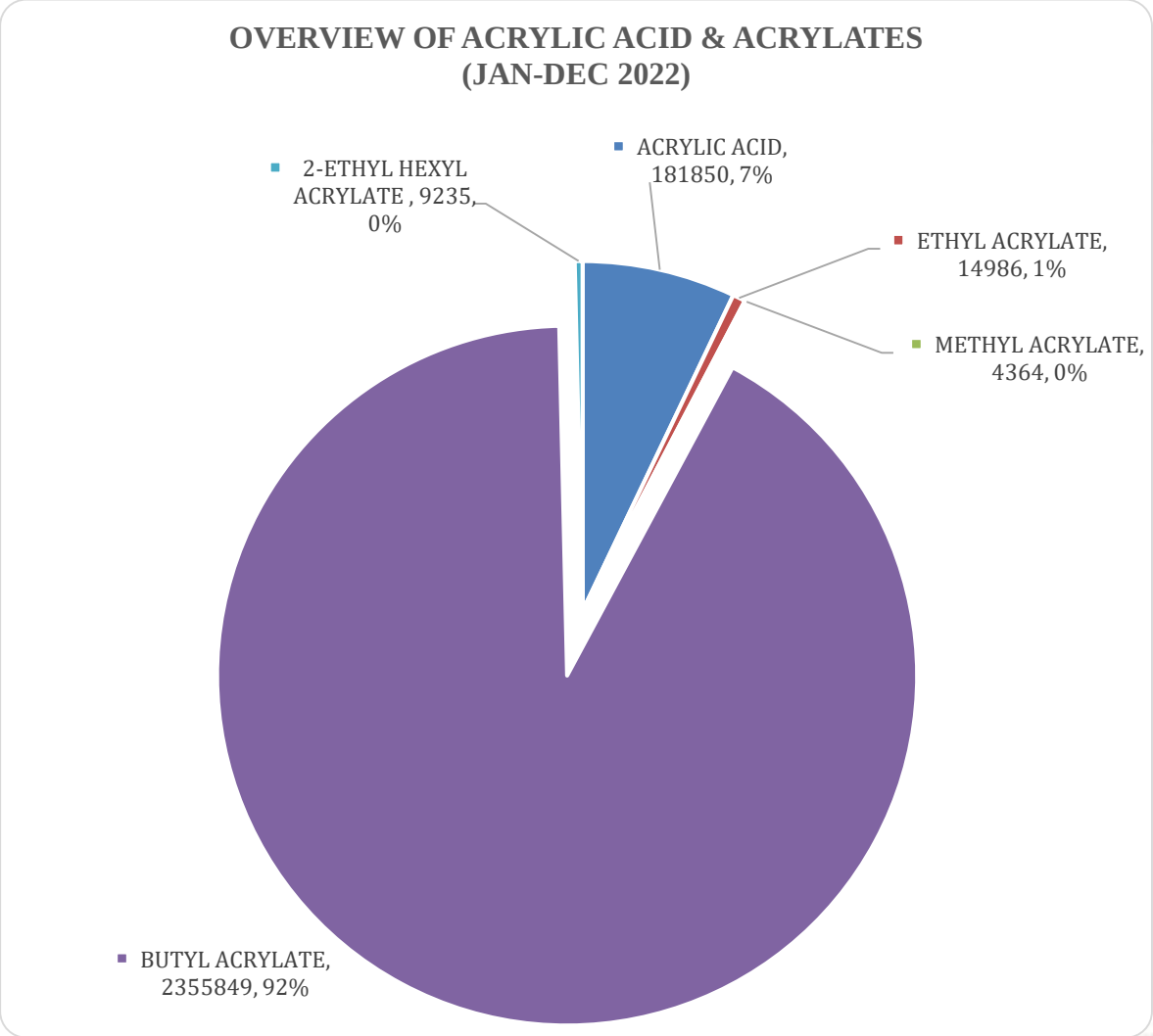
There are several types of acrylates available, each with its own unique properties and applications. Here are some commonly used types of acrylates:

1. Methyl Acrylate: Methyl acrylate is a colourless liquid with a pungent odor. It is used in the production of coatings, adhesives, sealants, and textiles. Methyl acrylate is also used as a chemical intermediate in the manufacturing of other chemicals.
2. Ethyl Acrylate: Ethyl acrylate is a clear, colorless liquid with a characteristic fruity odor. It is primarily used in the production of coatings, adhesives, and sealants. Ethyl acrylate is known for its good adhesion properties and resistance to weathering.
3. Butyl Acrylate: Butyl acrylate is a clear liquid with a fruity odor. It is widely used in the production of coatings, adhesives, and sealants. Butyl acrylate offers good water resistance, flexibility, and adhesion, making it suitable for various applications.
4. 2-Ethylhexyl Acrylate: 2-Ethylhexyl acrylate is a clear liquid with a mild, fruity odor. It is commonly used in the production of coatings, adhesives, and sealants. This type of acrylate is known for its good weatherability, chemical resistance, and flexibility.
5. Hydroxyethyl Acrylate: Hydroxyethyl acrylate is a clear liquid with a mild, sweet odor. It is used in the production of coatings, adhesives, and sealants. Hydroxyethyl acrylate is valued for its ability to improve adhesion, flexibility, and water resistance.
6. Glycidyl Methacrylate: Glycidyl methacrylate is a clear liquid with a mild, fruity odor. It is commonly used in the production of coatings, adhesives, and resins. This type of acrylate provides excellent adhesion, chemical resistance, and durability.

These are just a few examples of acrylates commonly used in various industries. Other types of acrylates include isobornyl acrylate, cyclohexyl acrylate, and lauryl acrylate, among others. The choice of acrylate depends on the specific application requirements and desired properties.

1.4 OVERVIEW OF THE ACRYLIC ACID AND ACRYLATES (JAN-DEC 2022):

PRODUCT	TOTAL QUANTITY (MT)
ACRYLIC ACID	181850
ETHYL ACRYLATE	14986
METHYL ACRYLATE	4364
BUTYL ACRYLATE	2355849
2-ETHYL HEXYL ACRYLATE	9235
TOTAL	**2384434**



1.5 LOCAL MANUFACTUER OF ACRYLIC ACID AND ACRYLATES:

Acrylates Comprehensive Techno-Commercial Market Study, 2013-2030.The demand for acrylates in India stood at more than 200 KTPA in 2018 and is projected to grow at a healthy rate during forecast period. In India, currently no company is manufacturing acrylates monomers. Thus, India is totally depended on imports of acrylates such as Butyl acrylate, Ethyl acrylate, Methyl acrylate and 2-Ethyl hexyl acrylate.

I)BPCL KOCHI REFINERY

30 April, 2021BPCL dispatches first batch of acrylic acid from Kochi refinery

India's Bharat Petroleum Corporation Ltd (BPCL) has shipped the first consignment of acrylic acid from its Propylene Derivative Petrochemical (PDP) complex at Kochi Refinery.

Acrylic Acid is one of the six niche petrochemical products produced in the new PDP Complex at Kochi Refinery.

Built at the cost of Rs 6,000 crore (~USD805 million), the complex utilises 250,000 metric tonnes per annum (mtpa) of Propylene and produce 180,000 mtpa Butyl Acrylate, 10,000 mtpa 2-Ethyl Hexyl Acrylate, 47,000 mtpa Acrylic Acid, 47,000 mtpa 2-Ethyl Hexanol and 38,000 mtpa butanol.

"The first supplies of acrylic acid, which is used in hygienic medical products, detergents, and wastewater treatment chemicals, plastics, coatings, adhesives, elastomers, paints, and polishes, etc, were made to Rossari Biotech and Visen Industries," the company said in a statement.

In the next few weeks, production of Oxo Alcohols and Acrylates is also expected to commence.

Acrylic acid unit is the largest single-train unit in the world with a capacity of 160,000 tonnes per annum. Technology for these products has been sourced from Air Liquide Global E & C solutions, Germany, Mitsubishi Chemical Corporation, Japan & Johnson Matthey Davy Process Technologies, United Kingdom.

Commenting on this milestone, S Jena, ED (Industrial & Commercial), BPCL said products from the complex would replace almost 90 per cent of the country's imports in this segment.

Stared commissioning of its propylene derivatives project of Acrylates.
Currently started production of Acrylic Acid at Kochi Refinery.
It has the manufacture capacity of **329 KTPA** of Acrylic Acid.

ACRYLIC ACID is an unsaturated Carboxylic Acid produced from the latest Global Propylene Derivative technology using in-house Polymer Grade Propylene with 99.8 % purity.

The Butyl Acrylate Train with **180 KTPA** capacity installed in the PDPP plant is one of the largest single units designed and commissioned globally.

2-Ethyl Hexyl Acrylate-10KT,
2EHA-47 KT), the stunted supply
has begun to recover.

II) IOCL Dumad:

Indian Oil signed an agreement with Mitsubishi Chemical Corporation, Japan for sourcing technology & associated services for Acrylic Acid Unit at Dumad, Gujarat. The agreement was signed by Mr. A. N. Jha, ED (Petrochemical-Projects), Business Development, Corporate Office and Mr. Masaya Nomamoto, GM, C3 Derivatives Department, Petrochemicals Business Domain, Mitsubishi Chemical Corporation, Japan in the august presence of Mr. B. V. Rama Gopal, Director (Refineries), IndianOil at Business Development (Petrochemicals) office, SCOPE Complex, New Delhi on April 19, 2018. Mr. S. M. Vaidya, ED, (Operations), RHQ and Mr. Debasish Roy, ED, (Finance), RHQ also graced the occasion with their presence.

Acrylic Acid will be used in the production of Butyl Acrylate. With currently no domestic production of Acrylic Acid and Butyl Acrylate, these products are entirely imported into India. This project is planned as a strategic move towards import
substitution and further will consolidate the specialty chemical business of IndianOil.

Within a short period of time, IndianOil has established itself as the second largest player in Petrochemicals in India, with a wide range of products having a total capacity of 2.5 MMTPA. Petrochemical Business has contributed significantly to both the top-line and the bottom-line of IndianOil business in recent years. Further to upcoming 680 KTA of Poly Propylene Plant and Ethylene Glycol Project having a capacity of 356 KTA glycols at Paradip Refinery, 150 KTA of Butyl Acrylate plant is planned at Dumad, near Gujarat Refinery. Acrylic Acid, for which this agreement has been signed, is a raw material for Butyl Acrylate production. The capacity of the upcoming Acrylic Acid Unit is 90 KTA.

The LuPech project will produce import substitutes like Lube Oil Base Stock (LOBS) and Polypropylene. The Acrylics/Oxo Alcohol Project at Dumad and Gujarat Refinery will manufacture value-added Butyl Acrylate, a key ingredient for paints, coatings, adhesives, textile chemicals, plasticizer industry, and other similar products.
Acrylic acid-90 KT,
Butyl acrylate-153 KT

1.6 OBJECTIVE OF THE STUDY:

The objective of acrylates is to provide a versatile group of chemicals that can be used in various industries and applications. The primary goal is to develop acrylates that offer specific properties and functionalities required for different products and processes. The scope of acrylates encompasses their use in paints and coatings, adhesives, textiles, plastics, and other sectors where their unique characteristics can be beneficial.

The key objectives and scope of acrylates can be summarized as follows:

1. The primary objective of the study was to evaluate and forecast acrylates production, demand, inventory, global suppliers and the demand-supply gap in India.
2. To categorize the demand for acrylates based on end-use, type, sales channel and region.
3. To study trade dynamics and company share in the Indian acrylates market.
4. To identify major customers of acrylates in India.
5. To evaluate and forecast acrylates pricing by type in India.
6. To identify and profile major companies operating in the Indian acrylates market.
7. To identify major developments, deals and expansion plans in the Indian acrylates market.
8. Performance Enhancement: Acrylates are designed to improve the performance of various products. They enhance the adhesion, durability, flexibility, chemical resistance, and weatherability of coatings, adhesives, and sealants. The objective is to develop acrylates that can withstand harsh environmental conditions and provide long-lasting protection.
9. Versatility and Adaptability: Acrylates are versatile chemicals that can be used in a wide range of applications. The objective is to develop acrylates with diverse properties to meet the specific requirements of different industries. This allows for their use in paints, textiles, plastics, and other sectors, catering to a broad scope of applications.
10. Polymerization and Formulation: Acrylates are commonly used as monomers in polymerization reactions to form polymers and copolymers. The objective is to develop acrylates that can easily undergo polymerization to produce desired materials with specific properties. This includes the development of acrylates with different molecular structures, functionalities, and reactivity.

1.7 SCOPE:

The scope of acrylates also involves ongoing research and development activities. This includes exploring new formulations, improving manufacturing processes, and discovering novel applications for acrylates. The objective is to continuously innovate and optimize acrylates to meet evolving industry needs and address emerging challenges.

Overall, the objective and scope of acrylates are to provide high-performance chemicals that contribute to the development of durable, reliable, and sustainable products across multiple industries.

1.8 PURPOSE OF STUDY OF ACRYLATES:

Main purpose to study of Indian Market of Acrylates, end customers, applications, total consumption, local manufacturers, dependence on Imports of acrylates & Global suppliers

CHAPTER 2: LITERATURE REVIEW

Review of literature has vital relevance with any research work due to literature review the possibility of repetition of study can be eliminated and another dimension can be selected for the study. The literature review helps researcher to remove limitations of existing work or may assist to extend prevailing study. Several researches have been conducted to analyse the different aspects of study of Acrylates in India. But there are very few research and literature available on the subject related to lead Acrylates and its impact. There have been many researches and studies on imports of Acrylates & forecast in India.

A brief review of these studies is highlighted in the following paragraphs to highlight the importance of the study. The conclusions and finding from the available literature and research are analysed as follows:

2.1 Dublin, Feb. 21, 2020 (GLOBE NEWSWIRE) Research & Markets on India Acrylates Comprehensive Techno-Commercial Market Study, 2013-2030

The demand for acrylates in India stood at more than 200 KTPA in 2018 and is projected to grow at a healthy rate during forecast period. In India, currently no company is manufacturing acrylates monomers. Thus, India is totally depended on imports of acrylates such as Butyl acrylate, Ethyl acrylate, Methyl acrylate and 2-Ethyl hexyl acrylate.

2.2.Dr. Angel Serrano-Aroca(Professor,Biomaterials and Bioengineering Lab, Centro de InvestigationTranslational San Alberto Magno, Universidad Cattolica de Valencia San Vicente Mártir,Spain) & Dr.Sanjukta Deb (King's College London)
Both professors studied on Applications of Acrylates& come across the result as under:

Acrylic polymers and co-polymers are currently widely used in industry in all kind of applications due to their chemical purity, stability, high heat resistance, sunlight resistance, excellent weathering, low temperature performance, water resistance and hydrophobicity. Acrylates have found application in the manufacture of co-polymers for coatings and paints, sealants, adhesives, textile fibres, printing inks. It is highly superabsorbent polymers and thus used in diapers. Thermoplastic acrylate co-polymers, in biomedicine and a variety of other advanced application areas.

2.3 Kathrin Nollenberger (Evonik Industries AG, Kirschenallee, 64293 Darmstadt, Germany) International Journal of PharmaceuticsVolume 457, Issue 2, 5 December 2013, Pages 461-469

Author studied on Poly(meth)acrylates-based coatings for pharmaceutical &declared results as under:
Poly(meth)acrylates are synthetic (co)polymers prepared by free-radical polymerization. They exhibit extremely low batch-to-batch variations when compared to natural, raw material polymers. Synthetic polymers have very narrow specifications due to their excellent reproducibility and are monographed in the European Pharmacopoeia, the USP/NF and the Japanese Pharmaceutical Excipients. Drug master files for the entire range exist at the US Food and Drug Administration (FDA). Poly(meth)acrylates

2.4.P. V. T. Raghuram, U. S. Nandi :
Studies on the polymerization of ethyl acrylate& evaluated conclusion

Transfer constants for different solvents representing hydrocarbons, halogenated compounds, alcohols, ketones, acids, and esters were determined in the thermal polymerization of ethyl acrylate at 80°C and they are compared with the available data on methyl acrylate and ethyl methacrylate. It was observed from the values of transfer constants that ethyl acrylate radicals are a little more effective than methyl acrylate or ethyl methacrylate in abstracting hydrogen atom from hydrocarbons and alcohols. In acetic and *n*-butyric acid media, it has been found, by the aid of end group analysis, that the derived solvent radicals from transfer reactions are not too efficient to start a new chain.

2.5.C Quan, M Soroush, MC Grady, JE Hansen
High-Temperature Homopolymerization of Ethyl Acrylate and *n*-Butyl Acrylate: Polymer Characterization

This paper presents a thorough molecular characterization of ethyl acrylate (EA) and *n*-butyl acrylate (nBA) homopolymers made at high temperature (140−180 °C) to high conversions (50−90%) in xylene isomers without the use of added thermal initiator. Electrospray ionization/Fourier transform mass spectrometry (ESI/FTMS) analysis shows four dominant chain types formed during high-temperature polymerization. Chains initiated by β-scission radicals and by xylol radicals that grow and eventually terminate to form terminally saturated and unsaturated chains. These chain structures suggest the underlying secondary mechanisms in high-temperature acrylate polymerization include β-scission (disproportionation) of the carbon-centered tertiary radical that is most likely formed via intramolecular chain transfer. Additionally, chain transfer to solvent, xylene in this case, also plays an important mechanistic role. Results from 1D NMR using ^{13}C, ^{1}H, and distortion less enhancement polarization transfer (DEPT) corroborate the ESI/FTMS results and additionally predict (i) 2 branch points per chain on average for EA homopolymer with a number-average molecular weight of 4000 and (ii) 1.25 branch points per chain on average for nBA homopolymer with a number-average molecular weight of 3300. The presence of branch points indicates propagation of the midchain tertiary radical does occur to significant extent under the conditions of the experiments. Neither the ESI/FTMS nor NMR results suggest a mechanistic route by which the acrylates initiate polymerization without added thermal initiator.

2.6 India Butyl Acrylate Market Analysis: Plant Capacity, Production, Technology, Operating Efficiency, Demand & Supply, End-User Industries, Sales Channel, Regional Demand, Company Share, Foreign Trade, FY2015-FY2035

The India Butyl Acrylate market reached approximately 230 thousand tones in FY2023 and is expected to grow at a steady CAGR of 5.48% by FY2035. Indian Oil Corporation Limited (IOCL) has planned to start its new butyl acrylate plant facility in Dumad, Gujarat which is anticipated to be operational by FY2024,

Butyl Acrylate is an organic compound that is an ester of acrylic acid. Butyl Acrylate is synthesized by the chemical reaction between acrylic acid and butanol in a reactor with an acidic catalyst. Butyl Acrylate is a colorless liquid that is utilized as an organic solvent in various industries. Butyl acrylate is added to enhance low-temperature characteristics and toughness in various products. In order to create homopolymers and co-polymers for further usage in water-based architectural and industrial paints, butyl acrylate is predominantly used as a raw material. Additionally, it can be found in cleaning materials, antioxidant compounds, fabrics, sealants, enamel paints, and paper finishes. Various industries use butyl acrylates such as polymers, leather, paints, adhesives, and textile products.
The market for Butyl Acrylate is primarily driven by its application as a solvent in paints & coatings, and Adhesive & Sealants which are majorly consumed by the construction and automotive sectors. Due to reasons like shifting lifestyles and rising investment, residential and commercial development has seen a significant surge in recent years in the Nation. Government schemes like Pradhan Mantri Awas Yojana (Urban)-PMAY (U) towards providing housing to everyone in urban areas by 2022 have been fuelling the demand for building

construction materials in the past years. The Butyl Acrylate market volume is estimated to reach approximately 470 thousand tones byFY2035.

Based on the region, the Indian Butyl Acrylate market is segregated into the West, South, North, and East. As of FY2022, West India has been leading the market with a share of 62 percent. Western states like Gujarat and Maharashtra have been the key consumer of Butyl Acrylate due to the presence of leading industries of paints & coatings such as Asian Paints, and other manufacturers located in these states. Before FY2022, the demand of butyl acrylate in the nation was fulfilled by imports. However, in FY2022 (October 2021), a new Propylene Derivatives Petrochemical Complex plant was commissioned by Bharat Petroleum Corporation Limited at the Kochi refinery to cater to the domestic demand for butyl acrylate. Moreover, to fulfil the growing demand for Butyl Acrylate, IOCL has commissioned a new plant which is estimated to being operation in FY2024.

Based on end-use, the India Butyl Acrylate market is segregated into Paints and Coatings, Adhesive & Sealants, Printing Inks, Textile, Cleaning Products, and Others. In FY2023, the Paints and Coatings industry made up approximately 50% of the domestic demand followed by the Adhesive & Sealants industry. Both these industries are anticipated to lead the market even in the forecasted period as a result of their expanding use in the construction and automotive industries, as well as an increase in the replacement of old coatings with water-based paints and coatings and exceeding usage of adhesives.

As of FY2022, Bharat Petroleum Corporation Limited is the only producer of butyl acrylate. Other major global players fulfilling the Butyl Acrylate demand in India via exports are Basf Petronas Chemicals Sdn Bhd, Pinghu Petro Chemical Co Ltd, National Petrochemical Industrialza, Toyota Tsusho Corporation, and Others.

2.7 Acrylate Monomers Market Review 2021 and Strategic Plan for 2022 - Insights, Trends, Competition, Growth Opportunities, Market Size, Market Share Data and Analysis Outlook to 2028

Acrylate Monomers Market Overview Acrylate Monomers Market is expected to register an attractive growth rate during the outlook period driven by technological innovations and application-specific developments. Market Players in the Acrylate Monomers Market business are aligning their operating model to the new normal by pivoting towards digitalization of operations and adapting to emerging technologies in robotic automation and artificial intelligence. Mergers and acquisitions to acquire new technologies, strengthen portfolios, and leverage capabilities to remain key strategies of top companies in the Acrylate Monomers Market industry during the outlook period.

Investing in R&D and technology to improve product lines will be the major growth driver in the short to medium term for the Acrylate Monomers Market amid prevailing tough conditions. The market study provides a comprehensive description of current trends and developments in the Acrylate Monomers Market industry along with a detailed predictive and prescriptive analysis to 2028.

Acrylate Monomers Market Market Dynamics – COVID Impact and Post COVID Scenario Analysis
The high demand for chemicals and materials essential to fight the pandemic COVID 19 lead to a shortage in raw materials for other products despite high prices, thus disrupting the Acrylate Monomers Market supply chain. Companies that are adding capacities aggressively to cater to the short-term COVID-induced demand need to be cautious in analyzing these unprecedented demand patterns.

Post pandemic transformations in social, economic, trade, and political conditions with expected reforms in environmental regulations will shape the future of the Acrylate Monomers Market industry from 2021 to 2025. Acrylate Monomers Market has reported mixed results during the COVID 19 for different applications and geographies. The research identifies segment-wise implications of the pandemic and offers different case scenarios representing the Acrylate Monomers Market growth prospects to 2028.

Acrylate Monomers Market Insights – Latest Trends, Drivers, Opportunities, and Challenges
Customizing products to cater to a specific application than improvising the product characteristics on a whole has been the emerging trend in the Acrylate Monomers Market Enterprises should incorporate digitally connected processes and focus on operational efficiency, diversifying supply sources, and cost management to create opportunities in the Acrylate Monomers Market during the forecast period. Uneven recovery in different end markets and geographies is a key challenge in understanding and analyzing the Acrylate Monomers Market landscape.

Acrylate Monomers Market Structure – Competition, Strategies and Company Profiles
While catering to the short-term needs of the market, Acrylate Monomers Market players can address this uncertainty with a clear revision of the product portfolio and a lucid long-term strategy with scenario planning. Investing in innovation, identifying emerging applications, and developing sensible business models to generate sustained growth are the winning strategies in the future Acrylate Monomers Market. The report presents detailed profiles of top companies serving the Acrylate Monomers Market value chain along with their strategies for the near-, medium-, and long-term period.

Acrylate Monomers Market Segmentation – Regional Analysis of different Acrylate Monomers Market Product Types, Applications, and End-Users
Near saturated demand in Europe coupled with comparatively slower momentum in China, after many years of exceptional growth trajectory are limiting the Acrylate Monomers Market demand from these regions. However, the fast-paced recovery of developing nations from the COVID impact is expected to bolster the Acrylate Monomers Market demand.
The research estimates global Acrylate Monomers Market revenues in 2021, considering the Acrylate Monomers Market prices, supply, demand, and trade analysis across regions. A detailed market share, penetration, and shift in demand for different types, applications, and geographies in the Acrylate Monomers Market from 2021 to 2028 is included.

The report covers North America, Europe, Asia Pacific, Middle East, Africa, and LATAM Acrylate Monomers Market statistics from 2020 to 2028 with further division by leading product types, applications, and use cases of Acrylate Monomers Market. The status of the Acrylate Monomers Market in 16 key countries over the world is elaborated to enable an in-depth understanding of the Acrylate Monomers Market industry.

Acrylate Monomers Market Research Scope
• Global Acrylate Monomers Market size and growth projections (CAGR), 2021- 2028
• COVID impact on Acrylate Monomers Market industry with future scenarios
• Acrylate Monomers Market size, share, and outlook across 5 regions and 16 countries, 2021- 2028
• Acrylate Monomers Market size, CAGR, and Market Share of key products, applications, and end-user verticals, 2021- 2028
• Short and long term Acrylate Monomers Market trends, drivers, restraints, and opportunities
• Porter's Five forces analysis, Technological developments in Acrylate Monomers Market, Acrylate Monomers Market supply chain analysis
• Acrylate Monomers Market trade analysis, Acrylate Monomers Market price analysis, Acrylate Monomers Market supply/demand
• Profiles of 5 leading companies in the industry- overview, key strategies, financials, and products

• Latest Acrylate Monomers Market news and developments

Who can benefit from this research

The research would help top management/strategy formulators/business/product development/sales managers and investors in this market in the following ways

1. The report provides 2021 Acrylate Monomers Market, market sales data at the global, regional, and key country level with a detailed outlook to 2028 allowing companies to calculate their market share and analyze prospects, and uncover new markets, and plan market entry strategy.

2. The research includes the Acrylate Monomers Market split by different types and applications. This segmentation helps managers plan their products and budgets based on future growth rates of each segment

3. The Acrylate Monomers Market, market study helps stakeholders understand the breadth and stance of the market giving them information on key drivers, restraints, challenges, and growth opportunities of the market and mitigate risks

4. This report would help top management understand competition better with a detailed SWOT analysis and key strategies of their competitors, and plan their position in the business

5. The study assists investors in analyzing Acrylate Monomers Market business prospects by region, key countries, and top companies' information to channel their investments.

2.8 Stuti Srivastava (2009) Co-polymerization of Acrylates, Designed Monomers and Polymers, 12:1, 1-18, DOI: 10.1163/156855508X391103

Co-polymers of methyl methacrylate (MMAs) are widely used in coatings because of their film-forming capacity, which is due to better bond-forming tendency with various substrates. The adhesion of coating with various substrates such as wood, metal or plastics is an important property for protective, as well as decorative coatings. Co-polymers of MMA with different monomers such as butyl acrylate (BuA), 2-ethyl hexyl acrylate (2-EHA) and hydroxyl ethyl methacrylate (HEMA) are extensively used for coatings on different substrates to improve the roughness, acid scratch and solvent resistances. Co-polymerization of diacrylates/methacrylate's of glycols with various alkyl esters have been investigated by several scientists. In the synthesis of these materials an understanding of polymerization mechanism and kinetics is important
for better control of gel structure. The rate constant depends largely on the physical properties of the system, which in turn, are strong functions of monomer conversion. Cross-link density is one of them, and *T*g also depends on it, increasing with increasing cross-link density. © Koninklijke Brill NV, Leiden, 2009

4.2. Butyl Acrylate (BuA)

BuA is one of the principal acrylic monomer included in emulsions intended for decorative coatings. In many cases it is co-polymerized with MMA to obtain a film of the requisite degree of hardness [39]. Yoshida [40] proposed weather-resistant lacquer compositions based on a co-polymer of BuA and MMA. A solution of this co-polymer and 4-methacryloyloxy-2,2,6,6-tetramethyl-piperdine, when sprayed on a urethane enamel-coated surface, gives coatings with good weather, water and alcohol resistance. A co-polymer [41] synthesized using BuA-acrylonitrile-acrylic acid in a ratio 35:15:0.14 having glass temperature (Tg) of 50–130◦C was used as peelable coating. Grubert et al. [41] synthesized aqueous polymer dispersions of a halogen containing monomer (vinyl dichloride) by co-polymerization with BuA.

The polymer gave a film without discoloration.

Water-thinned coatings [43] from BuA-2-HEMA-2-isocynatoethyl methacrylate synthesized in the presence of (NH4)S2O8 were transparent with good water resistance.

In a patented work [44] aqueous acrylic polymer emulsions for sprayable clear coatings have been synthesized by co-polymerization of acrylic acid-BuA-tert.

BuA- hydroxypropyl acrylate- hydroxypropyl acrylate- MMA- styrene, and neutralization with Me2NCH2CH2OH. Emulsion of this co-polymer was sprayed on a primed steel, dried at room temperature and baked for 30 min at 130◦C to give a 42-μm-thick film with 84 and 82% gloss. Hidalgo et al. [45] prepared latex with a styrene/BuA/amide functional monomer through emulsion polymerization, varying the hydrophilicity of the functional monomer employed.

The second-stage polymerization kinetics, size and morphology of latex particles, and the location of the functional groups in the final latexes were studied. It was shown that increasing the hydrophobicity led to better homogeneity in the co-polymer formed during the second-stage polymerization, while the more hydrophilic functional monomer 6 S. Srivastava / Designed Monomers and Polymers 12 (2009) 1–18 partly homo-polymerizes in a separate phase. The seeded semi-continuous emulsion co-polymer of BuA with divinyl monomers, viz., butanediol diacrylate (BDA) and allyl methacrylate (AMA) at 80◦C using potassium persulfate as initiator was investigated by Bouvier-Fontes and co-workers [46]. The results showed that the most reactive cross-linked BDA produced the fewest cross-linked branches and gel containing polymer. Mechanical properties data confirmed this unexpected trend. Co-polymers of BuA when cross-linked with ethylene glycol Di methacrylate (EGDMA) were evaluated as potential chromatographic packings by Bryjak [19]. It was found by Bryjak that increase of cross-linker content mostly affected the surface hydrophobicity. Co-polymer systems based on various molar ratios of MMA/BuA and different mass content of N-methylolacrylamide (NMA), as a cross-linking agent, were investigated by Leskovac et al. [47]. The changes in mechanical properties of co-polymer were found to be connected with the crosslinking and/or degradation mechanism.

4.3. 2-Ethyl Hexyl Acrylate (2-EHA)/2-Ethyl Hexyl Methacrylate (2-EHMA) 2-EHA is also incorporated with other monomers in latex coating. Combination of 2-EHMA with styrene and MMA is beneficial in multilayer coating with good appearance. Polyisocynate was used as cross-linking agent in this combination [48]. The compounds useful for building exteriors, contain emulsions of polymers showing *T*g of −10 to +50◦C [49].
A co-polymer combination of 2-EHA-acrylonitrile-acrylic acid in a ratio of 89:8:3 (*T*g = −53◦C), useful in flooring coating, was proposed by Schwerzel *et al.* [50]. A co-polymer from 279.6 parts MMA, 108 parts 2-EHA and 16.3 parts methacrylic acid was synthesized by Takeuchi *et al.* [51]. When this co-polymer was neutralized with 17 parts ethanolamine, coated on metal and dried at 20◦C and 65% relative humidity for 24 h, it gave a glossy, water-resistant coating. The effects of the type and amount of surfactant on the overall polymerization features and final product properties for the seeded semi-continuous emulsion terpolymer of 2-EHA, styrene and methacrylic acid were investigated by Mosa *et al.* [52].
The emulsifier system studied included (i) pure anionic emulsifier (Na lauryl sulfate), (ii) anionic ethoxylated emulsifiers and (iii) non-ionic emulsifiers.

2.9 Acrylates (ethyl acrylate, ethyl methacrylate, and methyl methacrylate) are ingredients found in artificial nail products. We are mainly exposed to these chemicals through inhalation or skin contact. Despite evidence of adverse skin, eye, and throat reactions to these chemicals, they continue to be used in nail products.

Acrylates are derived from acrylic acid and are commonly found in cosmetic nail preparations. Ethyl acrylate acts as an adhesive to apply artificial nails and eyelashes. Ethyl methacrylate and methyl methacrylate allow sculptured artificial nails to mold and adhere to the natural nail plate.

Direct contact and inhalation are the main hazardous forms of contact, and the Center for Disease CDirect contact and inhalation are the main hazardous forms of contact, and the Center for Disease Control and Prevention (CDC) warns that ethyl methacrylate and methyl methacrylate vapors may block air vents. Proper ventilation in nail salons can reduce ethyl methacrylate levels by 90 percent.

In the early 1970s, methyl methacrylate was the primary monomer, or molecule, used in acrylic nails. In response to consumer complaints of severe nail and skin reactions, the U.S. Food and Drug Administration concluded it was a “poisonous and deleterious substance” and decided to seize and recall nail products containing 100 percent liquid methyl methacrylate in 1974. Ethyl methacrylate became and remains the main ingredient. In most artificial nail products, ethyl methacrylate makes up 90% of the products.is found in both professional products and home kits

Artificial Nail Products (Acrylic Nails, Nail Enhancing Polishes)

What to look on the Labels:

- Ethyl acrylate: Acrylic acid ethyl ester, ethyl propenoate, EA
- Ethyl methacrylate: ethyl methacrylate, ethyl ester, methacrylic acid, ethyl ester, ethyl 2-methyl-2-propenoate, EMA

- Methyl methacrylate: Methacrylate monomer, Methyl ester of methacrylic acid, methyl-2-methyl-2-propenoate, MMA

Regulations

Although the Food and Drug Administration banned 100 percent liquid methyl methacrylate in 1974, no specific regulations prohibit its use at concentrations lower than 100 percent in cosmetic products. Across the United States, at least 32 states ban the professional use of methyl methacrylate in nail salons. Still, the FDA found trace amounts in 15 to 25 random samples of the chemical in powdered form and reports that it continues to be found in artificial nail products. Air samples from 12 randomly selected nail salons in Salt Lake City County in Utah, which banned methyl methacrylate, found 58 percent of the salons had methyl methacrylate circulating in the air. Considering the corrosive and skin sensitizing properties of ethyl methacrylate and methyl methacrylate, the Methacrylate Producers Association, Inc. has stated that these chemicals are not appropriate for artificial nail products. Yet, they continue to be ingredients.

How to Avoid?

Avoid using artificial nails unless you know that they do not contain acrylates. Nail technicians should use ventilated manicure tables and wear appropriate safety masks and protective gloves. The Occupational Safety and Health Administration recommends NIOSH-approved filtering face piece respirators (e.g. dust masks) and nitrile gloves.

RESEARCH METHODOLOGY

3.1 SCOPE OF STUDY

3.1.1 The scope of this study (project) is includes exploring new formulations, improving manufacturing processes, and discovering novel applications for acrylates. The objective is to continuously innovate and optimize acrylates to meet evolving industry needs and address emerging challenges.

3.1.2 The objective and scope of acrylates are to provide high-performance chemicals that contribute to the development of durable, reliable, and sustainable products across multiple industries.

3.2 SAMPLE SIZE

3.2.1 I have collected the 12month data import of acrylic acid & acrylates of company shares in the Indian acrylate market

3.3 DATA COLLECTION

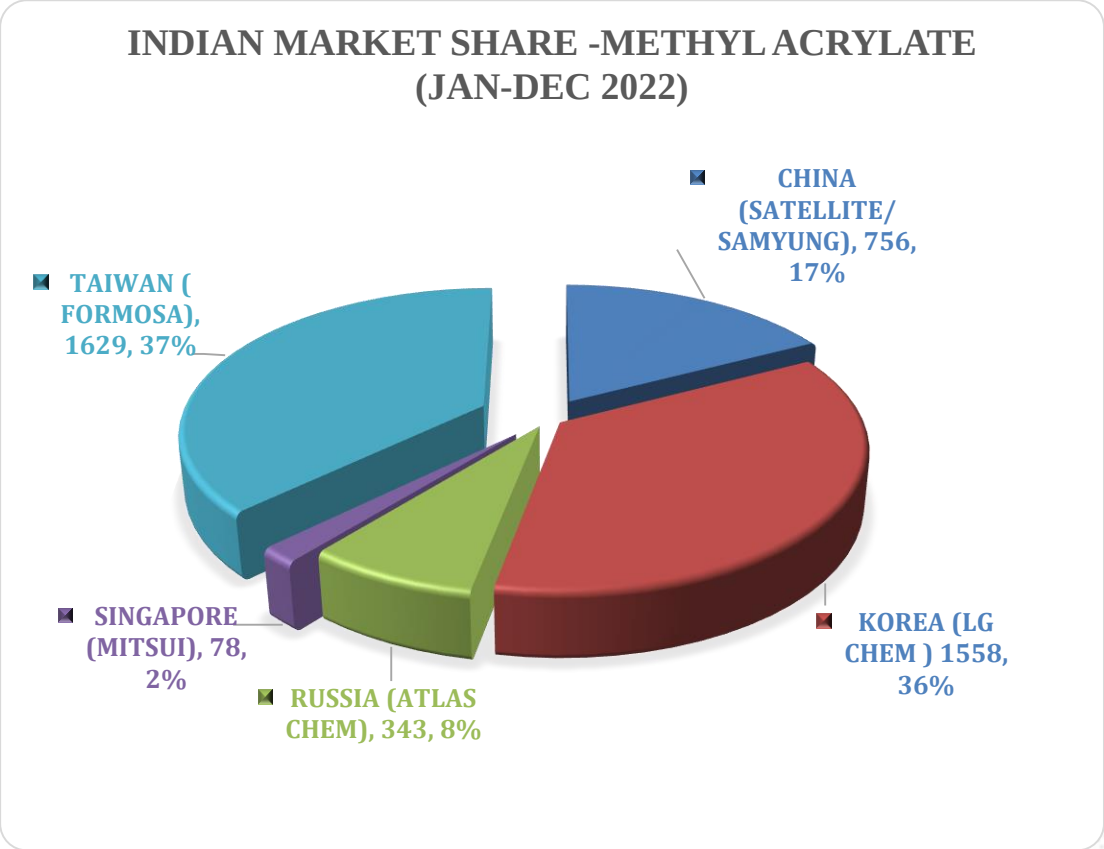
3.3.1 For this project I have collected the Secondary data from the Custom Authority of India
3.3.2 Collected data from articles, books, research papers and different website.

DATA ANALYSIS

4.1 TRADE DYNAMICS AND COMPANY SHARE IN THE INDIAN ACRYLATE MARKET (JAN-DEC 2022)

4.1.1 METHYL ACRYLATE

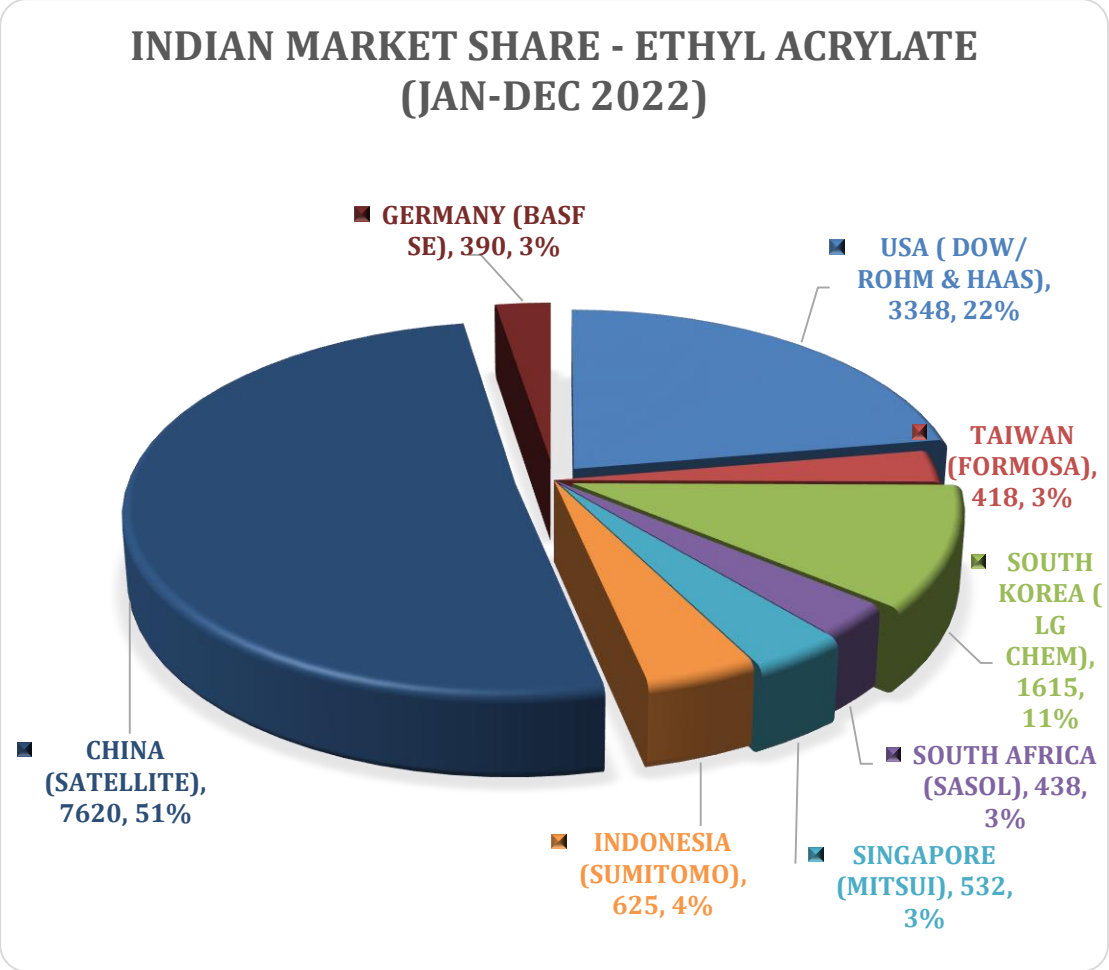
ORIGIN /SUPPLIERS	QUANTITY (MT)
CHINA	756 (17%)
KOREA (LG CHEM)	1558 (36%)
RUSSIA (ATLAS CHEM)	343 (8%)
SINGAPORE (MITSUI)	78 (2%)
TAIWAN (FORMOSA)	1629 (37%)
TOTAL	**4364**



Interpretation:
From the above pie chart we came to know that Taiwan Country (FORMOSA) has maximum export of Methyl Acrylate in Indian Market.

4.1.2ETHYL ACRYLATE

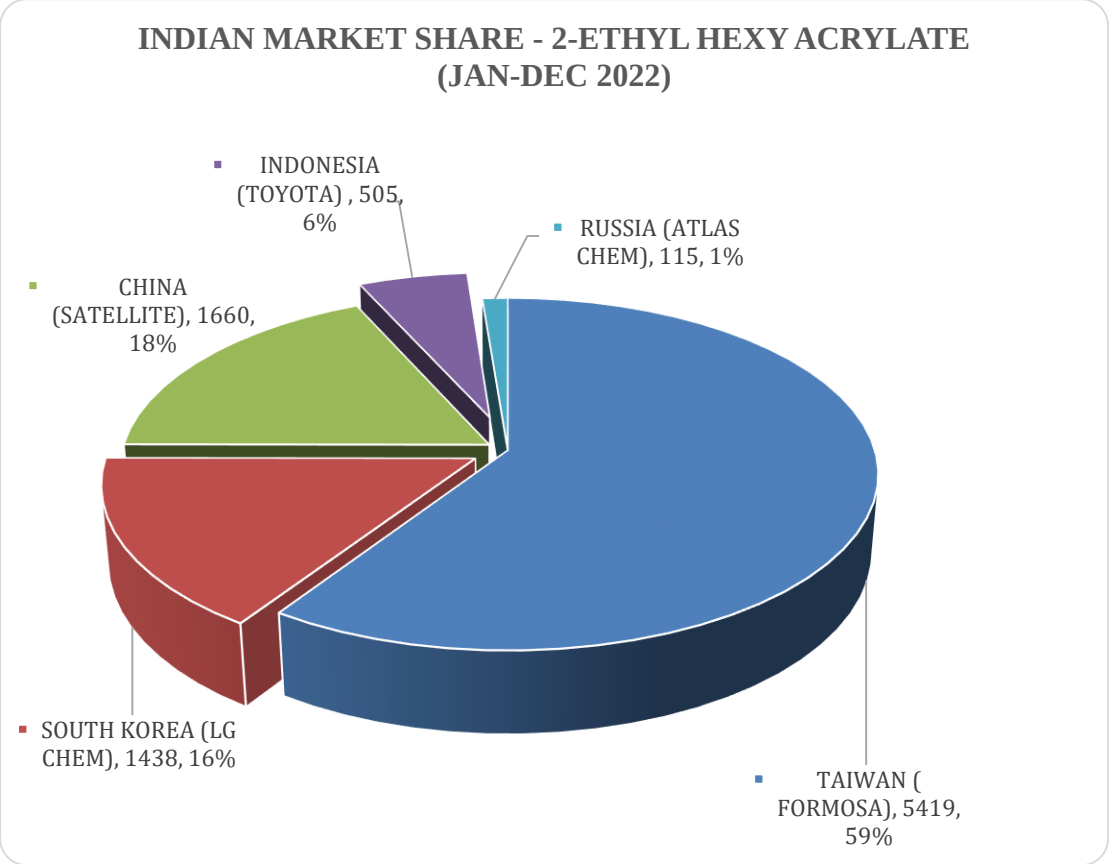
ORIGIN /SUPPLIERS	QUANTITY (MT)
USA (DOW/ ROHM & HAAS)	3348 (22%)
TAIWAN (FORMOSA)	418 (3%)
SOUTH KOREA (LG CHEM)	1615 (11%)
SOUTH AFRICA (SASOL)	438 (3%)
SINGAPORE (MITSUI)	532 (3%)
INDONESIA (SUMITOMO)	625 (4%)
CHINA (SATELLITE)	7620 (51%)
GERMANY (BASF SE)	390 (3%)
TOTAL	**14986**



Interpretation:
From the above pie chart we came to know that China Country (SATELLITE) has highest export of Ethyl Acrylate in Indian Market.

4.1.32-ETHYL HEXYL ACRYLATE

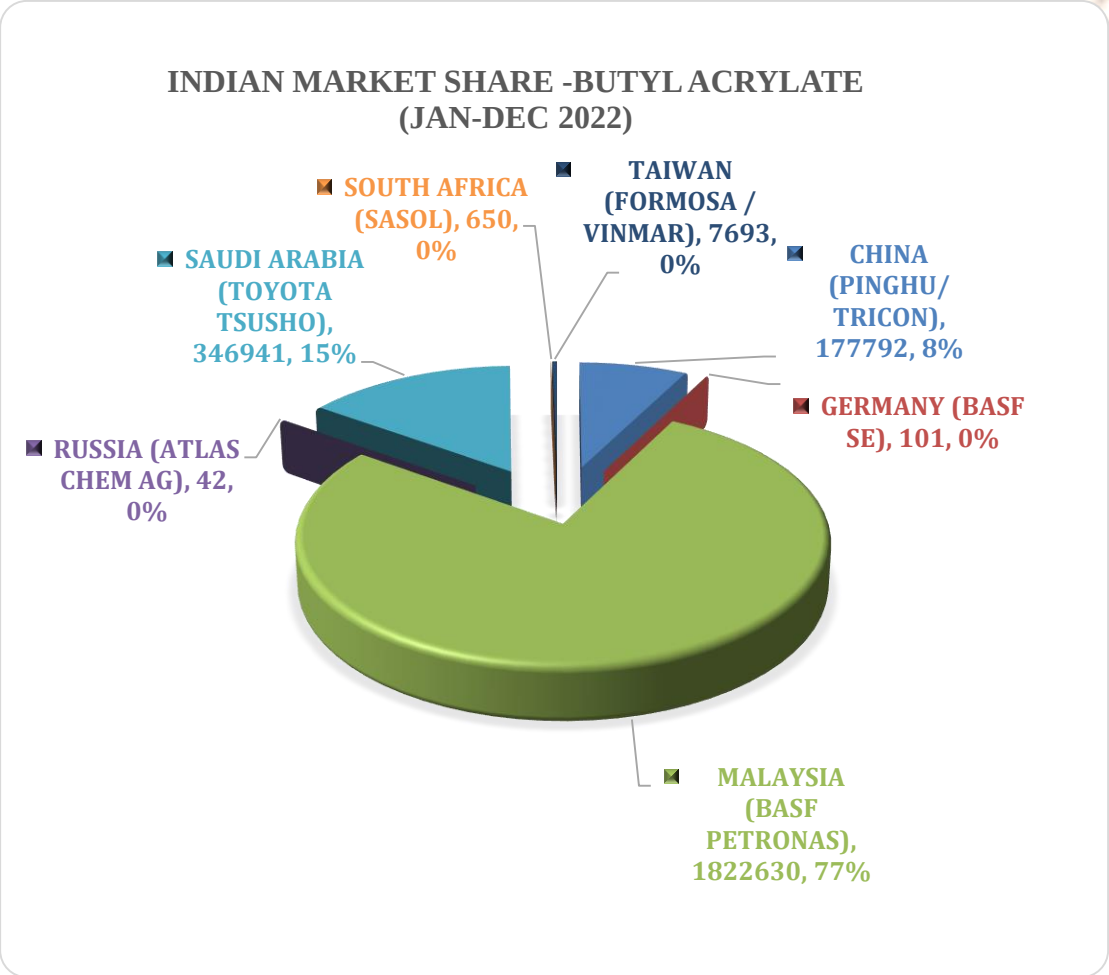
ORIGIN / SUPPLIERS	QUANTITY (MT)
TAIWAN (FORMOSA)	5419 59%)
SOUTH KOREA (LG CHEM)	1438 (16%)
CHINA (SATELLITE)	1660 (18%)
INDONESIA (TOYOTA)	505 (6%)
RUSSIA (ATLAS CHEM)	115 (1%)
TOTAL	**9137**



Interpretation:
From the above pie chart we came to know that Taiwan Country(59%) (FORMOSA) has highest export of Ethyl Hexyl Acrylate in Indian Market.

4.1.4BUTYL ACRYLATE

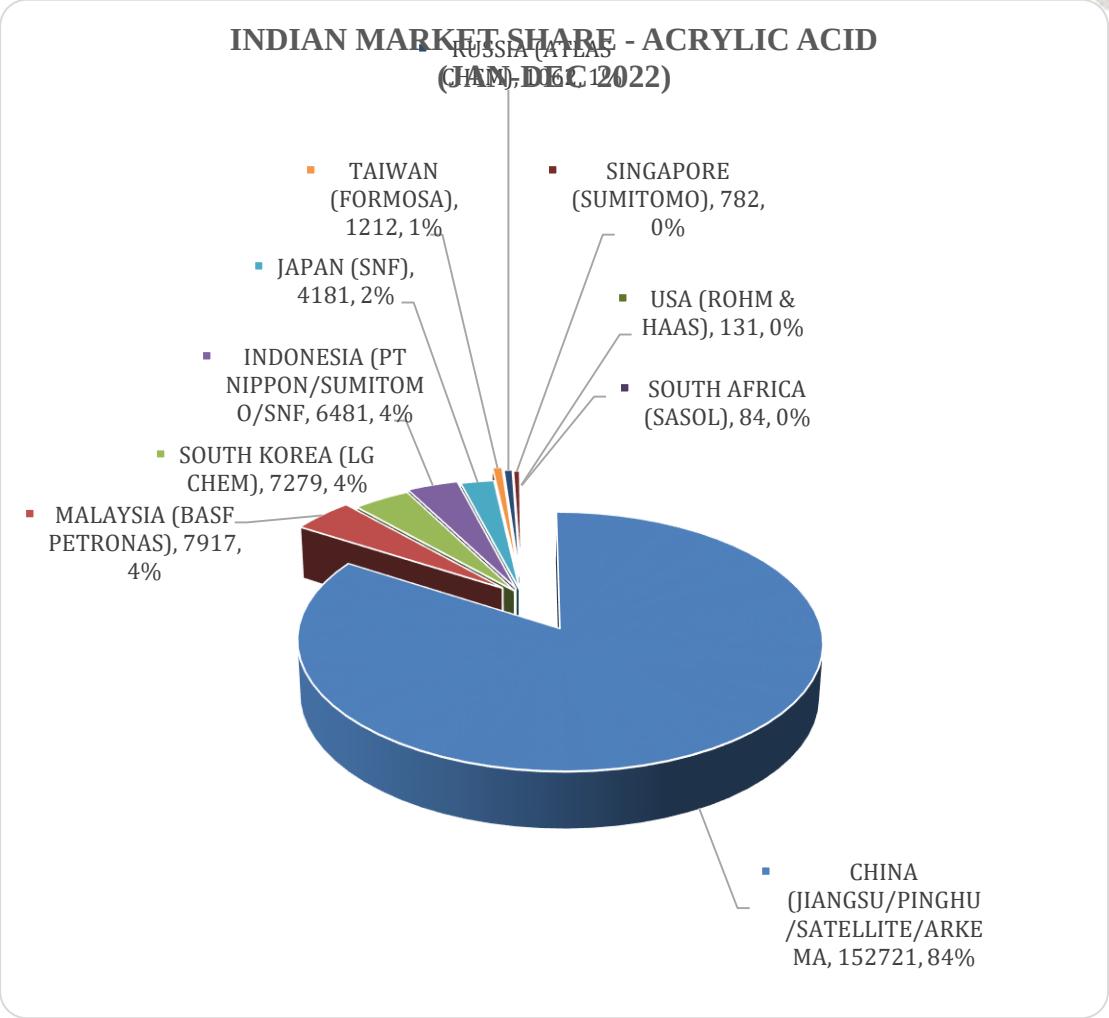
ORIGIN / SUPPLIERS	QUANTITY (MT)
CHINA (PINGHU/ TRICON)	177792 (8%)
GERMANY (BASF SE)	101 (0%)
MALAYSIA (BASF PETRONAS)	1822630 (77%)
RUSSIA (ATLAS CHEM AG)	42 (0%)
SAUDI ARABIA (TOYOTA TSUSHO)	346941 (15%)
SOUTH AFRICA (SASOL)	650 (0%)
TAIWAN (FORMOSA / VINMAR)	7693 (0%)
TOTAL	**2355849**



Interpretation:
From the above pie chart we came to know that Malaysia Country(77%) (BASF PETRONAS) has highest export of Butyl Acrylate in Indian Market lowest from GERMANY (BASF SE)

4.1.5 ACRYLIC ACID

ORIGIN / SUPPLIERS	QUANTITY (MT)
CHINA (JIANGSU/PINGHU/SATELLITE/ARKEMA	152721 (84%)
MALAYSIA (BASF PETRONAS)	7917 (4%)
SOUTH KOREA (LG CHEM)	7279 (4%)
INDONESIA (PT NIPPON/SUMITOMO/SNF	6481 (4%)
JAPAN (SNF)	4181 (2%)
TAIWAN (FORMOSA)	1212 (1%)
RUSSIA (ATLAS CHEM)	1062 (1%)
SINGAPORE (SUMITOMO)	782 (0%)
USA (ROHM & HAAS)	131 (0%)
SOUTH AFRICA (SASOL)	84 (0%)
TOTAL	**181850**



Interpretation:
From the above pie chart we came to know that China Country (84%) has highest exporter of Acrylic acid in Indian Market lowest export from SOUTH AFRICA (SASOL)

Acrylic Acid serves as a monomer for various acrylic polymers, including polyacrylic and polymethacrylic acids. Major applications of acrylic acid are for the manufacturing of Acrylic Esters and Super Absorbent Polymer (SAP). Furthermore, the numerous industrial applications of acrylic acid and its derivatives and copolymers, are paints, coatings, adhesives, textiles, inks, and more.

The primary driver of the Acrylic Acid global market is the manufacturing of acrylate esters. Acrylate ester is widely employed for various applications such as paints & coatings, textiles, plastics, and adhesives.

This is largely driven by the growth observed in the construction sector and global infrastructure projects propelling the overall acrylic acid market. In addition, increasing use of butyl acrylates, by coating application is expected to further expand the overall market. The Acrylic Acid global market is anticipated to swell up to approximately 8500 thousand tonnes by the forecast period of 2030.

Based on demand by region, the Asia Pacific dominates the Acrylic Acid market with 48% of the market share of global Acrylic Acid in 2021. The demand for Acrylate Ester for applications in the construction sector is expected to expand in the future due to the rapid economic growth of nations like China and India.

Furthermore, the increase in demand for sanitary napkins and other personal hygiene products, is anticipated to swell up the demand for Super Absorbent Polymer, resulting in acceleration of the demand of Acrylic Acid in APAC. North America and Europe stand next in the line after Asia Pacific region. Asia Pacific is also leading as the producer of the global the Acrylic Acid market. In 2021, Asia Pacific contributed more than 50% of the global Acrylic Acid.

Based on the end-user industry, the global Acrylic Acid market is segmented into Acrylate Ester, Super Absorbent Polymer, Water Treatment, Detergent, Paper, and others. Among these industries, the Acrylate Ester sector dominates the Acrylic Acid market across the globe.

This industry consumed about 40% of the Acrylic Acid in 2021 and is expected to maintain its position in the forecast period. Super Absorbent Polymer sector is also a prominent consumer of Acrylic Acid. Super Absorbent Polymer displays amazing absorption properties and finds application in multiple industries.

The rise in demand for sanitary items and baby diapers with the increasing awareness regarding personal hygiene and other adult intimate products among people is expected to result in global Acrylic Acid market expansion in the forecast period.

Major players in the production of Global Acrylic Acid are

- Arkema SA
- BASF SE
- Nippon Shokubai Co. Ltd.
- LG Chem limited
- The Dow Chemical Company
- Jiangsu Jurong Chemical Co. Ltd
- Zhejiang Satellite Petro Chemical Co. Ltd.
- BASF-YPC Company Limited
- Wanhua Chemical Group Co. Ltd.
- Evonik Industries AG
- Shanghai Huayi Acrylic Acid Co. Ltd.

Years considered for this report:

- Base Year: 2021
- Estimated Year: 2022
- Forecast Period: 2023-2030

4.2MAJOR CUSTOMERS OF ACRYLIC ACID AND ACRYLATES

4.2.1 MAJOR CUSTOMERS OF ACRYLIC ACID

YAHSKA PLOYMERS PVT LTD
AQUAPHARM CHEMICALS PVT LIMITED
AUM ADHESIVES PVT LTD
REENA ORGANICS PRIVATE LIMITED
KLJ RESOURCES LTD
SHIVA PERFORMANCE MATERIALS PRIVATE LIMITED
SNF FLOPAM INDIA PRIVATE LIMITED
SNF INDIA PVT LTD
AUM ADHESIVES PVT LTD
PETCHEM PRODUCTS PRIVATE LIMITED
ROSSARI BIOTECH LTD
NASENSE LABS PVT LTD
SIKA INDIA PRIVATE LIMITED
REDA CHEMICALS INDIA PRIVATE LIMITED
STAHL INDIA PRIVATE LIMITED
CREST COMPOSITES PLASTICS PVT LTD
AAREY DRUGS PHARMACEUTICALS LTD
SHIVA PERFORMANCE MATERIALS PRIVATE LIMITED
ANUVI CHEMICALS LTD
FINEOTEX CHEMICAL LTD
AAREY DRUGS PHARMACEUTICALS LTD
HUBERGROUP INDIA PRIVATE LIMITED
APCOTEX INDUSTRIES LTD
AEZIS GLOBAL PRIVATE LIMITED
AROFINE POLYMERS PVT LIMITED
PETCHEM PRODUCTS PRIVATE LIMITED
ANSHIKA POLYSURF LIMITED
ULTIMATE CHEM INDIA PRIVATE LIMITED
JESONS INDUSTRIES LIMITED
PRISM JOHNSON LIMITED
VAPI PRODUCTS INDUSTRIES PVT LTD
KELVIN BIO ORGANICS PRIVATE LIMITED
ION EXCHANGE INDIA LIMITED
G G ORGANICS PRIVATE LIMITED
CHRYSO INDIA PRIVATE LIMITED
COREL PHARMA CHEM
VIMAL INTERTRADE PVT LTD
NIKHIL ADHESIVES LTD
KANSAI NEROLAC PAINTS LIMITED
ASIAN PAINTS LTD
BERGER PAINTS INDIA LIMITED
GUJARAT POLYSOL CHEMICALS PVT LTD
THURS ORGANICS PVT LTD
CONCRETE ADDITIVES AND CHEMICALS PRIVATE LIMITED
SNF FLOPAM INDIA PRIVATE LIMITED
PAARICHEM RESOURCES LLP

J P DYECHEM PVT LTD
VISEN INDUSTRIES LIMITED
DAI-ICHI KARKARIA LIMITED
PIDILITE INDUSTRIES LIMITED
FUJIFILM SERICOL INDIA PVT LTD
LUPITITE POLYMER INDUSTRIES
RSD POLYMERS PVT LTD
AIM CHEMICALS INGREDIENTS
TRISHA SPECIALITY CHEMICALS PRIVATE LIMITED
AQUAPHARM CHEMICALS PVT LIMITED
JSV INGREDIENT
ELPPE CHEMICALS PRIVATE LIMITED
DON CONSTRUCTION CHEMICALS INDIA PRIVATE LIMITED
BASF INDIA LIMITED
HIMADRI SPECIALITY CHEMICAL LTD
MITHILA RASAYAN PVT LTD
VINATI ORGANICS LTD
NALCO WATER INDIA LIMITED

4.2.2 MAJOR CUSTOMERS OF METHYL ACRYLATE

HPL ADDITIVES LIMITED
ION EXCHANGE INDIA LIMITED
R NANDLAL SONS
VAMSI LABS LTD
SAHASTRAA EXPORTS PVT LTD
TAGOOR CHEMICALS PRIVATE LIMITED
UPL LTD
AEZIS GLOBAL PRIVATE LIMITED
VASUDHA PHARMA CHEM LTD
GARWARE POLYESTER LTD
CHEMTRADE GLOBAL IMPEX LLP
ASSOCIATED DYE CHEM CORPORATION
SHAKTI CHEMICALS
GARWARE POLYESTER LTD
AEZIS GLOBAL PRIVATE LIMITED
HINDPRAKASH TRADELINK PRIVATE LIMITED
VEERAL ADDITIVES PRIVATE LIMITED
VIPLUS PHARMACEUTICALS PRIVATE LIMITED
LOHITHA LIFE SCIENCES PVT LTD
PAARICHEM RESOURCES LLP
LEO CHEMOPLAST PVT LTD
SHILPA MEDICARE LIMITED
AQUAPHARM CHEMICALS PVT LIMITED
SANJAY CHEMICALS I PVT LTD
SHAH C J WORLD LLP
K UTTAMLAL COMPANY
AVRA LABORATORIES PVT LTD

ATMY ANALYTICAL LABS PRIVATE LIMITED
COLOURTEX INDUSTRIES PRIVATE LIMITED
DHARA LIFESCIENCE PRIVATE LIMITED
FLORA CHEMICALS
CHEMICAL CORP PRIVATE LIMITED
VASTANI CHEMICALS LIMITED

4.2.3 MAJOR CUSTOMERS OF ETHYL ACRYLATE

DOW CHEMICAL INTERNATIONAL PRIVATE LIMITED
BERGER PAINTS INDIA LIMITED
DHARA LIFESCIENCE PRIVATE LIMITED
DRAGADO INFRA INTERNATIONAL PRIVATE LIMITED
K UTTAMLAL COMPANY
ANUVI CHEMICALS LTD
SHIVA PERFORMANCE MATERIALS PRIVATE LIMITED
INDOFIL INDUSTRIES LTD
PETCHEM PRODUCTS PRIVATE LIMITED
JESONS INDUSTRIES LIMITED
INTERNATIONAL FLAVOURS FRAGRANCES INDIA PRIVATE
NIKHIL ADHESIVES LTD
BASF INDIA LIMITED
DHUPAR CHEMICALS PVT LTD
SUPREME INDIA INTERNATIONAL
COREL PHARMA CHEM
HAZEL MERCANTILE LIMITED
K UTTAMLAL COMPANY
SHAH C J WORLD LLP
JADAVJI SONS
VISEN INDUSTRIES LIMITED
SNF INDIA PVT LTD
SIKA INDIA PRIVATE LIMITED
HERALDS TRADING PVT LTD
MACRO POLYMERS PVT LTD
ARKEMA CHEMICALS INDIA PRIVATE LIMITED
HINDUSTAN CHEMICAL INDUSTRIES
KANSAI NEROLAC PAINTS LIMITED

COREL PHARMA CHEM
SHAKTI CHEMICALS
SANJAY CHEMICALS I PVT LTD
CHIRIPAL INDUSTRIES LTD
VAPI PRODUCTS INDUSTRIES PVT LTD
JADAVJI SONS
PIDILITE INDUSTRIES LIMITED
BASF INDIA LIMITED
STAHL INDIA PRIVATE LIMITED
R NANDLAL SONS
HINDUSTAN CHEMICAL INDUSTRIES
SHAKTI CHEMICALS
CHEMICAL CORP PVT LTD
LEO CHEMOPLAST PVT LTD
HINDPRAKASH TRADELINK PRIVATE LIMITED
VINAY CHEMOPLAST INDUSTRIES
SOHAM POLYMERS PVT LTD
K UTTAMLAL COMPANY
R NANDLAL SONS
COREL PHARMA CHEM
STAHL INDIA PRIVATE LIMITED
R NANDLAL SONS
SUPREME INDIA INTERNATIONAL
SANMAN TRADE IMPEX LIMITED
IMPERIAL SALES CORPORATION
IMPERIAL SALES CORPORATION
ACCORD CHEMICAL CORPORATION
DHARA LIFESCIENCE PRIVATE LIMITED
TFL QUINN INDIA PRIVATE LIMITED
LOK CHEMICALS PVT LTD
HINDPRAKASH TRADELINK PRIVATE LIMITED
TRICOLOUR ENTERPRISES
MLJP CHEMICALS LIMITED
AMBANI ORGANICS LIMITED
ANUVI CHEMICALS LTD
VIKRAM THERMO INDIA LTD

DHUPAR CHEMICALS PVT LTD
PIDILITE INDUSTRIES LIMITED
PIONEER CHEMICAL INDUSTRIES PVT LTD
MANE INDIA PVT LTD
SPECIALITY INDUSTRIAL POLYMERS COATINGS PVT LTD
DRAGADO INFRA INTERNATIONAL PRIVATE LIMITED
NEELAM PRODUCTS
TFL QUINN INDIA PRIVATE LIMITED
GIVAUDAN (INDIA) PRIVATE LIMITED

4.2.4 MAJOR CUSTOMERS OF 2-ETHYL HEXYL ACRYLATE

NIKHIL ADHESIVES LTD
ULTIMATE CHEM INDIA PRIVATE LIMITED
KANSAI NEROLAC PAINTS LIMITED
ASTRA CHEMTECH PVT LTD
ASIAN PAINTS LTD
AMBANI ORGANICS LIMITED
PIDILITE INDUSTRIES LIMITED
VISEN INDUSTRIES LIMITED
NIKHIL ADHESIVES LTD
JESONS INDUSTRIES LIMITED
VIMAL INTERTRADE PVT LTD
VAPI PRODUCTS INDUSTRIES PVT LTD
ASIAN PAINTS LTD
BASF INDIA LIMITED
GARWARE POLYESTER LTD
SHIVA PERFORMANCE MATERIALS PRIVATE LIMITED
ULTIMATE CHEM INDIA PRIVATE LIMITED

4.2.4 MAJOR CUSTOMERS OF BUTYL ACRYLATE

ARKEMA CHEMICALS INDIA PRIVATE LIMITED
HINDUSTAN ADHESIVES LTD
EOC TAILOR MADE POLYMERS INDIA P LITD
SOHAM POLYMERS PVT LTD
CHEMI TECH ENGINEERS PVT LTD
PIDILITE INDUSTRIES LIMITED
KAMSONS POLYMERS PRIVATE LIMITED
SHIVA PERFORMANCE MATERIALS PRIVATE LIMITED
PETCHEM PRODUCTS PRIVATE LIMITED
CHIRIPAL INDUSTRIES LTD
ACCORD CHEMICAL CORPORATION
MLJP CHEMICALS LIMITED
JESONS INDUSTRIES LIMITED
BERGER PAINTS INDIA LIMITED
KANSAI NEROLAC PAINTS LIMITED
AROFINE POLYMERS PVT LIMITED
PETCHEM PRODUCTS PRIVATE LIMITED
ATULIT CHEMICAL PRODUCTS PVT LTD
SPECIALITY INDUSTRIAL POLYMERS COATINGS PVT LTD
ADITYA CHEMICALS
VISEN INDUSTRIES LIMITED
AMBANI ORGANICS LIMITED
MEXIM ADHESIVE TAPES PVT LTD
MLJP CHEMICALS LIMITED
APOLLO INDUSTRIES
UJIN PHARMACHEM
HINDPRAKASH TRADELINK PRIVATE LIMITED
ARYANN CHEMICAL TRADING PRIVATE LIMITED
APOLLO INDUSTRIES
ARCHROMA INDIA PRIVATE LIMITED
ARYANN CHEMICAL TRADING PRIVATE LIMITED
ASTRA CHEMTECH PVT LTD
PIDILITE INDUSTRIES LIMITED
NIKHIL ADHESIVES LTD
BASF INDIA LIMITED
ACCORD CHEMICAL CORPORATION
INDOFIL INDUSTRIES LTD
JUPITER DYE CHEM PVT LTD
HINDUSTAN ADHESIVES LTD
GUNJAN PAINTS LIMITED
ATULIT CHEMICAL PRODUCTS PVT LTD
POWERBAND INDUSTRIES PRIVATE LIMITED
MEXIM ADHESIVE TAPES PVT LTD
ADITYA MERUCHEM PRIVATE LIMITED
IPG ASIA PRIVATE LIMITED
EOC TAILOR MADE POLYMERS INDIA P LITD
IPG ASIA PRIVATE LIMITED

4.2MAJOR SUPPLIERS OF ACRYLIC ACID AND ACRYLATES

JIANGSU SANMU GROUP CO LTD	CHINA
SATELLITE CHEMICAL CO LTD	CHINA
PINGHU PETRO CHEMICAL CO LTD	CHINA
SATELLITE CHEMICAL CO LTD	CHINA
ARKEMA COMPANY LTD	CHINA
FORMOSA PLASTICS CORPORATION	TAIWAN
DOW CHEMICAL INTERNATIONAL PVT LTD	USA
LG CHEM LTD	SOUTH KOREA
ROHM & HAAS TEXAS INC.	USA
SASOL MIDDLE EAST FZCO	SOUTH AFRICA
MITSUI CO ASIA PACIFIC PTE LTD	SINGAPORE
PT NIPPON SHOKUBAI INDONESIA	INDONESIA
SUMITOMO CORPORATION ASIA OCEANIA PTE LTD	INDONESIA
BASF SE	GERMANY
ATLAS CHEM AG	RUSSIA
BASF PETRONAS CHEMICALS SDN BHD	MALAYSIA
SNF COMPANY LTD	JAPAN
TRICON ENERGY LTD	USA
OXYDE CHEMICALS SINGAPORE PTE LTD	CHINA
TOYOTA TSUSHO CORPORATION	SAUDI ARABIA
VINMAR INTERNATIONAL LLC	TAIWAN
SAM YUNG TRADING CO LTD	CHINA

CHAPTER 5:

FINDINING and SUGGESSION:

5.1 New capacity may be based on propylene as the raw material. Currently only BPCL started productions of acrylic acid but since no technology base is available for other Acrylates in India so import becomes inevitable.

5.2 R&D efforts should be directed towards development of technology for propylene-based routes since this technology is difficult to get and technology fees are also very high (approx. Rs.500 to Rs.1000crores) A25000 TPA Acrylates plant is expected to cost between Rs. 800 to Rs. 1000 Crores and projects become unviable. If our laboratories able to develop this technology, we may in position to export the same. In addition to building our capacity in a propylene-based Acrylates plant. With indigenously developed technology, the project cost is expected to be substantially lower than the above figure Rs. 800 to Rs. 1000 crores.

5.3 BPCL set to commission acrylate unit at Rs 6000-crore Kochi PDP complex by June-end.

KOCHI: Kochi Refinery, the largest asset of Bharat Petroleum, is set to complete a Rs 6,000-crore PDP complex by this month-end with the commissioning of the last unit that will manufacture niche petrochemical product acrylate, helping the nation save over Rs 4,000 crore in foreign exchange annually.

The Rs 6,000-crore propylene derivatives petrochemical (PDP) complex got delayed by a year due to the pandemic as project engineers from Japanese giant Mitsubishi, the technology and engineering partner of the project, could not travel to the project site in Kochi, forcing BPCL to get most of the project monitoring work done virtually.

The Kochi PDP complex marks the first major endeavour in the country, either in the public or private sector, to produce niche petrochemicals which are predominantly being imported now.

The unit making acrylate -- the key input used by the specialty chemicals, plasticisers and paints and adhesives industries -- is the third and the final unit, planned to be commissioned last June, but got delayed and leading to a cost escalation to Rs 6,000 crore from a little over Rs 5,000 crore for the divestment-bound BPCL.

The company is on course to complete the acrylate unit by the end of this month.

With the commissioning of this unit, the Rs 6,000-crore PDP complex is complete and will help save at least Rs 4,000 crore in import bill annually, Sanjay Khanna, the executive director in-charge of refineries at BPCL, told PTI.

The first unit of the complex was commissioned in February, making it the first unit in the country producing acrylic acid, and the second unit producing oxo-alcohol was commissioned in April this year.

The complex can produce 3.29 lakh kilo tonnes of niche petrochemicals such as butyl acrylate (1,80,000 metric tonnes per annum or mtpa), 10,000 mtpa of ethyl hexyl acrylate, 47,000 mtpa of acrylic acid, 47,000 mtpa of ethyl hexanol and 38,000 mtpa of normal butanol, S Jena, executive director (industrial and commercial) at BPCL told PTI.

Jena said that these products are fully imported but now the end user industries in the specialty chemicals, plasticisers and paints and adhesives segments can save Rs 4,000 crore in foreign exchange annually.

With the commissioning of the PDP complex, BPCL joins the world leaders in this space such as Tasnee of Saudi Arabia, Dow Chemicals of the US, BASF of Germany and Sasol of South Africa, among others, which control the 22 million tonnes market globally.

These six niche products will together replace almost 90 per cent of the imports in this segment, Khanna said.

The unit making acrylic acid -- used in hygienic medical products, detergents, wastewater treatment chemicals, plastics, coatings, adhesives, elastomers, paints and polishes -- is the largest single train unit in the world with capacity of 1.6 lakh mtpa and also the first in the country. "Most of the user industries are primarily in Gujarat and Maharashtra," Jena said.

Normal butanol is second of the six major niche petrochemicals being produced for the first time in the country.

Again, vast majority of the end-customers are in Gujarat and Maharashtra and around 10 per cent in Tamil Nadu, Jena said, adding normal butanol finds application in plasticisers, textiles, impact modifiers for rigid PVC, amino resins and butyl amines.

Annual consumption of normal butanol, predominantly by plasticisers and automotive paint manufacturers, is 60-65 MT, which was mostly imported till now. Kochi Refinery is equipped to produce 38 MT annually. "Over the next few weeks, commercial production of oxo-alcohols and acrylates will also commence," Jena added.

Jena said with the commissioning of the PDP complex, the domestic industry will also gain from price stability and assured supplies in shorter time as imports involve considerable transit time, supply uncertainty and price unpredictability.

On average, the prices will come down by USD 200 from USD 18,000 a tonne. Khanna said the complex took 35-million-man days for construction, and will open up more job opportunities with allied industries in the upcoming petrochemical park in Kochi.

BPCL had earlier this month said it had indigenously developed the country's maiden superabsorbent polymer technology, a project which will also come up adjacent to the PDP complex, and which will save Rs 1,000 crore in forex.

The PDP complex will be the feedstock for this complex that will manufacture superabsorbent polymers used in various hygiene products like diapers.

In the first phase, BPCL will set up a small unit with 200 metric tonne capacity to produce superabsorbent polymer at Kochi Refinery, which in the second phase will go up to 50,000 metric tonnes per annum.

5.4 The Indian Oil Corporation (IOCL) has placed USD 255 million contract on Tecnimont, the Indian entity of Italian firm Tecnimont, for implementation of new acrylic acid and butyl acrylate units for production of high value added products for the chemical market.

As per the lump sum contract for engineering, procurement, construction and commissioning, (EPCC) the units will be located in Dumad, near Vadodara in Gujarat.

Once commissioned, the acrylic acid unit will have a capacity of 90,000 tpa, while the new butyl acrylate unit will have a capacity of 1,50,000 tpa.

The time schedule is 26 months for mechanical completion and expected to start productions in Year 2025

CONCLUSIONS

6.1 BPCL have successfully implemented production facilities of propylene-based technology & already started productions of Acrylic Acid and Acrylates.

6.2 IOCL also started implementing production facilities of propylene -based technology for Acrylic Acid and Acrylates & most probably production of Acrylates (also Acrylic acid) will start in year 2025.

6.3 Total consumer demand of acrylic acid 182 thousand metric tons during year Jan – Dec 2022 and Total consumer demand of Acrylates 2500 thousand tons during year Jan-Dec 2022 calculated based on import trade dynamics.

6.4 As of today, Indian Acrylates consumers totally depends on imports except BPCL as a local manufacturer.

Both BPCL and IOCL will start production with full capacity of acrylic acid 130 thousand tons (BPCL) and 90 thousand tons (IOCL) then we can able to fulfil current demand of 182 thousand tons of Acrylic Acid but need bigger production capacity to fulfil current demand of Acrylates 2500 thousand tons.

FUTURE SCOPE OF STUDY

1.1 Global Acrylates forecasted demand 8500 thousand tons estimated during year 2023-2030 and Indian Acrylates estimated demand 50% of the Global Acrylates i.e., 4250 thousand tons estimated till year 2030. However, propylene-based Acrylate's plant would be required to have a bigger capacity, which is of the order of 5000 to 6000 thousand tons per annum.

1.2 India Acrylate ester market stood at 0.26 million Tons in FY2022 and is forecast to reach 0.46 million Tons in FY2030 growing at healthy CARG of 6.51% until 2030. Increasing use of acrylic esters in paints & coatings, adhesive, textiles and plastics. India's constructions industry expected to expand over the forecast period driven by the Governments efforts to develop the country's infrastructure and improve the housing sector. Increasing demands of paints & coatings industry, Adhesives & plastic industry due to improved characteristics adaptation such as heat and ageing resistance, less toxicity, colour stability and low temperature flexibility is expected to drive end user industry.

Acrylates are also used as precursor of industrial polymer and have great stability at transition temperature in comparison to the normal polymers, which shows that transition at glass temperature and lose their property, while acrylates remain stable.

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