EXECUTIVE SUMMARY

1. Basic Structure of PVC

Poly Vinyl Chloride (PVC) is the most versatile thermoplastic forming on one extreme, highly rigid products such as pipes and profiles and on the other, highly flexible products such as soft leather cloth & flexible footwear. The basic structure of this polymer is $(C_2H_3Cl)n$. The degree of polymerization varies from 300 to 1500. The chlorine content in PVC is about 57% by weight which makes it less dependent on hydrocarbon content.

2. Review of Process Technology

There are four polymerization routes for the manufacture of PVC. They are as follows :

Process Route	% of World Production
a. Suspension Polymerization	80
b. Emulsion Polymerization	10
c. Bulk or Mass Polymerization	8-10
d. Solution Polymerization	0-2

It can be seen from above that suspension polymerization is the most prevalent technology in the world today. The leading licensors for this technology are B.P. Goodrich, European Vinyls Corporation & Hoechst/ Uhde. In this process Vinyl Chloride Monomer (VCM) droplets are dispersed in water medium aided with suspending agents and agitation in the polymerizers. Polymerization of VCM to PVC takes place in this medium initiated by peroxide catalyst. Multiple batch polymerizers discharge into a continuous polymer separation and finishing line. The polymer slurry from the polymerizers is first separated from unconverted VCM by degassing and steam stripping. Water is separated from the polymer by means of centrifuging followed by drying.

PVC produced through the Emulsion polymerization process is mainly used as latex or paste in speciality applications. In Europe manufacture of PVC started with the emulsion process. The process is similar to the suspension process except that large amounts of emulsifying agents are used which result in very fine PVC particles. Consequently separation of these fine PVC particles from water cannot be done by centrifuging action. Hence this technology employs spray dryers to seperate water from the fine PVC particles.

The Bulk or mass polymerization, the latest of the four technologies, is carried out under anhydrous conditions without the water and dispersion medium. This eliminates centrifugation and drying steps of suspension polymerization. The licensor for this process is Autochem of France.

3. Product Applications of PVC

PVC products are generally classified in the industry in terms of K-value. Higher the K-value, higher is the molecular weight. A low molecular weight PVC with a K-value of 57 finds main application in rigid films and sheets, blow moulded bottles and other injection moulded articles. PVC if used in food applications, should have a residual VCM content of less than 1 ppm.

Higher molecular weight PVC with a K-value of 66-67 finds major application in extrusion of pipes and profiles. This constitutes one of the major PVC consumption. PVC with a still higher K-value of 70-72 along with higher poresity finds typical applications in wires & cables and other flexible applications such as shoe lasts, flexible films etc.

Emulsion PVC is used in form of plastisols or latex typically for PVC coatings, multilayer films, battery separators and such speciality applications.

4. Indian Industry Status

PVC industry in India is more than 30 years old. The first production plant of 6.0 KTPA capacity was commissioned in 1961 by M/s. Calico (Presently ILAC). In India, PVC production is having a strong background of chloroalkali plants, which are essentially promoted by producers of textiles, paper and soda ash for want of sodium hydroxide in their process. Earlier PVC was produced from calcium deposits through the acetylene route. However this route proved to be highly utility intensive and hence uneconomical. Much later companies like NOCIL and IPCL put up PVC plants using the alternate ethylene route available from naphtha cracker. Till date there are five PVC manufacturers having an installed capacity of 175 KTPA with a capacity utilization of around 77%. With total consumption of PVC being around 250 KTPA more than 100 KTPA is being currently imported. The committee for Perspective Planning of Petrochemicals Industry estimates PVC demand to be around 500 KTPA by 1995 and over 700 KTPA by 2000 AD. Currently Reliance Petrochemicals has set up a PVC plant with installed capacity of 100 KTPA which is expected to be commissioned by year 1991-92.

It may be highlighted that the size of all PVC plants are very small compared to international standards. Government of India have recommended a capacity of 100, KTPA as minimum economic size for PVC plants. In India

IPCL has the largest PVC plant which has a capacity of 55 KTPA which is much lower than minimum economic capacity. Further, IPCL and Shriram Chemicals have the latest available technology. However companies like NOCIL & DCW have reportedly upgraded their plants incorporating some of the latest technology features.

5. International Industry Status

The present installed capacity of PVC in the world is 18 million TPA. Present capacity utilization is believed to be between 75-80%. Projected world demand/consumption of PVC is expected to be 21 million TPA by 1995 and 27 million TPA by 2000 AD. Recent consumption and growth rates of PVC in major world markets show a current growth rate of only 1-2% in Japan and Western Europe as a result of continuing pressure on PVC consumption from alternative material. However current growth rate in the US markets show an impressive 10-11%. This is largely due to higher sustained demands for PVC in pipe extrusion.

6. Latest Development & Future Scenario

The discovery in 1973 that exposure to VCM resulted in increased incidence of a form of liver cancer led to fundamental changes in PVC industry.

This has led to major technological improvements such as larger & closed reactor technology, improved steam stripping process, use of computer control and VCM vent emmision control. All of these technological improvements have led to a highly safe environment and higher productivity. Further the Government of India has recommended a Minimum Economic Size of a PVC plant having a capacity of 100 KPTA. Hence, all future PVC plants to be set up in India are likely to have a capacity of 100 KTPA or higher incorporating all the above mentioned latest technology features.

7. Technology Absorption & Gaps

In India expertise is available in the fields of process engineering, detailed engineering, procurement, construction, plant operation, management and product applications. Technology is said to be absorbed totally when capabilities are also developed in the areas of catalysis, process chemistry, reaction engineering, process design, and product grade development.

Research and development have been going on in the country and individual organisations have been successful in development of new product grades & upgrading their technology indigenously. To achieve self-sufficiency in PVC

technology, an orchestrated approach involving industry, research organisations and the academic institutions, has to be evolved. The lead should come from the operating companies.

8. Recommendations

i. Any new PVC unit can use updated technology incorporating all the modern features like large reactor, clean reactor technology, slurry stripping, waste water stripping, vent gas stripping and others. VCM containment and monitroing is essential.

ii. Residual VCM in PVC product should be less than 1 ppm in technology selected for new units.

iii. Existing units may be persuaded to upgrade their technologies. Some of the features like slurry stripping, waste water and vent gas stripping etc., can be incorporated without much modifications. Even clean reactor technology may be possible to be incorporated in most of the cases.

iv. Appropriate authority may bring out statutory regulations in respect of VCM exposure and emissions in line with OSHA (Occupational Safety and Health Administration, USA refer Annexure VII for specifications) and EPA (Environmental Protection Agency, USA). These regulations are in force in USA and in many developed countries since late seventies.

v. PVC with residual VCM content of more than 1 ppm should not be allowed for food grade applications. To ensure this, relevant industries/ laboratories should be equipped with instruments to ensure 1 ppm VCM in polymer.

vi. Development of PVC technology be taken up on a consortium basis involving various manufacturing organisations, engineering companies and the research institutions. One of the major producing companies participating in the programme should be identified as a leader.

vii. Imports of intermediates such as EDC (Ethylene Dichloride) be allowed as feed stock for PVC manufacture. Plants based on ethylene and chlorine as feed stock may prove to be highly capital intensive with caustic soda (by product of chlorine plant) requiring effective utilisation.

viii. At present most of catalyst and chemicals used for PVC manufacture are imported. With more plants expected to come up the import bill for these catalyst and chemicals may go upto 10 Million US $ by 1995. Efforts may be made to indigenise production of these catalyst and chemicals as, it will result in considerable savings in foreign exchange.