Plastic Films For Packaging

Technology, Applications and Process Economics

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CALVIN J. BENNING

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The Author

Calvin J. Benning received his Ph.D. from Ohio State University and has attended courses for Senior Managers at Dartmouth and the IRI Research Managers Course at Harvard. He was part of the team that synthesized the first polycarbonate liquid prepolymers and produced the first one shot polyurethane foam process in the U.S.

Eleven years at W.R. Grace were devoted to Polymer Applications where he supervised the development of: a new class of shrink films, plastic foams, porous membranes, rigid containers and specialties. As Director of Wood Products and Industrial Packaging at International Paper, he continued to expand his expertise in the new product area where he managed groups that developed 'rigid-when-wet' corrugated containers, resins and adhesives for wood products, and special polymers. He is the recipient of the first International Award in PLASTIC FOAM for his 2-volume treatise in 1973. He has approximately 46 U.S. patents and publications. Dr. Benning founded and was the first chairman of the Gordon Research Conf. dealing with Plastic Foams. He is on the Board of Trustees of the Plastic Institute of America and has given courses and lectured for the ACS, PIA and several colleges. Dr. Benning is currently, as of 1979, Chief Environmental Officer of Essex Chem Corp.

Introduction and Overview

The data contained in this treatise have been derived from many sources. Originally this work started as a shrink film study. Later it was expanded to include an indepth comparison of "shrink vs. stretch" (a techno-economic comparison) and a technological look at plastic laminated film structures in packaging. This final update includes a look at major packaging films and the impact of changing technologies upon monomer supply, resin cost and supply, and plastic film markets in packaging.

Several key points bear particular emphasis at this time. These are: (1) the emerging technology of linear low density polyethylene and how this new resin and the versatile, low cost processes for polymerization (relative to LDPE) will affect market trends, (2) the effect of decreasing demand for vinyl chloride and styrene monomers on the ethylene monomer glut (this includes the decreasing importance of PVC as a food packaging film), and (3) the persistent problem of operating capacity of petrochemical plants over supply and new production capacity.

All of the data in this manuscript comes from the various sources listed in the many different literature references in Chapter 13. To give exact credit to each and every author is almost impossible since many references present similar information. Although the conclusions and remarks are the authors, similar conclusions in some cases have been voiced by others and credit is shared with them.

There are two main objectives in this effort: first, to define the impact that new technology in polymer science and raw material supply patterns will have during this decade on market size, share of market, and the economics of flexible packaging films. Second, to define and explain the science and technology involved during the transitions between monomer, polymer, packaging film, and application.

The first section describes market trends and uncertainties. The second and third sections describe the theories and technology of two major areas: shrink and stretch films. This is followed by a description and analysis of individual polymeric systems as each pertains to packaging films, oriented film products, and laminated and coated structures. Polymer structure, as it directly influences application, is discussed in each resin section. Section six examines film laminates and, as noted, these laminates have some very interesting new thrusts based on specific properties, tailor-made to the application.

Contents

Chapter 1

Economics, Markets and Supply Trends of Plastic Packaging Films

Market Trends – The market thrusts of the various polymeric films can be described from the viewpoint of the resin properties, cost, and availability, in other words, its competitive position in the market place. Predicting market thrust (or penetration) is complex, especially when one considers the impact of outside forces such as:

a) The emerging expertise that allows one to make LDPE, HDPE, PP, and LLDPE (with approximately 10% of the cost of a new facility) at the same facility (i.e. dual purpose reactors etc.).
b) The high cost of energy and labor in assembling pallet loads and bundles for shipping.
c) Environmental constraints on vinyl chloride and PVC manufacturing facilities; (i.e. air and hazardous waste controls) and plasticizers like DEHP.
d) The emergence of new petrochemical and polymer facilities in Alaska, Canada, Mexico, and the Near East (all near natural gas or oil sources).

Four film areas should continue to maintain steady growth. LDPE which includes LDPE and LLDPE (approximately 4% year); high density polyethylene (HDPE) (9-10% year); polypropylene (6-7% year); and polyester (7-8% year). PVC packaging film and cellophane will continue to lose position in food packaging. (Figure 1 and Figure 2). Most of the growth in PVC films is expected to be in non-food packaging and non-packaging areas.

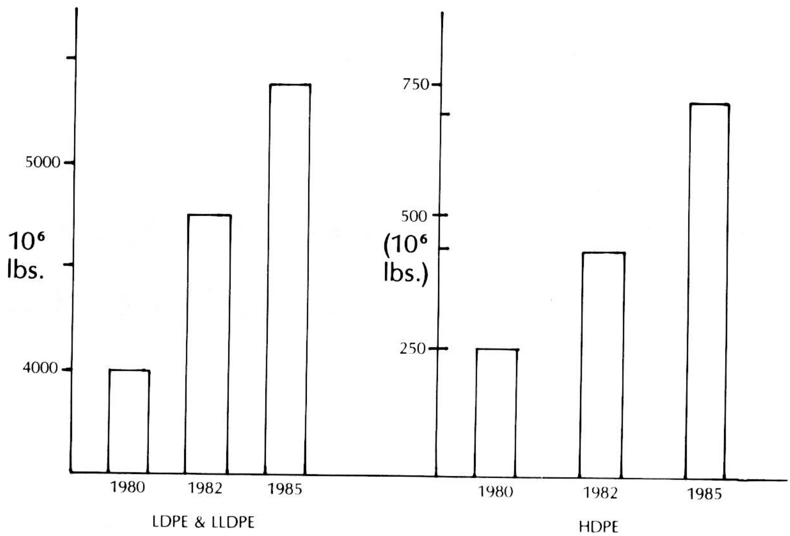

Figure 1. LDPE, LLDPE & HDPE market demand (million lbs) for film and sheet. (Source: Dow Chem & Plastics World (Nov. 1981, p. 13)).

The advent of LLDPE will make up the bulk of the growth in polyethylene films used in packaging. This intrusion will take place where clarity is not an essential property and where abuse resistance is a key – namely in material handling and bags. Some experts believe LLDPE will capture the grocery sack market and replace Kraft paper. If any system accomplishes the goal, it will probably also involve HDPE or blends of HDPE because of HDPE's rigidity and lower elongation.

Polypropylene could be in short supply in 1984 just prior to new capacity "coming on stream." PP's sustained growth in the overwrap market and in the baked goods market is predicted due to the lower "applied" cost of OPP and the growth of OPP as a laminate

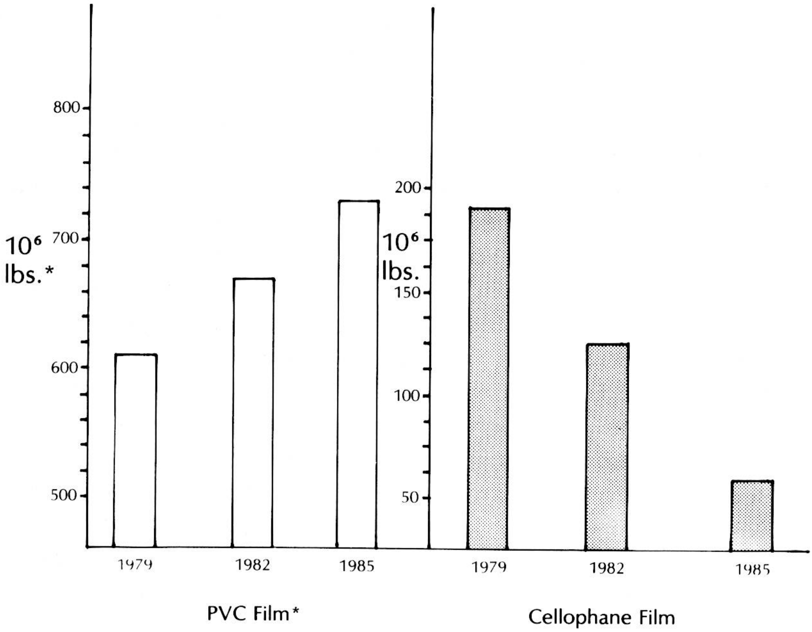

Figure 2. Film Market Projections. (Ref. Plastics World Dec. 1981).
**When comparing PVC film markets and growth (based on lbs.) one should use data that allows for differences in yield – i.e. m²/kg. Most of the growth in PVC film is in non food packaging areas.*

base, specifically as a lower cost competitor to oriented polyester, nylon and cellophane. Cellophane is expected to lose most of its market position as an overwrap.

High density polyethylene can be expected to continue to replace glassine in the "bag-in-box" application (dry mixes, crackers, cereal, etc.) and merchant type bags (and grocery sacks as noted before).

Polyester film (together with OPP, HDPE, and oriented nylon) will continue its market growth in the laminated, structured and specialty films area.

MONOMER (SUPPLY)

Basic petrochemicals will be in oversupply for some time. Between 1980 and 1982 relatively little growth is seen due to a significant increase in plant capacity and raw material costs. This means low profit margins. These problems will continue because of the planned decontrol of natural gas, which will provide additional costs to U.S. producers and increased foreign competition. Therefore, poor profitability, excess capacity, and increasing feed stock costs will persist.

Perhaps the best word to describe the situation is "chaos" because, in addition to these problems, one can expect a flood of petrochemical derivatives between 1985 and 1987 from outside the U.S. New imports will come from large, ultra modern, automated, and efficient facilities constructed close to the gas fields or well heads. The only positive note is that these new plants are expensive and are using expensive capital; however, raw material costs in Mexico, Canada and the Middle East are quite low and could offset the high cost of capital. These disruptions come at a time of low growth and undercut market forecasts.

A Chemical and Engineering News article* notes that the total production of ethylene, propylene, benzene, butadiene and p-xylene in 1982 will be 62 billion pounds, the same as 1979.

The feedstocks to watch are ethylene and propylene. In 1979 the industry was almost at capacity but in 1981 the sluggish economy, together with conservation, had reduced production of ethylene to 70% of capacity. Propylene is in a better position. Tighter supplies have helped to maintain prices and in the first half of 1981 resin prices increased 18 to 23% (Figures 3 and 4).

An example is Gulf Oil's activation of its 800×10^6 lb. capacity monomer plant in Cedar Bayou, Texas.

It is difficult to predict where propylene monomer prices will go, except up. Other contributing factors are: a shift to lighter natural gas liquids in the ethylene crackers, instead of heavy naphthas. This means less propylene by-product. In addition, propylene is being used with isobutane, (currently selling for approximately 90-96¢ gal.) to make a low-cost octane booster for gasoline. The decrease in demand for styrene and vinyl chloride monomer also contributes to inventory problems, i.e. a surge in ethylene inventory.

No new source for feedstocks will arise unless coal tar chemicals receive more attention.

Cellulose feedstock will continue to be directed towards making paper or wood products. In addition, emphasis will increase within the forest products industry to make it energy self-sufficient and put the industry in a cogeneration mode. However, the cost of paper products will

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*CHEMICAL & ENGINEERING NEWS – November 1981, p. 11, Bruce Greek and W. Fallwell.

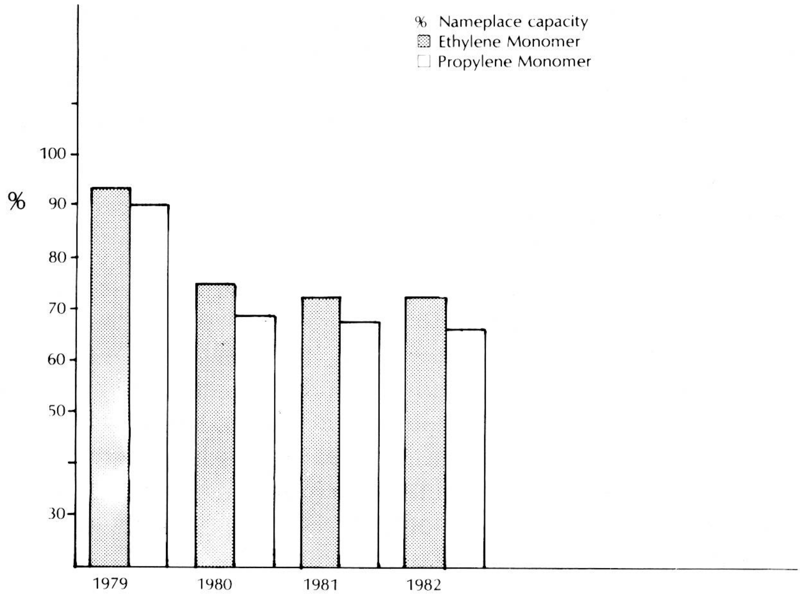

Figure 3. Production as a percent of nameplate capacity for ethylene and propylene monomer. Source C&EN estimates Nov. 30, 1981 and Plastics World.

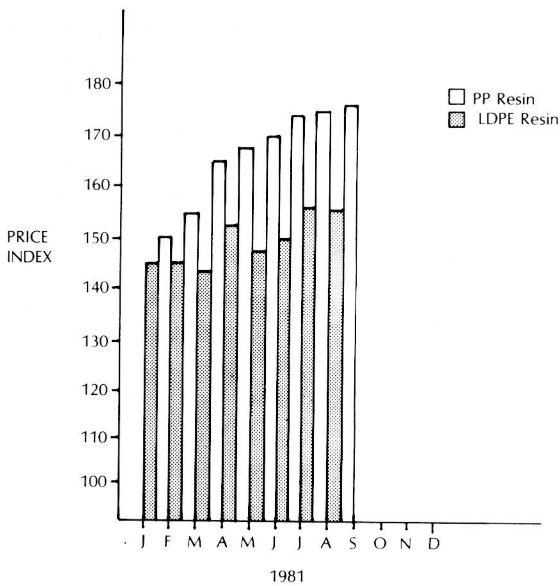

Figure 4. Price Index for PP and LDPE. Dec-75 = 100. Source Plastics World Data