Bruno Arcelli (PLASTIC CONSULT)

LLDPE PRESENT AND FUTURE

INTRODUCTION

Contrary to what might be thought from the very large number of articles appearing in specialist publications over the last 4-5 years, linear polyethylene is something quite other than a recent discovery. For more than 30 years Du Pont Canada have been operating a process for its production and for more than 20 have been exploiting it on an industrial scale.

For some time the use of the materials has been restricted to the speciality field and applied in a relatively limited market.

Only in 1977-78 with the massive entry of Union Carbide and Dow Chemical in the American market has there been a decisive turn that has brought linear polyethylene into the area of mass production and has started a rapid progress in its substitution for the commercial low density polyethylene.

It should be clearly stated that speaking of linear polyethylene implies a considerable generalisation and taking this to its extreme it could be said that "the" linear polyethylene does not exist but rather comprises a series of polyethylenes with linear characteristics. In effect under the generic denomination of linear polyethylene a number of polymers of different structure, density and characteristics (including workability) are grouped together and that are different acording to the type of comonomer used as well as in its content percentage, quite apart from the production process.

One should not be surprised therefore on hearing the expression "I have tried linear polyethylene but have noted that the Dow product behaves in quite a different manner from that of CdF or of Phillips or of any other manufacturer".

Having cleared this point let us examine what developments have taken place in the linear polyethylene market.

THE AMERICAN MARKET

The American market for linear polyethylene has experienced a very rapid development.

This large growth has come essentially through a process of substitution of the conventional low density polyethylene even although there are other factors such as the opening up or the development of new important markets (shoppers, stretch film) and the substitution for other polymers.

Notwithstanding the high degree of penetration already experienced there are no signs of any real slowing down in the growth rate and forecasts indicate that the market for linear polyethylene as a total of that for low density which was 3% in 1979, rising to 28% in 1983, will pass 35% in 1985.

The productive capacity has naturally registered a proportional increase reaching 1.3 million tons in 1983 and over 1.5 million in 1984.

Alongside Union Carbide and Dow who have not relinquished their predominant position reached through a considerable increase in capacity there have arrived a number of companies as well as those who are about to do so, in the race towards linear polyethylene (see table).

It should be noted that a considerable part of the increase in the productive capacity has been obtained not by building new plants but through a conversion of low and/or high pressure lines already in existence, or, as in the case of Union Carbide, by using a new type of catalyst.

The strong advance in the consumption of LLDPE has been made possible by the active participation of the resin producers with regard to the processors to whom they have given their assistance in modifying plants to make them suitable for the working conditions of the new polymers.

A particularly effective action was taken by Union Carbide: from the moment when the extrusion of resin powder brought considerable difficulties in operating the existing production lines, this company offered a "restricted" price package to their customers in modifying their plant as well as giving the assistance by their own technicians in optimising the line yields.

The wide distribution in the use of polymer resin in the United States should be borne in mind, where amongst other things, the structure of the processing industry already generally equipped to receive products in bulk, renders the market more receptive.

Another interesting aspect of the American market is that from the start it has been orientated towards the use of linear polyethylene. It is only later that the mixture form has been adopted essentially for technical reasons to improve the overall performance of the finished product and also because the price of linear polyethylene is substantially allied to the conventional variety.

THE EUROPEAN MARKET

Passing to an examination of the situation in Europe it can be seen that the dimensions of this market for linear polyethylene are uptil now quite modest (the penetration did not exceed 4% in 1982) even though it is the general opinion that it is now on the verge of a take off in consumption. The reasons for the relatively limited introduction of the new polymer uptil the present are to be ascribed to:

- ☐ Insufficient availability. The large overcapacity that exhisted in the low density polyethylene field has induced the European producers to move with a notable caution in programming new plants for linear polyethylene.
- ☐ High prices. In introducing linear polyethylene onto the market the European producers asked a "pre-

PRODUCTION CAPACITY IN USA (1000 TONS-1985)	LDPE	LLDPE
CHEMPLEX	190	—
DOW	390	370
DU PONT	320	—
EASTMAN	275	—
EXXON	220	320
ELPASO	185	—
GULF	390	—
MOBIL	220	190
NORCHEM	200	120
UNION-CARBIDE	190	490
USI	380	50
TOTAL	2.960	1.540

MARKET SHARES IN USA (1983)	000 TONS	% LLDPE
FILM	2.102	29
NON FILM	1.143	22
EXPORT	411	32
TOTAL	3.656	28

EUROPEAN CONSUMPTION (1000 TONS)	1980	1985	1990
LDPE	2800	2800	2300
LLDPE	40	450	800
% LLDPE	1.4	14	26

LLDPE PRODUCTION CAPACITY IN EUROPE (1984)	1000 TONS/YEAR
DOW	140
DSM	50
BP	40
UNIFOS	175
ATO	30
CdF	155

mium" with respect to the conventional polyethylene that varied from 10-20%, according to the products.

- ☐ Excessive diversification in the product offered. The considerable variety of products offered to the market induced a certain amount of confusion with the processors who found themselves working polymers that required different techniques.

Other important differences with regard to the American market are:

- ☐ The scarcity of the product and its high price has meant that initially the use of the new polymer has been as a mixture and the use of linear polyethylene at 100% has been limited to sporadic cases.
- ☐ The European processors have encountered greater problems in adapting their plant to working in linear polyethylene either because of the wide diversity of products on offer (not to speak of the variability of individual products from one sector to another in the case of experimental production) or because of the lack of a comprehensive programme of assistance on the part of the resin producers.
- ☐ The distribution of the product in powder form is very limited, either because of the little inclination of the processors to work with powder or to the difficulty in the homogeneisation of the polymer powder and granules when wanting to use a mixture of linear and conventional types.

The main brake on expansion in comsumption should therefore be removed in a short while.

As far as products on offer are concerned there is now in fact in Europe a multiplication of such initiatives (see table) with CdF, Dow, Unifos who have now been joined by others (DSM, Phillips, BP) meanwhile various other companies, several of which will shortly enter the market (amongst whom the Italian Enichem) are actively interested in this new product.

It should be noted that a large sector of the European capacity comprises plants already in existence, modified to make them suitable for the production of linear polyethylene, which maintain a high degree of flexibility and which will concentrate on one product or another according to the market situation.

When defining the evolution of the supply of linear polyethylene in Europe the fact must be borne in mind that in certain areas and in particular in Canada and in Saudi Arabia a number of important investments have been made that will raise the productive capacity of linear polyethylene much in excess of local needs and that a not inferior amount of the product is destined to find an outlet on the European markets.

As far as Canada is concerned the large complex of Esso, Dow and Novacor will be located alongside that of Du Pont which will bring the LLDPE capacity to above 600 thousand tons and that of low density polyethylene to around a million tons in an area where the total internal market is around 300-350,000 tons.

The large linear polyethylene plants with a total capacity of 600,000 tons have now started production in Saudi Arabia.

If we consider the possibile direction of exports from Canada and above all Saudi Arabia towards Europe, the overall availability of linear polyethylene on the European market could be in the region of 1.2 - 1.3 million tons by 1987-88 with a consequent excess of supply.

In considering the other main restraining factor of price, without wishing to arrive at any forecast, the following points can be taken into consideration:

- ☐ The required investment for a new LLDPE low pressure plant is somewhat lower in the gas phase than one of similar capacity for conventional polyethylene. However the fact must be considered that the installation of new capacity for conventional polyethylene is not being considered and that as a result any confrontation with this materials has little significance. The financial cost of a new linear polyethylene plant should be compared with that of one already existing for high pressure and at least in part written off. The advantages in terms of production costs are nonetheless marginal.
- ☐ The main item of cost is that relative to the base material and therefore the difference in price between ethylene (the only single prime material in the production of conventional polyethylene) and the comonomers used in linear polyethylene is decisive. Butyne which is the comonomer most widely used has a 50% higher price with regard to ethylene and given the normal application usage results in an incidence on the raw material price of about 4%. Such a difference is higher where ottene is used as in the case of Dowlex.

It is logical to deduce that also from the point of view of costs, linear polyethylene should call for a higher price than that of the conventional material.

The amount of the "premium" is however a question of opinion. It is our personal convinction that in view of the forecast wide availability of the product, the tendency will be towards a greater alignment of prices with regard to low density polyethylene so as to offer a major competitiveness for linear polyethylene.

THE ITALIAN MARKET

The overall consumption of linear polyethylene including the medium density type reached 40,000 tons in 1984 with a degree of penetration substantially in line with the European medium.

The result can be considered as satisfactory if the signs appearing of a slowing down in the general consumption in Europe are considered (too low an availability at high prices).

In Italy there are other factors to be considered: the absence of a national production, a large overcapacity situation as well as at the processing industry level, little weight given to the quality factor, difficult appreciation in monetary terms on the part of the end user and consequently the preoccupation of the processor with the containment of costs, the difficulty in having an effective collaboration between machinery manufacturers and processors that is also motivated by an excessive reserve with regard to the problems encountered and the results obtained in the fear that competitors will gain an advantage.

Overall the impression is that the retardant factors are gradually destined to diminish and that the use of linear polyethylene will spread rapidly.

As far as the individual sectors are concerned the following considerations can be made.

Film for heat-shrinking and stretching

In the production of heat shrinkable film linear polyethylene is used exclusively as a mix in the region of 15-25%. A number of manufacturers are already using it regularly and a number of others have carried out a series of tests and seem about to start a regular production. It is probable that within the next few years the use of a mix with linear polyethylene will become general.

As far as stretch film is concerned there is already in Italy a production based on linear polyethylene either by means

of bubble or flat head extrusion and there are a number of companies who are about to start up with one or the other method.
Overall a rapid increase in the use of linear polyethylene in this sector is forecast.

Film for laminating

The demanding quality for this type of production is such that the adaption of existing extrusion lines is rather difficult and it is necessary to use ad hoc plants that can work any type of linear.
There already exist in Italy various processors who extrude linear polyethylene film for laminating either for their own consumption or for sale. Penetration has already reached a significant level and sholud eventually increase in the coming years even at a relatively limited rate due to the complexity of this type of production.

Refuse sacks

Apart from a limited sector of sales to shops, generally distinguished by a good quality level, the market is characterised by a wide use of reground. This makes feasible the use of a linear mix at 5-10% in substitution for the conventional low density virgin polymer in order to improve the characteristics of the finished product and to allow a certain reduction in the thickness.

Shoppers and bags

This is a large market that represents the most important outlet for linear polyethylene mix. There are a number of Italian film producers who have experimented with the new material although in using plant empirically modified far removed from the best conditions.
In most cases the results have been satisfactory even though a number of negative aspects have been revealed (reduction in productivity, increase in energy comsumption, increase in scrap) that have resulted in a considerable attenuation in profitability.
A net tendency towards the greater use of linear polyethylene can be traced that amongst other uses can be employed with high density polyethylene to improve the handle and give a better resistance to tearing of the bag.

CONCLUSION

From what has been said certain conclusions can be reached.
The profound structural differences that exist at all levels (resin producers, processors and end users) make it improbable that in Europe linear polyethylene will run the same course as in the United States, although there may be a temporary variation.
It would not be the first time that the behaviour of two of the main world markets presented a serious divergence: is it enough to think of polyester bottles for gaseous drinks.
Even if in Europe (and in Italy) the substitution process of the conventional low density polyethylene should not have avalanched in the same manner as in the United States, the growth of linear polyethylene will nonetheless be very rapid.
This is a market in which the true development has still to begin and can hold surprises only in a positive sense in terms of a confirmation superior to forecasts.
The Italian processors must be ready in time to take advantage of the opportunity that linear polyethylene offers to avoid finding themselves pushed out of the export markets where a not inferior part of the output of the most experienced companies is to be found.
The working of linear polyethylene calls for a revision of the criteria employed in machine design and in the conversion or adaptation of existing installations.
The gearing up and the renewal of equipment is absolutely necessary and must be faced as soon as possibile, at the same time reconsidering the product mix with regard to the possibilities of the new markets.