CHEM3020: POLYMER CHEMISTRY

Unit-5: Preparation, structure, properties and application of polymers

VINYL AND, ACRYLIC POLYMERS

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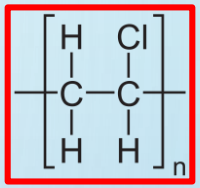
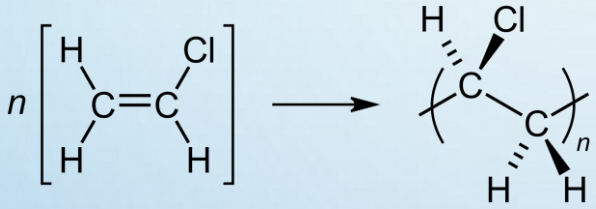
Polyvinyl Chloride (PVC):

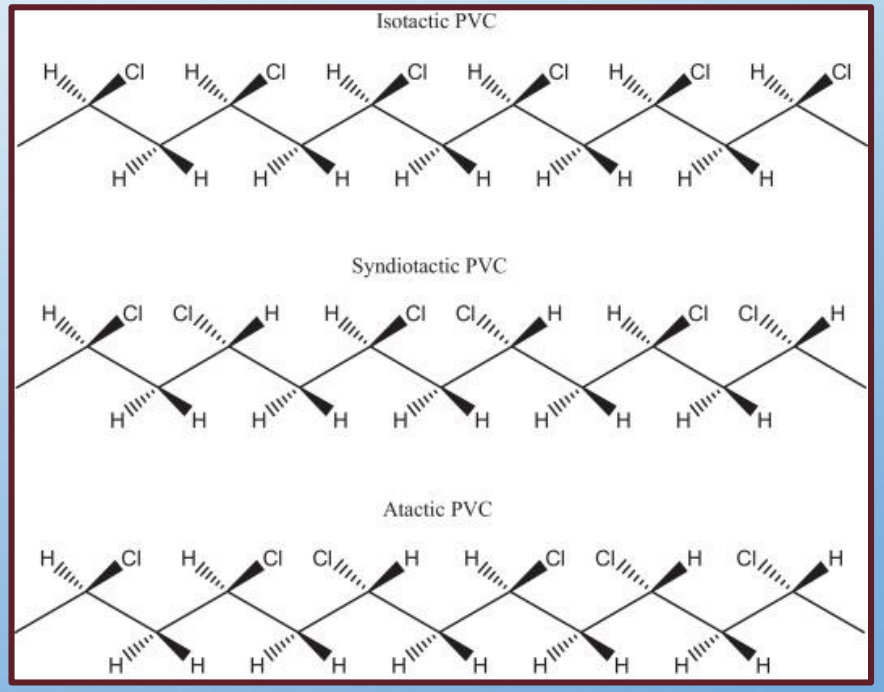
Polyvinyl Chloride (PVC): The manufacture of Polyvinyl Chloride (PVC) follows addition type kinetics and produces linear polymers. The vinyl chloride monomer is a gas at room temperature and pressure.





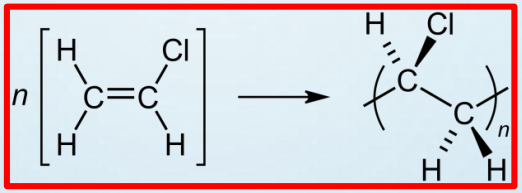
Configuration of Polyvinyl Chlorides:

The relative stereochemistry of the chlorides centres in PVC are randomly arranged and hence, PVC shows mainly an atactic stereochemistry.



Polyvinyl Chloride (PVC):

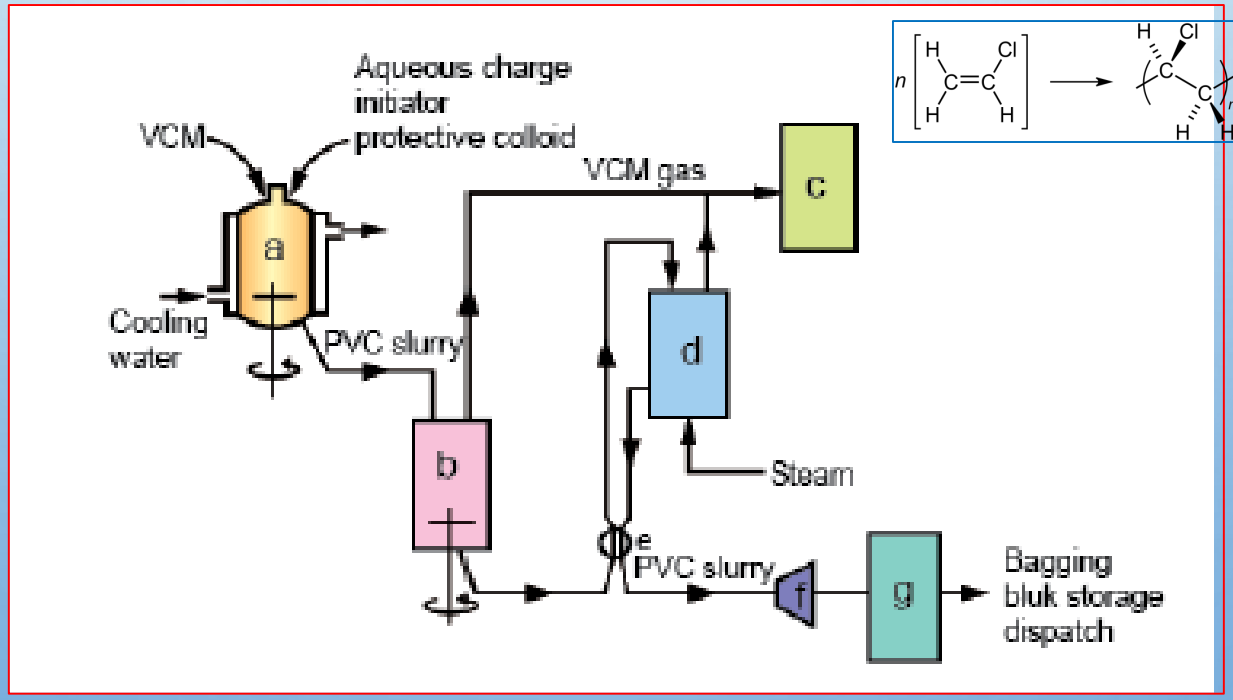
Manufacturing of Polyvinylchloride: The two most commercially use methods for the manufacture of PVC are Emulsion Polymerization and Suspension Polymerization.

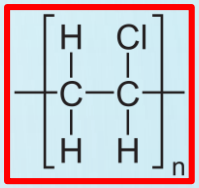


Suspension Polymerization: The Suspension Polymerization process is actually a bulk polymerization process which is carried out in millions of droplets. Each of these droplets act as small reactors. The liquid vinyl chloride is dispersed in water by vigorous stirring in a reactor. The reactor is fitted with baffles for optimum agitation and also has a condenser for heat removal. A monomer soluble free radical initiator is added into the reactors and the reactor temperature is increased to 45–75^{0}C . Some of the initiators decomposes to free radicals, and the monomers in these droplets begin to polymerize. The polymerization reaction is highly exothermic and the generated heat is removed via cooling jackets or by boil–off to the condenser. Thereafter, the condensed monomer is returned to the reactor. Although the PVC is insoluble in its monomer, it is swollen by VCM to form a coherent gel. Even in the gel phase , the polymerization continues. The volume is reduced during the reaction as PVC is denser than monomer, therefore water is added to the reaction mixture to maintain the suspension.

Manufacturing of Polyvinylchloride:

The rate of polymerization decreases slowly due to decrease in the concentration of the monomer (vinyl chloride monomer, VCM) and the reaction is ended by adding a chain terminator or by removing the unreacted monomer. Even after removing the unreacted monomer, the aqueous slurry contains 2–3% unreacted monomer, which is then removed by stripping in a Stripping Column. The slurry is then passed through a heat exchanger and is passed through a continuous centrifuge to give a wet cake with 20 – 30 % moisture.





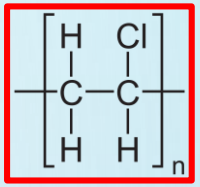
Properties and applications of PVC:

PVC has high hardness and mechanical properties. The mechanical properties enhance with the molecular weight increasing but decrease with the increase in temperature.

PVC is a polymer with good insulation properties, but because of its higher polar nature. The electrical insulating property is less as compared to the non-polar polymers such as polyethylene and polypropylene. it is generally suitable for medium or low voltage and low frequency insulation materials.

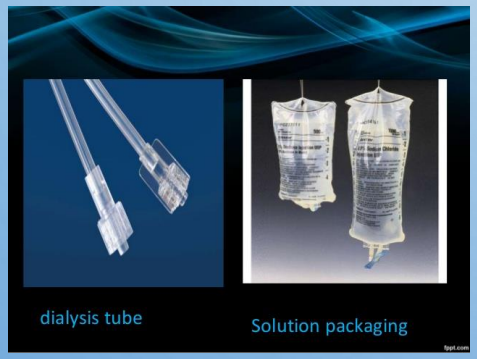
PVC is chemically resistant to acids, salts, bases, fats, and alcohols, making it resistant to the corrosive effects of sewage, which is why it is so extensively utilized in sewer piping systems.

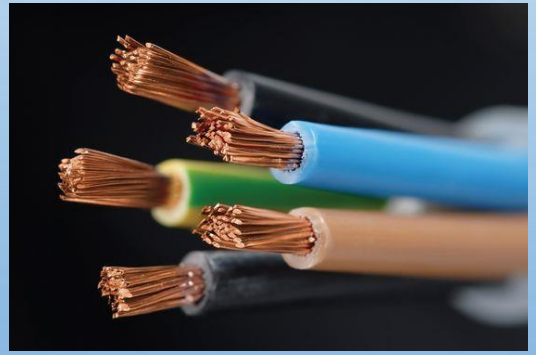
PVC fabric is water-resistant, used for its weather-resistant qualities in coats, skiing equipment, shoes, jackets, aprons, and sports bags.

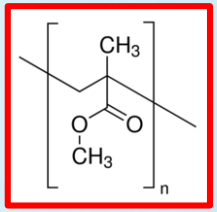


Applications of Poly(vinyl chloride)

PVC usually comes in rigid and flexible forms. The rigid form of PVC is used in construction for pipe and applications such as doors and windows. It is also used in making bottles, non-food packaging, food-covering sheets. It can be made softer and more flexible by the addition of plasticizers, the most widely used being phthalates as plasticizer. In this form, it is also used in plumbing, electrical cable insulation, imitation leather, flooring, signage, phonograph records, inflatable products,

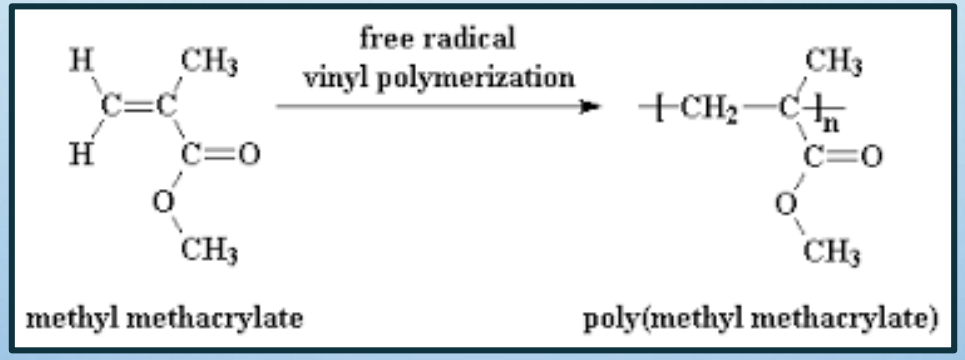




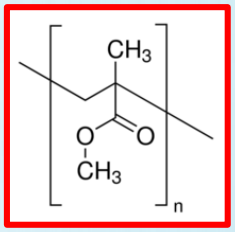


Acrylic polymers: Poly (methyl methacrylate)

Poly(methyl methacrylate) (**PMMA**): Poly(methyl methacrylate) also known as **acrylic**, **acrylic glass**, or **plexiglass** PMMA is routinely prepared by using emulsion polymerization, solution polymerization, and bulk polymerization. Usually , a radical initiator is used but in case of anionic polymerization of PMMA can also be performed. This is prepared by the polymerizartion of the vinyl ester, methyl methacrylate using benzoyl peroxide as a free radical chain initiators.

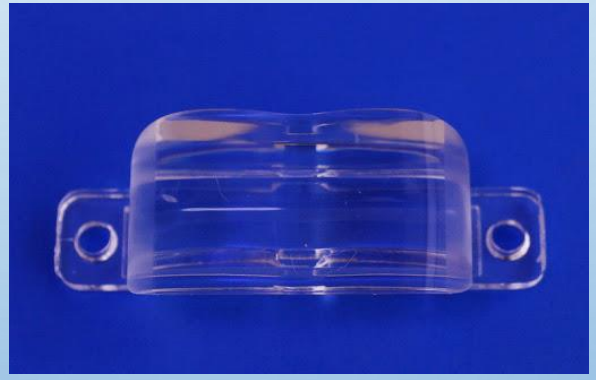


Properties: Poly(methyl methacrylate is a linear thermoplastic , about 70-75% syndiotactic. Due to lack of complete stereoregularity and its bulky groups, it is amorphous. The outstanding property is its optical clarity and lack of color.

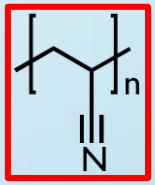


Applications of Poly(methyl methacrylate):

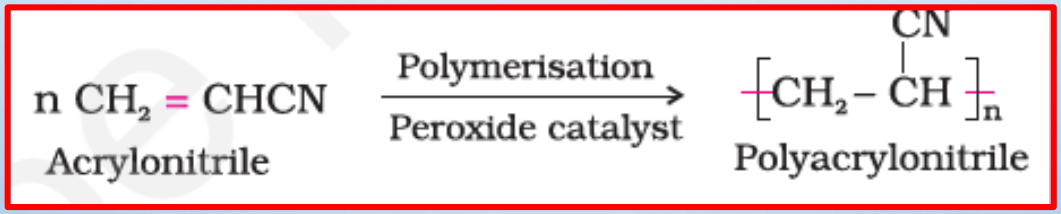
It is used in automotive lenses, reflective devices, instrument and appliance cover, optical equipment's and home furnishings. Acrylic sheeting's are used for sigs, glazing (in particular aircraft windows, furniture's, partitions.



Polyacrylonitrile



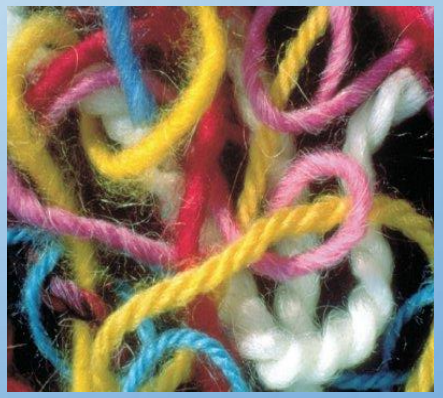
Polyacrylonitrile: The addition polymerization of acrylonitrile in presence of a peroxide catalyst leads to the formation of polyacrylonitrile. It is used as a substitute for wool in making commercial fibers as orlon or acrilan. **Polyacrylonitrile** (**PAN**), also known as polyvinyl cyanide and Creslan 61, is a synthetic, semicrystalline organic polymer resin.



Properties of acrylic fibers: The acrylic fibers exhibits the properties of very high strength, stiffness, toughness, abrasion resistance. They are relatively insensitive to moisture, good resistance to stains, chemicals, insects and fungi.

Application of Polyacrylonitrile

Homopolymers of polyacrylonitrile have been used as fibers in hot gas filtration systems, ultra filtration membranes, outdoor awnings, sails for yachts, hollow fibers for reverse osmosis, fibers for textiles and fiber-reinforced concrete. Its mechanical properties derived are important in composite structures for military and commercial aircraft.



References and suggestions for further reading:

1. Textbook of Polymer Science by Fred W. Billmeyer, Wiley

2. Polymer Chemistry by Charles E Carraher, Jr., Marcel Dekker, Inc.

3. Principle of Polymerization by George Odian, Wiley

THANK YOU