Polyvinyl Chloride

by

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Global Demand

- The global demand for Polyvinyl Chloride (PVC) has been steadily increasing over the last ten years.
- In 2000, global PVC demand stood at 22 MMT, before increasing to 32 MMT in 2011.
- A significant portion of the increase in demand for PVC was from the Asia-Pacific region, and the same trend is expected to continue in the forecast period.
- The Chinese construction sector is widely expected to be a driver for growth in the PVC industry in the next few years.

Global Demand

- PVC demand from the agriculture, packaging, electrical and automotive sectors in the Asia-Pacific region is also driving growth.
- The demand from these PVC-downstream end-use sectors is witnessing strong growth of more than 6% on average, providing a further boost to overall PVC demand.
- The Asia-Pacific region will continue to account for more than 65% of global PVC demand in 2020 and global demand for PVC is expected to grow to reach 50 MMT tons in 2020.

Global Capacity

- The global installed capacity for PVC production is currently 47.5 million tons per year. It is expected to grow to 59.1 million tons per year in 2020. The PVC production in world has grown from 24.7 million tons in 2000 to 32.3 million tons in 2009.

- It is expected to reach around 55.2 million tons in 2020.

- China Emerges as the Leader in Global Production.

PVC : A Unique Polymer

- Material of choice for Infrastructure and Construction sector
- Only polymer where basic organic building block can be extended more than 3 times while converting into value added end products- the remaining material being predominantly low cost inorganic in nature.
- Only polymer, where 60 - 70 % primary applications go into very long-life (more than 25 years) products, hence minimizing load on our fragile ecosystem.
- Only PVC has emerged as material of construction, meeting techno-economic requirements of modern society, while supplementing and complementing fast depleting natural resources like wood.

PVC : A Unique Polymer

- **PVC: Still the predominant material** which supports infrastructural requirements across the globe, meeting developing needs in this crucial sector.

- **PVC: Still facilitates growth of :**
- Building & Construction.
- Water Supply and Management.
- Power Distribution.
- Telecommunication.
- Medical Devices

PVC

While polyolefins are the first material of choice for packaging, PVC still continues to be the major building block for construction application segment.

Polymer for Infrastructure

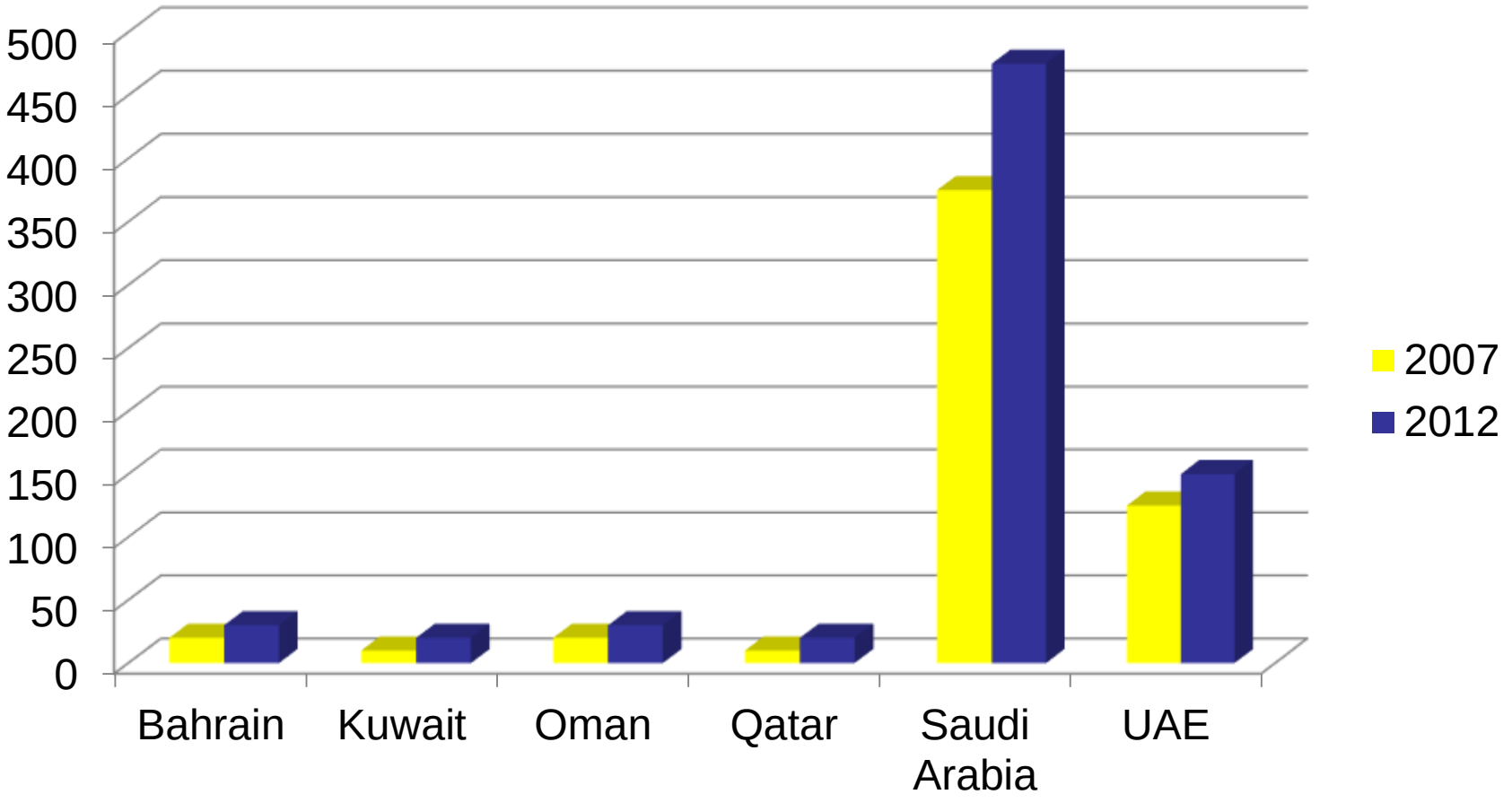
PVC in GCC - Supply

- PetroKemya (a SABIC affiliate) is the only producer in GCC, and operates a 436 000 tons per year plant producing mainly suspension PVC (S-PVC) and around 20 000 tons per year of emulsion PVC (E-PVC).
- There are currently no reported plans of future expansions. Overall, the region is a net major importer of PVC in the order of 300 000 tons per year, with SABIC exporting very little outside the GCC.

PVC in GCC - Demand

- Demand for PVC is driven by the construction industry in pipe and cable applications. Other rigid applications include profiles which are mainly used for window frames and doors. Pipe demand has been growing strongly on the back of the construction boom, particularly in sewerage where it has a high share of the market.
- PVC demand has risen by five percent since 2007 to its current 2012 level of 707,000 tons, and demand is forecast to grow over the next five at an annual rate of 8.7 percent as major infrastructure/construction projects are realised.

PVC in GCC


500
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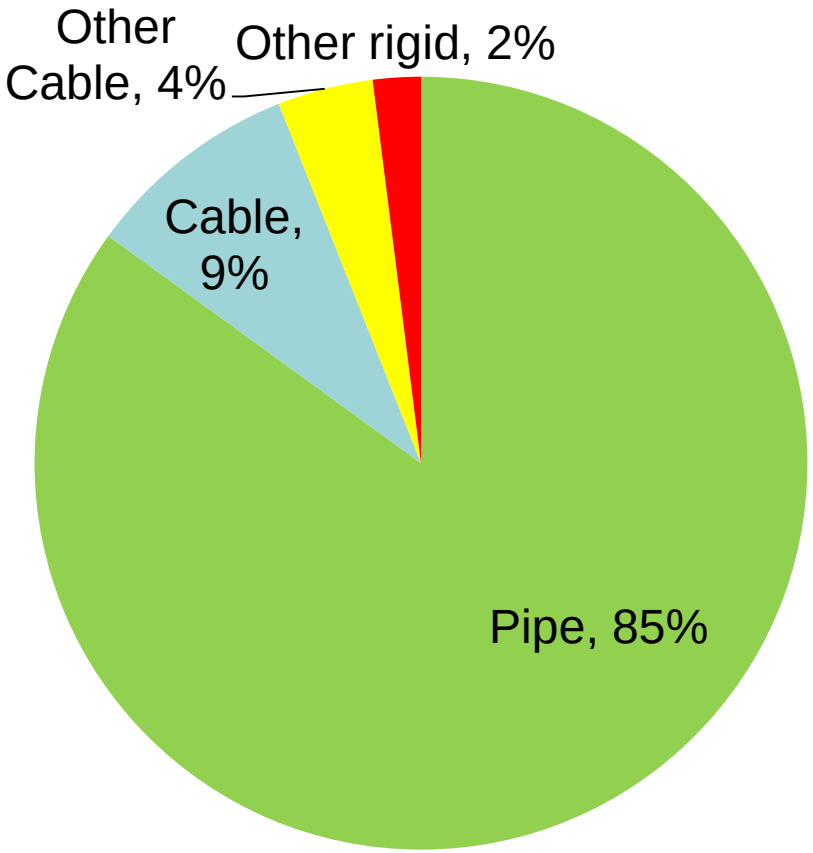
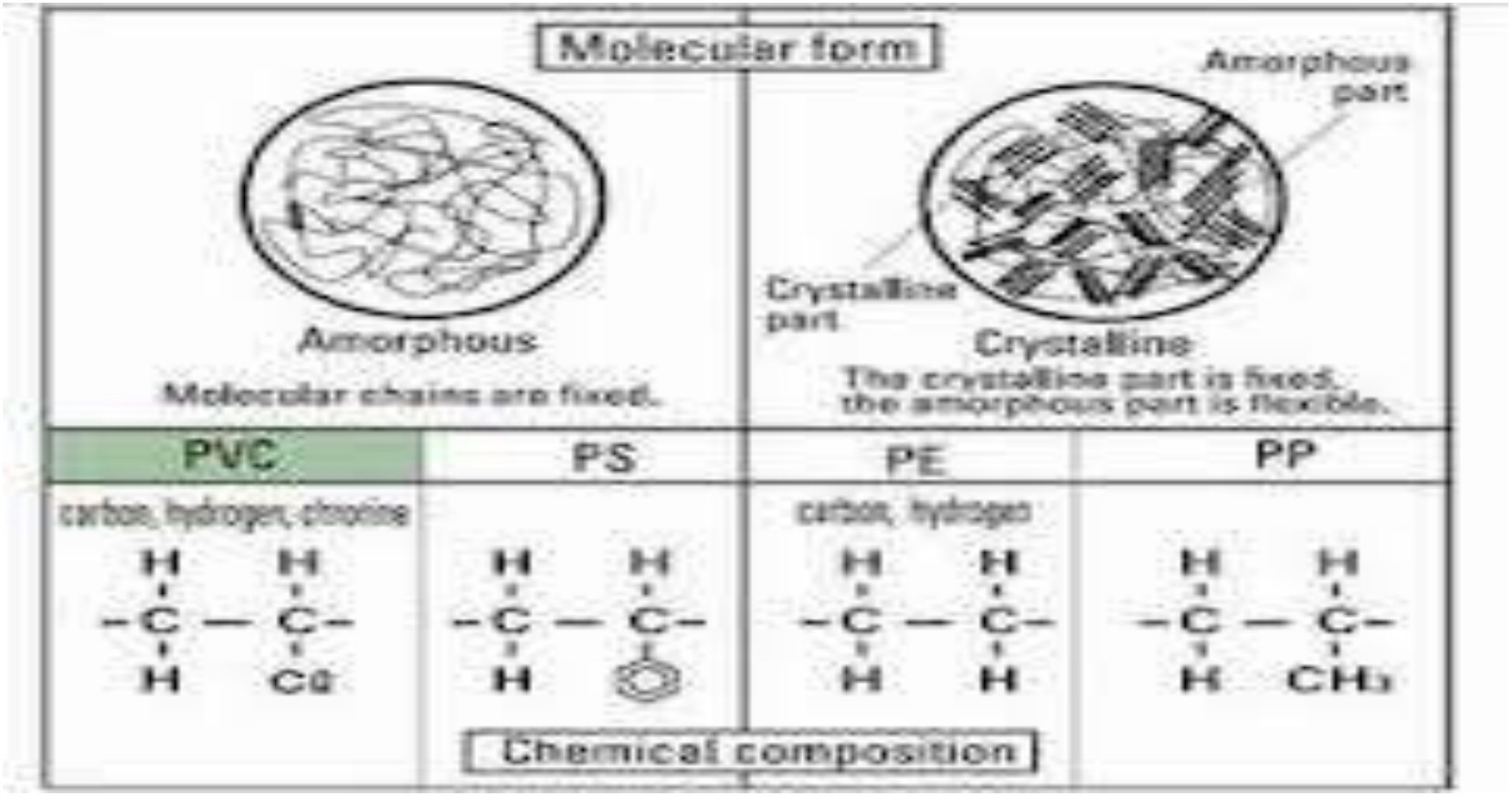
Saudi Arabia
UAE
2007
2012

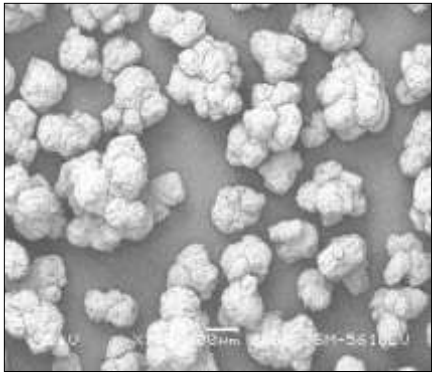
GGC Consumption in Sectors

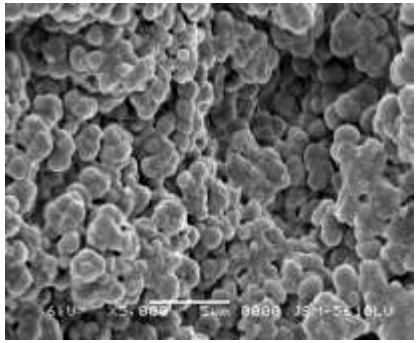


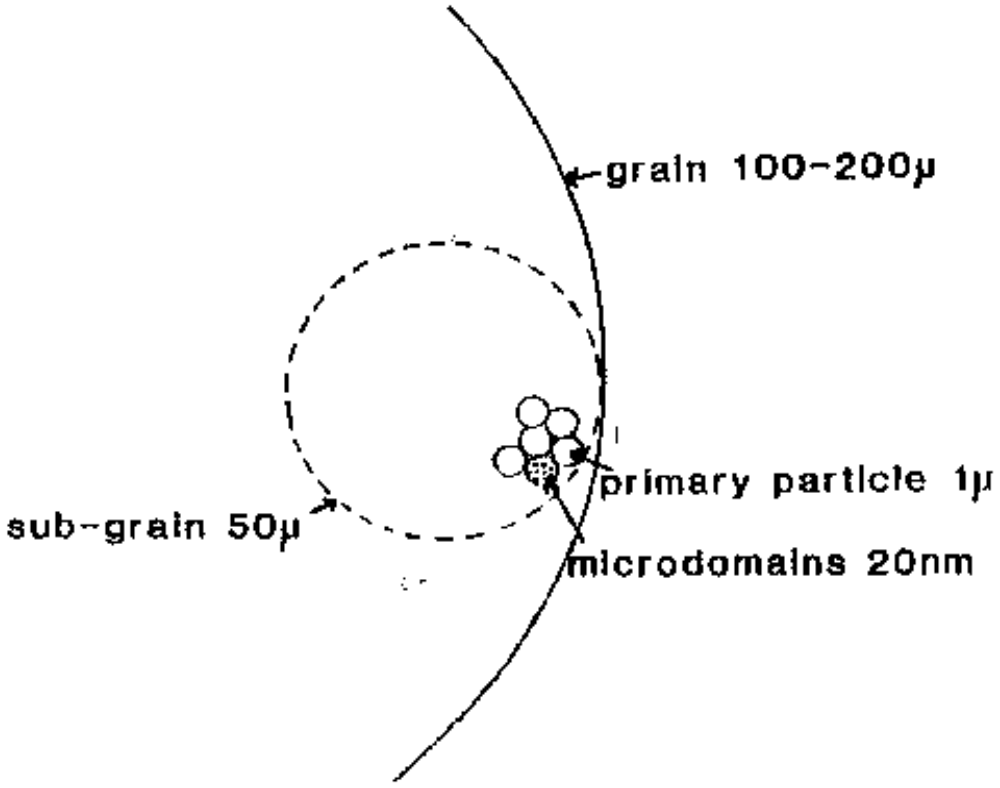
PVC Structure



PVC Particle Morphology





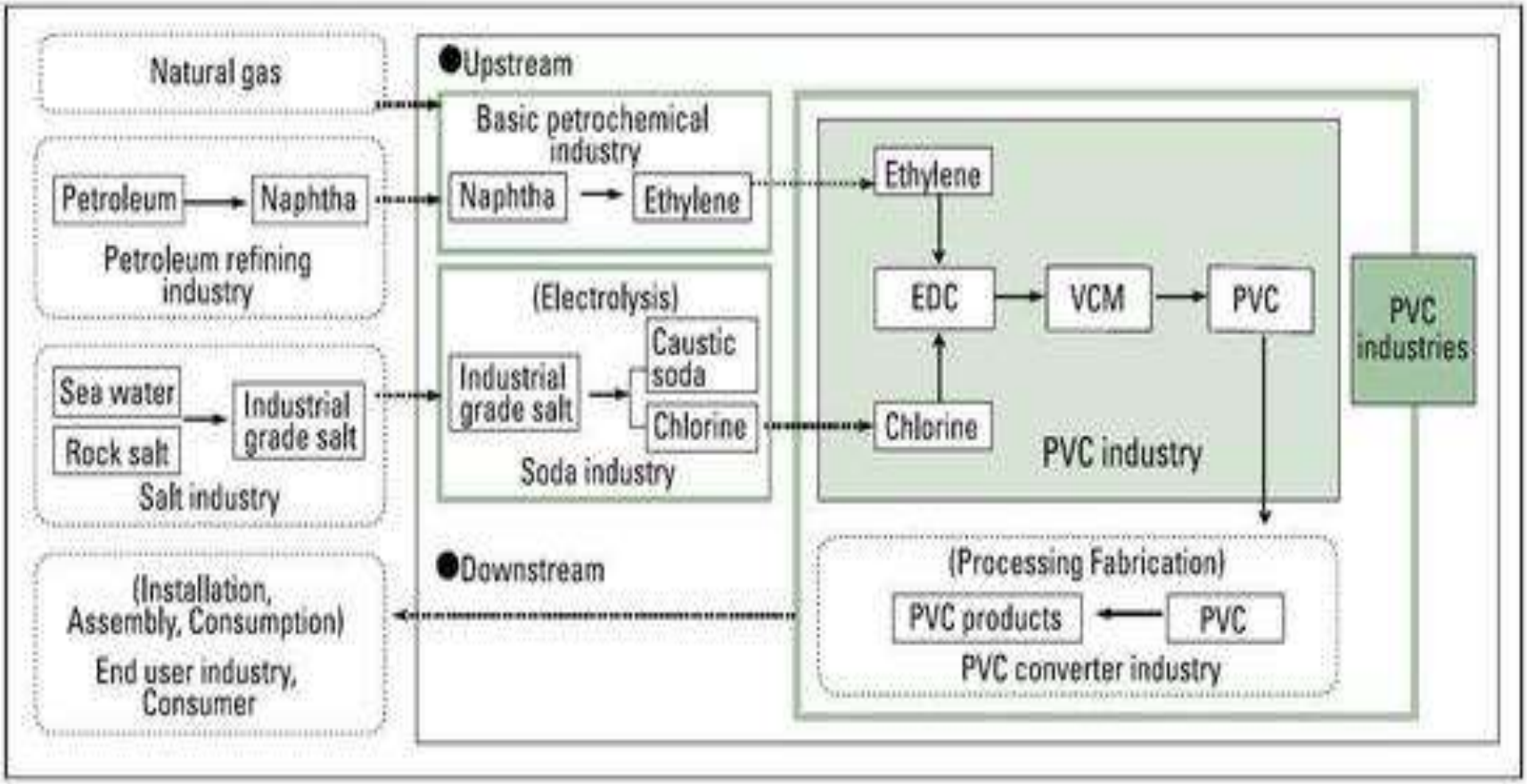


Polymerization of VCM to PVC

- The suspension polymerization process is most widely used process to manufacture PVC.

- Emulsion polymerization produces finer resin grades having much smaller particles, which are required by certain applications. This type of resin is sometimes called ‘paste’ PVC and referred to within the industry using the abbreviation P-PVC to distinguish it from S-PVC.
- Suspension process accounts for about 90% of the global production

PVC Manufacture – RM to PVC



K Value of PVC

Low Molecular Weight	K Value	45 t0 50
Medium Molecular Weight	K Value	60 to 65
High Molecular Weight	K Value	> 70

K Value is an indicator of molecular weight : K-57 is medium for injection molding,K-67 is medium-high for rigid extrusion, K-70 is higher for plasticized extrusion or calendering.

Particle Size &Morphology

Particle Morphology plays an important role in processing and performance of products. The particles are tuned finer or coarser according to the applications.

- pipe grade, suspension grade, has the coarsest particle size, since pipe is processed from dry blend. The particles are tuned finer or coarser according to the applications.
- The emulsion grades designed for spread coating have the most narrow particle size (4 micron)
- Clear rigid PVC products like film or bottle have finer particle size range to achieve excellent dispersion of additives and attain clarity.

Particle Size &Morphology

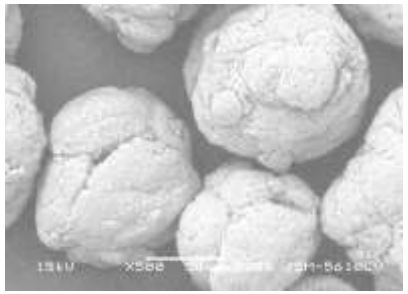
Important Properties are

- Bulk Density: plasticized applications have bulk density on a lower side (less than 0.53) while grades for pipes have bulk density on a higher side (> 0.56).

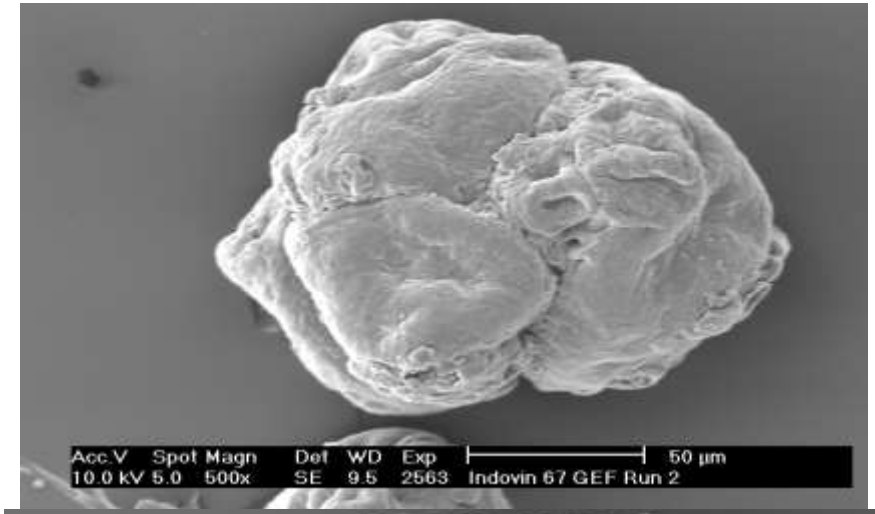
- Porosity: uniform porosity is a prime requirement of all plasticized applications

Particle Size &Morphology

- Particle Size: instance clear rigid PVC products like film or bottle have finer particle size range to achieve excellent dispersion of additives and attain clarity
- Particle Morphology: grade polymer has solid spherical particles with in a narrow particle range. Addition of plasticizers to such polymer results into a formation of paste.



Particle Morphology



PVC Resin to Products

- Various additives including stabilisers and plasticisers need to be added to PVC resin to create a ‘compound’ that meets the requirement of the end product and of the processing technology to be used.
- Compounding may be carried out by the converters themselves or by separate ‘compounders’ who supply ready-made blends ready for processing.
- The PVC compound is then ‘converted’ by processes such as extrusion, moulding and calendaring

PVC Additives

- Without additives PVC would not be a particularly useful substance.
- Wide range of additives are used to soften it, color it, make it more processable or longer lasting, results in a broad range of potential applications.
- PVC products can be rigid or flexible, opaque or transparent, colored and insulating or conducting.

- There is not just one PVC but a whole family of products tailor-made to suit the needs of each application.

Plasticisers

- A plasticiser is a substance which when added to a material, usually a plastic, makes it flexible, resilient and easier to handle.
- PVC is basically rigid at normal temperature.
- When plasticizers are added to PVC at this stage, the plasticiser molecules make their way between the PVC molecules and prevent the PVC polymer molecules from coming closer with each other.
- The polymer molecules are kept apart even at normal temperature and softness is maintained. This is the role of plasticisers and such process is technically called plasticising

Plasticizers

- diisononyl phthalate (DINP),
- diisodecyl phthalate (DIDP) and
- di-2-ethylhexyl phthalate (DEHP, sometimes also referred to as DOP),which have the well balanced properties described above. These plasticizers account for about 75% of all plasticisers used for PVC.
- Apart from phthalates, several other kinds of plasticisers are used to meet specific requirements, including adipates for low temperature resistance and trimellitates for heat resistance.

Stabilisers

- When PVC is heated to 170~180°C, chlorine and hydrogen in the molecules are eliminated and release of hydrogen chloride becomes evident. Once such decomposition starts, unstable structures are formed in the molecule, which further accelerate HCl elimination and decomposition. As PVC is heated to soften during the extrusion or moulding process, prevention of hydrogen chloride elimination due to heat and subsequent decomposition is required. The stabiliser prevents such initial elimination of hydrogen chloride from PVC.

Stabilisers

Use of stabilisers (metal compounds) is essential to prevent the chain reaction of decomposition. They can also impart to the PVC enhanced resistance to daylight, weathering and heat ageing and have an important influence on the physical properties and the cost of a formulation.

Stabilisers

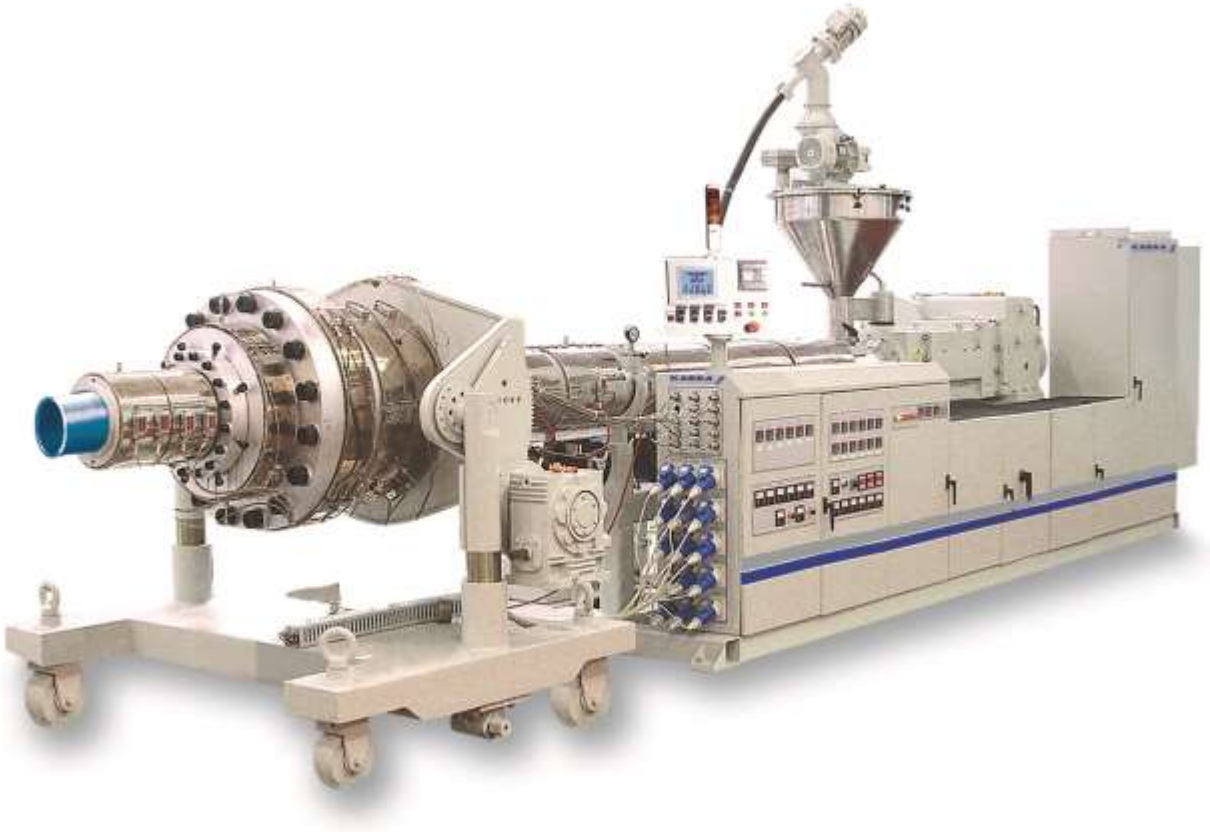
- The major metals contained in stabilisers are lead (Pb), barium (Ba), calcium (Ca), and tin (Sn).
- The stabilisers are classified into Pb stabilisers, Ba-Zn stabilisers, Ca-Zn stabilisers, and Sn stabilisers.
- Ba-Zn stabilisers and Ca-Zn stabilisers are used as metallic soaps such as stearates.
- Sn stabilisers are used as organic tin (dialkyl tin compounds). Other than metallic soap,
- Pb stabilisers are used as basic sulphate, basic carbonate, or basic phosphate.
- Pb based systems are being voluntarily phased out within Europe

PVC-Additives

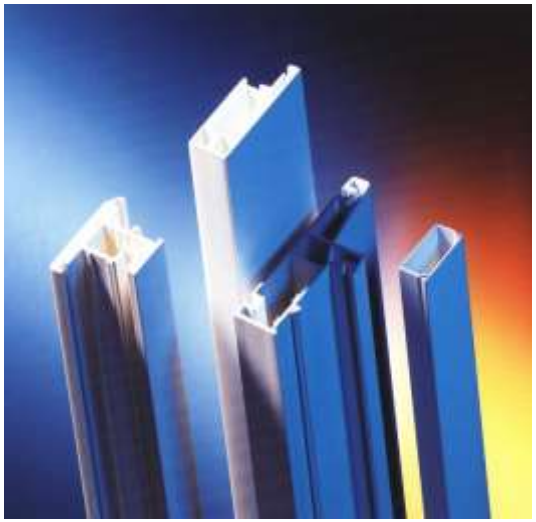
PVC Compound for various end products would contain

- Plasticizers
- Stabilizers
- Impact Modifers
- Fillers
- Pigments for coloring, etc.

Processing - Pipes



Processing - PVC Profiles



PVC Compounds

Major Applications

PVC for Health

The two main application areas for medically approved PVC compounds are flexible containers and tubing: containers used for blood and blood components for urine

PVC : A Unique Polymer

- The environmental issues have caused concerns on growth of PVC over the last three decades. The scientists and researchers involved in PVC always have come up to resolve these problems regularly.
- PVC is the world's most thoroughly researched thermoplastic in terms of HSE and LCA.
- Defying predictions of experts on maturation of PVC industry and products in the life-cycle, PVC is expected to show strong demand, not only in traditional sectors but also offers challenges in creating innovative products

Innovative Products-PVC Wood

Market Outlook for PVC is Bright !

- Material of choice in infrastructure
- Market continues to attract entrepreneurs
- Machinery building sector well established
- Opens up opportunity for innovation
- PVC –Wood Composites is an innovative business option
- Additives available for established products as well as facilitate innovation in PVC products.

Future is Bright for PVC

Thank You