EXECUTIVE SUMMARY

POLYTETRA FLUOROETHYLENE (PTFE)

1. PRODUCT INTRODUCTION

Polytetrafluoroethylene is a versatile engineering plastic, possessing an exceptional combination of many useful properties like total inertness to chemicals, resistence to solvents, lowest coefficient of friction for any known solid material, low dielectric constant and dissipation factor and excellent insulation property, wide operating temperature (-270°C to +260°C), non-stick and non-flammability. PTFE has wide scope of applications in industries like chemical, mechanical, electrical and strategic applications.

2. MANUFACTURING PROCESS

PTFE is manufactured from Tetraflouroethylene known as TFE which inturn is prepared by pyrolysis of Chlorodifluoromethane. The TFE should be dry and be of ultra high purity and is obtained by passing through driers, scrubbers and ultimately through refrigerated distillation under pressure. Special attention is drawn for safety of the TFE which is highly explosive.

3. POLYMERISATION

Polymerisation of TFE is carried out under pressure in reactors, the gaseous TFE reacting in an aqueous medium in the presence of peroxide initiators. Two principal methods of polymerisation are :

(i) Suspension polymerisation to give granular powder grades.

(ii) Emulsion Polymerisation to give dispersion grades.

4. SUSPENSION POLYMERISATION

Suspension polymers are produced as fine granular particles in water. They are obtained by polymerising the monomer with initiator in the prime of an alkaline buffer. These are washed, filtered off, dried and processed by different methods according to

their respective grades. The most common methods are homogenisation, light sintering, milling and granulation.

5. EMULSION POLYMERISATION

The product of emulsion polymerisation is about 20-30% aqueous dispersion of PTFE with particle size of about 0.1-0.5 μm. Different grades are obtained by subjecting the dispersion polymer to various further processes like coagulating to get fine powders and concentrating to 60% PTFE content by weight for coating applications.

6. FILLER ADDITION

Fillers like glass, carbon (in various forms), metals, metaloxides, and also lubricating materials like molybdenum sulphide are added to both the suspension and emulsion polymers to improve:

(a) Compressive strength;

(b) Thermal conductivity;

(c) Abrasion resistance and

(d) Decrease in thermal expansion.

The filler percentage varies from 5-40% by weight.

7. PROCESSING TECHNIQUES

PTFE cannot be processed by the normal techniques like the other engineering plastics i.e., by extrusion injection moulding, because of its high melt viscosity and resistance to flow. However it can be processed by the normally adopted process in ceramics and powdered metals in metallurgy.

8. SUSPENSION POLYMERS

Suspension polymers are processed by the following method:

— Compaction of the powder in a suitable mould to give a preform called Green Form.

— Heating of the compact/preform in an oven above its crystalline melting point (327°C) to effect fusion of the particles called Sintering.

— Cooling in a controlled manner to give moulded articles.

Various techniques adopted for processing granular powders are:

— Compression Moulding for simple shapes.

— Isostatic Moulding for complex shapes.

— Ram Extrusion for continous rods.

9. EMULSION POLYMERS

Fine powders of this grade are processed by:

— Mixing with a low boiling lubricant into a paste

— Extrusion of the paste through a narrow slit die into tapes and cords under pressure.

The aqueous dispersions are processed by:

— Coating on pre-surface treated metallic or other substrates and sintering

— Impregnation on to a glass and asbestos cloth.

10. STRUCTURE OF INDUSTRY (INTERNATIONAL)

Internationally PTFE is manufactured by the following with trade names as:

DuPont (USA)	-	Teflon
ICI (UK)	-	Fluon
Hoechst AG (FRG)	-	Hostaflon
Daikin (Japan)	-	Polyflon
Montefluous (Italy)	-	Algoflon
Allied Chemical	-	Halon
Hindustan Fluoro Carbons Ltd. (India)	-	Hiflon

The technologies of these manufacturers are almost same except for minor modifications. Around 50-60 grades are manufactured by them.

11. DEMAND

The total world demand is reported to be around 34,000 TPA with a growth rate of 6% p.a. The major share of the market is reported to be met by Du Pont, ICI, Hoechst and Daikin.

12. STRUCTURE OF INDUSTRY (NATIONAL)

Consumption/Demand

Though PTFE was invented in 1933, it entered the Indian market in the late fifties. The demand was around 25 TPA with only a few processors in and around Gujarat. In sixties it picked up and raised to around 150 TPA. Then in seventies it increased to 200 TPA with many processors coming up in Bombay, Gujarat and Delhi. The present demand is around 250-300 TPA and projected is around 800 TPA by 2000 A.D.

Manufacturer - Hindustan Fluoro Carbons Ltd.

Having identified the increasing demand of PTFE, a public sector unit, Hindustan Fluoro Carbon Ltd. HFL promoted by Hindustan Organic Chemicals and Andhra Pradesh Industrial Development Corporation was set up to manufacture PTFE at Rudraram in Medak Distt. of Andhra Pradesh, with technical collaboration from Atochem of France.

The installed capacity of the plant is 500 TPA. The product is marketed in 11 grades (though other 6 are reported to have been developed) consisting of suspension emulsion, aqueous dispersions and filled grades, under the trade name HIFLON.

Processors

The processors of PTFE come under three major categories. They are:

(a) moulding sector;

(b) wire and cables sector; and

(c) coating sector.

Moulding sector is the major consumer of the PTFE. Major processors of this sector are situated in Gujrat, Bombay and a few in Delhi. The process used is compression moulding and sintering. The equipment is indigenous.

The wire and cable sector is also situated in Gujrat, Delhi and Bombay. This sector is able to make PTFE insulated wire, of international standards with indigenous equipment. The process adopted is wrapping of unsintered tape on to a conductor and subsequent sintering and this sector consumes only 20 odd tons of PTFE.

The coating sector is scattered all over the country. The process adopted is surface treatment by sand blasting or etching, coating with PTFE dispersion and sintering. The equipment used is indigenous.

13. LATEST TECHNOLOGY

The latest technologies available world wide are isostatic moulding and automatic molding in the moulding sector, extrusion in the wire and cable sector and electrostatic spray coating in the coating sector.

14. TECHNOLOGY GAPS

Though there is a gap in the technologies of PTFE processing, the processors seem to contend themseleves with the existing technologies due to lack of demand for the same.

15. EXPORTS

Export by the sole manufacturer of PTFE, HFL was nil in the initial phase of the plant. However negotiations are reported to be on with Du Pont and other agencies for export to South Asia. Recently they have exported a sufficient quantity to Canada.

On the other hand, exports by PTFE processors are meagre with the exception of cable industry. This is due to high initial cost of the raw material compared to international market and lack of incentives.

16. FUTURE COURSE OF ACTION/SUGGESTIONS

Though the manufacturer of PTFE does not have much problem except marketing its product against the stiff competition from the international companies, the processors have the following common suggestions.

- The indigenous raw material needs improvement especially present filled grades required for the moulding sector do not give the results as they are expected to. While the trend world wide is to reduce the pressures, sintering time and temperature, HIFLON is making the processors to work in opposite direction. This involves more energy consumption and less output thus further reducing the profitability and competitiveness in international/national market.
- Shelf life of the indigenous aqueous dispersion grade used by the coating sector needs to be improved. Moreover the dispersion should be supplied with the pigments and other additives which can withstand the sintering temperature of PTFE. This will relieve the processors from importing the same.
- The customer services need improvement.
- The sole manufacturer of PTFE ought to bring confidence in the Indian processors by supplying the raw material of quality, hearing to their problems and attending to the same. Market has to be developed/improved for PTFE by convincing the processors with live demonstrations and visiting them, conducting training/coaching, technical lectures/seminars etc. The application development centre should gear up its activities and help processors for new product development.

POLYVINYLIDENE FLUORIDE

17. PRODUCT INTRODUCTION

Polyvinylidene Fluoride (PVDF), the homopolymer of 1,1,- difluoroethene is a tough engineering thermoplastic that offers a unique balance of properties like excellent chemical resistance, good mechanical properties, excellent resistance to abrasion and low friction co-efficient, high temperature use and excellent thermal stability, outstanding ageing resistance, UV and gama

radiation stability and very high dielectric and piezoelectric constant.

18. USES

PVDF is widely used in equipments for chemical, petrochemical, hydrometallurgical, pharmaceutical, food and nuclear industries as well as in paper and pulp industries, as components in electrical and electronic industries, as thin films for building and automobile industries, as coatings and also as solar energy panels.

19. MANUFACTURING PROCESS

Monomer

PVDF is a homopolymer of vinylidene fluoride which is obtained by any one of the following methods:

(i) Dehydrohalogenation of 1-chloro-1,1,-difluoroethane or 1-bromo- 1,1,-difluoroethane or 1,1,1,-trifluoroethane.

(ii) Dehalogenation of 1,2- dichloro-1,1,-difluoroethane.

(iii) Pyrolysis of trifluoromethane in presence of catalyst or with either methane or ethylene.

(iv) Pyrolysis of dichlorodifluoro methane with either methane or methylchloride.

(v) Electro-reduction of 1,1,-difluoro-1,2-dibromo ethane.

(vi) Cracking 1,1,2,2 - tetrafluorobutane or 1,1,2- trifluoro-2 (trifluoromethyl) cyclobutane followed by dimerisation.

20. POLYMERISATION

Vinylidene fluoride can be polymerised by free radical, emulsion and suspension techniques under pressure. In free radical polymerisation technique the free radical initiators are benzoyl peroxide, ammoniumpersulphate or sodium bisulphate. The recommended pressure is above 300 atmospheres at temperature of 200-250°C. However, suspension and emulsion polymerisations are reported to have been done at low pressures.

In emulsion polymerisation, a chemically stable fluorinating agent must be employed. Buffers may be used. Though inorganic peroxy compounds such as persulphates and organic peroxides may be used as polymerisation initiators, organic percarbonate compounds were found to be useful for vinylidene fluoride polymerisation.

Vinylidene polymerisation in suspension is carried out by using an aqueous recipe with and without colloidal dispersants. Organic percarbonates and peroxy compounds are used as initiators.

21. PROCESSING

PVDF can be processed by the normal melt processing techniques like:

a) Extrusion.
b) Injection Moulding.
c) Compression Moulding.
d) Transfer Moulding.
e) Reciprocating Screw Injection Moulding.
f) Welding.
g) Heat Forming.
h) Powder Coating.

Though it is of corrosive nature, the normal equipment can be used. However, Hastelloy C, Duranickel or X-Alloy 306 are used by some processors.

22. STRUCTURE OF INDUSTRY (INTERNATIONAL)

The major producers of PVDF in the world, with their trade names are.

M/s. Pennwalt Corporation U.S.A.	Kynar
M/s. Solvay, Brussels	Solef
M/s. Huls Troisdorf A.G. W. Germany	Dyflor
M/s. Kureha Chemical Co. Ltd., Japan	KF
M/s. Produits Chemique Ugine Kuhlmann, France	Foraflon
M/s. Suddeutsche Kalkstickstoff Werke, W. Germany	Vidar

The process of their manufacturing, the production capacity and other details like world demand are not available.

23. STRUCTURE OF INDUSTRY (NATIONAL)

PVDF has entered India as finished components like pipes, pipe fittings, valves etc. for the Chloralkali industries where it is best suited for nascent Chlorine. Moreover, PVDF pipes are rigid, do not need any support and can be welded without much problem to any length.

24. PROCESSORS

In processing of PVDF around 13 processors namely five in the moulding sector, eight in the wire and cable sector have come up in the country who are importing the basic resin and processing with indigenous equipment.

25. IMPORT

The basic resin imported into India is reported to be around 5 tons with a duty of 225% costing around 50 lakhs and finished components are about 3.5 tons costing around 74 lakhs at a duty of 150%. As the existing Chloralkali industries are intended for expansion, the demand may go up still further. Also, the PVDF can be used in pesticides, paper and pulp, and electronic industry for high purity media, in the TV industry and others.

26. DEMAND PROJECTION AND SUGGESTIONS

The market has picked up for PVDF as entrepreneurs as well as the users are becoming aware of this product because of its easy processability and its wide range of applications.

Expecting that all the existing Chloralkali industries changing their pipe lining and fittings etc., the demand is expected to be 50 TPA. Besides some more processors might enter the market and the final targeted demand may be around 100 TPA. As more and more Chloralkali plants are coming up or the existing ones expanding up the situation will improve and the PVDF consumption will rise. So, there is a need to prepare for the same in about 5 years time. This may involve R & D in developing better techniques of processing and development of process for indigenous production.