EXECUTIVE SUMMARY

1. Acrylic Fibre is an integral part of the total textile fibre mix which satisfies clothing and other needs of an increasing population. Textile fibre mix consists of cotton, wool, silk, natural and man made fibre. Manmade fibre based on natural polymer - cellulose - was first developed in 1890s and world production reached a peak in 1973 at 3.661 million tonnes. With the introduction of nylon, polyester and acrylics in 1939, market share of cellulosics have come down and in 1988 production was 2.885 million tonnes.

2. Manufacture of rayon, started in India in 1950, synthetic polymer and nylon in 1962, polyester in 1965 and acrylic in 1979. With the introduction of synthetics in the Indian market, the share of man made fibre based on natural polymer has also dropped in tune with the world trend. In 1988 share of cellulosics was 40 per cent and synthetics was 60 per cent. It is estimates that cellulosics consumption in the Indian market will stabilise at 150,000 tonnes per year by the year 2000. The share of acrylic fibre mix is assessed at 1,20,000 tonnes per year by the year 2000.

3. To achieve the targetted demand of acrylic fibre in India, market development thrust should be on large markets. For this purpose, a real "MARKETING" efforts rather than just 'SALES' efforts should be made.

4. Growth of the acrylic fibre market is mainly due to replacement of wool. Due to several inherent characteristics of this fibre, like softness, superior thermal insulation, moth resistance, light-weight, resilience properties and also high resistance to acid and alkalies, the fibre has become popular in the Indian textile market.

5. Acrylic fibres are available as staple and tow, filament products, high bulk, bicomponent fibres and modacrylic and fire resistant fibres in the world market. Continuous product development work is going on to improve product properties like - hot - wet properties, wear comfort, modification of handle, low pilling, antistatic, antisoiling, whiteness and heat stability and abrasion resistance and lustre.

6. The use of acrylic fibre in carbon fibre and other industrial applications in world is negligible. Only 6000 - 7000 tonnes per year of PAN is used for manufacturing carbon fibre in the world and it is a specialized plant. IPCL is in search of a technology for such specialized PAN precursor.

7. Recent production and consumption data world wide shows that acrylic has lost to polyester and production/demand in the developed world has stabilised and growth prospects are low. Major growth area is in the developing world to meet the fibre needs of an increasing population.

8. Indian acrylic fibre consumption was highest at 30506 tonnes in 1988-89. The 1989-90 consumption is estimated at 40000 tonnes. Major application area is knitwear (74.5%), dresses (15.5%), shawls (9%), blankets (0.7%), and drapery & upholstery (0.3%). However, IPCL's estimate is 4-5% for dresses.

9. Acrylic market growth is at the expense of wool. Wool consumption in India is estimated to be 20000 tonnes in 1989-90 and hence there is not much scope for growth of acrylic fibre on this basis. Further, the Indian climate is tropical and subtropical and the potential for consumption of wool and its equivalent products is limited.

10. Polyester and its blends with cotton is the most popular fibre in India as per data given in the Indian textile fibre mix (Table E.3) and it is likely to grow faster. Hence, a considerable development work will have to be done to popularise consumption of acrylic fibres for many new applications.

11. There is a definite need for formulation of national standards, initially on acrylic fibre and yarn, and subsequently on products made out of such yarn.

12. The manufacturing process can be broadly divided in two parts, polymerisation and spinning. Polymerisation includes copolymer composition, catalyst system, polymerisation reaction and monomer recovery. Spinning includes solution/dope preparation, spinning techniques and finishing operations including after treatment, cutting and baling. Acrylic fibre manufacture requires a polymer with specific composition, controlled molecular weight and the dyesites. All acrylic fibres are made from acrylonitrile (90-94%) combined with a comonomer. The comonomers most commonly used are neutral monomers such as methyl acrylate and vinyl acetate and Ionic monomers such as sodium styrene sulphonate or Sodium methallyl sulphonate.

13. Major polymerisation processes are bulk polymerisation. aqueous suspension/dispersion polymerisation. emulsion polymerisation and solution polymerisation. Aqueous suspension and solution polymerisation processes are used by industry. Other processes are used for special applications.

14. Most of the acrylic polymers manufactured for fibre use are made through suspension polymerisation route, which gives high percentage of conversion, better product whiteness, shorter residence time and easy control of polymerisation, but at the same time one has to set up a fairly large complex and costly plant for washing, drying, milling, and dissolving the polymer in a solvent.

15. In solution polymerisation, the reaction is carried out in a homogeneous medium such as dimethyl formamide (DMF), dimethylacetamide (DMAC) or dimethyl sulphoxide (DMSO) and a spinning dope is prepared directly. It has the advantage in terms of reduced energy consumption and operating cost through the elimination of polymer drying and solution preparation units. In this process, it is difficult to achieve high molecular weight polymer.

16. Most important variables in polymerisation are water/monomer ratio, SO_2/persulphate ratio, reaction temp., dwell time, pH of reactor slurry, agitator r.p.m. etc.

17. Continuous stirred tank reactor is the preferred method of polymerisation in the acrylic fibre industry. The reaction contents reach a natural steady state after a start period of 3 to 5 dwell times. Heterogenities in the polymer composition and molecular weight are greatly reduced and reaction control is much more effective.

18. There are two major spinning processes, wet spinning and dry spinning. There is also a hybrid process called dry-jet-wet spinning. Dry spinning is used for nearly 22 per cent of the total world manufacturing capacity today. Post spinning operations like washing, stretching, finish application, drying, crimping, are carried out after spinning of the fibre.Both processes are commercially used depending upon the product mix and product quality required by the market. Melt spinning of acrylic fibres is not yet commercialised because fibres degrade, when heated near their melting point.

19. Acrylonitrile is the basic raw material. Today most of the acrylonitrile is consumed in the acrylic fibre market. ACN is also used in other products like ABS, Acrylates, Nitrile-Butadiene-Rubber, Polyacrylamides, SAN etc. It is perceived that consumption of acrylonitrile for these products will grow faster than that for acrylic fibre. Such users can pay a higher price for ACN than the fibre industry. Hence, market price for ACN is likely to go up. However, IPCL is of the view that this may not push ACN price unless acrylic fibre market picks up.

20. In India, IPCL is the only producer of ACN and has a capacity of 25000 tonnes per annum. This is not sufficient for Indian needs and hence ACN is imported. The installed capacity of acrylic fibre is likely to be 70500 tonnes in 1991, which indicates continued dependence upon imports. It is, therefore, necessary to establish additional ACN manufacturing capacity to meet domestic need.

21. In addition to ACN, the industry requires spinning solvents and finishes and comonomers, some of these are available indigenously but majority of them are imported. Even though these are required in small quantities, it is desirable to develop local manufacturing capacity.

22. Acrylic fibre production started in India in 1979 and there are two manufacturing units operating to-day. These are, M/s. J.K. Synthetics Ltd., Kota and IPCL, Baroda. 1988-89 Production was 24506 tonnes These units are based on imported technology.

23. Present installed capacity and that under installation is 72000 tonnes per annum. This is likely to come on stream by 1991. Additional capacity registered is 99,000 tonnes per year, based on imported technology.

24. Discussions with existing producers has shown that they have achieved the operational efficiency in their plants. They have also indigenised some of the equipments and spares and have acquired process know how of plants under operation; but they have not been able to develop the technology of their own. For their own expansion plans, they have been dependent on imported technology.

25. As regards technology transfer, present producer have capability to transfer process know-how but transfer of technology involves indigeneous development of related engineering know-how for equipment. This involves development of design of equipment, knowledge of material of equipment, development suppliers of equipments, etc. Again, transfer of technology involves certain legal issues like patent rights etc. Thus, producer alone cannot take up technology transfer activity. For this purpose, a centralised engineering organisation may be required to be set up with a specific task of development of technology for synthetic fibre and other related industries. This central engineering organisation has to join hands with the fibre producers and equipment fabrication companies and carryout technology development and technology transfer activity.

26. The technologies imported by the existing manufacturers viz. Ashahi and Monte fibre technology, have proven to be good in the Indian context.

There is a need to improve upon them in terms of reduced energy consumption, automation in process control and development of new products.

27. R&D activities at industry level have resulted into development of certain speciality fibres like gel-dyed acrylic fibres, porous acrylic fibres, optically bright acrylic fibres, super bright acrylic fibre, flame retardant acrylic fibres. These fibres are developed on a laboratory scale on trial basis. They are not yet commercialised. Besides, there are developments of indigenous spin-finish and catalysts for some grade of fibres, waste utilisation and study of process parameters.

28. R&D activities in industry is carried out in laboratory or in the main plant. None of the units are having a pilot plant facility. R&D activities are not yet directed towards development of basic process know-how.

29. Two organisations namely IIT, New Delhi and BTRA, Bombay are active in research work on Acrylic fibre. Research is carried out in the area of study of various process parameters and development of spin-finish. These activities have not resulted into development of basic process know-how or development of new products at commercial level. These institution lack facility of pilot plant.

30. The world production of acrylic fibres increased from 109000 tonnes in 1960 to 2476000 tonnes in 1988. The leading producers and technology suppliers in the world are Du Pont, Ashahi, Japan Exlan, Kanebo Ltd., Mitsubishi Rayon, Toho Rayon, Courtaulds, Bayer. Share of acrylic fibre in the total world production of synthetic fibres (Acrylic Polyester and Polyamide) from 1970 to 1988 shows that it has remained constant between 18 to 20 per cent over this period. Polyamide has lost market share and polyester has gained at the cost of polyamide because of its good blending properties with cotton and good crease properties.

31. The trend shows that this is a mature product and is not likely to grow in the developed world. Hence, new manufacturing plants are unlikely to be established in these areas. However, production of synthetic fibres is increasing in the developing world, Asia, Africa and Oceania, because of increasing population, shortage of natural fibre and better living standards.

32. Major suppliers of Acrylic Fibre technology are Du Pont, Ashahi, Japan Exlan, Snia Viscosa, Monte Fibre, American Cyanide and Countauids.

33. Basic technology has reached a maturity level and hence technology development work in the last decade in acrylic fibre manufacturing

process has been in the following areas :

(a) Increasing polymerisation capacity and spinning speeds.

(b) Simplification and substitution of complicated process steps.

(c) Reducing raw material and energy consumption.

(d) Reduction of waste.

(e) Improving safety and reducing pollution.

(f) Development of new and improved quality products such as Hi-bulk and Pile, Antipeel fibres, Trilobal and Pentalobal fibres, Fire retardant fibres, geldyed fibres etc.

34. In the Indian context, it is necessary to adopt the latest technological developments of increasing plant operational efficiency through better process control and improved design of equipments. For this purpose, technology upgradation of existing plants and import of only the latest technology is necessary.

35. Technology absorption in Industry has been to an extent of achieving operational efficiency and indigenisation of some spares. They have still to depend on import of technology for their expansion, and key equipments.

36. Research institutions have done work in dyeing areas, substitute for processing chemicals, study of process parameters; and other effect on fibre properties etc. Attempt to develope indigenous know-how for polycondensation, spinning and post spinning operations is still to be made.

37. Technology gaps exist in the availability of indigenous technology for basic process, key equipments like reactors, spinning lines, spinneretles, autoclave etc. and spares and know-how for speciality fibres as well as in the field of basic engineering.